

ORAL ABSTRACTS



NZ MARINE SCIENCES SOCIETY CONFERENCE

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WEAVING THE STRANDS



Fisheries New Zealand

Tini a Tangaroa



Biosecurity New Zealand

Ministry for Primary Industries
Manatū Ahu Matua

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Structural changes in intertidal rocky reefs following the 2016 Kaikoura earthquake

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The Kaikoura earthquake caused extensive uplift of the seabed, ranging from 0.5 m to over 6 m, along more than 100 km of coastline. We established a long-term monitoring program to quantify changes in the structure of intertidal communities across 23 sites affected by different degrees of uplift. Data collected within a year of the earthquake (combined with pre-earthquake data when available) showed widespread damage on intertidal reefs. Even in areas with low uplift (0.5 to 1 m), the structure of intertidal systems was significantly altered by the reduced abundance of brown and red algae (including important habitat-forming species) and by the increased domination of ephemeral green algae. However, green algae died off within a year, and experimental tests showed that they had little effect on other species. At all uplifted sites the vegetated area was considerably reduced, with most algal species confined to the low tide mark. Potential for recovery of key habitat-forming species remains unclear, but reproduction assessments on the bull kelps *Durvillaea willana* and *Durvillaea poha* showed that surviving adults were reproductive during winter 2017 independently of the extent of the uplift. This research represents the first comprehensive assessment of the state of intertidal systems following the earthquake and provides an important baseline for management decisions and new research.

Long-term changes in reef fish assemblages in New Zealand's oldest marine reserve

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Marine reserves protect areas of the coast from fishing and are therefore extremely valuable for understanding the ecological effects of fishing. The direct effects of protecting harvested species are well documented, but the indirect or ecosystem-level consequences of protection remain poorly understood and seldom examined. Baseline surveys of the Leigh marine reserve, carried out when it was established in 1977, provide a unique opportunity to examine long-term changes in reef fish assemblages in northeastern New Zealand and investigate how species might respond directly and indirectly to protection. Reef fishes were resurveyed in 2017-2018 using the original visual census methodology, to quantify changes in fish communities and habitat types in the marine reserve.

We found further evidence for previously described ecological responses; including increased size of snapper *Pagrus auratus*, and a shift from urchin barrens to *Ecklonia*-dominated macroalgal stands. We also provide evidence for unexpected changes in the abundance of some non-targeted fish species. Investigating these patterns, we consider the potential influences of larger-scale regional patterns, and the direct and indirect effects of reserve protection itself. Further comparisons of reef fish assemblages will be carried out across multiple marine reserve and fished sites to better elucidate these proposed mechanisms.

Living through the Haze: How changes in light energy budgets determine depth distribution of habitat forming seaweeds

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Accumulating stressors have profound impacts on ecosystem resilience and functioning in coastal ecosystems. Increasing amounts of land-derived suspended sediments in coastal waters caused by coastal modification, land-use intensification and river run-off are a major concern for the health of coastal marine ecosystems because seaweed productivity can be compromised by reduced light availability and changes in spectral quality. In some cases, even small changes may lead to depth and range shifts or, in extreme cases when a stressor exceeds a species' tolerance-limit, local extinctions. The aim of this study is to test the functionality of algal communities occurring in turbid coastal waters and their tolerance limits to light limitation. Here we use photosynthesis-irradiance curves of low and high light adapted brown, canopy forming seaweeds to model their light energy budgets across various turbidity scenarios and identify (depth) distribution thresholds. These models reveal the importance of a range of physiological and life-history strategies that determine the productivity of individual species and the interspecific tolerance to low light. We use integrated productivity over turbidity and depth gradients to develop a conceptual framework for integrating multiple stressors.

ROCKY REEF COMMUNITY ECOLOGY: Is there a Paradigm for the paradigms explaining pattern? Insight from Poor Knights Islands' marine caves.

Prof Christopher Battershill¹

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Paradigms to explain ecological drivers in benthic encrusting reef communities, there are many. Who is right?

A 'natural experiment' was possible at the Poor Knights Islands, where cave, archway and open vertical cliff walls allowed examination encrusting species distribution and patch size dynamics. Patterns in species assemblages and their patch size were evident. Regardless of phyla, patch size appeared to reflect relative position on reef walls, with respect to depth or penetration into the reef wall system. Patch size additionally exhibited consistent changes across phyla with regard to prevailing wave shock, light and current.

Organisms found on these walls would be influenced by different combinations and intensities of physical and biological factors – reflecting a mix of the need to cope with disturbance, competition for space and metabolism. Species assemblage and the relative size of individuals therefore reflects ability/'fitness' to compete for and maintain space. Hence the assemblage present, and the average size of individuals, can be used as an integrator of prevailing environmental conditions.

Of note was the fact that both encrusting species of algae and encrusting invertebrates demonstrated the same trends with regard to patch size pattern as a function of wall position. This suggests that in addition to variable influence of physical versus biological drivers of community structure, there is an overarching constraint on 'individual' patch size.

Near real-time forecasting of contamination risks to shellfish harvests and beaches

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The productivity of aquaculture areas and the water quality of recreational beaches are inherently linked to land-derived contamination entering the coastal marine environment through fluvial discharges. For aquaculture, thresholds for harvesting closures are often based on simple relationships derived from nearby fluvial discharge rates which can be overly conservative and can result in potential loss of revenue. Conversely, beach closures managed by local and regional councils, rely on sampling and subsequent analysis, with associated delays having the potential to put recreational users at risk.

To provide more certainty around aquaculture harvesting and beach notifications, a research program with strong industry relationships is underway through the Sustainable Seas – Valuable Seas research program. The aim of the research is to develop and supply near real-time forecasts of coastal water quality by combining catchment models with a high-resolution coastal hydrodynamic model to forecast contamination risk. Understanding the risk profile for beaches and aquaculture areas will allow better management of these valuable assets, leading to safer recreational use and increased productivity respectively.

While the specific study area is Golden and Tasman Bay, the goal is to develop a system that can be implemented anywhere.

Understanding the spread of non-indigenous species

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While it is recognised that ports and harbours play a crucial role in the movement of freight into, out of and throughout NZ (accounting for 99.6% of exports and 99.5% of imports), these environments represent the frontline in terms of the introduction of non-native invasive marine species, with most arriving via international marine traffic either as biofouling or in ballast water.

The biosecurity within these environments is one of the Ministry for Primary Industries (MPI) four key branches or areas of responsibility, which requires MPI to understand the potential spread of these non-native invasive species. To assist with this, an interactive application (MPI/MetOceanTrack) has been developed that models the potential spread of an organism or contaminant around the coastline of New Zealand. This has been achieved by integrating a particle tracking model that simulates an array of biological responses (die off, life stages, etc.) within both 3D regional and local scale hydrodynamics, represented by a 10-year hindcast. Investigations can be performed over specific periods, including yearly, seasonally or for specific events within the database.

MPI are actively looking to expand MetOceanTrack capabilities by including bespoke high-resolution locations and exploring options for cloud-based processing, with the intent to make the tool available to a wider audience or user-base.

Marine biosecurity, from conception to application

Dr Andrew Bell¹, Katherine Walls¹, Trecia Smith¹

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Protecting New Zealand's marine environment from the impacts of pests and diseases has been of growing importance to New Zealanders. Over the last year, biosecurity protection has taken a significant step forward with the implementation of the International Ballast Water Management Convention and New Zealand's Craft Risk Management Standard for biofouling.

New Zealand now has comprehensive regulations in place to minimise the risks posed by all of the major pathways for invasive pests and diseases, however, no regulatory approach can provide 100% protection. A comprehensive risk approach to biosecurity requires a system that addresses pests and diseases before, at and after introduction. With the implementation of the Biosecurity 2025 Direction Statement a specific marine biosecurity workstream will be initiated.

Working collaboratively, all participants in the marine environment, will be encouraged to identify and, where appropriate, lead initiatives that ensure New Zealand has effective marine biosecurity. An effective biosecurity system will need to be agile enough to deal with the changing natural environment, collaborative enough to ensure all marine activities consider biosecurity implications, and flexible enough to enable full participation.

This presentation will cover both the developing strategic context and the practical implications of making marine biosecurity work.

Use of mangrove habitat by Threatened or At Risk birds in New Zealand

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Few published studies have been carried out on the use of mangroves by Threatened or At Risk birds. Our review relied on chance observations, theses, technical reports, statements of evidence and personal communications. For each species identified, a number of parameters were reported on, including: the degree of dependency, the purpose of use, important characteristics, seasonal use, connectivity and habitat patch size.

Banded rail are well known for their use of mangroves for foraging and roosting as well shelter from predation and as a corridor for dispersal. New Zealand fairy tern, white heron, Australasia bittern, pied shag, north island fernbird, pied oyster catcher, pied stilt, and eastern bar-tailed godwit have also been observed using mangroves, or habitat fringing mangroves, for foraging, roosting and/or as refuge.

Negative effects of mangrove removal are likely to occur as a result of direct loss of foraging and roosting habitat, exposure to predation and human disturbance, loss of habitat connectivity, elevated turbidity, macroalgal blooms and decreased oxygen levels.

Currently there are many gaps in our knowledge and outstanding on this topic. We make a number of recommendations to address the gaps, and to better enable the conservation of Threatened or At Risk birds associated with mangroves into the future.

The habitat use of a resident population of bottlenose dolphin in Doubtful Sound: implications for the design of MPAs

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In Doubtful Sound, New Zealand, a resident population of bottlenose dolphin (*Tursiops truncatus*) is subjected to human impacts via tourism. In an attempt to mitigate this, Dolphin Protection Zones (DPZs) were established (2008) with the aim of reducing boat activity in habitat identified as critical to the dolphins. However, habitat use can change over time, so fixed management areas run the risk of becoming ineffective. Increasing our understanding of what drives dolphin distribution would allow management to adapt, ensuring long-term effectiveness of DPZs. This study utilises distribution data to describe and explain the habitat use of bottlenose dolphin in Doubtful Sound. Kernel Density Estimates (KDEs) were developed using sightings made between 2005 and 2016 (n=412). Preliminary Species Distribution Models were developed from a subset of these data, and a suite of explanatory variables, using Generalised Additive Models (GAMs). KDEs revealed distinct high and low use areas within Doubtful Sound that vary with season, and, high use areas that extend beyond the DPZs. Preliminary GAMs indicated that dolphins may change their foraging strategy between seasons through the inclusion of different predictor variables (depth and distance to the fiord wall). Drivers of these distribution patterns may be the result of direct influences to the dolphins, such as responses to water temperature; or through indirect influences, such as shifts in prey distribution.

Tetrodotoxin concentrations and its micro-distribution in the New Zealand clam *Paphies australis*

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Tetrodotoxin (TTX) is a potent neurotoxin. It has long been known as the causative agent in puffer fish poisoning and was originally thought to only occur in puffer fish. It is now identified in 12 classes of marine and freshwater organisms but its origin remains a mystery. The present study focuses on *Paphies australis*, a TTX-containing clam endemic to New Zealand. To look at the distribution of TTX in *P. australis* across NZ, eight *P. australis* beds from different regions were selected. Fifteen wild specimens were collected per region: five were homogenised whole and ten were dissected with the organs pooled into five groups (siphons, digestive gland, adductor muscles and the 'rest'). These samples were analysed for TTX using liquid chromatography and mass spectrometry (LC-MS). The micro-distribution of TTX was visualised using immunohistochemistry techniques incorporating a TTX-specific monoclonal antibody in section taken from ten toxic wild specimens. The LC-MS analysis revealed that TTX concentrations were different across all populations of *P. australis*, and that the concentrations were highest in the siphons. This result was confirmed by the immunohistochemistry analysis which showed that TTX was localised in the interior cells of the siphons and the digestive track. Improving knowledge on the location of TTX in bivalves will provide new insights into the ecological function and sources of TTX in these organisms.

The impact of increased mud sedimentation in Waiwera Estuary on whole and nitrogen cycling microbial communities.

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Estuaries are dynamic, productive and frequently perturbed ecosystems that are experiencing habitat displacements from increased sedimentation due to anthropogenic activities such as land use changes. To investigate the effects of terrestrial mud inputs on estuarine microbial community structure and impacts on nitrogen-cycling members of the community, we sampled an intertidal mud-sand gradient in the Waiwera estuary. Samples were collected at spatial scales of several centimetres to hundreds of metres apart. We amplified and sequenced 16S rRNA genes, archaeal and bacterial amoA genes for ammonia oxidizers, and nosZ genes for denitrifiers. Results indicate archaeal and bacterial microbial communities, denitrifiers, and nitrifiers grouped strongly based on mud content, suggesting the influence of terrestrial mud inputs on the microbial nitrogen cycle. To test microbial community resilience to pollution-associated factors, we incubated sediments of varying mud contents with a source of carbon (intertidal macroalgae), nitrate, both or nothing under diurnal light conditions for 14 days. Communities retained distinct compositions based on mud content. However, community responses in sandier sediments showed a larger magnitude response, which may be explained by the heterogeneous physicochemical and hydrological properties of sand. Together, these results indicate increased terrestrial mud input influences microbial nitrogen cycling and increases community resilience to disturbances.

The invasive Mediterranean fanworm, *Sabella spallanzanii*, in the context of mussel farms in the Coromandel

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Greenshell mussel aquaculture is the most valuable aquaculture industry in New Zealand. However, biofouling of mussel farms reduces the production of mussels and increases production costs through a requirement for increased cleaning and processing. The recent introduction of the biofouling Mediterranean fanworm *Sabella spallanzanii* to New Zealand has created concerns for mussel farmers operating in the Hauraki Gulf. The fanworm is now well established in many parts of the country, especially around ports and sheltered harbours, where it is capable of establishing on all types of structures, including mussel farms, as well as a range of natural habitats. When established in mussel farms, the fanworm is thought to compete with the cultured mussels for food and space, resulting in reduced growth of the mussels.

The aim of this study is to further look into the settlement and growth behaviour of the Mediterranean fanworm in the context of Greenshell mussel farms in the Coromandel area and learn more about their general biology in New Zealand conditions. Special emphasis of the study is on the reproductive behaviour, seasonality, and potential survival after fragmentation in the context of mussel harvesting.

Latitudinal isotopic variability in suspended particulate organic matter validates Southern Ocean isoscapes and informs megafaunal trophic ecology

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A joint collaborative venture between National Institute of Water and Atmospheric Research (NIWA) and Australian Antarctic Division (AAD) resulted in two voyages to the Antarctic Ross Sea, the first in February/March 2010 and the second in February/March 2015. On both voyages, underway suspended particulate organic material (SPOM) was sampled on latitudinal transects from New Zealand to the Ross Sea shelf and along the shelf edge. The SPOM samples were analysed to generate $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ phytoplankton baseline isotopic values in the areas traversed. Measurements of underway temperature, salinity, chlorophyll a, HPLC, and fluorometry enabled key oceanographic features to be identified and variations in SPOM isotopic values to be interpreted. Whilst a strong gradient in $\delta^{13}\text{C}$ was observed throughout most of the transect (reflecting predicted decreases in $\delta^{13}\text{C}$ with increasing latitude), non-linear temperature- $\delta^{13}\text{C}$ relationships were observed in the sub-Antarctic front, sea-ice melt areas and highly productive areas, such as around the Balleny islands. These data have been used to ground-truth a modelled Southern Ocean carbon and nitrogen isoscape, and have subsequently been used to interpret the trophic status and diet of humpback whales studied around, and to the east of, the Balleny Islands.

Expanding New Zealand's capability of stable isotope analysis for terrestrial, marine and freshwater applications

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NIWA's recent multi-million dollar stable isotope facility upgrade provides water, gas and solid-matrix sample analyses, delivering highly accurate and precise results. The investment included the acquisition of a GasBench II and Thermo Chemical Elemental Analyser (TCEA) linked to Delta V Plus mass spectrometers. The GasBench II is an on-line preparation system, capable of high throughput analysis of carbon, nitrogen, oxygen and hydrogen isotopes in water and gas samples; whilst the TCEA enables us to measure O and H isotopes in organic, inorganic and water samples. Recent in-house methods developments now provide new applications to the isotope research community. The Gasbench II measures: $2\text{H}/\text{H}$ and $18\text{O}/16\text{O}$ in water, with applications relevant to climatic, hydrological, oceanic water mass, ecological and animal movement studies; $18\text{O}/16\text{O}$ and $13\text{C}/12\text{C}$ in carbonates for palaeoceanographic and climate studies; $13\text{C}/12\text{C}$ of dissolved inorganic carbon for carbon flux and palaeoclimate research; and $15\text{N}/14\text{N}$ of N_2 , plus $15\text{N}/14\text{N}$ and $18\text{O}/16\text{O}$ of N_2O for nitrogen cycle studies. The TCEA analyses $2\text{H}/\text{H}$ and $18\text{O}/16\text{O}$ in solid organics, such as plants, soils, feathers, claws, tree-ring cellulose, and chironomid head capsules supporting terrestrial water dynamics, palaeoclimate, climatology, animal migration and ecological research. We will present some examples of these developments and applications.

Feeding on the fringe! The implications of mangrove removal for eagle rays.

Helen Cadwallader¹, Gemma Fernihough¹, Dr Phil Ross¹, Dr Malcolm Francis², Professor Chris Battershill¹

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Mangroves provide important habitat for a number of elasmobranch species. In NZ, the abundance of mangrove forest has steadily expanded over 50+ years leading to widespread mangrove removal with unknown ecological consequences. Following mangrove removal, maintenance of a new forest edge, via removal of seedlings and pneumatophores, is often performed to prevent mangrove recovery. We know that natural mangrove fringe zones exhibit moderate levels of infaunal biodiversity and abundance and may provide a valuable feeding habitat for benthic predators. The ecological value of managed mangrove fringe zones is unknown.

In this study we compared the density of eagle ray (*Myliobatis tenuicaudatus*) feeding pits in a trimmed fringe zone with an adjacent untrimmed edge in order to assess the use of fringe habitat by this common coastal ray and address questions around the degradation of feeding habitat caused by mangrove management. The density of feeding pits in the untrimmed fringe zone was significantly higher than in the trimmed fringe, suggesting that the natural edge is a preferred foraging habitat. Based on these results, we suggest that mangrove fringe maintenance may impact on the feeding habitat of benthic predators and that the ecological consequences of mangrove removal, as well as its aesthetics, should be considered when developing mangrove maintenance plans.

Mapping change - Kaikōura to Cape Campbell

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In 2016 Land Information New Zealand (LINZ) completed an evidence based hydrographic risk assessment that identified locations and levels of risk in relation to the accuracy and adequacy of nautical charting in New Zealand. The Kaikōura Peninsula was identified as an area of heightened risk, even more so following the 7.8 magnitude earthquake of November 2016. As a result of the earthquake the seabed rose between 1 and 6m along the coast, posing a hazard to safe navigation. In partnership with the Ministry for Primary Industries (MPI), LINZ developed a programme of work to carry out hydrographic surveys for safety-of-navigation and scientific purposes.

Two contractors were used to survey this large area. Discovery Marine Limited (DML) focused on collecting hydrographic data around Cape Campbell for safety-of-navigation purposes, and iXblue collecting data for safety-of-navigation and science purposes. MPI identified areas close inshore between Haumuri Bluffs and Cape Campbell to collect seafloor backscatter and water column backscatter.

This presentation will describe the rationale behind the survey and discusses the challenges encountered during the fieldwork, especially working in very shallow water (2-5m), which in some places are poorly charted.

NZROCS: an ocean climatology of primary production in the NZ region. Part 2: Observations and model validation from Bio-Argo

Dr Stephen Chiswell¹, Dr Helen Macdonald¹, Dr Graham Rickard¹

¹Niwa, Wellington, New Zealand

The companion talk to this presentation describes the development of a coupled physical-biogeochemical climatological model tuned for the present-day New Zealand region - New Zealand Regional Ocean Climatology Simulation (NZROCS).

NZROCS needs to be validated, and we present an analysis of this climatology using data from Bio-Argo profiling floats. Bio-Argo floats are Argo floats that have been supplemented with various biogeochemical sensors including chlorophyll, oxygen and nitrate sensors.

Profiles of temperature, salinity, chlorophyll, oxygen and nitrate from Bio-Argo are compared with respective profiles extracted from NZROCS. The annual cycles of these quantities are computed in a Lagrangian framework from both NZROCS and Bio-Argo derived profiles for the various water masses in the NZ region.

Overall results suggest that NZROCS well represents the ocean physics, except that it has less vertical mixing than in the real ocean. This reduced mixing impacts the production differently in each water mass.

The multivariate Benthic Health Model: a standardised and sensitive approach to assessing estuary health across New Zealand

Ms Dana Clark¹⁻², J.Hewitt³⁻⁴, Dr Joanne Ellis⁵, C.Pilditch², Dr Anastasija Zaiko^{1,4}

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Many indicators have been developed in response to the need to assess the ecological status or health of marine benthic habitats. These measures of ecosystem response range from simple univariate measures, to more complex univariate measures that integrate information on taxa sensitivities to stress through to multivariate approaches that incorporate information on all species and their relative abundances. Multivariate techniques have been found to be more sensitive in defining change, and thus ecological health, than univariate measures because they preserve more information about the community.

The multivariate Benthic Health Model uses canonical analysis of principal coordinates (CAP) to extract variation related to a single environmental variable and produce a score of community structure related to that variable. This approach can be used to determine if sites are improving or degrading over time, which can aid and assess the effectiveness of management decisions. A national Benthic Health Model is being developed for New Zealand, based on the response of estuarine taxa to key environmental stressors. Council estuary monitoring data was used to construct the model allowing estuary health to be assessed on a national scale. This approach provides a sensitive tool for monitoring improvement or degradation in estuary health.

Invasive species vector management: The Northland Regional Marine Pathway Management Plan

Sophia Clark¹

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Northland Regional Council has developed a marine pathway plan for managing spread and establishment of new and existing marine pests. This talk will look at the pathway approach in detail including the requirements of developing a pathway plan, robust cost-benefit analysis, managing risk utilising current research and the tools required for practical outworking of marine biosecurity.

Long tongues and wet patches – when is moist wet enough for toheroa?

Jane Cope¹, **Phil Ross**¹, Shade Smith²

¹*University of Waikato, , ,* ²*Triplefin, ,*

Toheroa populations collapsed following decades of unsustainable harvest. Despite subsequent protection for 40+ years toheroa have failed to recover, for reasons unknown. Numerous hypotheses have been proposed to explain the continued demise of this iconic shellfish including habitat loss associated with changing land use, particularly the reduction in the flow of freshwater to the coast. In northern NZ, there is a strong association between toheroa and the streams which flow onto the west coast beaches. Unfortunately, the mechanisms behind the toheroa-stream relationship are unknown making it difficult to determine the ecological consequences of stream loss. Here we present an investigation into the physical properties of Ripiro Beach, with a focus on determining how streams modify sediment temperature, topography, salinity and depth to water table. For toheroa spat which recruit to the upper intertidal our results suggest that streams may act as low-lying aggregation points in addition to a refuge from heat stress. For adult toheroa in the mid-intertidal, the brackish water table in stream areas remains close to the sediment surface throughout the low tide, providing an opportunity for toheroa to be partially submerged even when the tide is out. Agriculture, forestry and even dune restoration may alter water table dynamics. If an ability to keep ones long foot wet is indeed a key feature of toheroa habitat it appears there may be incompatibilities between toheroa restoration and other land uses on what is now a highly modified coastline.

Stakeholder processes to support spatial planning in the South Pacific high seas

Martin Cryer¹, Ashley Rowden², Carolyn Lundquist⁴, Tiffany Bock¹, Shane Geange³

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Fisheries outside national EEZs are managed by regional bodies with international membership. The South Pacific Regional Fisheries Management Organisation (SPRFMO) manages non-highly migratory fisheries in the South Pacific, including New Zealand and Australian bottom trawl fisheries for orange roughy and other deep-water species. Since 2011, when interim measures were put in place, New Zealand officials and scientists have been collaborating with Australia, Chile, and the EU on to the development of a revised management measures for bottom fisheries. As part of this process, officials, scientists and stakeholders engaged in a series of eight formal workshops in 2016 and 2017 to agree data and settings for decision-support tools and to develop options for spatial management areas. Additional consultation on the detail of candidate management areas addressed unforeseen problems with the initial proposals. The final proposed management areas had substantially better performance than existing measures in terms of protecting vulnerable marine ecosystems and providing access for the fishery. We discuss the advantages of using quantitative decision support tools to assemble and interrogate available information to engage diverse stakeholders in processes that allow them to state their objectives for management and appreciate those of others. Working in this way, stakeholders can understand and consider the trade-offs inherent in most resource management decisions and focus their energies on issues that really matter.

Pipi vs. the Dredge! Tracking the recovery of *Paphies australis* following the Tauranga Harbour Capital Dredging Campaign.

David Culliford¹, Dr Philip Ross¹

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The Port of Tauranga undertook dredging in 2015/16 to widen and deepen the main shipping channel. During this process > 6 million m³ of sediment were dredged from the harbour, including the removal of 95 m wide strip along the north east edge of the central sand bank in the Tauranga Harbour known as Te Paritaha. Te Paritaha is occupied by large numbers of pipi and is one of the most important kaimoana gathering sites in the southern harbour. Dredging was expected to remove most pipi from the impacted area and there was concern from both ecological and cultural perspectives as to whether these pipi beds would recover.

Monitoring was undertaken to determine the effects of the dredging on pipi and monitor their recovery. As expected, pipi abundance decreased after dredging but as a consequence of a large recruitment event, full recovery was evident after just 15 months. The monitoring program indicated that impacts of the dredging campaign were short lived and that capital dredging did not compromise the ecological functionality of pipi on Te Paritaha or their ability to support recreational and customary harvest.

Modelling the spread of invasive species in New Zealand waters

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Over 360 non-indigenous species have been recorded in New Zealand waters. Understanding the dynamics of their growth and spread to other areas in New Zealand is paramount to attempt to control the epidemic, and assess the potential effectiveness of control strategies.

Here I will present a modelling framework which takes as its input (i) probabilities of establishment and growth rates in different habitats, (ii) observations of different species around the New Zealand coastline through time, and (iii) volumes of vessel traffic between major ports (as a potential additional route of transmission). The model fits these data to a spatial transmission model (originally designed to study honeybee infections) using a Bayesian MCMC scheme, and the resulting parameter distributions used to simulate epidemics into the future. We are thus able to quantify the impact that different management methods can have on the population sizes and rates of spread of different species, to find the optimum strategy.

Tackling cumulative effects in Aotearoa New Zealand: a collaborative approach

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Coastal and marine management in Aotearoa New Zealand is covered by 25 statutes governing 14 agencies across seven spatial jurisdictions. This fragmented approach does not easily account for cumulative effects (CE), broadly conceived as the effects of stressors overlapping in space and/or time. Slippage in baselines resulting from the inadequate management of CE could lead to the degradation or loss of resources, and creates uncertainty for investors.

This research addresses current fragmented management of CE in coastal and marine environments by developing a pathway for interagency collaboration on CE that stretches from ki uta ki tai (mountains to sea), thus supporting long term protection and investment in our valuable seas. Research partners and participants in this project are working across disciplines, regulatory regimes, and cultures to tackle CE management. Using qualitative methods such as focus groups and workshops, we are in the process of co-designing procedures that support interagency collaboration and approaches to address CE; developing a collective understanding of alignments and potential conflicts that result from past and present handling of CE; establishing a shared interagency, iwi and stakeholder vision for how CE could be addressed; and producing a collaborative interagency supported suite of principles or guidelines for CE management in coastal and marine environments.

Water Sensitive Design and Community Science

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Water sensitive design (WSD) is a development approach that utilises natural systems and processes for the management of stormwater. This reduces sediment and the accumulation of contaminants in the marine environment. WSD projects can be implemented at greenfield development or to retrofit homes, community facilities or other buildings to incorporate low impact design features. These are intended to manage impacts on water quality, and erosion through on-site treatment and attenuation of stormwater. WSD initiatives can also aim to educate communities, schools, householders and business about the source and impact of stormwater pollution from residential and industrial properties on receiving environments. Water sensitive community objectives encourage a sense of ownership and responsibility towards the ongoing maintenance and protection of waterways. WSD projects are an example of successful interaction of science and community and can also be incorporated to extend the reach of larger freshwater or coastal restoration projects. This presentation will highlight the contribution of community based WSD initiatives to wider ecological objectives which aim to improve the health of receiving environments.

Plankton process and export fluxes in subtropical waters northeast of New Zealand

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Subtropical waters to the northeast of New Zealand are characterized by seasonally low nutrient concentrations, dampened spring blooms, and low export. To understand the biological processes determining biogeochemical fluxes in NZ subtropical waters, we investigated plankton trophic structure in coastal, shelf break and oligotrophic areas, in waters in the vicinity of the Hauraki Gulf and Colville Channel. During two oceanographic voyages, conducted in May 2015 and May 2016, we evaluated patterns in phytoplankton productivity, protistan/metazooplankton grazing, and export fluxes, in relationship to the physical environment. We find peaks in production, zooplankton biomass and zooplankton-mediated export near but inshore of the shelf break during 2015. In contrast, export fluxes were highest in offshore stations during 2016, evidencing the dynamic oceanography of the area. Highest zooplankton standing stocks were consistently found inshore of the shelf break in the Colville channel, where high nutrient concentrations suggest the prevalence of upwelling. We evaluate these differences in productivity, trophic transfer and export fluxes, in relationship to the variability in vertical velocity structure and resulting nutrient delivery rates. These proximate yet contrasting subtropical plankton communities provide an excellent opportunity to evaluate the effect of local oceanographic features on plankton processes and biogeochemistry.

Impacts of the 2016 Kaikōura earthquake on breeding habitat and population of the Hutton's shearwater (*Puffinus huttoni*).

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¹Hutton's Shearwater Charitable Trust, Kaikoura, New Zealand, ²World Land Trust, Suffolk, United Kingdom

With the exception of a recently established small man-made breeding colony on the Kaikōura Peninsula, the population of the Hutton's shearwater is restricted to two alpine sites at 1200m asl within the Seaward Kaikōura Mountains. These two sites are the remnant areas of the species former breeding range which has been reduced as a consequence of changes in land use and the predation and habitat destruction by feral pigs. Within the two remaining mountain colonies suitable breeding habitat is of limited capacity, which resulted in high burrow densities in comparison with other species.

The Kaikōura earthquake of November 2016 struck when birds were incubating eggs, causing a potential high number of deaths due to burrow collapse, rockfall and slips. First estimates anticipated about 20-30% mortality. With the help of MPI earthquake recovery funds, the Hutton's Shearwater Charitable Trust was able to carry out a combination of on the ground and aerial surveys in December 2017 to assess loss of breeding habitat, the impact on population numbers and the potential for recovery. Furthermore, we aimed to explore the suitability of alternative breeding sites for future colony establishment. This research was carried out by Dr Richard Cuthbert, with reporting due at the end of May 2018. We look forward to sharing his results at the NZMSS 2018 conference special session.

The midget octopus, *Octopus huttoni*, a victim of parasitism

Erica Donlon¹, Leonardo Durante¹, Erin Damsteegt², Dr. Miles Lamare¹

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Despite the important role that octopus play in many marine food webs, little is known about the impact of their parasites. In this study, a coccidian parasite and a trematode were found in two different populations (Otago Harbour; OH and Foveaux Straight; FS) of midget octopus, *Octopus huttoni*. Log transformed morphometrics of 250 *O. huttoni* from 2008-2010 and 47 from 2017-2018 were compared between the datasets and populations. Of 50 individuals, 14% (seven males) caught in FS were heavily infected with the intracellular protozoan coccidian *Aggregata*. In the renal sac or surrounding membrane, trematodes morphologically similar to *Plagioporus maorum* were found in 9% from OH, and 2% from FS (three females, one male). No parasites were found in the 2008-2010 dataset. All measurements except head width (HW) were significantly different between datasets indicating that body size has changed over 10 years. The infected individuals were significantly smaller in mantle length (ML) and significantly larger in total length (TL) indicating that parasites may decrease ML by causing necrosis like *Aggregata* does in the digestive tract. As the ocean warms, parasite loads are predicted to increase, making it crucial to study parasite-host interactions in order to predict changes in food web dynamics.

Does calcium carbonate alter the functional resilience of coastal sediments to eutrophication-induced acidification?

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In eutrophic systems when algal blooms collapse the input of organic matter (OM) to the benthos increases microbial respiration lowering oxygen levels and acidifying porewaters. Biodiversity losses and/or community composition shifts may follow, affecting ecosystem function. Calcite and aragonite shell material (CaCO₃) in coastal sediments may provide a mechanism to maintain ecosystem functions by buffering against acidification. We investigated experimentally the effect of OM loading on ecosystem function in Tuapiro estuary, and the potential for excess CaCO₃ to provide resilience against negative effects. Intertidal sand plots (1m²) were enriched with OM quantities ranging from 0-2250 g dw/m² in a gradient design, each replicated with and without the addition of 2 kg ground oyster shell (CaCO₃). After nine weeks, light and dark solute fluxes were measured to derive measures of ecosystem function (community metabolism, nutrient regeneration, primary production), and macrofaunal communities and sediment properties were assessed. The level at which OM loading impacted ecosystem functions was higher in CaCO₃ added plots (e.g. without CaCO₃ net autotrophy ceased at 750 compared to 1500 g m² in its presence). Calcium carbonate may therefore provide resilience against negative effects of eutrophication-induced acidification, maintaining some ecosystem functions.

What lies beneath...subtidal habitats along the Kaikoura coastline post-earthquake

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¹Cawthron Institute, Nelson, ²University of Canterbury, Christchurch,

The Kaikoura earthquake uplifted land and seabed to varying degrees. Massive effects on the intertidal zone were immediately apparent, but effects on subtidal habitats were concealed by the turbid, dynamic coastline. We surveyed 20 nearshore sites along the coast (from Cape Campbell in the north, to Oaro in the south) to gauge the impact of the earthquake on available habitat, algal and sessile invertebrate cover, and numbers of mobile invertebrates. We found that sites with high-degrees of uplift now have extensive areas of bare rock that have been exposed through the sand and gravel. These areas are slowly undergoing recruitment and succession. In contrast, low- to mid-degrees of uplift appeared to have had little effect on communities, with diverse arrays of seaweeds, mobile and sessile invertebrates and fish still present. However, we observed considerable damage to *Lessonia variegata* and *Macrocystis pyrifera* caused by extensive grazing by the herbivorous butterflyfish *Odax pullus*. Some of the far-reaching consequences of these subtle changes, and how these findings can be used to inform management decisions, will be discussed.

Changes in demersal fish assemblages along the East Coast of the South Island over the years

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The East coast of the South Island (ECSI) is a heterogeneous seascape comprised of rocky reefs and a sandy continental shelf, allowing for the development of an extensive trawl fishery. Transformed catch per unit area (kg/km²) data of 32 dominant species from the RV Kaharoa ECSI winter trawl surveys during 1991-1996 and 2007-2016 were analysed. Using multivariate analysis of variance (PERMANOVA+) we found that assemblages differed significantly between periods, interacting strongly with latitude and depth. Bottom temperature and fishing pressure were found to be significant factors to statistically explain differences in community structure between periods. Half of these community differences were due to changes in relative abundance of eight dominant species, including red cod (*Pseudophycis bachus*) and spiny dogfish (*Squalus acanthias*), coincident with a decline in their commercial catches. These changes were more pronounced in the southern regions, where half of the community biomass comprised species of trophic level above 4.4 in the 1990's, declining to 3.6 during the 2000's surveys. The ECSI is currently managed as a single area for a majority of trawl fisheries, here we demonstrate the importance of smaller scale perspectives to target management of commercial species.

Tāhuhu Matatau mo Te Ao o Tangaroa

Regan Fairlie¹

¹Manaaki Te Awanui, Tauranga, New Zealand

In this research project, the Manaaki Te Awanui research team are working collaboratively with local kaitiaki and participating hapū to: (i) review Western Science literature in domains relating to marine ecology, spatial planning, real-time monitoring and aquaculture, to (ii) identify, prioritise and validate areas of relevance and possible knowledge gaps, while (iii) mediating the transfer of approaches, frameworks and tools to frontline kaitiaki via the development of an online training programme and resource centre.

The project is a stepping stone and an acknowledgement to hapū and kaitiaki whom have established and defined clear aspirational goals in relation to the management of the Taiao.

It was envisaged that the implementation of Western Science and the uptake of tools and frameworks would enable kaitiaki to be more efficiently informed, and help them to align, express and disseminate tikanga based values towards the co-management of Tauranga Moana.

To date the project is relatively in its emerging stages where the first three themes are almost complete. These themes include: (i) Marine Ecosystem Based Management, (ii) Marine Spatial Planning and (iii) Aquaculture. Throughout the project kaitiaki narratives are such that alignment between Western Science and mātauranga maori is a two-way process and that the uptake of Western Science frameworks and tools can indeed provide beneficial outcomes if guided by Te Ao Marama, tikanga and kawa.

The risk of commercial fishing risk to NZ sharks: how have we progressed our understanding?

Rich Ford¹, Malcolm Clark², Clinton Duffy⁴, Matt Dunn², Malcolm Francis², Emma Jones³, Lyndsey Holland¹, Richard Wells⁵

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Management of sharks in New Zealand is guided by the National Plan of Action – Sharks. A key component of this is determining risks to sharks in order to prioritise actions (research or management) to shark taxa. The largest known risk to sharks in New Zealand is from commercial fishing. The first attempt to quantify the risk to sharks in New Zealand from commercial fishing was a data informed qualitative risk assessment published in 2015. Since then our information, particularly regarding age, abundance and reproduction of high-risk non-quota management system (QMS) sharks, has improved. This information was incorporated into a rerun of the data informed qualitative shark risk assessment in late 2017. This resulted in an increased perception of risk for the Plunket's shark, thresher shark and shovelnose dogfish (all Non-QMS species). Carpet shark and electric ray (both Non-QMS), and smooth and rough skates (both QMS) all now have a decreased perception of risk. This latest ranking will be displayed within management categories (QMS, non-QMS and protected species) and recommendations made by the risk assessment panel discussed.

A symbiotic relationship: An ethnographic account of a Northland community and their toheroa

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The relationship of Māori with the environment is symbiotic and interconnected. For Māori everything is connected through whakapapa. Their relationship with the environment is one of great respect and at the same time the environment and its natural resources provide for Māori livelihoods and social relationships. These relationships are in turn maintained through reciprocity and hospitality.

In this talk I will ethnographically describe the interaction between Māori and their natural environment with reference to a Northland community and their taonga shellfish the toheroa (*Paphies ventricosa*). My research highlights the value of incorporating people into ecological thinking as in this case people provide an understanding of the social and cultural consequences of fisheries management practises.

Impact of long-term near future ocean acidification on the physiology of adult *echinus chloroticus*

Emily Joy Frost¹, Professor Mary A. Sewell¹

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How marine organisms respond to changes in pH and pCO₂ is multifaceted, and can depend on environmental history, nutritional status and life-history. There are two buffering systems, bicarbonate and non-bicarbonate that animals, including adult marine invertebrates, can employ to compensate changes in pCO₂ and pH. We aimed to assess how adult *E. chloroticus* respond to long-term (10-months) pCO₂ exposure. In particular, we focused on two major organs, the oesophagus and gonads. We determined the impact of exposure on urchin morphometrics, energetics, the concentration of gonadal and oesophageal protein, lipids and transcript abundance of major ion-transporters, oesophageal bicarbonate and non-bicarbonate buffering capacity and total histidine concentration. The results suggest that exposure of adult *E. chloroticus* to two levels of elevated pCO₂ (1069µatm, 1602µatm) elicited two different mechanisms to buffer pH. In urchins maintained at 1069µatm pCO₂, the mechanism of pH buffering employed in the oesophagus was dominated by non-bicarbonate buffers. The concentration of protein and total histidine was elevated which mirrored significantly elevated structural lipid concentration and the upregulation of active ion transporters. Conversely, in high pCO₂ urchins, buffering was dominated by bicarbonate buffering, with significant reductions in structural lipid concentration. and the lack of Na⁺/H⁺-exchanger and Na⁺/K⁺-ATPase upregulation.

“Let’s get bio-geochemico-physical”: Decade scale monitoring in the Firth of Thames.

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Ten years of in-situ mooring and seasonal voyage data in the Firth of Thames are combined with remotely sensed MODIS Aqua satellite surface observations, to assess seasonal and annual variability in phytoplankton biomass and primary productivity, and causal factors. Moored instrumentation tracked variability and vertical stratification of temperature, salinity, light penetration, and phytoplankton biomass, in high temporal detail. Forty research voyages on the RV Kaharoa, with CTD profiles and water collections at six depths provided high vertical resolution and seasonal detail in dissolved nutrients, particulates, phytoplankton biomass (chlorophyll-a concentrations), species identification, and particulate absorption spectra. Site specific, high resolution (500 m²) MODIS coastal products were extracted for the site, compared to in-situ measures, and efficacy discussed. Phytoplankton biomass and productivity (depth integrated model – DIM) varied seasonally and annually, driven by the timing and temporal extent of chemico-physical factors (nutrients, light and critical mixing depths / stratification). At times, geological factors (river plume suspended sediments and their low salinity influence) modified water column light availability and vertical stratification. Decade statistical trends are considered in context to the Southern Ocean Oscillation Index (SOI) and climate change indicators (coastal temperature, acidity and flooding).

Habitat mapping for the Waikato Region Coastal Marine Area: Bathymetry and substrate type

Dr Sarah Gardiner¹, Dr Hannah Jones², Dr Juliana Albertoni de Miranda¹

¹*Metocean Solutions, Raglan, NZ,* ²*Waikato Regional Council, Hamilton, NZ*

Effective management of coastal resources relies on an understanding of the state of, and the impact of pressures on, the coastal marine area. This includes an understanding of the extent and condition of seabed habitat. WRC is responsible for managing the coastal marine area (CMA) that extends from the shoreline to 12 nautical miles offshore. Habitats range from sheltered shallow estuaries to dynamic open coast beaches, intertidal and subtidal rocky reefs, and deeper water offshore marine environments.

We have summarised the state of knowledge of seabed habitats within the Hauraki Gulf and the comparatively sparsely studied Waikato CMA west coast, to provide a single habitat and bathymetry resource for the entire Waikato CMA (east and west coast). The bathymetric and substrate data have been used to identify what type of ecological communities are likely to be present, especially ecologically valuable areas. We also intend to use this work to identify data gaps and inform future data collection.

Assessing the recovery of juvenile black-footed abalone (pāua) and habitat following the uplift and reconfiguration of the Kaikōura coastline

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¹*Marine Ecology Research Group - University of Canterbury, Christchurch, New Zealand*

The 7.8Mw Kaikōura earthquake and associated coastal uplift caused a widespread die-off of intertidal and shallow subtidal algae and invertebrates and permanently reconfigured over 130km of coastline. The black-footed abalone, or pāua, experienced high mortality from this event, likely resulting in a compromised reproductive season and/or reduced recruitment. In addition to this unprecedented mortality of broodstock, rocky intertidal reefs previously known to be important for juvenile recruitment and survival were rendered unsuitable due to changes in tidal height, loss of physical and biogenic habitat, and increased sedimentation. Because of the social, ecological, and commercial importance of a healthy pāua stock in this area, it is critical to understand the current status of the juvenile population and their habitat. Using aerial drone imaging, comprehensive on-the-ground surveys, and artificial reef installation, we are assessing the current status of habitat availability, recruitment, and juvenile survivorship for this ecosystem in recovery. Our extensive sampling has shown that some locations maintain adequate habitat and support recruitment and survivorship, as indicated by normal size-frequency distributions of pāua, including post-earthquake recruits. Other locations, however, appear to be in a transitional phase, providing little to no habitat for juveniles. We discuss this in terms of the pāua fishery recovery.

Passive acoustic monitoring reveals unknown beaked whales' echolocation signals and sperm whales' foraging off eastern New Zealand.

Giacomo Giorli¹, Kimberly T Goetz¹

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Little data exist on the distribution, abundance and behaviour of deep diving odontocetes in the New Zealand Exclusive Economic Zone (NZEEZ). This lack of information is a consequence of the logistical and financial difficulties associated with monitoring such a vast marine area. Passive acoustic technology provides the opportunity to study cetaceans in remote marine ecosystems over extended periods of time at a fraction of the cost of standard marine surveys. We moored three acoustic recorders to study cetaceans off the east coast of New Zealand for two six-month periods between June 2016 and August 2017. Both sperm and beaked whales, including two previously unknown echolocation signals likely produced by Gray's and strap-toothed beaked whales, were discovered. The two signals were labelled BW39 and BW53 in reference to their peak frequency. Sperm whale foraging echolocation signals were detected year-round, with no distinction between night-time or day-time. Size distribution of sperm whales, investigated using cepstral analysis, ranged between ~ 8 and ~22 m. This study provides the first long term dataset on cetacean occurrence in New Zealand waters where over half of the world's whales and dolphins are known to visit. Future directions include the use of gliders to monitor cetaceans over larger areas of the NZEEZ.

Biophysical feedbacks between eutrophication and sediment erodibility demonstrate cumulative effects of multiple stressors in estuaries

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With the intensification of urban development, agriculture, and forestry, coastal waters are becoming enriched with sediments and nutrients. Excess terrestrial sediments and nutrients can negatively impact benthic fauna and ecosystem function. The rate of sediment re-suspension across the sediment-water interface is an important process that affects water turbidity, and the redistribution of deposited sediments in the coastal environment, ultimately influencing the evolution of estuarine morphology. The rate of re-suspension is mediated by biophysical interactions between the sediment, biofilm and macrofauna. Nutrient loading into estuaries results in elevated porewater nutrient concentrations, which can alter the community of microbes and fauna. We hypothesised that porewater nutrient enrichment would increase biofilm growth, stabilising the sediments. To test the existence of these feedbacks, we set up plots on an intertidal sand flat in Tauranga Harbour, New Zealand, where we enriched the sediment with two concentrations of nitrogen fertiliser (200 and 600 g N m⁻²). After 3 months, we collected intact sediment from the plots (including controls), and subjected these sediments to sequential increases in water flow velocity using annular flumes. We calculated sediment erosion rates to explore the feedbacks between nutrient enrichment and sediment transport. Our preliminary results suggest that nutrient enrichment may reduce the resuspension of sediments, demonstrating cumulative effects of two of the main stressors in New Zealand estuaries: sediments and nutrients.

Tracking the movements of tuna and sharks around New Zealand and the South Pacific.

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Annual commercial catches of skipjack, yellowfin, bigeye, and albacore tuna in the Western and Central Pacific Ocean (WCPO) have increased steadily since the start of large-scale fishing shortly after WWII. This fishery is one of the most important in the world (by value and volume). WCPO tuna stock assessments require knowledge of their movements and mixing in the Pacific. In addition, we need to assess the movements of bycatch species to assess the impacts and develop potential mitigation. In this MPI-funded project, we examined the movements of tuna and sharks collected by MPI observers on board New Zealand long-line vessels from 2015-2018 using stable isotope techniques. Based on the comparison of hundreds of samples, tuna and sharks are more transient in waters around New Zealand compared to those studied in other regions of the South Pacific. Tropical tuna, southern bluefin tuna, and mako sharks showed the greatest degree of (N-S) movements. There were unique inter-annual trends, with species arriving to New Zealand waters during separate times and with species catch shifts associated with the warmer than usual offshore waters. We will discuss these results in context with other datasets, including electronic tagging studies, and implications for fisheries management.

Environmental drivers of the fine-scale foraging distribution of sperm whales

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The Kaikōura Canyon is a foraging ground for sperm whales, but the number of whales feeding in this area has declined over the last two decades. This trend could reflect a shift in distribution away from the canyon, potentially driven by ecological or oceanographic changes within the whales' habitat. It is therefore important to understand what environmental factors drive the foraging distribution of sperm whales at Kaikōura. Locations of foraging whales (n=334) were recorded during boat-based surveys over three years in 2015-2017, and pseudo-absence locations (n=360) were generated in areas where no whales were detected. We used species-distribution models to relate whale presence to habitat variables, including seafloor topography and water-column data to 500m depth. In winter, the presence of foraging whales was correlated with seafloor depths of 500–800m and with the depth of maximum sub-surface productivity. In summer, whales foraged more often over depths of 1000–1300m and steep slopes, and favoured areas with strong vertical temperature gradients. The seasonal differences in habitat use probably reflect temporal patterns in prey preference and distribution. Our results suggest that oceanographic processes play an indirect but important role in attracting prey to the canyon and in shaping sperm whale habitat use. The next step is to investigate long-term interannual variability in oceanographic conditions and its potential correlation with sperm whale abundance at Kaikōura.

The effects of the Kaikōura Earthquake on sperm whales

Marta Guerra¹, Steve Dawson¹, Amandine Sabadel¹, Elizabeth Slooten¹, Tamlyn Somerford¹, Roger Williams², Lucy Wing¹, Will Rayment¹

¹University Of Otago, Dunedin, New Zealand, ²Whale Watch Kaikoura, Kaikoura, New Zealand

The Kaikōura Canyon is an important foraging ground for sperm whales. In November-2016, a 7.8 magnitude earthquake triggered extensive mud-slips and erosion in the canyon, impacting benthic invertebrate communities. Combining information on abundance, distribution, behaviour and stable isotope analyses, we investigated the effects of the earthquake on sperm whales. Although whales were present in the area within one week of the earthquake, abundance in December and January of 2016 was lower than previous years. Based on sightings from three pre-earthquake years (n=351) and one post-earthquake year (n=135), sperm whales had longer surface intervals (+25%, SE=4%) in the year following the earthquake. In addition, their spatial distribution shifted away from the upper canyon, which had previously been an important foraging area. However, echolocation behaviour (n=188 pre-EQ, 70 post-EQ) and stable isotope ratios of carbon and nitrogen in sloughed skin (n=74 pre-EQ, 23 post-EQ) did not change significantly after the earthquake, suggesting that whales were targeting similar prey. Surface intervals returned to pre-earthquake levels after one year, suggesting that whales were reverting to pre-earthquake behaviour. Overall, sperm whales in the area appeared to modify their foraging patterns in response to habitat changes caused by the earthquake, demonstrating resilience to natural disturbance. However, due to the ongoing decline in their abundance at Kaikōura, sperm whales might be particularly vulnerable to impacts on their habitat.

Sustainable Seas: where has the waka taken us?

Dr Julie Hall³, Dr Carolyn Lundquist^{1,2}, Dr Conrad Pilditch³, Dr Judi Hewitt^{1,2}, Linda Faulkner⁶, Dr Chris Cornelisen⁵, James Whetu⁷,

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The Sustainable Seas National Science Challenge is a large, multi-institutional, transdisciplinary research programme involving over 200 individuals from 38 organisations including Maori and a diverse range of stakeholders from regional and central government to industry and local communities. The Challenge mission is to provide the knowledge and tools that will enhance the 'blue' economy (i.e., the benefits New Zealanders obtain, both monetary and non-monetary, from the oceans) while supporting healthy marine ecosystems through ecosystem based management. To begin this symposium of Sustainable Seas research highlights, we will first bring our audience up to speed with the Challenge mission, its five research programmes and the extent of involvement of the Aotearoa New Zealand marine research community. Challenge research has been underway for three years and is approaching conclusion of its first phase. It has made significant innovations across biophysical, social and kaupapa Maori research in marine social-ecological systems.

Monitoring the disappearing Hauraki Gulf Lobster: Preliminary surveys across the Cape Rodney to Okakari point and Tawharanui Marine Reserves.

Benn Hanns¹, Dr Nick Shears¹, Dr Diana LaScala-Gruenewald¹

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Monitoring of lobster in the Cape Rodney-Okakari Point (CROP) and Tawharanui marine reserves (TMR) has identified substantial declines over the last 10 years. Fishing effort is heavily focused on the boundaries of these reserves, suggesting fishers are targeting lobster near boundaries and protected-lobster crossing boundaries. To understand the extent declines of protected-populations are related to boundary-fishing, lobster population abundance and demographics were surveyed across reserves and in adjacent non-protected areas. Sampling used "pots" supplied by a local commercial-fisher. 100 drops were performed across 60 stations in CROP and 40 in TMR, and 70 drops across fished-areas. Fewer lobster were caught than expected based on previous reports, with only one legal female caught across all fished-areas. Large-males were highly represented, where comparatively higher reserve CPUEs were generated by one-two males. Overall, catch data was right-skewed due to a high proportion of empty pots, and CPUE across boundary stations was significantly lower than reserve stations. These data suggest local catches are likely supplemented by protected populations through boundary fishing, which may subsequently be pushing the deleterious effects of fishing within the reserves. To address potential bias associated with the potting-methodology, another survey will be conducted using SCUBA, and to better understand lobster/boundary interactions, individuals are being tracked using acoustic-telemetry.

Assessing ecosystem health in a multi-indicator world

Prof Judi Hewitt²

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Assessments of ecosystem health can be required for many reasons, from an assessment of impacts to reporting on the effectiveness of policies and interventions. Indicators should provide a means of communicating complex information in a simplified way. However, assessment of health becomes more complicated as the number of stressors increase and the number of health indicators and surrogates proliferate. Initial indicators of health focused on the ecosystem components most likely to show responses and to a single stressor, e.g., eutrophication). But marine environments are only rarely affected by a single stressor in isolation, which raises the question of whether we need an indicator that summarises health regardless of stressor, or indicators targeting each likely stressor. If the former, how do we know what is causing changes in health and therefore what management actions are required. If the latter how do we understand the overall health of the system? Even if we know which option is best, how do we select from the numerous indicators available. In this talk, I discuss: some of the many indicators available; pros and cons behind deriving a single overall indication of health; and some implications of the purpose behind the health assessment on study design.

The use of sedimentation rate as a practical indicator of estuary ecosystem health

Dr Stephen Hunt¹

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The rate of sedimentation at which adverse effects occur within estuarine systems is not known with certainty but it is generally accepted to be of the order of mm's per year above a baseline rate. Measuring this amount of sedimentation over appropriate spatial and temporal scales and determining an appropriate baseline rate presents a range of challenges. WRC have been measuring contemporary sedimentation rates for the past 15 years and have established baseline rates for a range of estuaries in the region using sediment cores. Here I use this data to critically assess the suitability of sedimentation rates as an appropriate metric of estuarine ecosystem health.

Behavioural ecology of Bryde's whales

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Bryde's whale is a non-migrating species of baleen whale with a cosmopolitan distribution; very little is known about the behaviour of this whales. The small year-round population of Bryde's whales in the Hauraki Gulf, New Zealand, is categorised as a Nationally Critical species. Here, we investigate two critical behavioural states of Bryde's whales, resting and foraging. Data on the behaviour of Bryde's whales were collected by an archival tag, boat-based surveys, and drones. Low activity periods and lunges were detected using tag data. Visual observation data were used to design head models and physical experiments to simulate head slaps, a behaviour which is performed when whales feed on zooplankton. Bryde's whales show strong diel behavioural patterns with long periods of low activity occurring exclusively at night while spending their days actively foraging, mostly at the surface. Surface foraging tactics differ when whales were feeding on plankton or fish. Head slaps have biophysical applications and create water currents to increase the density of prey-laden water 3-5 times. The activity pattern indicates that either Bryde's whales rely on senses that are less effective in the dark to locate prey, or that prey aggregate less densely at night. Also, dynamic behavioural tactics and diet plasticity seem to be the key for non-migrating Bryde's whales to meet their energetic demands in poorer quality waters.

Identifying emerging issues and priorities for the future of New Zealand marine science.

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The health of our oceans is of paramount importance. Yet a multitude of threats, including human activities, global warming, ocean acidification, overexploitation, pollution, habitat destruction, and invasive species, continue to threaten our New Zealand waters. As such, it is crucial that we identify the key questions that will ensure we can adequately conserve and manage our marine environments and resources. In this talk we will introduce you to our horizon scanning tool, and invite you to participate in identifying the emerging issues and priorities for marine science in New Zealand. This horizon scan invites contributions from marine scientists across a variety of disciplines, in addition to individuals from conservation, industry, government, and non-governmental organisations. Outputs will be ranked and prioritised, before being organised into key themes. Such an approach will be used to enhance collaboration, broaden engagement, and improve transparency around research and decision-making. Furthermore, the horizon scan can be used as a roadmap to optimise work and investments. Not only will this horizon scan help us in 'Weaving the Strands' by fostering collaboration and drawing together data, disciplines, and perspectives, it will also identify the most pressing questions and priorities for the future of marine science in New Zealand.

Biophysical characterisation of two sub-mesoscale eddies in Greater Cook Strait using underwater gliders

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Sub-mesoscales eddies (SMEs) are ubiquitous features in the ocean, yet some of these features are more productive than others. The energy generated, mixed and transported by submeso- and mesoscale processes account for 50% of the global ocean energy budget. They play a key role in the redistribution of heat, salt and biogeochemical tracers. The presence and physical drivers of SMEs have been elusive due to the difficulty in observing these eddies of 0(km). This research identifies and characterises the generation mechanism of two SMEs in Greater Cook Strait (GCS). Using a novel and multidisciplinary approach, observations from autonomous underwater vehicles (gliders), remotely sensed observations and numerical modelling outputs are used to identify how the physical drivers of surface wind stress, buoyancy inputs and vertical shear interact to regulate productivity of SMEs in a New Zealand shelf sea. In this talk, two SMEs which had increased and unchanged production during Spring 2016 and Autumn 2017 respectively, will be compared. Differences and physical drivers of SMEs in GCS will be evaluated to explain the dominant scale and locations of these SMEs. Connections to biological productivity will be made by developing a realistic algorithm to quantify optical observations of phytoplankton production from SMEs.

Sweepstake reproductive success in the grey mullet (*Mugil cephalus*), and temporal fractioned genetic diversity between adults and juveniles

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The seasonal reproductive success of adults due to variation in mortality rates of juveniles is the basis of the Sweepstake-Reproductive-Success hypothesis (SRS). The result is a loss of genetic diversity in juveniles compared to the adults, often leading to a pattern of chaotic genetic structure. Four genetically distinct populations of *Mugil cephalus* have been identified in New Zealand which showed a chaotic genetic structure. The aim of this study was to test whether the genetic variation in *M. cephalus* populations was a result of differences in the reproductive success of adults. Seven microsatellite DNA markers were amplified from 576 adults and 274 juveniles sampled in five estuaries in the North Island, New Zealand. The juveniles were grouped in age-classes based on their size and growth rate. The levels of genetic diversity in the juveniles were compared to the adults by calculating the differences in allele frequencies, effective population size (N_e), number of breeders (N_b) and excess of heterozygotes. Significant differences between the N_e of juveniles and adults were detected, which was consistent with the SRS hypothesis. Three distinct spawning groups were also identified, an early spawning group, a late spawning group and a group that might undergo multiple spawning events during summer.

Understanding and predicting trawl codend selectivity in the New Zealand inshore fishery.

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In the New Zealand inshore fishing industry, concerns over the bycatch of undersized and non-target species have prompted Industry-led efforts to improve trawl selectivity; e.g. increasing the size, and / or changing orientation of the meshes. The selective properties of trawl nets in New Zealand are not well documented, and this lack of information may be hindering more widespread uptake, and the ability of the industry to demonstrate their improvements in sustainability.

The aim of this project is to utilize the FISHSELECT software tool to better understand the selectivity of N.Z species, and how changes being made within the fleet will affect catches of undersized fish. Trials were carried out onboard a Hawkes Bay commercial trawler FV "Chips". Paired selectivity tows compared a standard 5" (125 mm) diamond mesh commercial trawl codend, with a non-selective small mesh-lined codend. Morphometric data were collected for 3 species (snapper (*Pagrus auratus*), red gurnard (*Chelidonichthys kumu*) and English sole (*Peltorhamphus novaezeelandiae*)).

Preliminary analysis comparing the results from sea trial selectivity data with predictions based on the morphometric data, indicate that we should be able to predict selectivity across a range of mesh sizes (100 – 200mm) and orientations (diamond, square and T90).

State of the Hauraki Gulf / Tikapa Moana / Te Moana-nui-a-Toi

Shane Kelly¹, Carina Sim-Smith¹

¹*Coast And Catchment, Pine Harbour, New Zealand*

The Hauraki Gulf has been transformed over two human lifespans. Terrestrial species have been driven to extinction, native forests and wetlands have been replaced with pastoral land or urban development, water quality has been degraded by contaminants and sediment, marine habitats have been destroyed, and fish populations have been greatly depleted. Damage caused by boom and bust industries, such as mining, native forest logging, and mussel dredging have left a lasting environmental legacy. These historical effects have been compounded by ongoing development, commercial activity and demand for the Gulf's resources.

The 2017 State of Our Gulf report highlighted that cumulative pressures on the sea continue to mount as population and commercial pressures escalate. The Gulf is subject to terrestrial pressures associated with Auckland's rapid growth and intensive agriculture. Demand for facilities, infrastructure and resources is pushing development into the sea, and fisheries indicators point to significant stress. Auckland is also a gateway for invasive marine species, with new species regularly arriving. Gains have been made in some areas, such as terrestrial pest eradication and reduction in stormwater contaminants, but these could easily be undone by new activities or climate change.

Turning around environmental outcomes is a serious challenge. Legacy impacts constrain what can potentially be achieved, and the ongoing pace of change is outstripping the response of current management frameworks.

Coastal water quality states and trends in Hawke Bay: a review of 15 years of satellite data.

Weimin Jiang, **Ben Knight**¹

¹*Cawthron, ,*

The decline in water quality of freshwater rivers around New Zealand has been well-documented, thanks in part to well-maintained long-term science and regional council programmes that are dedicated to monitoring these important conduits. However, limited data is available on changes in the much larger coastal environments of New Zealand. Satellite data from MODIS sensors collect twice-daily images from 2002 to the present and provide information on the state of and changes to neritic waters. In this study, Hawke Bay is used as a focus region to investigate states and trends from satellite-derived proxies of turbidity, chlorophyll-a and temperature. This shows the results from state and trend analyses of the data, which will be used to inform and focus future coastal monitoring in the region.

Maternal investment in the viviparous temperate reef fish *H. percoides*

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Older, larger fish can have distinctly different reproductive attributes than smaller, younger individuals, as fecundity increases geometrically with body size in fishes. This highlights the importance of larger, older spawners for effective reproductive output in fish populations. For example, the retention of older, larger females can increase both the temporal and spatial distribution of effective reproduction in a population network. Here we provide first estimates of the relationship between maternal characteristics and larval traits in sea perch (*Helicolenus percoides*). Maternal characteristics of individual *H. percoides* from the Otago shelf including age, length, weight and condition were used to predict oil globule volume, notochord length and growth of cohorts of their larvae. The relationship indicated that larger, older females in better condition produced offspring with larger energetic reserves, and likely better survivorship, than offspring from smaller, younger females. The patterns observed support a growing body of evidence demonstrating that larger, older females are vital contributors to the reproductive biology of fish populations. While most current fishery management practices do not incorporate maternal age and size effects into considerations about catch, results of the present study demonstrate that gains in reproductive potential could likely be made by incorporating maternal age into management considerations.

Bonamia ostreae in the New Zealand flat oyster *Ostrea chilensis*: details of a marine biosecurity response (Part 1)

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In January 2015 the haplosporidian parasite *Bonamia ostreae* was reported for the first time in New Zealand infecting the New Zealand flat oyster *Ostrea chilensis* where it was associated with high mortalities. Prior to this report, *B. ostreae* was restricted to the European flat oyster *Ostrea edulis* in the Northern Hemisphere. Following the detection of *B. ostreae*, a New Zealand biosecurity response was initiated by the Ministry for Primary Industries. This presentation discusses the risks and impacts that this detection posed to the New Zealand flat oyster industry, including aquaculture and the wild fishery. Subsequently, we look at mitigation measures that were considered and the science-based evidence that led to the response actions taken, including New Zealand-wide targeted surveillance and the implementation of movement controls.

Marine Biosecurity in the Bay of Plenty "The Journey"

Hamish Lass¹

¹Bay Of Plenty Regional Council, Tauranga, New Zealand

The marine environment in the Bay of Plenty is highly valued for numerous reasons including economic values, cultural values, biodiversity, tourism, recreation, harvesting of seafood, aquaculture, natural character and amenity.

In 2013, a single Mediterranean fan worm (*Sabella spallanzanii*) was detected in Tauranga Harbour.

Following that detection, a systematic surveillance operation was developed in collaboration with key stakeholders. Since the 2013 incursion 13,249 boat hulls, 136 km's of marina walkway pontoons, 560 swing moorings, 1800 wharf piles 18km of marina rock walls and 2.3 km's of beach have been searched. This has resulted in the discovery of infestations at Bridge marina, Sulphur point marina and moored boats.

This surveillance, and the management of marine pests in the region, has been based on a collaborative and strategic approach and the development of the Marine Biosecurity Management Plan for the Bay of Plenty. BOPRC, Iwi, industry, MPI and other stakeholders work together

towards common environmental, cultural, social and economic goals. To support the management plan, BOPRC has developed a Small Scale Management Plan (SSMP) under section 100v of the Biosecurity Act. This was required to give BOPRC powers to manage any new incursions as no marine pests are listed in the current Regional Pest Management Plan.

Factors Underlying Community Support of Different Decommissioning Options for Offshore Oil and Gas Structures

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Once decommissioned, offshore oil and gas structures can be completely removed, partially removed, or re-used. However, levels of support for each decommissioning option can vary greatly between individuals, and as seen in the international context, this can sometimes result in unforeseen controversy. Given the importance of social acceptance in environmental projects, it is surprising then that no study to date has explored what factors underlie perceptions toward decommissioning options. To close this gap, the present study used theories from environmental psychology to investigate whether and what variables can predict support for different options. Using a survey posted to the Taranaki community (N = 154), we measured three types of variables (familiarity, psychological constructs, demographics), and analysed this data using path analyses. Our findings showed that: (1) lower awareness, higher levels of knowledge, and egalitarian worldviews predicted support for complete removal, (2) individualist worldviews and egalitarian worldviews predicted support for partial removal, and (3) younger age predicted support for re-use. Some of these associations may appear contradictory but as will be discussed, this may be due to perceived uncertainties surrounding the consequences of each option. More importantly, these findings provide insight into what factors and values are drawn upon during the decision-making process and suggest future directions for engagement, both in New Zealand and the international context.

Neural Networks Trained with Known Algal Blooms Events and Satellite Images for Bloom Detection

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Harmful Algal Blooms (HABs) occur when colonies of algae grow out of control while producing toxic or other harmful effects, e.g., the depletion of oxygen. HABs can cause devastating damage to the ecosystems at coastal areas. Fishes and other marine organisms are at risk of being suffocated or poisoned with toxins; and humans and animals may become ill if they eat poisoned seafood. Besides, impacts on the economy and the coastal ecosystems can be very serious.

In this talk, we shall discuss the development of an algal-bloom detection system which could provide timely notifications of any potential occurrences of HABs. There are departments in Hong Kong Government which collect water sampling data on regular dates, and when there are reported algal bloom events. Unfortunately, the sampling frequency is too low and the collected data cannot offer trends based on nutrient and chemical data. In our project, we examine satellite images with assistance from known algal bloom events to identify and predict the HABs in Hong Kong. Due to the sizes of satellite images, a Big Data computing platform is constructed and neural networks are trained with known algal bloom events. The accuracy and speed in identifying HABs will be evaluated.

Ships and partnership in the Prow

Peter Lawless^{1,2,3}

¹*Top of The South Marine Biosecurity Partnership, Nelson, New Zealand,* ²*The Lawless Edge Ltd, Nelson, New Zealand,* ³*Phoenix Facilitation Ltd, Nelson, New Zealand*

Partnership is critical in becoming effective to prevent harmful marine organisms spreading. The Top of the South Marine Biosecurity Partnership, established in 2009, demonstrates the potential for collaboration in a complex social and ecological environment. Essential elements and lessons learned are illustrated in the context of Tasman, Nelson, and Marlborough. Incident response times, intelligence, surveillance, public awareness, education, and the application of innovative technologies have all been enhanced by the aligned efforts of a wide range of partners, from iwi to industry. Surveillance results are presented showing the spread of pests with and without active containment programmes.

Community leadership in coastal management

Peter Lawless¹

¹*Top Of The South Marine Biosecurity Partnership, , ,*

²*Phoneix Facilitation Ltd, ,*

The core hypothesis of this study was that, by comparing experiences of involving communities in protecting and restoring areas of the marine environment, generally applicable lessons could be found that could enhance New Zealand's capacity to be effective in marine protection.

British Columbia's co-governance of the marine environment with the indigenous people was added after the initial itinerary was set.

The Great Barrier Reef Marine Park displays world best practice in creating and refining a very large, multiple use marine protected area.

The Gully Marine Reserve shows the importance of sustaining processes of influence to capitalise on initial success and the change in mode required when the general political environment changes.

In British Columbia experience a Provincial leadership cut across the Federal neo-colonial style conservatism to make what progress it could in integrated marine management under its own authority.

In the USA it is very hard for any participant to comprehend the whole and there are strong homeostatic forces at play, meaning that any action draws compensating responses that tend to lead to outcomes of delay or cosmetic protection that appears to satisfy the wishes of environmental stakeholders while achieving little in practice.

Catalyst processes are the technologies of dialogue, synthesis and collaboration.

Transformational participatory processes in multi-use/r marine spaces: Is Aotearoa New Zealand (ANZ) leading the world?

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Sustainable Seas project 1.1.1 has created an inventory of 19 relatively independent participatory processes (PPs), outlined conditions in which the PPs are set, and conducted in-depth multi-site interviews in five selected participatory initiatives.

This multi-stage methodology enables examination of both the PP accomplishments in different multi-use/r settings and the effectiveness of each PP in its own right. This reveals the pioneering contributions of ANZ's diverse PPs in terms of their efforts to negotiate future-oriented outcomes that 'stick'.

The findings show much achievement in addressing organising principles and practices that underpin transformational changes and strategizing ways to overcome multiple (contextual and internal) obstacles.

The paper discusses the value of building a culture that confronts power relations and creates possibilities to transition towards social, ecological, economic and cultural outcomes.

The principles and practices identified place the ANZ experiences at the forefront internationally over developments in constructive societal engagement. We draw two conclusions. First, the contemporary PP achievements and their social learning-societal interactions are crucial to any narration regarding the future potential of the country's marine spaces. Second, early efforts put into co-mandating and co-designing PPs are necessary ingredients for transformation but this emphasis should be matched by 'fit for purpose' operational refinements.

The deep-sea fauna of Kaikoura Canyon: impacts of the November 2016 earthquake and evidence for trophic subsidies from river catchments

Daniel Leduc¹, Ashley Rowden¹, David Bowden¹, Scott Nodder¹, Alan Orpin¹, Joshu Mountjoy¹, Max Gibbs², Andrew Swales²

¹NIWA, Wellington, New Zealand, ²NIWA, Hamilton, New Zealand

Kaikoura Canyon is among the most productive non-chemosynthetic deep-sea habitats globally, supporting exceptionally high biomass of mega-infauna and demersal fishes. The turbidity current caused by the 2016 Kaikoura earthquake had a dramatic impact on the seabed fauna, with seabed video 10 weeks after the event showing no signs of benthic invertebrate life. Here, we provide further insights into the ecology of the canyon's seabed fauna through analysis of samples and data obtained pre- and post-earthquake, including preliminary findings from voyages ten weeks and ten months after the event. The abundance and biomass of macro-infauna were high prior to the earthquake and decreased markedly afterwards, but seabed images 10 months after the earthquake show signs of recovery, including bioturbation marks, foraminiferan and polychaete tubes, high abundance of rattail fishes, and recruitment of urchins and sea cucumbers. Stable isotope analyses show that land-derived organic matter may be assimilated by seabed invertebrates, thus contributing to the high productivity of the canyon by providing an additional food source. Despite their immediate destructive impact on seabed communities, earthquake-triggered flows may have a positive influence on canyon ecosystems through periodic transportation of large quantities of organic material from the coast to the deep sea.

Quantifying the transfer of terrestrial organic matter into the Kaikōura and Hokitika submarine canyons using bulk and compound-specific stable isotopes

Dr Andrew Kingston¹, **Daniel Leduc**¹, Max Gibbs², Andrew Swales², Brittany Graham¹, Scott Nodder¹, Ashley Rowden¹

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Submarine canyons that incise the continental shelf facilitate the transfer of particles from shallow waters to the deep ocean, thus providing a link between the terrestrial and deep marine environments. However, our ability to study the transport of organic matter is hampered by the remote nature of these systems and limitations of existing tracer methods. Here, we examine stable carbon and nitrogen isotope values of organic matter from sediment cores to assess the proportional contribution of terrestrial and marine sediment sources in two of New Zealand's submarine canyons, Kaikōura and Hokitika. Bulk $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values were used in mixing models to evaluate terrestrial and marine contributions to deep-sea canyon organic matter. Then, using compound-specific stable isotope analysis of natural biomarkers ($\delta^{13}\text{C}$ of fatty acids) and multivariate mixing models, we quantified the contributions of individual rivers and marine sources to sediment organic matter along depth gradients in the canyons. The results from this study indicate significant differences in the origin of organic matter along these two canyon systems, and suggest that the magnitude of suspended sediment yields from rivers is an important factor influencing organic matter transport into submarine canyons.

Epibiotic pressure contributes to biofouling invader success.

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Reduced competition is a frequent explanation for the success of many introduced species. In benthic marine biofouling communities, space limitation leads to high rates of overgrowth competition. Some species can utilise other living organisms as substrate (epibiosis), proffering a competitive advantage for the epibiont. Additionally, some species can prevent or reduce epibiotic settlement on their surfaces and avoid being basibionts. To test whether epibiotic pressure differs between native and introduced species, we undertook *ex situ* experiments comparing bryozoan larval settlement to determine if introduced species demonstrate a greater propensity to settle as epibionts, and a reduced propensity to be basibionts, than native species. Here we report that introduced species opportunistically settle on any space (bare, native, or introduced), whereas native species exhibit a strong tendency to settle on and near other natives, but avoid settling on or near introduced basibionts. In addition, larvae of native species experience greater larval wastage (mortality) than introduced species, both in the presence and absence of living substrates. Introduced species' ability to settle on natives as epibionts, and in turn avoid epibiosis as basibionts, combined with significantly enhanced native larval wastage, provides a comprehensive suite of competitive advantages contributing to the invasion success of these biofouling species.

Population demographics of sevengill sharks (*Notorynchus cepedianus*) in Sawdust Bay, Stewart Island.

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The broadnose sevengill shark (*Notorynchus cepedianus*) is an abundant large marine predator found around coastal New Zealand. Data on the ecology of the species are severely lacking and anthropogenic impacts are unquantified. To partially address this, we studied the demographics of a population in Paterson Inlet, Stewart Island. Sampling trips were carried out over six seasons from winter 2016 to spring 2017. A baited remote stereo-video system (BRUV) was deployed on 81 occasions (mean = 13.5 deployments per season) in a shallow coastal embayment to capture underwater video of the sharks for photo-ID capture-recapture and photogrammetry. Sevengill sharks were recorded on all but one deployment, and 78 individuals were subsequently measured using the image analysis software Vidsync 1.1661. Total lengths ranged from 149.0 to 276.5 cm (mean = 211.4, S.E. = 2.97). There was no significant difference among seasons in the size classes that used the study area ($F(5, 129) = 1.60$; $p = 0.16$). The observed sex ratio was heavily biased, with females making up 95% of the population in winter 2016 and 73% in summer 2017. This study presents the first data on population demographics of sevengill sharks in New Zealand and can be applied in future conservation management of the species in Paterson Inlet.

Multispecies analysis of genetic diversity: emergent patterns across the Indo-Pacific Ocean and initiating a collaborative research network in New Zealand

Dr Libby Liggins^{1,2}, Diversity of the Indo-Pacific Network, Ira Moana - Genes of the Sea - Network

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Patterns of genetic diversity provide a window into the past and present demography of a focal species, and can inform their conservation management. Despite the potential for genetic diversity information from a whole assemblage of species to provide insight regarding the origin, maintenance, and future of biodiversity, there have been few synthetic analyses of genetic diversity patterns in the marine environment. Many researchers independently collect genetic data for marine organisms, but combining these data has been previously impeded by data accessibility and interoperability of database infrastructures. The Diversity of the Indo-Pacific Network (DIPnet) has formed the Genomic Observatory Metadatabase (GeOMe) to provide a centralised repository for genetic data. GeOMe is now the most extensive database of georeferenced DNA sequences comprising over 36,000 individuals and 230 species. I will present the first multispecies, synthetic analyses regarding genetic diversity patterns for Indo-Pacific marine organisms, conducted by DIPnet and based on GeOMe data. I will then discuss extension of the network into New Zealand. The Ira Moana - Genes of the Sea - Network invites the participation of all marine researchers who produce genetic data, or have an interest in using genetic data to help manage our marine environment.

Weaving the threads of climate change into the management of fisheries

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Fisheries New Zealand is funding research initiatives to better inform our managers about the types of changes we expect to see in the ocean, how the underpinning ecosystems may change, and our fish populations may respond. We are also considering how climate change science helps understand the ecosystem to help us make practical and meaningful fisheries management decisions. Fisheries science is a complex beast that requires a robust understanding of the biology and life histories of fish stocks as well as the complexities associated with interpreting abundance data, catch-effort data, fishing gear and economics. In New Zealand, we have moved beyond the simple acknowledgement that climate change and ocean acidification are happening and think that they will have direct and indirect effects on fish productivity. Detecting the effects of changing environmental conditions on fish productivity and separating them out from fishing effects is difficult, and our stock assessment models are only just beginning to consider the issue. In this talk, we will describe how we are trying to weave together all the different threads to better understand potential changes in the marine environment, and hence build resilience to increasing extremes and long-term environmental change in fisheries.

Rapid responses of Antarctic coastal benthic communities to recent sea ice breakouts

Drew Lohrer¹, Joanna Norkko², Jen Hillman³, Simon Thrush³, Vonda Cummings¹, Alf Norkko²

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Seafloor organisms in Antarctica are important bellwethers of change, and there is empirical evidence of links between sea ice characteristics and coastal seafloor community structure. A major component of the food that feeds coastal seafloor organisms comes from diatom-dominated under-ice algal communities, which are affected by sea ice characteristics. Here we discuss results from New Harbour in 2009, when the sea ice had not broken out for more than a decade, relative to 2017, after recent sea ice breakouts. The quantity of detrital algal material in the sediment was ten times higher in 2017 than it was in 2009, rates of oxygen consumption measured in our seafloor incubation chambers were roughly three times higher in 2017 than 2009, and photos from 2017 and 2009 show an explosion of life in the intervening period (particularly arborescent bryozoans and *Homaxinella* sponges). These changes are likely a response to the recent break-outs of sea ice from New Harbour and show the importance of sea ice characteristics to seafloor biota and ecosystem functions. The relatively rapid transformation that was documented runs counter to the existing paradigm that Antarctic seafloor biotic communities are stable, long-lived, and slow growing.

Risk profiling and compliance under the Craft Risk Management Standard for Biofouling

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The Craft Risk Management Standard for Biofouling (CRMS) aims to manage the biosecurity risk associated with international vessel biofouling, by requiring vessel operators to manage biofouling prior to arrival in New Zealand. Prior to arrival, vessels are risk profiled based on information submitted to the Ministry for Primary Industries (MPI), including information on the vessel's antifouling system, voyage history, and records of biofouling management. Similarly, compliance with the CRMS is based on a vessel's ability to submit documentation showing that the requirements of the standard have been met. Data from several vessel surveys and other research inform risk profiling and compliance, so that in most cases, MPI can be confident that biofouling has been managed without having to physically verify the condition of the vessel's hull. In order to ensure that MPI's risk profiling is accurate, a percentage of vessels undergo a desktop verification, and high risk vessels may be subject to physical verification in the form of a dive inspection. Data from these verification processes can be used in the future to further refine these assessments and increase confidence in the risk profiling process.

Characterisation of New Zealand King Salmon Whole Blood for Immunological Assays

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In vivo studies on fish physiology have ethical limitations, are time consuming and costly. Thus, analyses that can be performed on blood samples drawn without killing the animal are often a preferred option. Fortunately, technical procedures for in vitro fish blood experiments have been emerging recently. For instance, peripheral blood mononuclear cells (PBMCs) have been employed in fish proteomics, toxicology, and immunology. Thus, fish PBMCs can serve as model cells for in vitro use in integrated metabolomics and Muse[®] flow cytometry without euthanasia. This approach provides a quick physiological snapshot of fish cells under experimental conditions, thus revealing important clues for better aquaculture management. In Atlantic salmon, *Salmo salar*, PBMCs have been characterised for in vitro immunological use, but not in New Zealand King salmon (*Oncorhynchus tshawytscha*), a key product for New Zealand aquaculture. Following standard protocols, we characterized NZ King salmon whole blood cells, and isolated PBMCs using Lymphoprep[™]. Preliminary results indicated that fish blood is composed of 92.06% RBCs, 0.25% thrombocytes and 7.69% lymphocytes. Additionally, isolated PBMCs were majorly composed of lymphocytes and monocytes. Finally, average total cell counts per μL , 1.26×10^6 were within the range for Atlantic salmon, and Rainbow trout, *Onchorhynchus mykiss*. Further studies are being conducted to use isolated PBMCs from NZ King salmon blood for analysis using metabolomics and Muse[®] flow cytometry approaches.

Sustainable Seas: where is the waka going?

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The Sustainable Seas National Science Challenge is currently finalising Phase II of its research plan which, if funded, will begin in July 2019. Here we place in context the highlights of the research performed during Phase I that underpin the research proposed for Phase II. We will also introduce the four thematic topics that form the backbone of Phase II of our research plan. These four themes (Understanding degradation and recovery in marine social-ecological systems, Creating value from the blue economy, Addressing risk and uncertainty, and Enhancing ecosystem-based management in practice) build on the learnings of Phase I, and provide a template for further integration of the transdisciplinary research already completed. This session of Challenge highlights will conclude with a panel discussion session with the Challenge Science Leadership Team to answer audience questions about Phase II research plans and processes.

The use of decision support tools to inform spatial planning of the South Pacific High Seas

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Decision support tools have been developed to facilitate spatial management planning, utilising various computational methods to select representative sets of priority areas to conserve biodiversity over extensive geographic areas, while at the same time minimising the cost to existing users. Here, we discuss the use of the decision support tool Zonation to support a stakeholder process to design revised spatial management of the South Pacific high seas for a process initiated by the South Pacific Regional Fisheries Management Organisation (SPRFMO). We detail how stakeholders directly contributed to the decisions required to parameterise the tool, including: the choice of datasets to represent the range of priorities of the stakeholders, including which taxa to include to best represent Vulnerable Marine Ecosystems using predictive habitat suitability layers, and the weighting of uncertainty in these layers; other biodiversity layers reflecting 'rarity and uniqueness'; layers developed by industry to represent an index of value to the fishery that included a novel 'buffer zone' to allow for logistics of deploying gear; a 'naturalness' layer to incorporate prior disturbance history; regional and depth (<3000 m) boundaries; and choice of Zonation model options such as aggregation parameters. Potential spatial closures were further iterated by stakeholders, and a draft revised spatial management plan was presented to the SPRFMO Commission in January 2018.

NZROCS: an ocean climatology of primary production in the NZ region. Part 1: Model Setup

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NZROCS: an ocean climatology of primary production in the NZ region
Part 1: Model setup

Climate change, aquaculture, tourism and runoff from changing land use all put strain on New Zealand's oceans. Global models of biogeochemical dynamics are not capturing processes and dynamics which are important to the New Zealand region which is limiting our ability to study these stressors in the region. To aid in understanding of biogeochemical dynamics in the region, we are building a New-Zealand specific coupled physical-biogeochemical model. The model presented here captures processes on spatial scales of approximately ~20 km and covers the whole of New Zealand. This model is setup using PISCES, a biogeochemical model within the framework of physical model, CROCO (see <https://www.croco-ocean.org>). This model can recreate climatological means in physical and biological variables and improves on CMIP-5 models for the region. The model can also reproduce the subsurface chlorophyll maximum and we look at some of the factors affecting this. This model is proving to have the skills required to be a useful as a tool for understanding and managing New Zealand's oceans.

What can Fisheries New Zealand data and research do for you?

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Fisheries New Zealand and its predecessors have collected a substantial amount of marine and fisheries research data, with many time series of 30 years and some that extend back 90 years. Much of the early data relate to fisheries landings but since the 1990s we have been collecting an increasing amount of new information on the marine environment including commercial and non-commercial marine fish and invertebrate species, marine mammals, seabirds, habitats and biodiversity. Data sources include catch and effort by species, observer data, statistically-designed research surveys, and focussed research projects. Fisheries stock assessments, sustainability risk analyses, and biodiversity and ecosystem analyses are being undertaken using these data, but they have mostly been used for fisheries management. There is considerable scope for these data to be used for much more in-depth examination and analysis, and development and testing of hypotheses. Potential further applications include more detailed examinations of how species mixes change over a variety of spatial and temporal scales, further development of biodiversity and ecosystem indicators, a greater understanding of species distribution and habitat utilisation, and examination of the potential impacts of environmental variation and climate change on our marine environment. The scope of this research is limited only by your imagination. Talk to us!

Application of molecular assays for rapid diagnosis of paralytic shellfish toxin producing micro-algae in seawater and sediments

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The establishment of large scale offshore shellfish aquaculture presents new challenges for harmful algal bloom (HAB) monitoring. With support from the Sustainable Seas Innovation Fund, several quantitative polymerase chain reaction (qPCR) assay formats (conventional qPCR, Aquila Hydrogel, Phytoxigene DinoDTec STX gene assay) were evaluated for the routine screening of seawater and sediment samples for the presence and abundance of toxic dinoflagellates and their resting cysts. The emphasis was on the trial of fast low-cost methods that can be applied by industry in real-world aquaculture settings. The results of validation trials comparing the different methods will be presented.

Temporal and spatial variability in light climate across New Zealand's estuaries

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The penetration of light to the sea floor within coastal ecosystems provides the basis for productivity through benthic primary production. Both the intensity and duration of light will vary seasonally and latitudinally within and between regions respectively. Within intertidal habitats these seasonal fluctuations will additionally be influenced by the total suspended sediment within the water column, cloud cover and tidal height among other abiotic factors. This temporal and spatial variability will have local implications for energy budgets of sessile primary producers which will alter the overall contribution to total primary production and the carbon cycle. Here we use PAR (photosynthetically active radiation) data collected continuously over 8 months at 24 sites throughout the North and South Island of New Zealand to investigate how cloud variation, turbidity and tidal height influence light climate in intertidal habitats.

Recovery of rocky intertidal invertebrates following earthquake disturbances

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The magnitude 7.8 Kaikōura earthquake on 14th November 2016 resulted in various degrees of intertidal uplift along the coastline and significant loss of intertidal invertebrates. This presentation describes the effects of earthquake disturbances on the population structure, abundances and health of limpets, cats' eyes snails and paua from along the Kaikōura coastline. Although there was high mortality of some species, surviving organisms appear to be resilient to earthquake disturbances, maintaining their body condition and becoming reproductive. Marine intertidal invertebrates on the Kaikōura Peninsula have been disturbed less than those in areas to the north and south, which experienced up to 4-6m of uplift. Our current research suggests that marine gastropods on the Kaikōura Peninsula are recovering well and that this is an important part of the recovery process.

Encapsulation technology: A tool to reduce feed wastage in aquaculture

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In aquaculture, feed accounts for more than 50% of the production cost. Commercial feeds are simplistic, lack animal specificity, disintegrate/leach in water and have poor consumption rates accounting for enormous wastage. New Zealand paua industry is a growing aquaculture sector with a significant export value. However, considerable costs from wastage of commercial feed has been pointed out by the industry as an influential factor in limiting the net output. Encapsulation technology is a novel approach in aquaculture that can be utilised to develop new forms of paua feed with improved features including high consumption rate, less nutrient leach and low disintegration rate in seawater. In this study, feed particles were formulated from natural polymers containing probiotics and nutrients specific for paua. The developed feed pellets were stable in seawater for up to 10 days. The matrix erosion test confirmed 3.2 ± 0.3 , 20 ± 1.8 and 26.5 ± 1.8 percent weight loss after 3, 4 and 10 days of incubation in seawater respectively. Initial feeding trials showed 92-100% consumption rates for feed particles, which was significantly higher than the consumption rate of commercial feed (12-50%). Once implemented, this novel feed technology will significantly boost paua production on New Zealand.

A biogeographic baseline of Taranaki sponge communities: assessing the effects of catchment runoff and reviewing stability of species assemblages.

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Characterisation of biogeographic regions around New Zealand has largely relied on collection records of a few key taxa. There are few studies on biogeographic distribution of sponges (Porifera), a group that arguably would better reflect prevailing coastal conditions. Sponge demography reflects the physical and biological microenvironment, hence sponges constitute a useful target for assessing trends in neritic system response to both land sourced stressors and oceanic change.

Land use intensification can substantially increase the rate of sedimentation and input of associated rural and urban contaminants to coastal marine environments. Studies examining the impacts of poorly managed catchment runoff have demonstrated a decline in coastal biodiversity and ecological function as a direct result of cumulative stressors. Added to direct coastal input, is the spectre of shifts in oceanic current systems associated with Climate Change altering larger scale coastal ecology. Biogeographically, the Taranaki nearshore coastal region is not well characterised. Remarkably, sponge species diversity within the Taranaki region (@55 sp. per 100 m²) is greater than the diversity of sponges found within the tropics (@45 sp. per 100 m²). This is surprising as land-derived sediments increasingly affect this coast.

Research on the stability of biogeographic zones around Taranaki's coast, as characterised by sponges, will be examined to test the impact of sedimentary regimes associated with different land use practices.

Paua population biomass estimates and monitoring following the Kaikoura earthquake

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The coastal uplift caused by the 2016 Kaikoura earthquake resulted in massive paua mortality and loss of critical paua habitats. This has led to a closure of the paua fishery in the affected areas. We have developed novel methodologies to estimate adult paua biomass along the earthquake-affected coastline, and established fixed monitoring points to monitor individual paua aggregations. We have observed notable variation in paua abundance and individual population recovery along the coastline. This is attributable to the extent of coastal uplift, the prior status of the fishery, and ongoing environmental changes. These early findings, supported by ongoing monitoring and results from other projects, will help inform decisions about when and at what level paua fishing may resume, and the management scales that should be implemented.

Example of a decision-matrix approach for Tasman Bay and Golden Bay scallop ecosystem management using Bayes-Decision-Nets (BDNs)

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Ecosystem Based Management (EBM) decision making is typically challenged by the need to consider a diverse mix of stakeholder (e.g. primary producers, environmentalists, first-nation people) societal values and perceptions. In New Zealand the implementation of EBM in the marine environment is difficult due to significant gaps in our understanding of coastal ecosystem responses to degradative pressures such as sedimentation, eutrophication, benthic disturbance, over-fishing and climate change. In order for marine environmental management measures to be fully accepted and adhered to stakeholder involvement in EBM decision making is critical. Marine EBM decision making thus involves balancing, often disparate, stakeholder environmental desired outcomes on the basis of incomplete ecological knowledge with due regard to risk and uncertainty.

In this talk we present an example of a decision matrix approach for Tasman Bay and Golden Bay scallop ecosystem management. The management decision matrix provides a means by which alternative management strategies can be evaluated against stakeholder-defined environmental objectives. Our management decision matrix is informed by an Bayes-Decision-Net (BDN) which has, in turn, been structured to reflect predictions from an Atlantis ecosystem model and 'expert' opinion. It is important to note this work has been undertaken to show how BDNs can be applied to an EBM scenario, the models presented are currently not being used for TBGB scallop management.

Tracking waste from aquaculture into infauna communities in the Marlborough Sounds; combining community and biochemical data in a quantitative analysis

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Development of high input aquaculture farming of salmon creates significant challenges and opportunities in the context of ecosystem-based management. Large inputs of feeds to farms and the production of organic wastes have the effect of increasing the ecological source and sink footprints of the farm. Here we have used forensic chemistry techniques to model the flows and fates of organic waste in response to nearby aquaculture operations, and to describe how food web structure is altered by these inputs of detritus.

Data from benthic grab samples collected at four farms sites, and two reference sites in the Marlborough Sounds were used to resolve patterns in density and biomass of infauna invertebrate communities among sites. Analysis of stable isotopes (^{13}C and ^{15}N) of individual taxa allowed us to model net incorporation of organic matter from salmon farm waste in terms of biomass per unit area, into benthic communities.

Our analyses are the first to quantify the flux of salmon farm waste entering infaunal food webs for whole communities of benthic invertebrates. The results highlight species likely to be important processors of detritus produced by the farms. Results from the present study have important implications for understanding how marine communities respond to further aquaculture development, how negative impacts may be mitigated and the role of natural communities in processing waste.

Marine Pest Management in Hawke's Bay

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Vessel movement is a primary pathway for the spread of invasive marine species. Currently, the Hawke's Bay Regional Council Proposed Regional Pest Management Plan (RPMP) is going through the consultation process – Mediterranean fanworm (*Sabella spallanzanii*) and clubbed tunicate (*Styela clava*) are proposed to be included as Exclusion Pests. This presentation will outline how a small Regional Council with a limited budget is looking at managing some of the high risk pests in the marine environment. The catalysts for including these pests in the RPMP, the tools we will use to assess the level of risk incoming vessels pose and how we will deal with vessels deemed high risk will also be discussed. Hawke's Bay Regional Council is a new partner of the Top of the North Marine Biosecurity Partnership which has provided valuable feedback on our proposed programme.

Modelling the spatial dynamics of Maui dolphins using individual based models

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Individual based models are an obvious choice for answering ecological and conservation questions, especially for endangered species with small populations. Proper parameterization of these models is challenging and time consuming. We have calibrated an individual based model of Maui dolphin movement, to generate Maui dolphin probability distribution maps. These will then be used to examine the overlap between Maui dolphins and fishing methods known to cause dolphin mortality, in particular gillnets and trawling. Sighting data were used for validation of the movement parameters. For each run of the model, we compared simulated dolphin movements to empirical data (line-transect surveys, observations of hourly movements, home range data, etc). First, each of the movement parameters was tested in a one-at-a-time sensitivity analysis. Three of the four parameters had a significant effect on the model's Goodness of Fit. Second, different combinations of these three parameters were simulated. We estimated the most likely parameter combinations based on Goodness of Fit. Maui dolphin probability distribution maps were then created, using these calibrated parameter values. These maps indicate that there is still considerable overlap between dolphins and fishing methods that cause dolphin mortality. This is consistent with sightings outside protected areas, and which the recommendations from the International Whaling Commission and IUCN to ban gillnets and trawling throughout the range of Maui and Hector's dolphin.

Establishing new marine reserves: Using species presence data to increase conservation of biodiversity

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Marine reserves are an effective way to protect biodiversity and are included in the 2016 New Zealand Biodiversity Action Plan. This plan published conservation goals based on the 2010 Aichi targets in order to increase conserved biodiversity. In order to meet our targets, New Zealand must adopt a standardized planning framework for establishing marine reserves with the goals of increasing protection, species richness and taxonomic distinctness.

A database of species protected within current marine reserve boundaries was created based on literature sightings and the online database OBIS (Ocean Biogeographic Information System). This new database was used to investigate/detect patterns between current reserves and was compared using a number of environmental factors. In combination with metrics like taxonomic distinctness, this information can be used to indicate the candidate sites for new marine reserves which would yield the biggest increase in conserved biodiversity for NZ's marine reserve network.

The addition of this information to the planning framework could provide conclusive results as to whether implementing a new reserve at any location will assist New Zealand in achieving our Aichi biodiversity targets by 2020. In turn, this could increase the sustainability of New Zealand's marine management.

Mesozooplankton grazing and selectivity on natural prey communities during the 2017 CARIM mesocosm experiment

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Copepod grazing can have significant top-down control on phytoplankton biomass and assemblage composition, which can ultimately shape higher trophic level dynamics. Though copepods have largely been thought tolerant of ocean acidification, previous findings suggest future ocean conditions may affect copepod feeding behavior both directly (e.g. via changes in metabolic demands) and indirectly (e.g. via changes in prey nutritional quality). To assess the effect of ocean acidification and warming on mesozooplankton grazing and feeding selectivity, we employed three 24-hour feeding incubations using copepods and natural prey communities under conditions predicted for years 2100 (+2.6°C, -0.33pH) and 2150 (+4.5°C, -0.5pH) during a 21-day mesocosm experiment. Experiments were designed to account for multiple trophic interactions occurring inside the incubations. Here we present mesozooplankton grazing rates and selectivity indices, corrected for trophic cascade effects resulting from mesozooplankton grazing on microzooplankton, under future ocean scenarios.

Eyes in the water: expanding our knowledge of rare and subtropical fishes in North East New Zealand using citizen science.

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The scientific literature has only sporadic accounts of tropical and subtropical fishes in New Zealand waters. Yet there are a vast amount of unexplored sightings that could be used to better understand the biological and environmental drivers for the immigration of these fishes into our waters. Citizen scientists including divers, spearfishermen, underwater photographers and game fishers often encounter and record sightings of 'unusual fishes' on social media. Overseas, analysis of datasets based on similar records have contributed to our understanding of long-term shifts in the distribution and abundance of fishes within temperate ecosystems. Such citizen science data regarding subtropical fishes in North Eastern New Zealand have not previously been consolidated, validated, and included in the scientific literature. I will present our first attempts at building a database to capture these valuable data points from targeted interviews and social media sources. Results from the citizen observations include several new records of subtropical fish species for New Zealand, including first-ever records, and likely range extensions. I will discuss biological trends (taxonomic and trait-mediated) in the new species records and the how these fish species may contribute to the species richness and diversity of North East New Zealand.

Co-seismic seafloor landslides and canyon change associated with the 2016 Kaikōura Canyon flushing event

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The 2016 Kaikōura earthquake triggered widespread landslides in the Kaikōura Canyon initiating a canyon flushing event and turbidity current that travelled >680 km along the Hikurangi Channel. Based on data from repeat echosounder surveys over the entire canyon system, as well as sediment cores from the canyon and channel, we can quantify seafloor landscape changes in the canyon and the magnitude of the sediment flow deposit (turbidite). We calculate an inter-event time of ~140 years, indicating a canyon incision rate of 40 mm per year, substantially higher than that of most terrestrial rivers. The event synchronously transferred large volumes of sediment (850 Mt) and organic carbon (7 Mt) to the deep ocean, and had a dramatic effect on the documented high-biomass benthic community in the canyon. Our observations demonstrate that earthquake-triggered canyon flushing is a primary driver of submarine canyon development for the Kaikōura Canyon, and for canyons globally. Canyon flushing is a fundamental process of material transfer from active continental margins to the deep ocean and our results provide an opportunity to gain significant insight into the functioning of benthic ecosystems in high-disturbance areas.

Quantifying fish functional trait variation across depth and latitude.

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Coupling studies of taxonomic diversity with functional diversity enables prediction of ecological processes, ecosystem services, and resilience. While our understanding of taxonomic diversity across the depth gradient has increased considerably over recent years, we know little about functional diversity changes across depth. Physical and biological changes associated with increasing depth include decreasing light, temperature, trophic resources, and increasing pressure. However, change in these parameters across depth is also expected to interact with latitude. My research aims to quantify how functional traits of fishes change with both depth and latitude. Fish community composition was obtained from stereo-baited remote underwater video footage in 7 locations from subtropical to subantarctic New Zealand, spanning 21 degrees of latitude, and across 7 depth strata (50m, 100m, 300m, 500m, 700m, 900m, and 1200m). Trait measurements were taken for 147 species from preserved specimens held in museum collections. My presentation will discuss how novel morphological traits that capture changes in body shape, gape/feeding ability, and locomotion/maneuverability vary in multivariate space along the depth gradient. I will then discuss the interaction of these traits changes across depth with latitude, and further explore the potential mechanisms shaping these relationships using univariate analysis of individual traits.

What can octopus see? A behavioural study of visual acuity.

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Octopuses are highly visual animals, relying on visual cues for a variety of ecologically relevant tasks such as hunting, communicating, and camouflaging. Their remarkably sensitive camera-type eyes provide them with a highly developed sense of vision. Nevertheless, the limits of octopus spatial resolution have not been studied. We presented octopus (*Octopus tetricus*) with parallel dark and bright lines of different widths over a grey background, allowing us to measure both behavioural contrast sensitivity and visual resolution. We show that octopuses have a maximum sensitivity to a frequency of 0.3 cycles per degree of visual angle, decreasing towards both lower and higher frequencies, and they can detect contrast as small as 2%, which is very similar to human contrast sensitivity. Furthermore, octopus visual resolution is close to the anatomical limit set by the distance between photoreceptors, indicating that the octopus eye has exceptionally good optics. The shape of the contrast sensitivity function implies that octopus has neural processing of images which enhances object borders. This is of great ecological importance for octopuses, as edges are one of the most important environmental features determining camouflage patterning, an essential aspect of octopus behaviour.

What's underneath the water?

Helen Neil^{1,2}

¹NIWA, , , ²On behalf of Sounds Survey - Hydrographic survey of Queen Charlotte Sound/Tōtaranui and Tory Channel/Kura Te Au; LINZ, MDC, NIWA, DML., ,

Here we consider the science requirements of the Hydrographic Survey of Queen Charlotte Sound/Tōtaranui and Tory Channel/Kura Te Au and how they address the need to provide a detailed appraisal of the coastal marine area, to assist Marlborough District Council (MDC), industry and the community better understand, sustainably manage and protect resources and important coastal marine ecosystems. In addition to the Safety-of-Navigation components, data will also be used to assess the bathymetry, type of substrate or sediments (e.g. hard gravel or soft mud), and what else is on and above the seafloor such as cables, kelp beds and biological aggregations (schooling fish), and geological and anthropogenic structures.

The project will provide a rich snapshot of the extent and distribution of different habitat types of the seafloor. This will include identifying habitats important for biodiversity, new avenues for marine research, eco-tourism opportunities, and will deliver a base for assessing the effects of economic activity.

100% of the World Ocean floor mapped by 2030 Contribution of the South and West Pacific Regional Data Assembly and Coordination Centre to the Nippon Foundation-GEBCO

Helen Neil^{1,2}

¹NIWA, , , ²On behalf of Seabed 2030 South and West Pacific Centre; Nippon Foundation, GEBCO, NIWA, LINZ, GNS, ,

GEBCO and the Nippon Foundation have joined forces to establish the Seabed 2030 Project, an international effort with the objective of facilitating the complete mapping of the world ocean by 2030. NIWA, GNS Science and LINZ will be leading the Regional Data Assembly and Coordination Centers (RDACC) for the South and West Pacific region of some 123,000,000 km² from South America to Australia to SE Asia up to 50°N. We will be responsible for assembling cleaned bathymetric dataset; develop protocols for data collection and tools to assemble and attribute appropriate metadata. We are responsible for identifying data gaps and opportunities for new data collection, including the facilitation of new mapping endeavors through coordination of groups of regional experts in Regional Mapping Committees. Encouraging the development of new technologies that can increase the efficiency of seafloor mapping, including crowd sourcing, will be key.

Distribution and extent of rocky reef habitats, Kaikoura

Helen Neil^{1,2}

¹NIWA, , , ²On behalf of Hydrographic Survey of Kaikoura; LINZ, NZ Fisheries, iXblue, NIWA, ,

Land Information New Zealand (LINZ) undertook a multi-beam hydrographic survey of the Cape Campbell to Kaikoura coastline, in partnership with NZ Fisheries. An iXblue survey provided a subset of seven key areas to NIWA specifically for the identification of distribution and extent of rocky reef habitats, following the Kaikoura 2016 earthquake. In particular, priority areas around Kaikoura and Cape Campbell were identified.

This baseline survey provides an accurate characterisation of geomorphic features, classification of substrates and therefore physical habitats, and characterisation of kelp beds extant in the water column. This will enable an assessment of the variable and at times significant impact of the Kaikoura earthquake, provide the new baseline to inform management in the coastal region, and allow future identification of biogenic habitats important for biodiversity and recovery.

Showcases of Metabolomics Applications in Studies of Bivalve Immunity

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Metabolomics (the broad-scale analysis of metabolites in biological samples) is one of the fastest growing “omics”. A dramatic increase of metabolomics applications in the field of life science, especially in aquaculture research has been observed in recent years (Alfaro and Young 2016; Young and Alfaro 2016). As metabolites are end-products of cellular regulatory processes, metabolomics could provide a novel phenotyping tool for understanding endogenous metabolic changes of an organism in the course of a biological process promoted by disease or environmental perturbations. In our recent studies, we have shown the successful application of integrated metabolomics approaches with novel flow cytometric techniques to provide insights into the molecular mechanisms of bivalve immune responses against pathogens and/or environmental contaminants. In this presentation, we showcase three examples where this integrative approach is used to characterize the metabolic and immunological responses of marine bivalves to pathogenic *Vibrio* sp. infection, lipopolysaccharides and copper exposure. Generation of metabolic signatures specific to different external stressors may provide valuable information to identify new intervention points and develop remediation strategies for infectious diseases and environment management in aquaculture. These studies also highlight the significant potential of metabolomics applications in studies of bivalve immunity that could be expanded to other aspects of marine science in the coming years.

Organic carbon transfer to the deep ocean by a co-seismic turbidity current event during the Kaikōura earthquake

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Significant ground-shaking events have the potential to transfer substantial organic carbon and other geological materials into deep-water environments via submarine mass transport processes along the continental margin. This carbon is effectively sequestered and restricted from further interaction with near-surface processes, thereby acting as a geological “sink” in the marine carbon cycle.

The November 2016 Kaikōura earthquake sequence caused significant local and regional ground-shaking that resulted in submarine mass failure in the Kaikōura Canyon. This event also led to the initiation of a co-seismic turbidity current and the deposition of deep-ocean turbidite deposits, at least ~300 km from source. As part of the scientific response to the earthquake, a series of new sediment cores were collected in Kaikōura Canyon itself, along the path of the turbidity current (Hikurangi Channel) and from adjacent submarine canyons. Organic carbon measurements of pre- and post-Kaikōura deposits indicate that the inferred Kaikōura deep-sea turbidite contains higher average amounts of carbon (and nitrogen) than pre-turbidite sediments, suggesting greater carbon sequestration potential during such episodic events. Comparable $\delta^{13}\text{C}$ and molar C:N ratios between these units indicate that similar geological materials have been mobilised during the co-seismic event as were being deposited on the pre-turbidite “modern” seafloor.

Oceanic extent of buoyant plumes from small rivers revealed by underwater gliders

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River plumes are ubiquitous features in the ocean and their distinguishable brown water is regularly spotted from a plane or satellite. The oceanic extent of these plumes is controlled, conceptually, by near-field processes that regulate the vertical and horizontal plume structure. However, the far-field length scales of river plumes and any potential impacts on ecosystems are practically unknown due to a lack of observations. New observations from coastal moorings and an ocean glider reveal the presence of a river plume in outer Hauraki Gulf, some 150 km from rivers in the southern Firth of Thames. Over three weeks, the plume was advected seawards by tides and residual flows with wind stress mixing the plume vertically to a maximum thickness of ~40m. The far-field plume thickness is ultimately a balance between the Earth's rotation and amplitude of local wind forcing. River flows responsible for this far-field plume came from several storms during spring 2016, indicating that the impacts in the ocean are far longer (in time and space) than the weather associated with storms. A rethink of what happens to polluted rivers flowing into the ocean is required with more storms (and rainfall) events expected in a changing climate.

Invertebrates, Indicators and the Integration of Marine Conservation and Management

Dr Jack O'Carroll¹

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Applied ecological research has resulted in the development of biometric assessment techniques, central to which is the understanding of the structure and function of ecosystems. This presentation draws on results of applied ecological case studies from the intertidal to the continental shelf, which outline the development of novel biometric assessment techniques. The focus of these studies was the interaction of the benthos with aquaculture and tidal energy. The findings highlight the potential for biometric assessment techniques to integrate marine conservation and management initiatives across multiple strands of regulation within a European context.

Co-seismic turbidites along the southern Hikurangi margin triggered by the Kaikōura earthquake

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Turbidite records of pre-historic earthquakes underpin our improved understanding of the pre-historic seismic behaviour and hazard represented by the Hikurangi subduction margin; New Zealand's largest yet most poorly constrained source of seismic hazard. Sediment cores allow the along-strike correlation of deep water turbidite deposits formed in response to earthquake strong ground motions. The 2016 Mw7.8 Kaikōura Earthquake triggered a collapse in the outer-shelf rim of the Kaikōura canyon and a canyon-flushing event (Mountjoy et al., 2018). An unprecedented opportunity now exists to examine a modern analogue and calibrate the along-strike variability of deep water turbidite deposits formed in response to measured ground motions. In addition to Kaikōura canyon, a number of slope-basin distributary systems along the southern Hikurangi margin have preserved a co-seismic event, characterised by a fluidised mud unit that is unbioturbated, faintly laminated and weakly graded. It immediately overlies a bioturbated and oxidised mud, interpreted to be the pre-earthquake seafloor. Recent emplacement of the turbidite and burial of pre-earthquake seafloor are confirmed on the levee of the Hikurangi channel by the very-short lived radioisotope ²³⁴Th in concert with CT data (Mountjoy et al., 2018). In addition, re-coring at critical locations is showing the progressive evolution of the event deposit and will inform our understanding of its preservation potential in the geologic record.

Elevated CO₂ impacts growth and respiratory performance in yellowtail kingfish (*Seriola lalandi*) aquaculture

Mr Hsiao-Heng (Tony) Pan¹, Mr Dave McQueen², Mr Steve Pether², Dr Neill Herbert¹

¹University Of Auckland, , , ²NIWA, ,

Accumulation and high concentration of dissolved-CO₂ (leading to reduced pH) is a central issue in recirculating aquaculture systems (RAS). Long-term exposure of fish to high CO₂ may lead to hypercapnia, diminished growth, and increased cost of production (COP). However, CO₂ removal also incurs a substantial cost in RAS. This research was undertaken to determine the effect of CO₂ exposure in farmed yellowtail kingfish (*Seriola lalandi*) to inform cost/benefit analysis. Juveniles (~230g) were reared for 54 days under the following:

- (1) 3.28 mg/L CO₂, pH 7.47
- (2) 12.52 mg/L CO₂, pH 6.85
- (3) 19.83 mg/L CO₂, pH 6.67
- (4) 28.2 mg/L CO₂, pH 6.53
- (5) 39.6 mg/L CO₂, pH 6.38

Growth rates were highest in the ambient (first) and second treatment. The third, differed from the first and fourth. But surprisingly, highest efficiency in feed conversion was common to the first three treatments with progressive increase in feed use for the fourth and fifth treatments. Swim-flume respirometry revealed that standard metabolic rates were higher in kingfish reared at ~20mg/L CO₂ (nominally treatment three) compared to ambient (treatment one) conditions, leading to reduced aerobic metabolic scope (potential for secondary activities such as growth). Overall, findings suggests that kingfish are a good candidate species for RAS-based production.

Bonamia ostreae in the New Zealand flat oyster *Ostrea chilensis*: details of a marine biosecurity response (Part 2)

Dr Anjali Pande¹, Dr Henry Lane¹, Cara Brosnahan¹, Adjunct Professor Brian Jones¹, Nicky Fitzgibbon¹

¹Ministry For Primary Industries, Upper Hutt, New Zealand

After the first detection of *Bonamia ostreae* in Marlborough New Zealand in 2015, a biosecurity response was initiated, and mitigation actions taken by the Ministry for Primary Industries, as described in Part 1 of this presentation by Henry Lane.

As part of the initial response an ongoing, long term surveillance plan was designed and implemented to monitor the spread. The design will be discussed in this presentation. It was under this surveillance plan that *Bonamia ostreae* was detected in Big Glory Bay in Stewart Island in 2017. This detection changed the overall picture of *Bonamia ostreae* presence in New Zealand.

We present the biosecurity response actions taken in 2017 and the science they were based upon, as well as looking forward to see how this story will continue.

Microplastics in Wellington Harbour

Dr Olga Pantos¹, Helena Ruffell², A/Prof Sally Gaw², Raquelle de Vine³

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There is currently estimated to be >15 trillion pieces of microplastic debris in the world's oceans, 80% of which originate from land-based activities, but all are manmade. This pervasive pollution is being found in all environments from the tropics to the poles, and from beaches to deep-sea trenches. The levels of microplastics in the in-shore coastal environments of New Zealand are unknown. Macroplastics (>20 mm) and microplastics (<5 mm) were collected, and polymer type identified, from beaches and surface waters of Wellington Harbour. This is the first time microplastics have been identified in the coastal surface waters, and adjacent coastal sediments in this area. These observations suggest that a large range of plastic pollution is entering the harbour, and that large pollution events have occurred on multiple occasions.

A whole genome-level analysis of New Zealand tarakihi stock structure (*Nemadactylus macropterus*)

Yvan Papa¹, Dr. Mark Morrison², Dr. Maren Wellenreuther^{3,4}, Dr. Peter A. Ritchie¹

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Tarakihi (*Nemadactylus macropterus*) is widely distributed around the inshore areas of New Zealand and South of Australia. It supports an important commercial fishery with annual landings in New Zealand averaging over 5000 t for the past 40 years. Very little is known about its stock structure and previous low-resolution genetic studies have sampled around Australia but only analysed one sample site from New Zealand. The aim of this research is to conduct a whole-genome sequencing study of *N. macropterus* and use a large population sample (1400 specimens from 20 New Zealand locations and two locations in Australia) to determine the population genetic structure. A high-coverage draft de novo genome will be assembled as the reference genome and coupled with a sample of several hundred low-coverage tarakihi genome sequences. This will be one of the first genome-level studies of a New Zealand fishery species and will enable precise population genetic testing for differentiation and the discovery of adaptive variation. The results of this study will be compared to a parallel study that will sample mitochondrial DNA.

The paradox of the Hauraki Gulf snapper population: does the nursery habitat concept apply?

Darren Parsons^{1,2}, Dane Buckthought¹, Scott Edhouse³, Drew Lohrer³

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Juvenile nursery habitats are a critical requirement for the maintenance of some fish populations. Snapper in northern New Zealand may fit this nursery habitat model, but nursery habitat association and dependency is poorly understood for New Zealand's largest snapper population, the Hauraki Gulf. We conducted a camera survey of fish communities associated with a range of structured habitats in a potential coastal Hauraki Gulf nursery, Kawau Bay. Overall the abundance of juvenile fish was low, although post-settlement snapper and fish diversity was higher amongst horse mussel habitat relative to bare sediment. Low post-settlement snapper abundance also occurred at restored green-lipped mussel sites. While locations within the Hauraki Gulf that we did not survey could serve as juvenile nurseries, we suggest that juvenile habitat may not be as limiting within the expansive semi-sheltered Hauraki Gulf as it is elsewhere in northern New Zealand. If correct, this provides important context for habitat conservation/restoration efforts.

Toka-tū-moana: navigating shellfish degradation, recovery promotion and uncertainty, a story of place-based participatory practice, policy and management.

Kura Paul-Burke¹, Joseph Burke², Resource Management Team Te Upokorehe³, Charlie Bluett⁴, Tim Senior⁵

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This presentation discusses a marine research project which used mātauranga Māori (Māori knowledge systems) and local kaitiakitanga (place-based participatory practice) to generate common management approaches and responses for the once abundant but now severely reduced green lipped mussel populations in Ōhiwa harbour, Aotearoa New Zealand. Findings from the co-designed, transdisciplinary project were used to develop a mussel management action plan (MMAP) which was endorsed and accepted in its entirety by the high-level Māori tribal and Governmental partners of the Ōhiwa Harbour Implementation Forum (OHIF). This presentation provides an overview of shellfish degradation and recovery promotion by local kaitiaki seeking to establish a harbour wide approach to assist understandings and decision-making for mussel populations across the Ōhiwa harbour. Further, this presentation critically discusses the lessons and learnings encountered from the small-scale, multi-level, longitudinal marine research project which actively sought to engage collaborative participatory processes as the foundation for improving, enhancing and safeguarding traditional mussel populations for present and future generations.

Are trait-based functional groups better predictors of benthic ecosystem functioning than constituent species?

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Functional groups are becoming more commonly used in measures of ecosystem health and function rather than taxonomic groups as it becomes apparent that traits shared between species may influence ecosystem function more than individual taxa. This research aimed to assess whether functional groups or key species serve as better predictors of ecosystem function.

Six sites throughout the Manukau Harbour were sampled to enumerate benthic macrofauna communities, measure sediment characteristics and quantify fluxes of oxygen and inorganic nitrogen across the sediment-water interface. These solute fluxes serve as indicators of benthic productivity, respiration and metabolism.

It was found that ecosystem functioning varied spatially due to changes in both biotic and abiotic factors, and the cycling of nitrogen occurred through different pathways due to changes in macrofaunal functional groups and primary productivity. Functional groups that were significantly correlated to measures of ecosystem function did not serve as better predictors than their key constituent species. However, the presence of multiple species sharing similar ecological roles may provide redundancy as key species are lost, which expands on our understanding of the resilience of estuarine ecosystems to stressors and impacts.

Why flux matters: marine snow, climate change and fisheries in the New Zealand region

Dr Matt Pinkerton¹, Dr Graham Rickard¹, Dr Scott Nodder¹, Dr Helen Macdonald¹

¹Niwa, Wellington, New Zealand

Particulate flux (“marine snow”) is the main conduit of energy between primary producers and prey species for commercial fish species in the open ocean. Climate change will affect phytoplankton primary production and the proportion of primary production that is exported from the surface layer of the ocean to depth. These future changes in the quantity and distribution of particulate flux have the potential to affect commercially important fish species by affecting the species on which they prey. We used satellite data and physical ocean models to provide new insights into patterns and variability of particulate detrital flux in the New Zealand ocean between 1997 and 2017. We then explored future changes in particulate flux using predictions of future ocean state from 12 global-scale Earth-system models under different climate change scenarios. Two alternative “Representative Concentration Pathways” (RCPs) were considered. In the first (RCP 4.5), greenhouse gas emissions peak around 2040, then decline. In the second (RCP 8.5), emissions continue to rise throughout the 21st century. In this presentation we show predictions of which species, which areas, and when 38 key species of fish may experience the effects of climate change through changes to particulate flux.

Plankton Planet: a citizen-based monitoring program of open-ocean plankton

Xavier Pochon^{1,2}, Sarah Romac³, Nicolas Henry³, Emmanuel Malpot⁴, Manu Prakash⁵, Mick Follows⁶, Emmanuel Boss⁷, Andy Allen⁸, Romain Troublé⁹, Chris Cornelisen¹, Colomban de Vargas³

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How is the biogeochemically-critical biodiversity of eukaryotic plankton changing over space and time in the world oceans? Given the immensity and highly dynamic nature of the oceans and the tiny size and high turnover rate of plankton, this is a great challenge that can only be addressed by sampling across much larger spatio-temporal scales than are currently performed by high carbon-footprint, extremely costly research vessels. Today, the miniaturization of sample/data collection devices, the low cost of DNA sequencing, the power of cloud computing, together with the good will of the thousands of citizen-sailors traversing the world blue waters at any given time, provide the conditions to initiate a citizen-based genetic monitoring program of plankton over relevant spatio-temporal and taxonomic scales. During the Plankton Planet pilot project (2015), we have demonstrated that we can obtain, in a single year, a global picture of world oceans eukaryotic plankton diversity using massive rDNA metabarcoding on samples collected from ~400 sites by a fleet of 40 volunteer sailboats. The simple, chemical-free and energy-0 protocol we have assembled provides proof-of-concept for a new eco-friendly, low-cost, and society-engaging mode of assessing the nature and dynamics of biodiversity in the pelagic realm.

Colours of octopus studied using spectrometry and digital photography

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The methods used to measure reflectance spectra on marine organisms are plagued with many issues. These issues range from long minimum exposure time for each measurement, to spectrometers being limited to point-only measurements. The use of digital photography RGB values to reconstruct reflectance spectra provides new opportunities for spectrometer research by removing most of these issues. With this new technique, photos only require milliseconds to be taken while providing whole images for analysis as well as being portable for convenient use in the field.

In this study the reflectance spectra of individual octopuses was measured using a PR655 SpectraScan spectrometer and compared to those of typical background objects: rocks, green and brown algae, and sponges. Photos were taken at the same time as spectra using a HTC 10 android phone, and RGB values were extracted for each measured point.

Using a principal component analysis, reconstruction of spectra was shown to be possible using three principal components corresponding to the RGB values.

This ability to use RGB values to reconstruct reflectance spectra enables the simple and cost-efficient collection of spectral data from animals that would be almost impossible to measure in situ, such as octopuses, squids, cuttlefish etc.

Seasonal variation in diversity and distribution of pelagic seabirds over the Otago shelf and canyons

Eva Leunissen¹, **Will Rayment**¹, Chris Lalas^{1,2}, Graeme Loh, Graham Parker³, Kalinka Rexer-Huber^{1,3}, Trudi Webster^{1,4}

¹University Of Otago, , , ²Penguin Rescue, , , ³Parker Conservation, , , ⁴Yellow-eyed Penguin Trust, ,

New Zealand is a global hotspot for seabird diversity. While most breeding locations are well known, the lack of at-sea survey data means that foraging distributions are poorly understood. A potential foraging hotspot occurs off the Otago coast, where the circumglobal subtropical convergence lies above a series of submarine canyons that incise the shelf. From autumn 2016 to summer 2017, we conducted four seasonal systematic strip-transect surveys of diversity and distribution of pelagic seabirds off Otago out to 50km offshore. We completed over 600km of survey effort and recorded 35 species. Over the entire year, highest densities were recorded for sooty shearwaters (6.6 individuals/km effort), fairy prions (2.3) and cape pigeons (1.9). Many species displayed notable seasonal variations in density, presumably linked to breeding behaviour and prey availability. For example, Buller's albatrosses occurred at high densities in autumn and winter, but were virtually absent in spring and summer, while white-chinned petrels were present in all seasons except winter. Seasonal distributions of several taxa were influenced by the locations of oceanic fronts. These surveys provide important baseline data for understanding impacts on seabirds in the coastal zone, and they will help reveal the important hydrological and bathymetric features that drive seabird distributions.

Multi-Scale Ocean Physical and Biogeochemical Modelling: Trying to Get From the Shelf to the “Farm” and Back Again

Graham Rickard¹

¹Niwa, wellington,

Quantifying how marine aquaculture “structures” interact with the different components of the source waters requires knowledge of both the structure scale mechanics, as well as how the source components arrive at and are modified by the structure. Numerical modelling can help in the quantification.

Here geophysical farm scale effects are investigated using the model “Gerris” for net drag on typical coastal tidal flows in domains spanning tens of metres. Gerris resolves Coriolis time scales, but not individual net linkages. Comparisons with laboratory and field experiments show that Gerris can represent the total drag force. The simulations show how the flow is modified by the net drag, leading to flow acceleration around and under the structure, and flow deceleration within. Further, vertical flows outside of and within the structure connect parts of the water column that would otherwise be isolated, leading to relatively complex patterns of material redistribution around the net.

For future shelf-to-shore connected modelling, a next step is to inflate the net-scale flow modifications to that of a regional system resolved typically to hundreds of metres. In this way aquaculture structures impacts may be better translated to inform planning for today and for projections into the future.

Modelling the movement and behaviour of a marine top predator in a remote ecosystem

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Using animal-borne loggers to monitor the movement of top predators can provide information on the prevailing conditions within remote ecosystems. We deployed 25 satellite tags on Oceania humpback whales (*Megaptera novaeangliae*) at the Kermadec Islands in 2015 to study their movements and habitat use patterns within their Southern Ocean (SO) feeding grounds. Fourteen tags transmitted data south of 60°S. We applied a hierarchical state-space model to identify behavioural states in the satellite tag data: transit, or search (indicative of feeding). We used modelling and remotely sensed data to correlate the whales’ behaviour with environmental parameters. The likelihood of whales being in search (i.e. feeding) mode was related to lower SSHs, faster surface current speeds and steeper bottom slopes. Other significant variables were region (Ross Sea vs. Amundsen and Bellingshausen Seas), month and distance to ice edge. Whales within the Amundsen and Bellingshausen Seas inhabited areas closer to the ice edge and the continental shelf edge, both of which have been linked with productivity. There may be different oceanographic features or processes driving whale behaviour in the two regions, and the whales might be using these two habitats differently. Large baleen whales may also play a role in the SO iron recycling; therefore, the recovery and movements of whale stocks may be critical environmental indicators in Antarctic waters.

Modelling coastal fisheries under climate change

Dr Alice Rogers¹

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Warming coastal waters and ocean acidification have the potential to alter ecosystems through changes to habitats, invasions of new species and reorganisation of community structure. As a consequence, trophic interactions like predation and competition are altered, and so too is the flow of energy through food webs. We have developed a combined food web and habitat model that can capture the direct and indirect effects of global climate change on coastal ecosystems and predict biomass and fisheries productivity under various future scenarios. In this talk we will describe the structure of the model and present examples of its applications to tropical coral reefs, where we have been able to quantify the impact of habitat degradation on reef fisheries productivity. We will also introduce intended and potential applications of this tool for New Zealand fisheries under future climate change, focussing in particular on quantifying the impacts of habitat loss, invasions and tropicalization in our coastal waters.

Don't forget the Toheroa Eaters — the importance of incorporating humans into ecosystem thinking

Dr. Phil Ross¹

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The study of marine ecology has often focused on understanding the impacts of humans on marine ecosystems, largely taking the view that humans sit outside of the natural environment. Under this regime, our knowledge of marine ecology has evolved and we have become very good at measuring the decline of the environment, often at our own hand. In spite of our continually improving ecological understanding, we often struggle to identify solutions to environmental problems, some of which threaten our way of life.

In this talk I explore the other side of the human-environment dichotomy. Taking a lead from the human centric field of environmental history, I place human motivation and action at the centre of ecological thinking and ask what knowledge can be attained to guide environmental management. Using the toheroa (*Paphies ventricosa*) as an example, I explore the human drivers of the rise and fall of the toheroa fishery, the human consequences of the decline of this iconic species and consider actions that can be taken to address issues identified using this method. Finally, I apply lessons learned from this toheroa tale to other human-environment interactions and explore the value of re-incorporating humans into ecosystem thinking when forecasting environmental problems and searching for solutions.

Bundles of ecosystem services provided by infaunal shellfish beds

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Studying the multitude of ecosystem services (ES) provided by infaunal shellfish beds (e.g. filtration, nutrient cycling, carbon sequestration) is crucial for a complete understanding of their contribution to human well-being. In estuaries, spatial and temporal variation in underlying biophysical structures and processes, as well as patchiness in shellfish distribution, result in variable ecosystem function (EF) and ES delivery. Focussing on bundles of ES (sets of associated services that appear together repeatedly across space and/or time) rather than studying individual services in isolation, will allow us to study service delivery whilst minimally impairing the complex links between EF and ES. Based on a literature review of 203 papers on ES and the underpinning EFs we compared the multitude of services provided by infaunal filter feeding shellfish (e.g. cockles and pips) with well-studied epifaunal reef forming species (e.g. oysters and mussels). Data obtained from this review provides a framework for assessing infaunal shellfish ES by grouping services in bundles based on spatial and temporal extent. Increasing our understanding on bundles of services for infaunal bivalve species that dominate most NZ estuaries is necessary to study synergies and trade-offs between multiple ES and to make informed management decisions.

Characterisation of particulate organic matter cycling during a summer North Atlantic phytoplankton bloom using amino acids stable isotopes

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Determining the fate of fixed carbon and nitrogen in marine food webs requires a deeper mechanistic understanding of the processes through which organic matter pools originate and the pathways through which they are transformed. We used compound-specific stable isotope analysis of individual amino acids (CSIA-AA) to characterize particulate organic matter (POM) sources and transformations in surface waters of the temperate and subarctic Atlantic Ocean. The robustness of several recently developed AA in situ biomarkers and proxies was assessed by comparison with pigment and flow cytometric community analyses. Trophic level (TL ~ 1.5) indicated the presence of higher trophic matter in POM, such as heterotrophic microeukaryotes and multicellular zooplankton. The carbon pattern indicated a switch in biomass nutritional mode, from autotrophic biomass dominating the euphotic zone to POM of mostly heterotrophic origin below the mixed layer. The ΣV parameter, proxy for heterotrophic bacterial AA resynthesis, indicated no major resynthesis in the mixed layer with POM mainly composed of live biomass ($\Sigma V \sim 1.3$). At 100 m POM exhibited a strong heterotrophic bacterial alteration signature ($\Sigma V = 2.5$) indicating active AAs recycling. The robustness of all these tested proxies will be discussed during the presentation.

The Big Old Fat Fecund Female Fish (BOFFFF) hypothesis; are big old female snapper (*Chrysophrys auratus*) actually fat?

Armagan Sabetian¹

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Survival, growth rates and functionality of larvae have been hypothesised to correlate with higher lipid provisioning in older teleosts. To test the lipid provisioning part of this hypothesis, we investigated the total and relative (mg/g) lipid (triglyceride) concentration in both the source (liver) and sink (gonad) lipidation organs of female snapper *Chrysophrys auratus* across age, size and condition factor throughout its spawning season. Age, size and condition factor had little discernible effect on the total or relative lipid concentration in either liver or gonadal tissue. Therefore, if oocyte quality (based on triglyceride concentration) is comparable across a population, research on the relationship between lipidomics and reproductive success needs to move beyond highlighting correlations to elucidating causation by focusing on the biochemical mechanisms of egg quality and larval survival, identifying maternal parameters associated with consistent lipid provisioning, and partitioning of phenotypic and genotypic maternal influences.

The importance of macrofauna functional trait interaction for biogeochemical fluxes in marine sediments

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Benthic biogeochemical fluxes in marine sediments are profoundly influenced by bioturbating species and the role of key bioturbators for ecosystem functioning is well documented. However, the role of the interactions between different functionalities has poorly been addressed. As a result, their importance for ecosystem functioning may have been underestimated thus far. In this study we present the first assessment of the interaction between infaunal species of different functional groups and its effect on benthic biogeochemical fluxes. In a laboratory experiment we incubated specimens of *Macomona liliana*, a deposit feeding bivalve, and *Macroclymenella stewartensis*, a conveyor-belt feeder polychaete, both separately and together, and measured fluxes of nutrients and oxygen. Oxygen uptake and nitrogen cycling stimulation due to their interaction were modelled, based on the results of single species treatments, and then compared to the results of multiple species treatments. The effect of the interaction of the two organisms proved to be stronger than the effect of single species treatments. Moreover, the predictions of benthic fluxes for trait interactions differed significantly from the empirical results. This study demonstrated the central role of functional trait interactions for ecosystem functioning and their non-additive, emergent nature, highlighting the importance of their incorporation in future research.

Massive changes to form and function of rocky reef communities following the Kaikoura earthquakes: an overview

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Many years of small-scale experiments have shown that the loss of key habitat-forming seaweeds causes a decline in local diversity, reduction in primary productivity, and altered competitive relationships. Full recovery usually takes many years from one-off impacts. The unprecedented, earthquake-induced loss of large fucoid algae and grazing invertebrates over 110km of coastline of the South Island allows a test of how well small-scale recovery informs about large-scale impacts and subsequent processes. There has been a loss of connectivity for many key species, extensive multi-month blooms of ephemeral algae as a result of disturbance, extensive loss of grazing invertebrates and increased sedimentation, increased and probably concentrated subtidal grazing by butterfish on remaining large seaweeds, and considerable issues relating to altered human usages of the coastal strip. Heavy sedimentation has affected algal recruitment, and the light environment is highly compromised in much of the nearshore zone. Here we discuss the 'trickle down' hypothesis – that zones will eventually just re-assort themselves downwards, the potential role of 'safe havens' – undamaged, protected areas as a potential source of propagules of key species, and crucial needs for recovery of this extensive part of the marine ecosystem.

Increasing turbidity and tipping points in New Zealand kelp forests

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An often overlooked effect of climate change in the coastal environment is a predicted increase in turbidity associated with increased storm activity, coastal erosion, and sediment runoff. This poses a major threat to sub-surface kelps and the communities they support, which may be exacerbated by other climate related stressors such as warming. We used a comparative experimental approach to investigate how the productivity and resilience of the kelp *Ecklonia radiata* varies across a turbidity gradient in northeastern New Zealand, and mesocosm experiments to investigate the interactive effects of increasing turbidity and nutrients on kelp and its key competitors. While kelp forest removal experiments demonstrated rapid recovery of kelp across the turbidity gradient over a two year period, the rate and extent of recovery was reduced at the most turbid sites. In these areas, the subtidal fucoid *Carpophyllum flexuosum* became the dominant canopy forming macrophyte suggesting that in low light environments *E. radiata* is unable to maintain dominance over low-light tolerant species such as *C. flexuosum*. This was corroborated by mesocosm experiments that suggested *C. flexuosum* was more tolerant to persistent low-light conditions than *E. radiata*. Overall, the results indicate that the productivity of kelp forests decline with increasing turbidity and a shift from kelp to a less productive fucoid-dominated system is likely with future increases in turbidity. This shift will have implications for overall ecosystem functioning and primary production of shallow reefs.

Effects of moonlight on larval fish growth, dispersal, and connectivity

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Lunar cycles determine the tides and degree of nocturnal illumination – and as a consequence, many marine reef organisms exhibit lunar periodicity in their spawning and larval settlement behaviour. Can moonlight also shape larval growth rates, dispersal potential, and population connectivity? We evaluate these questions for a common New Zealand reef fish. We reconstruct demographic information and dispersal histories of fish larvae from their otoliths (ear stones) and evaluate the effects of lunar cycles and nocturnal cloud cover on larval fish growth. We find that growth rates increase significantly on moonlit nights, and we explore some potential explanations and implications of this previously unrecognised pattern.

‘Te Korowai o Te Tai ō Marokura, (Kaikōura Coastal Marine Guardians)’

Gina Solomon¹

¹Te Korowai o Te Tai ō Marokura, (Kaikōura Coastal Marine Guardians),

I belong to a wonderful group, Te Korowai o Te Tai ō Marokura, (Te Korowai).

Standing for local leadership in the care of Tangaroa and in decisions on the use and protection of our marine environment, we came together in response to many issues and uses of our coast and developed our Kaikōura Marine Strategy: Sustaining our Sea - a korowai for Te Tai ō Marokura - we are weaving that korowai.

Our vision is a future where our Kaikōura moana is richer, healthier, used sustainably, providing for the needs of present and future generations. People will interact with the sea in ways that care for its mauri. Peoples’ activity will be managed to respect the natural connections between living and physical elements, sustaining the sea’s dynamic ecological balance. Users will be encouraged to practice kaitiakitanga, be good guardians/custodians.

Our 2014 Kaikōura (Te Tai ō Marokura) Marine Management Bill established a number of protection and sustainable fisheries measures.

I hope my korero will gift to you a glimpse of our journey, its beginning, how we worked together, our processes, practices to develop our values to achieve our successes and enrich your communities, creating better collaborative process for the benefit of us today and those to come.

Investigating the seasonal abundance of sperm whales at Kaikōura using robust design models.

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Male sperm whales are present at Kaikōura almost all year round, although individuals move in and out of the area, and none are truly resident. Estimates of demographic parameters therefore need to reflect this. The Otago Marine Mammal Research Group has studied sperm whales at Kaikōura since 1990, compiling a long-term photo-ID data set. Here, we present robust design capture-recapture analyses of seasonal abundance from 1990-2016, while accounting for temporary emigration. A suite of models was constructed for summer and winter seasons, and the best model for each chosen via AICc. The best summer model had constant survival and a change in temporary emigration after 2001, while the best winter model had constant temporary emigration and a change in survival after 2001. A weighted linear regression indicated a significant decline in the abundance of whales using the study area in summer from 55 (95% CI: 18-164) in 1990 to 5 (95% CI: 3-6) in 2016. There was no trend in winter abundance. The detected trend in summer may reflect actual population decline or, more likely, a redistribution of individuals away from the study area. The next step is to investigate potential drivers of the decline so that effective management can be determined.

Using Gradient Forests to summarise patterns in species turnover across large spatial scales and inform conservation planning

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To support efficient conservation management, spatial biodiversity patterns over large scales must be understood. However, many methods used to date have issues that can make outputs unsuitable for conservation planning. To address this, recently developed Gradient Forest (GF) models were used to analyse and predict spatial patterns of demersal fish species turnover (beta diversity) across the New Zealand EEZ to depths of 2000m, using a large demersal fish dataset (>27,000 sample locations) and a wide range of updated, high resolution and functionally relevant environmental data layers (1km² grid resolution). GF models had high predictive power for individual species (n=250, mean R²F of 0.521, range: 0.3 – 0.913) and were used to produce and map a demersal fish classification (30 groups of inferred assemblages) that was validated using independent sample data. Spatial patterns in fish assemblages were strongly related to environmental parameters including water currents and associated oceanic fronts. The hierarchical nature of the classification supports its use at varying levels of classification detail, which is advantageous for conservation planning at differing spatial scales. This approach also facilitates the incorporation of information on inter-group similarities into conservation planning, allowing greater protection of distinctive groups likely to support unusual assemblages of species.

Ocean Physical Processes: a Foundation-Stone for Ecosystem Based Management

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Ecosystem based management seeks to provide a framework for making better choices about how to use and value the oceans. Here we consider pathways for injecting improved knowledge of how physical processes control ocean ecosystems into this framework. The Stressor Footprints Project has sought to define the driving and responding flows in the Sustainable Seas Case Study area by developing improved empirical understanding of the regional and local hydrodynamics and then place this in a modelling framework. The talk synthesizes results from a variety of sources that: (i) highlights the paucity of existing data in the region at impact-relevant scales, (ii) captures realisations of "physical connectivity", (iii) provides a NZ-first sequence of ocean-glider transects defining the stratification boundary conditions and (iv) suggests a pathway forward to meet question-based modelling challenges. The work is synthesized in the context of the range of potential stressor scales. The challenge then becomes building a pathway to carry this best-practice science into the conversations that underpin the EBM approach.

The social effects of valuation processes in contested marine spaces: insights from the Marlborough Sounds

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The coastal marine environment is a highly contested space where multiple uses and diverse values often come into conflict through valuation processes. This presentation draws on diverse engagements with participants involved in high-profile marine development decisions in the Marlborough Sounds to examine the formal and informal ways that values are elicited, received and evaluated by decision-makers. Valuation encompasses far more than the practice of estimating the financial value of environmental services and changes. It extends to almost any socio-political process in which people seek to shape the development of their places and environments by describing what matters about these places. This study shows that formal valuation processes can be alienating for many participants, demanding huge investments of time and personal sacrifice, and demoralising participants when their local knowledge and expertise is delegitimised. Such processes can leave communities shaken, conflict-riven and unhappy, and undermine the legitimacy of democratic institutions. Although there remains a place for formal valuation processes, there is also a compelling case for informal participatory processes to provide alternative spaces for people to describe their values and for decision-makers to receive them.

Oceans Mesh – an art-science interpretation of ecosystem-based management for New Zealand’s marine environment

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A key challenge of the Sustainable Seas National Science Challenge remains that of making ecosystem-based management of New Zealand’s marine environment a reality. Ecosystem-based management gives primacy to the interconnectedness of marine species and their habitats; the land and sea; and of people and the environment. It has ramifications for the way we presently think about, manage for and interact with marine ecosystems. Oceans Mesh is a Sustainable Seas sponsored art-science collaboration between a social scientist and a multi-media artist. It draws upon the wellspring of knowledge and personal reflections of researchers, sourced through interviews with Sustainable Seas experts in biophysical, theoretical/modelling and social sciences, and mātauranga Māori. Oceans Mesh weaves diverse strands of knowledge together to create a narrative that invites the public to reconsider the ocean, our seas and coastal margins with a sense of wonder, appreciation, concern and commitment. Oceans Mesh is a large-scale (3m x 6m) audio-visual animation. It will debut at the Light Nelson festival, 6-10 July 2018, where it will be projected onto the exterior wall of the Suter Art Gallery in central Nelson.

Ancient aquaculture and the translocation of toheroa — it’s not just bull kelp!

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Māori have a well-documented history of translocating aquatic and terrestrial plants and animals both to and around Aotearoa/New Zealand. However, until recently, little attention has been given to the notion that Māori cultivated or translocated marine species. Thanks to recent research we now know that translocation of shellfish was an important component of Māori marine resource management. Evidence suggests that shellfish has been transported over distances ranging from tens to hundreds of kilometres. What we do not currently understand is the science behind this ahumoana tawhito (ancient aquaculture).

For my PhD I will examine the evidence for, and logistics of, shellfish translocation. I will focus on the iconic toheroa (*Paphies ventricosa*) and its historical distribution. An ingenious tool that is suggested to have facilitated translocation is pōhā, an organic biodegradable storage bag that has been utilized by Southern Māori for hundreds of years, made from *Durvillaea* bull kelp. I will combine Mātauranga Māori with methods from archaeology, ecology and natural products chemistry to gain a better understanding of historical toheroa distribution and the biological and practical implications of translocation using pōhā. I will also examine the anti-microbial properties of *Durvillaea* spp. and investigate the animal health benefits of transporting shellfish in pōhā.

Compromised ecological engineering across uplift gradients along the Kaikōura coast

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Large canopy-forming kelp and furoid algae were greatly impacted following the Kaikōura earthquakes, compromising habitat availability and a range of vital ecosystem functions. We have set up monitoring across an experimental gradient of uplift to examine the consequences of large scale loss of ecosystem engineers. Our results show that biological activity is greatly reduced at uplifted sites, with the replacement by ephemeral 'bloom' forming species unable to compensate for large habitat-forming species in modifying physical parameters. Maintenance of photosynthesis throughout the day by canopy-forming species contrasts to the short-term bursts in photosynthesis observed by ephemeral species. Altered engineering of the physical habitat and water quality parameters reveals not only the importance of key canopy-forming species, but also the potential constraints on recovery of other ecosystem components in the most heavily impacted areas.

Developing fish based indicators for Ecosystem Based Fishery Management: A Chatham Rise case study

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Ecosystems based fishery management (EBFM) requires an understanding of ecosystem functioning to measure and communicate ecosystem changes in meaningful ways. Indicators sensitive to pressures affecting an ecosystem can be an efficient communicator of ecosystem health, making them excellent tools for environmental and fisheries management. As New Zealand's most important fishing grounds, a NIWA scientific trawl survey has been conducted on an almost annual basis since 1992 along the Chatham Rise. The Chatham Rise trawl survey data set is an ideal opportunity to test and develop a representative set of ecological indicators.

By exploring patterns and trends of species through time, shifts in fish communities were identified. Candidate indicators were reviewed before they were investigated using Dynamic Factor Analysis techniques. To create a complementary, scientifically accurate, efficient and communicable indicator set redundant indicators were excluded leaving only effective indicators remaining. While this study has focused on the Chatham Rise, methods of indicators development may be applicable to other New Zealand surveys like the sub-Antarctic or inshore trawl surveys, thus facilitating New Zealand's progress towards EBFM.

Does size matter? The effect of bivalves on ecosystem functioning in sandflats

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Estuaries are hotspots for biogeochemical cycling, with large bivalves playing an important role within the sediment underpinning these ecosystem functions. Most research has focused on functional traits of key species and their effect on ecosystem functioning, few studies however, have studied intraspecific traits such as size and how these determine ecosystem functioning. We hypothesise that a reduction in biomass of the large bivalve *Austrovenus stutchburyi* will decrease ecosystem functioning through a reduction in ammonium fluxes and lower productivity within the estuarine system.

An in situ manipulative field experiment was used to compare large and small sized *Austrovenus* across a gradient of biomass. Ecosystem functioning was measured using nutrient and oxygen fluxes in light and dark benthic chambers.

Ammonium flux in dark chambers increased with large individuals, and biomass was a significant factor controlling the flux of ammonium. Primary productivity was higher with large individuals and biomass was a significant factor driving primary productivity.

Our research provides insights to how ecosystem functioning changes with reductions in biomass of large keystone species. This information is vital for helping with estuary management decisions to preserve healthy functioning systems and mimics the changes that can occur with overharvesting or increased anthropogenic activity.

A trifecta of earthquakes, marine heatwaves and weedy competitors threatens bull kelp (*Durvillea*) along the South Island of New Zealand

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Southern bull kelp (*Durvillea poha*, *D. antarctica*, and *D. willana*) are large, long-lived cold water furoid algae that modify environmental conditions, increase biodiversity and provide habitat for ecologically and economically important species. Here we discuss impacts on bull kelp from three major stressors following (a) seismic uplift from the Kaikoura Nov. 14th 2016 earthquake, (b) the Tasman Sea 2017-18 heatwave and (c) interactions with other seaweeds. Surveys were carried out along c. 500 km coastline from Cape Campbell to Moeraki, estimating cover and densities of bull kelp using quadrats, drone-images and semi-quantitative 'damage' estimations from landscape photos. In the lab, we measured effects of desiccation and temperature stress on pulse-amplitude modulated (PAM) fluorescence of the three species. *D. antarctica* and *D. poha* were virtually eliminated along much of the earthquake-affected coastline. Around some sites near Christchurch, *Durvillea* was negatively affected by a combination of low waves, low tides and high temperatures, which caused considerable mortalities. After the loss of *Durvillea*, *Ulva* or *Undaria* invaded many sites and, if persistent, may delay recovery of bull kelp populations. Bull kelp seems highly susceptible physiologically to desiccation and heat stress. Finally, we will discuss recovery processes, critical experiments, possible mitigation and management options, and what the future holds for bull kelp in southern New Zealand.

Biodiversity-Ecosystem function relationships and how tipping points transform ecosystems and inform sustainable management.

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The occurrence of thresholds profoundly limits our understanding of ecosystem dynamics and management of cumulative effects, but we have yet to develop practical techniques to assess the threat that thresholds will be crossed. Here we combine ecological knowledge defining critical system interdependencies with a latitudinal-scale field experiment investigating the effects of two important stressors (turbidity and nutrient loading) on ecosystem function in intertidal sandflats. We experimented on 24 sites in 15 estuaries across New Zealand in a 9 month manipulation of sediment pore water ammonia concentration (3 levels) across a range of sites that varied in suspended sediment concentration. Our approach seeks to show how the loss of positive feedbacks and changes in the architecture of ecosystem interaction networks, can provide mechanistic evidence that stressors lead to breakpoints in dynamics, which theory predicts predispose a system to a critical transition. This approach provides an urgently needed technique to link theory with empirical research and demonstrates that well-designed field studies can be used to test for key breakpoints in intrinsic dynamics associated with the subtle but cumulative impact of stressors before thresholds are crossed.

WFD OMBT, NZ: WTF?

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Ecological indicators can be extremely useful for describing the state of the marine environment and helping understand which areas are healthy and which need remedial action. Crucial to this is the rigor and appropriateness of indices that separate scores into different bandings e.g. high, moderate, low, which ultimately describe health status. These bands need to be reliable and supported by empirical evidence and appropriate to the place of application. The Estuarine Trophic Index (ETI) is an Envirolink tool that has been developed to help characterise the gradient of trophic condition within New Zealand estuaries using relevant ecological response indicators. The assessment for macroalgae cover in the ETI uses the European Water Framework Directive's (WFD) Opportunistic Macroalgae Blooming Tool's (OMBT) scoring bands. We discuss the appropriateness of replicating European standards, a continent that has undergone several thousands of years land use changes, in New Zealand. We highlight some of the issues applying the OMBT in New Zealand and encourage discussion, research and review to determine appropriate health bands that can be applied in New Zealand's marine environment.

Benthic and pelagic copepod bioassays show ecotoxicity of urban estuarine sediment

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Urban estuarine sediments are sinks to a range of anthropogenic contaminants, and a key challenge is to characterize the risk these compounds pose to receiving environments. In this study, the toxicity of urban estuarine sediments was tested using acute and chronic bioassays in the benthic harpacticoid *Quinquelaphonte* sp., and in the planktonic calanoid *Glabidocera pectinatus*, two native copepod species. The sediment samples from the estuary tributary sites significantly impacted reproduction in *Quinquelaphonte* sp. However, results from one of the estuary sites were not different to those from the tributaries sites, suggesting that chemicals other than trace metals, polycyclic aromatic hydrocarbons and ammonia may be the causative stressors. Sediment elutriate samples had significant effects on *G. pectinatus* reproduction, and on the induction of DNA damage in cells, as shown by the comet assay. The results indicate that the Ahuriri Estuary sediment has the potential to impact biological processes of benthic and pelagic organisms. The approach used provides a standardised methodology to assess the in situ toxicity of estuarine sediments.

A research project to manage emerging organic contaminants

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Emerging Organic Contaminants (EOCs) are natural or manufactured chemicals in household and personal care products, pharmaceuticals, and agrichemicals; their use and discharge is largely unregulated. EOCs are used daily by individuals and industries globally with substantial amounts released into the environment. There are concerns about the risk EOCs pose to the environment and our food. International research demonstrates EOCs are widespread in areas of human activity, and are detrimental to the health and resilience of freshwater and marine ecosystems. Our primary industry is vulnerable to EOC contamination. Our multi-disciplinary team, with international collaborators, iwi and stakeholders, integrates critical capability and expertise to characterise the risks EOCs pose to aquatic ecosystem health, tāonga, kai moana and key export industries. We will apply the latest passive sampling and analytical methodologies to identify the key EOCs in NZ's aquatic environment. A series of biological tests and gene sequencing approaches in native species will characterise the risks of the most harmful EOCs. The research aligns with the Strategy to Manage EOCs in NZ and a National Advisory panel of experts from regional councils, government agencies, industry, and Māori will oversee the progress of the research to ensure that the goal of protecting NZ from EOCs is achieved.

Discovering and analysing the diversity and distribution of coralline algae in southern New Zealand

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Coralline algae (Corallinophycideae) are calcifying red algae that form the foundation of many shallow marine ecosystems globally, providing settlement sites for a range of invertebrate larvae, stabilisation of reefs and habitat for grazing and infaunal species. Despite their ecological importance, little is known about their diversity, distribution and ecology. Phylogenetic analysis and species delimitation methods were used to examine species diversity from a range of habitats in southern New Zealand. A high level of diversity was found, with 74 species identified from three orders. Individual species are likely to respond differently to a range of local and global disturbances, such as ocean acidification and sedimentation. Disentangling these species-specific responses, and flow on effects for coastal ecosystems in response to environmental change, is likely to be difficult to assess for southern New Zealand coralline algae, given the high level of diversity discovered. High diversity was also found on small spatial scales, which creates unique challenges for future researchers sampling biodiversity. However, multivariate clustering techniques, grouping sites based on similarities in coralline algae community structure, identified a range of environmental variables correlated with these community groupings. These results could enable the prediction of coralline algae communities under specific environmental conditions and help to determine how changing conditions may shape these communities.

The Earth Summit 25 years on: why is biodiversity continuing to decline?

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The opening years of the 1990s brought great promise and hope for biodiversity. The United Nations Conference on Environment and Development, the “Earth Summit”, was held in Brazil in 1992, following a worldwide outcry at the loss of species and habitats in the 1980s, symbolised by alarming rates of destruction in the Amazonian rainforest. It seemed that the same collective will that had brought about the Montreal Protocol in 1987 (The Montreal Protocol on Substances that Deplete the Ozone Layer (agreed on 16 September 1987 and entered into force on 1 January 1989)) to phase out ozone-depleting substances would now move to protect life on earth. In this talk, we set out how New Zealand has responded over the last quarter of a century to the Convention on Biological Diversity (CBD), which arose from the Earth Summit. We consider the adequacy of these policy and implementation responses in light of the alarming findings on the state of our coasts and oceans in Our Marine Environment 2016 (Ministry for the Environment and Statistics New Zealand 2016).

Morpho-taxonomy and metabarcoding provide complementary data for surveillance of non-indigenous marine biofouling species

Ulla von Ammon^{1,2}, Dr Susanna A Wood¹, Olivier Laroche^{1,2}, Dr Anastasija Zaiko^{1,2}, Dr Leigh Tait³, Dr Shane Lavery^{2,4}, Dr Graeme Inglis³, Dr Xavier Pochon^{1,4}

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Marine infrastructure can enhance the spread of non indigenous marine biofouling species by providing suitable habitat for them to settle and proliferate. Cryptic organisms or those in early life stages can be difficult to identify through conventional morphology and molecular tools such as metabarcoding may enhance their detection. In this study passive samplers were deployed in an Auckland Westhaven marina to compare the detection sensitivity for non-indigenous species between morpho-taxonomy and metabarcoding (18S rRNA and COI). Using all methods, 56 potentially non-indigenous species were identified. Metabarcoding detected the highest proportion: 41% by 18S rRNA and 12.5% by COI, missing most Bryozoan taxa. An additional 17% (mainly Bryozoa) were detected by morpho-taxonomy only. A total of 22% of the species were identified by both morpho-taxonomy and metabarcoding. The data highlight several on-going challenges for the application of metabarcoding including: differential marker resolution, primer biases, incomplete sequence reference databases, and the influence of different sample biodiversity on the detection of rare species. Consideration should be given to the complementary application of morpho-taxonomy and molecular techniques that will enhance monitoring for non-indigenous species from complex biofouling samples and reduce "omission" and "commission" errors undesirable in biosecurity surveillance programmes.

Collaboration and co-design in marine ecosystem recovery: The Ōngātoto/Maketū Estuary case

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The Ōngātoto/Maketū Estuary, renowned for its cultural significance and abundant aquatic life, has become seriously degraded following the full diversion of the Kaituna River in 1956, the purpose of which was to increase wetland drainage and reduce flooding risk. While over time there has been official acknowledgement of the need to address the ecological deterioration of the estuary, there has also been strong resistance from the beneficiaries of the drainage scheme, and radically different views about causes and solutions to the estuary problem. In response to this, the Bay of Plenty Regional Council in 2006 began to lead a community engagement initiative bringing together the diverse stakeholders and iwi/hapū to develop a common recovery strategy. In this paper, we focus on this unfolding case of participation in marine environment decision-making where diverse stakeholders and iwi/hapū, with profoundly different worldviews and competing interests, have come together to develop and implement a common estuary recovery strategy. The case provides an opportunity to identify success factors in the development and implementation of collaborative planning for marine ecosystem recovery. It reveals how planning processes are likely to be more effective if they promote multi-directional information flows and mutual learning among participants. Such processes of co-creation and co-design require new approaches to marine governance and planning that integrate scientific insights with local and traditional knowledge.

The time is now! The Hawke's Bay Marine and Coastal Group.

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Over the past decade the community of Hawke's Bay has become increasingly vocal about the perceived degradation of the region's marine environment. Signs of this degradation have been reduced catches of recreational fish, reduced ability to collect sufficient kaimoana, poor water quality at popular swimming spots and changes in the distribution and numbers of commercial fish species. The community has attributed the cause of this degradation to two main impacts, commercial fishing and land-based contaminants.

The concerns of the community led to the formation of the Hawke's Bay Marine and Coastal Group in 2016. This group was formed with the intent 'to achieve a healthy and functioning marine ecosystem in Hawke's Bay that supports an abundant and sustainable fishery.' For the past two years this group has been developing a plan to increase the knowledge base about how the marine system of Hawke's Bay functions which in turn will inform more effective management.

This talk will describe the history of the Hawke's Bay Marine and Coastal group, the conditions that led to its formation and the direction moving forwards. A large component of this will be describing the learnings so far from this exciting collaborative journey.

Phylogeography of the New Zealand whelks *Cominella maculosa* and *C. virgata* (Gastropoda: Buccinidae)

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Cominella maculosa and *C. virgata* are common whelk species that inhabit rocky shores around much of the North Island, the northern South Island, and, for *C. maculosa*, the Chatham Islands. This study used DNA sequences from the mitochondrial gene CO1 to examine the phylogeographic structure of populations of both species in areas that have not previously been sampled. Collections of both species were made from sites in the Cook Strait region, of *C. maculosa* from the Chatham Islands, and of *C. virgata* from the northern North Island. Both species were found to have a considerable degree of genetic differentiation but genetic diversity and phylogeographic patterns differed greatly between regions. South Island populations of *C. virgata* may have originated, or been supplemented, by human-mediated translocations. Phylogenetic analyses were conducted using the mitochondrial genes CO1 and 16S rRNA, and the nuclear gene 18S rRNA. The northern subspecies *C. virgata brookesi* did not form a monophyletic lineage and is synonymised with *C. virgata*. A lectotype is designated for *Buccinum lineolatum* Quoy & Gaimard, 1833, of which *C. virgata* is a replacement name.

Ecological and environmental tolerance to sedimentation of the brachiopod *Calloria inconspicua* in Otago Harbour

Uru-Manuka Ming-Cheung Williams¹, Dr Jeffrey Robinson², Associate Professor Daphne Lee², Associate Professor Miles Lamare¹

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While not commercially exploited, brachiopods can provide valuable information about the water quality and health of the Otago Harbour ecosystem. Human activities such as road works, land clearing, and the regular dredging within the harbour by the Otago Harbour Board can add to the amount of sediment in the water (the turbidity) to as much as 20-times the natural levels. The aim of this study is to determine how the smooth, red, long-looped terebratulid brachiopod *Calloria inconspicua* is affected by a range of turbidity levels. Sampling under laboratory conditions was carried out over a month with sediment treatment levels based on environmentally relevant values. It was observed that above 40 Nephelometric Turbidity Units (NTU) the 'snap' rate (rapid closure of the valves: an indirect estimate of the rate of clearing inedible particles from within the mantle) almost doubled. These results suggest that *C. inconspicua* expends more energy to maintain normal function when exposed to higher levels of turbidity (increased snap rate and mucous production). Thus, the mortality rates of *C. inconspicua* may increase, causing a loss of biodiversity within the Otago Harbour. This study provides a foundation for future studies into understanding the environmental health of the Otago Harbour ecosystem.

The challenges with choosing a magic number

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Regional councils are required to develop water quality standards in their plans. With limited national guidance and the large natural variation of 'acceptable' values, deriving a specific concentration or load based standard can seem like pulling a magic number out of a hat. Drawing on the vast quantities of data collected across the country seems like a good place to start, but a recent collation and analysis of these data showed how differently 'standard' parameters are measured, which makes comparing them with each other difficult, if at all possible. In this talk, I will share some of the challenges with developing regional water quality standards and highlight some areas of work that will make the process more straightforward and robust for all regional councils.

Molecular detection of the mediterranean fanworm and club tunicate: comparing sampling methods and assessing the of persistence of environmental DNA

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Recent studies have highlighted the potential for molecular based techniques to be incorporated into marine biosecurity surveillance, but uncertainties around optimal sampling approach and interpretation of the eDNA signal remain. This study had two aims: (1) determine which sampling method results in higher detection probabilities of *Styela clava* when established population are present, and (2) investigate the persistence of *Sabella spallanzanii* and *S. clava* environmental DNA under laboratory conditions. Detection methods were explored in Nelson marina by collecting three types of samples (water, sediment and biofilm) fortnightly, for a 7 month period. Samples were analysed for presence of *S. clava* using quantitative PCR. To investigate eDNA persistence experiments *S. spallanzanii* and *S. clava* were housed singularly or in combinations in aquariums for 2 days, then removed and eDNA signal monitored for 21 days using digital droplet PCR. The results show that the highest detection rates were in water column samples and there was notable temporal variability in detection over the seven-month period. In the aquarium study, eDNA of both species degraded rapidly and was below detection limits after 48 hours of observation. This study highlights the importance of understanding differences in the effectiveness of sampling methodologies and fate of nucleic acids in the environment to implement robust and efficient molecular biosecurity surveillance.

Marine sentinels: update on the national Marine High Risk Site Surveillance (MHRSS) programme for 2017–18

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The Marine High Risk Site Surveillance (MHRSS), funded by the MPI and conducted by NIWA, is a national programme of surveys targeted at the early detection of high-risk marine non-indigenous species (NIS). The MHRSS programme involves targeted surveillance undertaken bi-annually at 11 major ports and marinas around the country deemed to be of highest risk for the introduction and establishment of marine NIS.

The primary objective of the MHRSS Programme is to detect incursions of New to New Zealand marine NIS listed on the Unwanted Organisms Register (*Asterias amurensis*, *Carcinus maenas*, *Caulerpa taxifolia*, *Eriocheir sinensis* and *Potamocorbula amurensis*). The MHRSS programme also has two secondary objectives, which are: (i) to detect incursions of marine NIS or cryptogenic organisms not previously recorded in New Zealand, and; (ii) to detect range extensions by marine NIS or cryptogenic organisms that are already established in New Zealand waters (e.g., *Arcuatula senhousia*, *Eudistoma elongatum*, *Sabella spallanzanii* and *Styela clava*).

Here, we present and discuss findings of the targeted surveillance at the 11 sites covered by the MHRSS programme in the survey rounds of Winter 2017 and Summer 2017–18, detailing new detections, range extensions, species of note and existing invasions.

Using genomics and transcriptomics to assess the impact of estuarine macro-algae on microbial communities and their roles in biogeochemical cycling

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Estuaries are considered to be highly productive ecosystems and play a major role in the world's biogeochemical cycles. However due to increased use of N fertilisers, many estuaries are becoming eutrophic leading to overgrowth of macroalgae which increases the amount of organic carbon available within estuaries. This study analyses sediment nutrients and community response (environmental genomics and transcriptomics) to determine the impact of macroalgae on biogeochemical cycling. Results show that sites of long term cover with algae have high sulfide and ammonia compared to sites without algae. This corresponds to a higher dominance of Proteobacteria with sulfur cycling capability based on genomic data. At nearby sites without algae, ammonia was significantly lower, likely due to the dominance of Planctomycetes carrying out anammox and Thaumarchaeota capable of aerobic ammonia oxidation indicating more nitrification, likely explaining higher levels of nitrate and nitrite found at these sites. A short term (10-day) algae transplant and removal experiment showed only subtle changes in sediment nutrients, and no difference in microbial community composition suggesting community resilience to perturbation. Results show that nutrient cycling is affected by the presence and persistence of algae, but microbial communities exhibited short term resilience to the introduction or loss of algal biomass.

Omics in aquaculture

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Aquaculture production is currently challenged to meet the growing demands for seafood protein throughout the world. To achieve this growth in an efficient, safe and sustainable manner, novel tools and applications will need to be incorporated at each step of the production line. A variety of 'omics' applications have already begun to emerge in aquaculture research with extreme success. Broad scale untargeted surveying of biomolecules in cultured aquatic organisms is providing important insights to efficiently improve nutrition and growth, enhance disease resistance, and increase production in various species. In this talk, I present recent omics-based case studies from our group and others, outline some new tools for use in the field, and present future opportunities to help grow sustainable aquaculture in New Zealand.

Molecular tools for implementing international ballast water regulations – insights from a cross-latitudinal en-route study

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The international Ballast Water Management Convention (BWMC) which aims to prevent, minimise and ultimately eliminate the transfer of harmful aquatic organisms and pathogens via ballast water transport associated with shipping, came into force on 8 September 2017. Regulation D-2 specifies a compliance threshold for the abundance of viable organisms in ballast water after on-board treatment. Currently no single method exists that can be applied to ballast water compliance monitoring. Most of the testing approaches are applicable only to specific taxonomic groups, are not quantitative, require high degrees of taxonomic skill, are time consuming and expensive. In this study we performed concurrent measurements of ATP and eDNA/eRNA-metabarcoding during cross-latitudinal vessel transit, collecting triplicate ballast water samples every second day over 3 weeks period. The results obtained by different methods provided complementary information, allowing more comprehensive inferences on biological activity than could be derived by each method separately. They suggest die-off of larger metazoans during the first week of observations, gradual fading of dinoflagellates and ochrophytes and persistent or increased cellular activity of proteobacteria and ciliates. Although these combined approaches show potential for gross-negligence screening, they are still unable to provide reliable numbers for detailed compliance tests as required by the BWMC.

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