Effect of Sediment Accumulation on the Productivity of Habitat-forming Seaweeds

Edwin AINLEY // The University of Auckland

Dr Nick Shears, Dr Alwyn Rees // The University of Auckland

Increasing human population, coastal development, infrastructure and land use changes are causing large amounts of sediment to be transported into adjacent marine ecosystems. Macroalgae are often at the heart of these ecosystems, and yet there is little information on the effect that sediment has on subtidal macroalgal stands in New Zealand. This study monitored the temporal and spatial variability in sediment accumulation on *Ecklonia radiata* and *Carpophyllum flexuosum* at a range of sites throughout 2011, and determined the primary environmental drivers responsible for this. In addition we examined the effects of experimentally simulated sediment accumulation on the growth and photosynthetic rates of *E. radiata* and *C. flexuosum* for up to 11 days. The results showed that the amount of sediment accumulating on seaweeds was temporally and spatially variable, and primarily related to two environmental drivers: wave action and rainfall. The maximum amount of sediment recorded on *E. radiata* was 4.5mg cm^{-2} which was estimated to reduce light levels by more than 75%. Not surprisingly sediment addition to *E. radiata* in the laboratory caused plants to lose weight, and caused bleaching, rotting and perforations on the thalli. Subsequently this had detrimental effects on photosynthesis, considerably reducing oxygen production of the plant. Conversely, *C. flexuosum* was slightly more tolerant of sediment accumulation. By better understanding the consequences that increased terrestrial sedimentation is having on natural marine systems we can emphasise the importance of improved policies and land management practices to ensure the maintenance of this important life-supporting habitat.

Impacts of Opportunistic Algae on the Early Life History of a Habitat-forming Fucoid

Tommaso ALESTRA // University of Canterbury

David Schiel // University of Canterbury

A decline of extensive populations of fucoid macroalgae has been reported worldwide as a result of human-driven coastal habitat degradation. Contributing to such declines may be the influence of opportunistic algae which respond quickly to stresses such as nutrient loading and warmer sea temperatures, thereby outcompeting the early life stages of fucoids. Here we examine the interactions between early life stages of the intertidal fucoid *Hormosira banksii* and fast-growing, opportunistic green algae, *Ulva* spp. Through a series of laboratory experiments, we test: 1) the impact of *Ulva* on the settlement of *H. banksii* zygotes; 2) the impact of *Ulva* on the rates of post-settlement survival and growth of H. banksii germlings, under both normal and increased levels of temperature and nutrient concentration; 3) the interactions between the two species under grazing pressure of the abundant intertidal snail *Lunella smaragdus. Ulva* was facilitated by increased temperature and nutrients and it negatively affected *H. banksii* by both impairing the settlement of the zygotes and by limiting the growth of germlings. Post-settlement survival of germlings was not affected by competition with *Ulva*, but there was an indication that this may decline with warmer waters. Both species were consumed by *L. smaragdus*, but a preference for *Ulva* indirectly facilitated *H. banksii*. These findings augment extensive field-based research showing the effects of small, ephemeral understory species on biogenic habitat-formers and highlight the threat posed by their synergisms with degraded physical conditions, which are now occurring in coastal ecosystems throughout the world.

Multi-disciplinary Approach to Study Larval Development

Andrea ALFARO // Auckland University of Technology

Tim Young, Annapoorna Ganesan, Adam Rusk, Le Viet Dung, Neil de Jong, Colleen Higgins, John Brooks, Chris Pook // Auckland University of Technology

One of the most enigmatic processes in the lives of marine invertebrates is the development of larvae into juveniles. A wide range of strategies exists among species, which involve morphological, physiological and behavioural changes geared to enhance survival and recruitment into adult populations. These rapid and complex changes are associated with high energy requirements and elaborate sensory mechanisms that allow larvae to respond to their immediate environment. Even with these adapted evolutionary strategies, exceedingly high larval mortalities are a common occurrence in the marine environment and within aquaculture settings. The consequences of these high early larval mortalities are vast, since they may directly impact on the persistence and structure of wild populations and/or may result in significant financial constraints for hatchery production. Thus, great scientific interest has been placed on the understanding of developmental processes and the mechanisms that underpin these dramatic changes. Within the Aquaculture Biotechnology Group at AUT, we have used traditional and new techniques to investigate larval developmental processes for a range of marine invertebrate species. Herein, we present some of the advances we have achieved with this multi-disciplinary approach. Furthermore, the results from these studies have been used to derive comparative analyses of strategies among taxa.

Overview of Current Research on New Zealand Mangrove Ecosystems

Andrea ALFARO // Auckland University of Technology

Kathy Campbell, Melissa Bowen, Lorna Strachan // The University of Auckland
Sebastian Leuzinger, Mark Duxbury // Auckland University of Technology
Cyril Marchand, Audrey Leopold // IRD, New Caledonia

Temperate mangroves occupy large areas of northern coastal New Zealand. Their ecological role is substantially different from their tropical counterparts, which the great majority of mangrove studies have focused on in the past. To alleviate this imbalance, the goal of the Mangrove Research Group supported by the Auckland University of Technology, Auckland University and the 'Institut de Recherche pour le développement' in New Caledonia is to establish a highly interdisciplinary, long-term study site at Mangawhai Harbour Estuary. We will provide comprehensive data covering all aspects of this temperate mangrove ecosystem, reaching from detailed habitat mapping, hydrodynamics, sedimentology, geochemistry to food web analysis and mangrove ecophysiology. For example, habitat maps will be established using ultralight aerial vehicles with hyperspectral cameras. Further, the nutrient-, water- and carbon cycles will be characterised, using classic (C, N, P analysis, stable isotope analysis) as well as state-of-the-art plant physiological measurements (continuous stem radius, sap flow and leaf water potential monitoring), and detailed studies of carbon pools and fluxes (e.g., eddy flux tower, quantification of biomass and litter fall/decomposition). Food-web analysis will include detailed studies of diversity and abundance of meiofauna and fish. The results are expected to provide a solid scientific basis for future management decisions as well as detailed insight into all scientific aspects of temperate mangrove ecology.

Fine-scale Data Management of the New Zealand Commercial Paua Fishery

Edward ABRAHAM // Dragonfly Science

Christopher Knox

Management of the commercial paua fishery has been hampered by lack of information at an appropriate scale. Since 2009/10, commercial fishers have begun using GPS loggers that record their position when they are on the surface, and depth profiles when thay are underwater. These loggers provide a view of the fishery with unprecedented spatial resolution. In this talk, we show preliminary results from the logger programme and discuss how these data may be used to indicate the status of the paua fishery.

Present & Future Applications of Remote Sensing of Water Quality in Rotorua Lakes

Mathew ALLAN // The University of Waikato

David Hamilton, Brendan Hicks // The University of Waikato
Lars Brabyn

The high spatial resolution of Landsat satellite data and free availability of a large image archive spanning more than 40 years have made Landsat the sensor choice for monitoring inland water quality in small lakes. We developed an automated procedure for the retrieval of chlorophyll a concentrations from Landsat Enhanced Thematic Mapper imagery of Rotorua lakes. A total of 106 Landsat 7 satellite images were captured from 1999 to 2011. Image processing routines included radiative transfer-based atmospheric correction, using 6sv (Second Simulation of the Satellite in the Solar Spectrum). A novel algorithm was developed using symbolic regression to predict chlorophyll a from visible reflectance of Landsat satellite imagery. Bio-optical models were applied to quantify the physical processes responsible for the relationships between the reflectance used in regression algorithms, and to examine possible sources of error. Results from this study suggest that remote sensing provides a valuable tool to assess temporal and spatial distributions of chlorophyll a. Estimated chlorophyll a concentrations displayed considerable intra- and inter-lake spatial variability, associated with differences in lake morphology, hydrodynamics and chemistry. The future of the NASA Landsat series satellites had been assured with the recent launch of an improved sensor known as Landsat 8.

Benthic Enhancement Trial for the Hydro-electric Storage Lake – Lake Mahinerangi

Richard ALLIBONE // Golder Associates (NZ) Ltd

Greg Burrell, Ian Boothroyd, Duncan Gray // Golder Associates (NZ) Ltd

Resource consents for the operation of Waipori hydro-electric scheme required an assessment of benthic enhancement techniques for Lake Mahinerangi, the scheme's storage lake. The consent required that leaf litter inputs and rock substrates be trialled to determine if these habitat enhancements improved invertebrate populations and forage fish abundance. Initial short-term trials with rock substrates and leaf packs were encouraging and a full five year trial was initiated in 2008. A small riparian planting programme was undertaken to investigate the establishment of leafy plants to provide leaf litter to the lake. Six rock pile transects were established in the varial zone of the lake bed. Invertebrate and fish communities on the lake bed and rock piles were assessed each winter and summer for five years. The rock piles were rapidly colonised and the fauna differed from the adjacent lake bed. However, the invertebrate communities were still dominated by small bodied organisms such as Diptera larvae. The CPUE for common bully and koura was significantly greater on the rock piles than on the soft sediment lake bed. However, as the rock piles offer refuge from predation it is unlikely the rock piles significantly increased the availability of forage fish for predator sports fish. Survival of the lake shore planting was very low and showed there were significant difficulties establishing a leaf litter source on the lake shore. The final success of the rock piles also appeared limited as the majority of rock piles were smothered by fine sediment by the end of the five year trial.

Management of Water Abstraction to Manage Effects on the Endangered Central Otago Roundhead Galaxias

Richard ALLIBONE // Golder Associates (NZ) Ltd

The Otago region is home to a number of threatened freshwater fish including the Central Otago Roundhead Galaxias (CORG). This species is of increasing conservation concern as populations are continuing to be lost. Populations persist today in streams abstracted for irrigation water and in relatively unmodified, but disturbance prone, low gradient systems where introduced salmonids are present. Both water abstraction and salmonids have been implicated in the extirpation of CORG populations. It has also found that water abstraction can moderate the effects of salmonids on CORG in streams where water abstraction causes intermittent flow during summer. Many of these water abstractions that have been active for up to 100 years are for large water volumes and are exempt from Otago Regional Plan Water rules. These abstractions, known as deemed permits will all expire in 2021. It is expected that any new consents granted for abstraction will have to comply with Regional Plan conditions. This will include minimum flow provisions and it is therefore possible that summer low flows will be increased in some streams with CORG populations. However, to date no method has been developed to assess change in stream flow and how whether improvements to summer flows will assist CORG or allow salmonids to permanently invade CORG populated areas. A habitat and flow based assessment method is being developed from non-abstracted streams with CORG and salmonid populations that can be applied to abstracted streams to assess the likelihood that salmonids will permanently establish.

In a Mess With Models

Chris ARBUCKEL // Aspiring Environmental Ltd

Whether you think the policies held within the water reform package, Freshwater reform 2013 and beyond launched in March this year, or closer to my home, the Otago Regional Councils Plan Change 6A and Environment Southland's "Water and Land 2020 & Beyond" are doing too much or too little to protect our waterways, the effectiveness of these policies ultimately lays in the hands of the people who just use water and land to make a living. Rural water users are being compelled to manage to environmental limits; with the hope that restrictions on substances like nitrogen, phosphorus, bacteria and sediment entering water, will swiftly improve degraded waterways. One of the biggest challenges at present is convincing a community or a water user facing restrictions on hard to manage substances, that numbers generated by many of our environmental models for limit setting are factual. The defensibility of many of our key models have been called in to question and over the next 5 to 10 years huge pressure will be placed on the science underpinning these so called "black boxes". A further challenge for water managers is that New Zealand lacks any framework to address model use in environmental management. My talk will examine how important some sort of framework is needed, especially as resource manager's lunge for at a grab bag of models to set limits, and the effectiveness of their limit setting relies on a virtual number; for both the water user and manager.

Codium fragile: An Assessment of the Morphological & Genetic Variation in Native & Introduced Subspecies

Phoebe ARMITAGE // The University of Auckland

Nina von Westernhagen // Hawke's Bay Regional Council
Kit Rutherford // NIWA
Olivier Ausseil // Aquanet Consulting Ltd

The green alga *Codium fragile* (Sur.) Hariot is a cosmopolitan species appearing along temperate coasts in both hemispheres. The finger-like fronds branch dichotomously from a basal holdfast and are coenocytic, composed of interlacing filaments that terminate in a pointed utricle. A native subspecies, *Codium fragile* ssp. *novae-zelandiae* (J. Ag.) Silva is found throughout New Zealand, and is abundant on the west coast of Auckland. A second subspecies, *Codium fragile* ssp. *fragile* is regarded as highly invasive. It has spread widely from its native range in Japan, and has been known in New Zealand since 1973, when it was reported from the Waitemata Harbour in Auckland. The current distribution of *C. fragile* subspecies in Auckland is unknown, in part due to a lack of reliable diagnostic field characters. Previous identifications based on morphology distinguish the invasive subspecies by the presence of a cinched and pointed utricle, and fewer fronds per thallus than the native subspecies. We aim to test the reliability of these morphological characters, using the plastid marker *rps*3-*rpl*16 to distinguish between subspecies of *C. fragile*. We will focus primarily on material from the Auckland region, and test whether it is possible to develop a sound morphological basis for distinguishing between ssp. *fragile* and ssp. novae-zelandiae, thereby allowing effective monitoring of the spread of the introduced subspecies.

Modelling of Dual Land & Water Discharge Systems

Olivier AUSSEIL // Aquanet Consulting Limited

Dual land and water systems, where wastewater is discharged to land at certain times of the year and to water at other times are becoming increasingly common. These allow in principle for a more rational utilisation of the land's wastewater treatment functions and the waterbody's assimilative capacity. The development and optimisation of dual discharge systems generally involves multiple and complex scenarios, which generally require detailed modelling, interpretation and communication. A daily time-step model was developed to assess the potential effects of dual discharge scenarios on river water quality. Model development and calibration involves the development of daily data series of discharge and river quantity and quality covering a significant period of time. Clear data summaries are also required in order to communicate the results to the different parties involved in the resource consenting process. The model has been applied to several small and medium-sized communities in the Manawatu Region and has been found to provide robust and useful support to system development, decision making and assessment of future compliance with specific Regional Plan water quality targets or limits. Real-life examples of model development and application will be presented.

Smelt Life Histories Within the Lower Waikato River Catchment

Cindy BAKER // NIWA

Joshua Smith, Brenda Bartels // NIWA

Within the Waikato River basin both diadromous and lacustrine smelt populations exist. To determine the degree of diadromy and mobility of smelt within the lower river catchment otolith microchemistry was undertaken. In total, 100 smelt were collected from Huntly during their spawning migration in autumn. To determine the elemental signature of different rearing habitats within the catchment, at monthly intervals smelt were also collected from 19 sites between Lake Karapiro and Port Waikato. To accommodate temporal changes in ambient water chemistry that may influence otolith signatures during smelt growth, water samples were also collected during each fish collection. Overall, 98% of the smelt captured, including those captured from the lower Waikato River lakes, were diadromous. Analysis of the outer (freshwater) region of otoliths from ripe smelt captured at Huntly found 20% of fish had signatures that matched the signatures of smelt rearing in nine locations within the lower Waikato River catchment. Of the nine sites, eight were located between 16 and 117 km upstream of Huntly. In addition, several distinct elemental signatures were found within the freshwater growth phase of many smelt. These data show that during their freshwater growth to adulthood, diadromous smelt are highly mobile with regard to distance and frequency of movements.

Like Sands Through the Hourglass, These are the Days of Piharau Lives

Cindy BAKER // NIWA

Shannan Crow, Don Jellyman, Michael Stewart, Erica Williams // NIWA

Although adult piharau (lamprey) spend extended periods of time in freshwater (up to 16 months) during their upstream migration to spawning grounds, lampreys are rarely seen, except where their migration is hindered or prevented at obstructions. As such, little is known about the cues lamprey use for migration, and the habitats utilised during this extended period in freshwater. This study is using Passive Integrated Transponder (PIT) technology to monitor the spawning migrations of adult lamprey within the Okuti River catchment. In total, 142 adult lamprey have been tagged after entering the catchment. Close to 100 of those fish have been re-located by either fixed or hand-held antennae as they migrate upstream. This project is currently on-going, however, results to date have shown that the upriver spawning migration of adult lamprey is closely linked with increased river flows. The micro-habitats utilised by lamprey during this migration, and the timing of movements have also been identified. This knowledge is fundamental to rehabilitation and restoration of lamprey populations and has important implications for ensuring lamprey populations are retained within rivers and streams utilised as water take sources.

Using Environmental DNA to Detect the Presence of Brown Trout *(Salmo trutta)* in New Zealand Streams

Jonathan BANKS // The University of Waikato, Cawthron Institute

Nick Demetras, Ian Hogg, Matthew Knox , Philip Ross // The University of Waikato
Adam Daniel // Fish & Game New Zealand
Dave West // Department of Conservation

The Lake Ecosystem Restoration (LERNZ) programme aims to restore New Zealand's freshwater ecosystems by removing introduced pest fish from selected lakes and their tributaries. Part of this programme was to develop a simple method for the detection of pest fish using environmental DNA (eDNA). To assess the feasibility of the eDNA technique, we chose brown trout, *Salmo trutta*, that were targeted for eradication from streams within a mainland reserve (Karori Sanctuary). We collected water samples before and after the eradication efforts and extracted eDNA to determine if we could detect the presence of brown trout DNA in the water column. From these water samples, we successfully amplified a segment of the brown trout d-loop region. Electrofishing surveys taken before and two months after the eradication have thus far confirmed the presence (or absence) of trout inferred from our eDNA analyses. The next steps in our programme are to develop: 1) quantitative, real time polymerase chain reactions (qrtPCR) to increase the sensitivity of the method and to provide an indication of brown trout abundances; 2) extend the range of fish that can be detected from eDNA, and 3) develop non-species-specific methods (e.g. using next generation sequencing) that will enable the detection of a range of pest fish species from environmental samples.

On 'Bloomin' Seaweeds & 'Bloody' Earthquakes – Changes in Nitrogen Biochemical Indicators in *Ulva* from the Avon Heathcote Estuary, Christchurch, Set in a National Context

Neill BARR // NIWA

Nina von Westernhagen // University of Canterbury
Kit Rutherford // NIWA

Historically, massive blooms of *Ulva* in the eutrophic Avon-Heathcote Estuary of Christchurch, have significantly affected both the estuary's aesthetic value and its ecosystem function. With the diversion of Christchurch City's wastewater discharge away from the estuary in March 2010 it was expected there would be close to a 10-fold reduction in nitrogen(N)-loading, which in turn promised a reduction in algal biomass. A 5-year MBIE-funded partnership between NIWA and University of Canterbury is examining, amongst other ecosystem components, macroalgal biochemical indicators of N-loading. Following the March 2010 diversion of the wastewater from the estuary there was a significant reduction in tissue-N, tissue-chlorophyll, and in particular tissue-free amino acid content in *Ulva*. However, the series of earthquakes that have rocked Christchurch since September 2010 caused substantial breakdown of the city's wastewater infrastructure resulting in overflows of untreated sewage into the estuary. This return to elevated N-loading and corresponding qualitative shifts in *Ulva* tissue N-isotopes (δ15N) reflected changes in the nitrogen sources (treated vs untreated sewage) that affected the estuary. We place all of these changes seen in *Ulva* nitrogen indicators in the Avon-Heathcote within the context of a National estuarine survey of *Ulva* conducted in 2002. This study proves the validity and utility of biochemical properties of extant populations of *Ulva* as indicators of relative shifts in both the amount and the source of nitrogen loading to New Zealand's estuaries.

Aquatic Fate of Herbicides in a Planted Forest Catchment

Brenda BAILLIE // Scion

Daniel Neary // US Forest Service
Stefan Gous, Loretta Garrett // Scion

In New Zealand's planted forests, management of competing vegetation during the establishment phase of the crop rotation is critical in ensuring seedling survival and growth and maximising timber yields. Herbicides are currently the most cost effective tool in New Zealand for vegetation management but there is increasing global pressure to reduce their use due to environmental concerns. Hexazinone and terbuthylazine are two herbicides commonly used in combination to control unwanted vegetation in New Zealand's planted forests. We monitored the concentrations of these two herbicides in two small streams in an area of Kaingaroa Forest that was aerially sprayed under normal operational conditions in November 2012. One site was 100% sprayed upstream, the other 45%, with a 10m no-spray buffer maintained around the stream margins. Concentrations of spray landing on the stream channel from drift were around 28% of the prescribed rate sprayed directly onto the treatment area. Highest herbicide concentrations occurred in both streams on the day of spraying. The streams were monitored for 8 months after spraying and herbicide concentrations remained low (<2 ppb for both herbicides) for the duration of the trial. These preliminary results indicate that when applied under standard operational conditions, these two herbicides posed a low threat to the aquatic environment. However, the trial occurred during a very dry period limiting the assessment of herbicide leaching and movement into waterways during normal and high rainfall events.

The CV Rena Incident: A Warning Shot Across the Bow for Environmental Preparedness

Chris BATTERSHILL // The University of Waikato

David Schiel // University of Canterbury

When the CV Rena grounded on Astrolabe Reef, Bay of Plenty, the first concerns of all stakeholders were scientific ones. What would be the effects of heavy fuel oil contamination along the coastline and how long would it last. In the scramble for relevant ecotoxicological information pertaining to Heavy Fuel Oil and the dispersants that might be used, it was clear that there was very little information of any relevance to a New Zealand situation. This was surprising given some of the early environmentally oriented oil and gas industry research of the 1980s, particularly relating to the Shell BP and Todd Maui development program. There both lab and field experiments were conducted to assess likely pollution scenarios should spills occur. Here we focus on early lessons learned and the need to focus on the synergistic effects of contaminant mixtures and sublethal intergenerational effects on marine organisms. In many ways, the Rena event is one of the world's most complicated oil spills because of the highly complex contaminant streams. The combination of HFO, other shipping petrochemicals, heavy metals from cargo and antifouling paints in the ecosystem has not previously been examined in a field scenario where long term effects on important marine food species is a focus. Sublethal effects are likely to be as important as toxicology in considering ecological effects.

Don't Shoot the Messenger: Communicating Science to an Audience That Wants Your Blood

Chris BATTERSHILL // The University of Waikato

Communicating tough messages, messages the audience doesn't want to hear, messages to an angry audience, and messages to a misinformed audience is hard. Combine that with communicating complex science, and you have a recipe for a lynching. Over the course of years in communicating the science underpinning the field of biodiscovery (bioprospecting), presenters faced audiences that were either rabid with loathing of biopiracy, or that were staunch sceptics. The task of breaking down misconceptions was monumental. It was achieved by elegant science and through easy to understand, ethical, well founded scientific communication. Honest review of the history of the discipline, warts and all, and substantive evidence underpinning the successes have resulted in a new age of popular and scientific support for this cutting edge biomedicinal science. In a contrasting situation, that of communicating to an angry public, complex environmental science associated with marine disaster events (e.g. CV Rena), the approach had to be ruthlessly direct. This meant relaying often bad news immediately, honestly and succinctly and being clinical in describing the likely environmental consequences. This approach garnered respect and anger soon dissipated as the audience had facts and could consider relevant scenarios. A consistent approach of this nature has led to a well informed public that now will rationally (mostly) review the ongoing development of the Rena incident.

Hydrodynamic Modelling of the Firth of Thames & Hauraki Gulf to Support Aquaculture Planning & Management

Brett BEAMSLEY // MetOcean Solutions Ltd

Ben Knight, Chris Cornelisen // Cawthron Institute
Hilke Giles, Vernon Pickett // Waikato Regional Council

Economical and environmentally sustainable development of aquaculture requires a suitable understanding of the salient hydrodynamic and atmospheric drivers at both local scale and in a broader regional context. In order to address these requirements, a 3-D finite-element model of the Hauraki Gulf and Firth of Thames using open source code (SELFE) has been developed for the Waikato Regional Council. The model consists of element sizes ranging from 75 m in the nearshore and 3,500 m offshore, while the vertical structure is defined using 40 terrain-following sigma layers. Specific higher resolution areas with element sizes of ~30 m were refined in areas identified for potential aquaculture development. Full 3-D baroclinic offshore boundary conditions are sourced from a multi-decadal New Zealand scale ROMS implementation, while a 4-km resolution WRF implementation provides temporally and spatially variable atmospheric forcing within the model domain (wind, solar radiation, precipitation, temperature etc.). In addition, the model includes temporally variable river fluxes from 52 different rivers within the Firth and the Hauraki Gulf, while satellite nudging of the sea surface temperature has also been implemented. The model physics were calibrated using ~6 weeks of multi-level measured temperature, salinity, and velocity data from 6 deployment sites within the Firth of Thames. The model was shown to faithfully capture the observed variations in velocities, temperatures and salinities over the validation and calibration period. The calibrated model has been used to generate a 2-year hindcast dataset to assist WRC in the on-going planning and management of aquaculture in the Firth of Thames.

Interactions Between Marine Mammals & Commercial Fisheries in New Zealand Waters

Katrin BERKENBUSCH // Dragonfly Science

Edward Abraham // Dragonfly Science
Leigh Torres // NIWA

Interactions between marine mammals and commercial fisheries occur frequently when their distributions overlap, with incidental captures affecting a range of cetacean and pinniped species across different fisheries worldwide. As bycatch assessments are often hampered by scarcity of data of the number and identity of captured individuals, risk assessments provide a systematic approach to identify and evaluate potential impacts of fishing-related mortalities, while also accounting for uncertainty. The present study forms the basis for such a risk assessment of the interactions between different commercial fisheries and marine mammals in New Zealand waters. Considering each of 10 mysticete, 23 odontocete (including dolphins and beaked whales), and three pinniped (sub)species that inhabit New Zealand waters, existing data from New Zealand and elsewhere identified the types of interactions that may occur when these marine mammals interact with trawl, longline, setnet, and pot/trap fisheries. For large baleen whales, the majority of recorded incidents were entanglements and injuries in static gear, with few records in offshore regions. In contrast, for smaller-sized dolphins and pinnipeds, direct interactions with fishing operations often lead to acute mortality, as captured individuals are unable to free themselves and drown in fishing gear. Furthermore, the coastal distributions of many dolphin and pinniped species mean that they co-occur with intensive fishing operations, resulting in bycatch mortalities. Data reviewed here allowed the identification of different fisheries-marine mammal interactions, and will inform the next step in the risk assessment process involving marine mammals and commercial fisheries in New Zealand.

Impacts of Small Arthropods on Algal Epiphytes Associated With Subtidal Coralline Turf

Anna BERTHELSEN // The University of Auckland

Richard Taylor // The University of Auckland

Small arthropods, particularly amphipod crustaceans, are highly abundant in subtidal coralline algal turf. Many of the arthropods are herbivores, but nothing is known about the impact of their feeding on their host seaweed. In the current study, abundances of arthropods in subtidal *Corallina officinalis* turf were experimentally reduced *in situ*. This was achieved using plaster blocks impregnated with the insecticide carbaryl; as the blocks dissolved the carbaryl was released over 1-2 weeks. Blocks were replaced ~weekly for 15 weeks. The carbaryl reduced arthropod abundances by 86.5% relative to controls. This resulted in major changes in the abundance and composition of algae growing epiphytically on the coralline turf. The clearest response to the reduction in arthropod densities was an increase in abundance of the brown seaweed *Colpomenia* sp. (to a mean cover of 7% in carbaryl treatments, compared to 0% in both controls and plaster treatments after 6 weeks). We will run feeding assays to identify the grazers responsible for suppressing *Colpomenia* sp. Our results support the emerging view that small mobile arthropods are capable of influencing the structure of their habitat, as opposed to simply being “hangers-on”.

Threatened Fish Reintroductions in the Lower Lakes of the River Murray 2011–2013: Successes, Lessons & Prospects

Chris BICE // South Australian Research and Development Institute

Nick Whiterod // Aquasave – Nature Glenelg Trust
Michael Hammer // Museum & Art Gallery of the Northern Territory, Aquasave – Nature Glenelg Trust

Desiccation of the littoral habitats of the Lower Lakes of the River Murray from 2007–2010 necessitated the rescue, captive maintenance and breeding of four threatened freshwater fish species to avoid localized extinction. Ex situ populations of Yarra pygmy perch, southern pygmy perch, Murray hardyhead and southern purple-spotted gudgeon were maintained and bred using various 'housing' and rearing techniques including aquaria, ponds and farm dams. The success of these approaches varied with species. Following widespread flooding in the MDB and restoration of water levels in the lower lakes a project was developed to guide reintroduction of these species. The aims of the project were to: 1) identify potential reintroduction sites and assess their suitability, 2) release fish and 3) assess the success of reintroductions. Since 2011, >15,000 individual fish, across the four species, have been released at a total of 10 different sites. All fish were stained with calcein prior to reintroduction to assist post-reintroduction identification. Post-reintroduction monitoring has yielded >100 individual fish across the four species, with ~50% likely recaptures of released fish, indicating survival at select release locations for periods of 6–18 months and there is evidence of limited wild recruitment. Nonetheless, the long-term sustainability of these species in the region remains uncertain. Further reintroductions may be necessary and surveillance monitoring and increased water security are likely required to ensure population establishment and persistence into the future.

Eye Development & Light Response in Deep-sea Cranchiid Squids

Kat BOLSTAD // Auckland University of Technology

Monica Acosta // The University of Auckland
Aaron Boyd Evans // Auckland University of Technology

Cephalopods are highly visual predators and possess (for the most part) well-developed eyes; their ability to perceive and process complex images appears similar to that of vertebrates. Many deep-sea species in particular possess relatively large eyes at maturity, some of which differ structurally from those of earlier, photic-zone-dwelling life stages. These ontogenetic changes are being investigated, focusing on the family Cranchiidae ('glass' squids). Histological analysis of preserved (and fixed) specimens has revealed changes in the retinal structure coinciding with migration into deeper waters. These developments, in particular a dramatic increase in the length of the outer photoreceptor segment, suggest cellular modification to greatly increase sensitivity to light. Live cranchiid squids observed at depth show clear behavioural responses to the presence of unusual bright light stimulus, and histological examinations of the eye following exposure to light are expected to reveal additional changes at the cellular level, as has been observed in other squid species. These findings provide insight into several aspects of deep-sea squids' ecology and have implications for research aiming to collect and/or observe these animals *in situ*.

To What Extent is Invertebrate Community Composition Across New Zealand's Rivers Related to Hydrological Regime?

Doug BOOKER // NIWA

Michelle Greenwood // NIWA
Ton Snelder // Aqualinc Research

Predictive relationships between hydrological regimes and ecological states are required to support environmental flow setting decisions. Data from 1,075 river sites across New Zealand were used in a variance decomposition analysis to investigate the proportion of variance explained by hydrological, geomorphological, land cover and catchment characteristics for the community matrix and each of three biotic indices representing: taxon richness; Macroinvertebrate Community Index; and percent of species in the Ephemeroptera, Plecoptera, and Trichoptera orders. Results showed that hydrological regime contributes a unique component to the explainable variation in the biotic indices and community, but this contribution is overestimated if other explanatory factors are not considered. A Gradient Forest model comprised of 93 Random Forest models each predicting the probability of occurrence of a taxon indicated that, of 20 environmental predictors, low flow magnitude, high flow magnitude and mid-range flow variability were among the top ten predictors of the community as a whole. The importance of high flows was confirmed by the models, but the other dimensions of hydrological variation were almost as important in predicting invertebrate taxa and biotic indices. Although many freshwater invertebrates in New Zealand are well adapted to a range of flow conditions through resistance traits and/or rapid colonisation, this study suggests that several aspects of the flow regime influence invertebrate communities. These results suggest that environmental flows may be designed to sustain or even optimise specific ecological taxa, but changes along several dimensions of hydrological variability are likely to disadvantage other taxa and change invertebrate community composition.

Taking Notice of Whitebaiting as a Value: the River Values Assessment System for Whitebaiting

Kay BOOTH // Lindis Consulting

The River Values Assessment System (RiVAS) is a tool that has been developed to assess river values (e.g. native birds, whitewater kayaking, irrigation). Applying a standardised and rigorous method, RiVAS results in a ranked list of the rivers, sorted by importance, for each river value under examination. RiVAS has been developed for the activity of whitebaiting; it considers attributes of the activity such as the level of use, river access, and social conflict and crowding, amongst other things. Application of RiVAS to whitebaiting offers a means by which councils, and others, can quantify the relative significance of whitebaiting for a set of rivers. The RiVAS method for whitebaiting will be discussed.

Waikato Regional Council Freshwater Fish Monitoring Programme – a Developmental Overview

Callum BOURKE // Waikato Regional Council

Bruno David, Mark Hamer // Waikato Regional Council

Healthy and abundant fish populations are essential to maintaining the value of the Waikato region's water bodies. However, little is known about the state of fish communities and for this reason, a fish monitoring programme was initiated in 2008/09 to develop a robust, standardised procedure for assessing assemblages in wadeable streams throughout the region. This field season (December 2012 – end of April 2013) numerous wadeable rivers and streams were sampled by way of electric fishing, netting, and trapping. This was the second season of freshwater fish monitoring using a probability-based (random) site selection survey design in conjunction with a reference site network. It was also the first season that sites were netted utilising the newly established New Zealand Freshwater Fish Sampling Protocols (Joy *et al.,* 2013). In 2012/2013, 62 wadeable river and stream sites were sampled of which 53 were random sites and 9 reference sites. A new electronic data capture system was used recording collected electric-fishing and spotlighting data. This has proved to be an accurate, effective, and efficient means of recording and uploading our field data in a consistent manner. In this paper we will outline the methods used and discuss findings of interest.

Conservation & Recovery of Threatened New Zealand Fishes

Sjaan BOWIE // Department of Conservation

Dave West, Jane Goodman // Department of Conservation

In 2003, the Department of Conservation (DOC) established recovery groups and formulated recovery plans for three key groups of freshwater fish groups; non-migratory galaxiids, mudfish and large galaxiids. Species covered by the plans range from lowland longjaw galaxias a national critical threatened species through to freshwater fish that are not threatened. These plans set out the strategic direction and prioritise what needs to be done for the recovery and conservation security of these fish and achieve greater coordination nationally. These plans are now nearing their completion date so a formal review has been begun. Alongside this options are being considered on what is the best tool to provide DOC and others this guidance and direction in the future. The recovery groups associated with these plans are made up of key DOC representatives and external specialists. The key functions of this group are to provide regular review, reporting and advice on the progress of the plan. These plans have been the driving force behind key conservation successes including gaining key information that has enabled recognition of local extinctions and better management and protection of these fish. An overview of these, preliminary results of the review and future options will be presented.

Susceptibility of Murray Cod (*Maccullochella peelii*) Larvae to Barotrauma During River Infrastructure Passage

Craig BOYS // New South Wales Department of Primary Industries

Wayne Robinson, Lee Baumgartner // New South Wales Department of Primary Industries
Anna Navarro // Charles Sturt University
Brett Pflugrath, Richard Brown // Pacific Northwest National Laboratory
Brett Miller // University of New South Wales

Understanding what mechanisms influence the survival of larval fish is critical to the management of adult populations. Murray cod, *Maccullochella peelii*, is an iconic species that has declined throughout its range in south-eastern Australia. It has a downstream drifting larval phase, which has lead to concerns that this species may be susceptible to injury or death when passing river infrastructure (e.g. weirs, regulators and hydropower turbines). Fish can be exposed to adverse hydraulic conditions when passing infrastructure, including elevated fluid shear and turbulence, or rapid drops in hydraulic pressure, but little is known of the magnitude and relative influence of these conditions on the injury and survival of most species and life stages. In this study hypo/hyper barometric chambers were used to determine the susceptibility of larval Murray cod (3 to 27 days post hatch, DPH) to barotrauma injury and death resulting from rapid decompression over ranges that may be experienced by fish when drifting downstream though river infrastructure. Larval Murray cod demonstrated buoyancy responses to decompression from 17 DPH suggesting inflation of the swim bladder. After this age, the probability of swim bladder rupture increased as the level of decompression increased, but did not exceed 20 % for the most extreme conditions tested and there was little evidence of mortality 24 hours post experiment. The results suggest that mechanisms other then rapid decompression and barotrauma (such as fluid shear or turbulence) may be more important in causing the injury and mortality reported for larval Murray cod when passing river infrastructure.

Systematics & Ecology of Whip-lash Squid (*Cephalopoda: mastigoteuthidae*) Found in New Zealand Waters

Heather BRAID // Auckland University of Technology

Kathrin Bolstad // Auckland University of Technology

Mastigoteuthids are bathypelagic and some species have circumglobal distributions. They are prey to marine mammals and commercially important fish species. Based on decreasing bycatch incidence in commercial fishing nets, at least one species, *Idioteuthis cordiformis*, appears to have experienced significant decline within New Zealand waters. Less is known on the impacts on smaller, less distinctive species that are less frequently encountered, but these smaller species could be similarly affected by human activities. Mastigoteuthid taxonomy is notoriously controversial, with many species descriptions based on single, badly damaged specimens. In addition, specimens frequently lose their skin and tentacles (heavily relied on by previous authors for identification) upon capture. An integrative taxonomic approach has been attempted for New Zealand material in order to clarify the local representatives of this family. Several methods have been trialled for extracting DNA sequences from formalin-fixed tissue from museum specimens and limited frozen material. A morphological distinction between the genera *Mastigoteuthis* and *Idioteuthis* has been supported by genetics. Though only three to five species of mastigoteuthid squid had previously been reported in New Zealand, five known species have presently been identified: *I. cordiformis*, *I. hjorti*, *M. dentata*, *M. famelica*, and *M. psychrophila*. One new *Idioteuthis* species was found that is genetically distinct from morphologically similar species, and two additional, possibly new *Mastigoteuthis* species also occur locally. Stomach contents and stable isotopes for ^{15}N and ^{13}C indicate that *I. cordiformis*, the heavily impacted species, is a top predator.

Tracking Changes in the Microbial Community Composition of Toxic Benthic Freshwater Cyanobacterial Mats in the Hutt River

Katie BRASELL // Victoria University of Wellington

Mark Heath, Ken Ryan // Victoria University of Wellington
Susie Wood // Cawthron Institute

Toxic benthic *Phormidium* blooms are becoming increasingly common in many of New Zealands rivers. During blooms, the benthic mats can cover large areas of substrate and extend for tens of kilometres along the riverbed. The blooms often produce a range of neurotoxic compounds and consumption of mats has resulted in numerous dog deaths. Little is known about the early stages of biofilm formation and how the *Phormidium* comes to dominate and reach such high biomass in relatively low nutrient environments. The aim of this study was to determine the microbial composition of benthic biofilms through their succession to *Phormidium*-dominated mats. Three sites along the Hutt River (Wellington), each with different water chemistries (low, medium and high nutrients), were monitored every 2 to 4 days for 32 days during summer 2013. Biofilm sampling began 4 days after a flushing flow. Environmental parameters were recorded at each site and water samples were taken for nutrient analysis throughout the sampling period. The biofilm was sampled for morphological and molecular analysis of the microbial communities and toxin assessment. Macroscopic analysis showed a succession from bacteria, to diatom to either green algae or *Phormidium* dominated biofilms. *Phormidium* coverage was highest at the low nutrient site, while the medium and high nutrient sites were dominated by filamentous green algae. Nitrates were the predominant nutrient detected at all sites (0.075-0.23 mg/L), while phosphate levels were barely detectable (<0.008 mg/L). Results from morphological, molecular and toxin analyses and the implications of this study will be presented.

Preliminary Investigation of White Island's Natural CO_2 Vents as Sites of Future Ocean Acidification Research

Johanna BRINKMAN // University of Otago

Abigail Smith // University of Otago

Ocean acidification is expected to affect a variety of marine organisms. Short-term studies have shown that calcifying organisms, including plankton, coralline algae and echinoderms, may suffer as energetic costs to precipitate $CaCO_3$ skeletons increase with decreasing $CaCO_3$ saturation. It is difficult, however, to accurately predict the response of these organisms based on short-term studies that exclude complex ecosystem interactions and often involve transplanting organisms directly into low pH environments to which they are unaccustomed. In situ studies using natural CO_2 vents near Ischia, Italy, and Papua New Guinea are now being used to gain a more complete understanding of the effects of acidification. These oceanic vents create natural environments that mimic projected ocean trends of lower pH. Shallow (~10 m depth) vents have also been found off New Zealand's White Island with pH as low as 7.56, within the range of predicted values for the year 2100. CO_2 vents with contaminants (i.e. sulphur, methane, mercury), however, would be unsuitable for acidification research. We have analysed water samples and gas chemistry around New Zealand's vents to determine the suitability of White Island's CO_2 vents for future ocean acidification research.

Mitigating Natural Barriers to Upstream Passage of Macquarie Perch

Ben BROADHURST // University of Canberra

Mark Lintermans, Rhian Clear // University of Canberra

The endangered Macquarie perch (*Macquaria australasica*) requires access to flowing water to spawn. A remnant self-sustaining population of Macquarie perch exist in the Cotter Reservoir, Australian Capital Territory, which rely on passage out of the reservoir to pools in the Cotter River to spawn each spring. Enlargement of Cotter Reservoir will inundate much of the current spawning habitat and passage to new spawning grounds is a high management priority. A survey of the natural barriers of the Cotter River from the headwaters of the current Cotter Reservoir 27 km upstream to the next reservoir was undertaken. Location of potential spawning habitats (i.e. pools) was also recorded. A subset of the identified barriers was monitored during low (10–40 ML Day^{-1}), medium (40–80 ML Day^{-1}) and high (80–160 ML Day^{-1}) flows to determine if natural barriers could be mitigated using flow releases from the upstream Bendora Reservoir to provide the best case access to potential spawning grounds. This presentation outlines the results, implications and management options for maintaining access to spawning habitat following the filling of the enlarged reservoir.

Separating Natural Plankton Variability from Aquaculture-induced Change: New Simulation Modules for the Regional Ocean Model

Niall BROEKHUIZEN // NIWA

Mark Hadfield // NIWA

A decade ago, concerns regarding shellfish aquaculture spurred the development of coupled hydrodynamic and nutrient-phytoplankton-zooplankton models to examine the influence that mussel farming may have upon plankton dynamics. Now, expansion of finfish farming activities is spurring further development of such models. NIWA uses the open-source ROMS modelling system for much of its coastal work. ROMS ships with several models of the plankton system but has node code to represent the influences that shellfish farms and finfish farms have upon the system. We have written new modules to provide that functionality. In this presentation, we will give a brief overview of the ROMS system and of the new modules that we have developed to enable it to represent the influence that mussel and fish farms have upon plankton dynamics. We will present illustrative results from artificial, test-cases and, if possible, also preliminary results for Queen Charlotte Sound.

Larval Dispersal Amongst the Cockle (*Austrovenus stutchburyi*) Beds Within Whangarei Harbour

Niall BROEKHUIZEN // NIWA

Carolyn Lundquist // NIWA
Ricky Eyre // Northland Regional Council

Whilst the Snake Bank, McDonald Banks regions of the outer Whangarei Harbour support healthy cockle (*Austrovenus stutchburyi*) populations, anecdotal evidence indicates substantial population declines within many of the beds in the central and inner harbour. To inform cockle restoration strategies in the harbour, we conducted field surveys to map habitat-quality features and cockle population densities. The data were used to create maps of spawn production and cockle-habitat suitability for inputs to a newly developed 3D particle tracking model designed to simulate the birth, dispersal and fate of cockle larvae. Simulations were made for a variety of wind scenarios. The majority of those virtual larvae which were able to settle did so within ~ 3 km of their natal location. Nonetheless, a few individuals disperse over much larger distances – such that all beds are (at least) weakly connected. There is an abundant supply of allochthonous recruits to the beds of the inner harbour. Most of these originate from the large Takahiwai bed that extends across the southern shoreline of the central and outer harbour. Whilst cockle densities on Takahiwai are believed to have declined, they remain moderately high relative to those elsewhere in the central/inner harbour. We infer that the population declines in the central and inner harbour beds reflect bed-specific habitat degradation rather than larval-supply decline. The simulations suggests that habitat improvement in the inner harbour will be followed by moderately rapid natural recolonization provided that the Takahiwai population does not decline further.

What Have We Learnt from 14 Years of Marine Sediment Contaminant Monitoring in Auckland?

Marcus CAMERON // Auckland Council

Geoff Mills, Bruce Williamson // Diffuse Sources Limited
Melanie Vaughan // Auckland Council

In 1998, the Auckland Regional Council (now Auckland Council) initiated a sediment chemistry monitoring programme aimed at assessing the spatial distribution of, and temporal trends in, key chemical contaminants across the region's urban estuaries, harbours, and sheltered open coast. Over the subsequent 14 years important lessons have been learned concerning factors such as QA procedures and reporting, consistency of methods and the influence of analytical variability. As a result the programme has recently undergone significant review and restructure and improvements have been achieved including the consolidation of three originally separate programmes. Substantial data analysis has been carried out and results (including trends) will be presented for copper, lead, zinc and polycyclic aromatic hydrocarbons (PAHs). Of particular interest is that the early patterns of linear increases in zinc and copper (and decreases in lead) have not necessarily persisted, and recent data illustrate that changes over time are more complex and variable than might have been expected. Consideration of other potential sources of contaminants (such as marinas) and implications for the ecological health of the marine receiving environment will also be discussed.

Comparison of Potential Management Controls for the White Banana Prawn Fishery in Australia's Northern Prawn Fishery

Rik BUCKWORTH // CSIRO

Nick Ellis, Shijie Zhou, Sean Pascoe, Roy Deng // CSIRO
Fiona Hill // Australian Fisheries Management Authority
Michael O'Brien // Tropical Ocean Prawns Australia Pty Ltd

Simulating a large number of annual white banana prawn fisheries, we examined the economic performance of individual fisheries when different management controls were applied. We first specified a range of fisheries consistent with historical observation, estimating fishable biomass, catchabilities and harvest rates, for 1987-2011, using depletion analyses. A binomial model described effort patterns. We evaluated economic performance of alternative management controls for the fishery, predicting profits (losses) of pre-season Total Allowable Catches (TAC), TACs up-dated mid-season (U-TAC), and an MEY catch rate trigger (MEYT), relative to the status quo (SQ) catch rate stopping rule. Superficially, performance under the different controls was similar, (mean annual profit, $10–11 million), but this was very variable (SD = $8-9 million). Marked differences from within-year comparisons exposed potential risks, concealed by averaged performance, from adoption of a particular strategy. Consistently effective, MEYT provided at least $1+ million in profit than SQ about half the time, and was rarely worse. There was, however, substantial risk of loss in adopting TAC. In bad (low catch) years, SQ and, especially, MEYT, were clearly more profitable than TAC; U-TAC in these years was not effective but tended to perform well in high catch years. There is substantial risk that introduction of TAC or U-TAC would lead to poorer profit performance than SQ or MEYT, especially in a series of bad years – drought – in marked contrast to the small differences apparent in long-term average or total profits from the different strategies.

Effects of Ocean Acidification & Warming on Fertilisation & Larval Development in the Antarctic Bivalve, *Laternula elliptica*

Christine BYLENGA // Victoria University of Wellington

Vonda Cummings, Neill Barr, Graeme Moss // NIWA
Sonja Hempel , Stephanie Menashe, Ken Ryan // Victoria University of Wellington

Laternula elliptica is a common and highly stenothermic species of clam in coastal regions of the Southern Ocean. Slight increases in water temperature reduce energetic activity and initiates anaerobic cellular respiration in this organism. Furthermore, reduced pH increases production of heat shock proteins in adults and reduces shell integrity. However, little is known of the effects of both of these climate change related processes on fertilisation success and larval development in *L. elliptica*. In March 2013, eggs and sperm were stripped from the gonads of mature clams. Through exposure to temperatures of -1.6, -0.5 and 0.5°C and pH levels of 7.95, 7.80 and 7.65, the rates of fertilisation, malformation of larvae and timing of development through the D-larvae stage were investigated. Preliminary results suggest larval development timing was affected by temperature and pH change. 24 days after fertilisation, 83.5% of larvae raised at 0.5°C and pH 7.95 were at the D-larvae stage compared to 15.3% of those raised at -1.6°C and pH 7.65. Results are currently being analysed

Graduated-field Fish Barriers as Conservation Tools for Managers: Invasive Species Control & Downstream Guidance Applications

Carl BURGER // Smith-Root, Inc

John Parkin // Parkin Engineering
Aaron Murphy // Smith-Root, Inc
Martin O'Farrell // Smith-Root Europe

Fisheries managers have used non-lethal, pulsed DC technology to control invasive fish migrations in several areas of North America and Europe. Electrode arrays have also been used to deter fish from hydropower intakes. Successful applications have employed an innovative design: the Graduated-Field Fish Barrier (GFFB), a technology that intensifies voltage gradients as fish enter the field. There are 49 GFFBs around the world. We provide examples from published literature on both successes and "lessons-learned," particularly for invasive species control. We discuss key elements of the technology and how it works. In the Southern Hemisphere, conservation priorities often require downstream guidance technologies. Accordingly, we present information on three installations to guide downstream-moving fishes. The first addresses juvenile salmon entrainment at an irrigation canal on the Sacramento River, California (where entrainment of downstream-moving, juvenile Chinook salmon was reduced by 79%). The second is a recent installation to keep adult salmonids from entering a hydropower diversion in Colorado. The third involves controlled flume trials on invasive sea lamprey juveniles in Michigan. Preliminary data show that very low voltage, graduated fields of pulsed DC guided 55-74% of the downstream migrants into a mock trap at end of flume (depending on approach velocities). An innovative, hybrid-design is proposed for future downstream fish guidance. The concept involves graduated electric fields *in concert with* low-frequency acoustics (to elicit fright responses and move fish around water intakes upstream of GFFB arrays). This combination may be key to achieving high levels of conservation success in future downstream guidance applications.

Preliminary Validation of MAM-PEC Modelling of Copper Concentrations in Eight Auckland Marinas

Marcus CAMERON // Auckland Council

Jennifer Gadd, Chris Hickey // NIWA

Copper is now found in almost all antifouling paints in New Zealand but can have adverse effects on non-target marine organisms when at elevated concentrations. NIWA undertook modelling for the New Zealand EPA to predict the water column concentrations of copper in ports and marinas using the MAM-PEC model. These predictions suggested that in most marinas copper concentrations would exceed water quality guidelines by up to 7 times. Given these high predictions, a field study was undertaken to measure copper concentrations in the water column of eight Auckland marinas to provide preliminary validation of these model results and to assess the likelihood for effects on aquatic biota. A further aim of this study was to estimate the export of copper from Auckland marinas to the wider coastal environment. Results from the field study compared well to model predictions. In most marinas, copper concentrations did exceed ANZECC (2000) water quality guidelines based on either 95% or 90% levels of protection. Several marinas also exceeded site-specific chronic and acute water quality guidelines based on dissolved organic carbon concentrations. Leaching of antifouling paints from vessel hulls appears to be the major source of copper in the water column for the marinas studied. Using the results from this study, and predictions of fate from the previous modelling study, an estimate of the total export of copper from Auckland marinas due to vessel leaching was made. This estimate equates to roughly double that predicted from stormwater for the entire Waitemata Harbour catchment.

Dicyemid Parasites as Biological Tags to Assess the Population Structure of *Sepia apama*

Sarah CATALANO // University of Adelaide

Ian Whittington, Steve Donnellan // University of Adelaide, South Australian Museum
Terry Bertozzi // South Australian Museum
Bronwyn Gillanders // University of Adelaide

Sepia apama, the largest species of cuttlefish in the world, is endemic to southern Australian waters, distributed from Ningaloo in Western Australian through to Moreton Bay in southern Queensland. A mass breeding aggregation of *S. apama* occurs in Upper Spencer Gulf (USG), South Australia (SA), Australia, during the winter months each year. However, the abundance and biomass of this mass breeding aggregation is in decline. Differences in host molecular data, morphology and behaviour suggests that the USG breeding aggregation may be distinct, and as such, recruitment from neighbouring populations may have no impact on sustaining this aggregation. Therefore, the population structure of this species needs to be investigated further and verified using an innovative approach. In this study, we used dicyemid parasites, microscopic organisms found in the renal appendages of cephalopods, as biological tags to assess the population structure of *S. apama* in southern Australian waters. Four dicyemid species were documented from *S. apama* collected throughout southern Australian waters, although all four species were never found together in the same host individual. Rather patterns of dicyemid fauna composition, inferred via morphological and molecular analyses, varied with capture locality of the host. In particular, the dicyemid parasite fauna of Spencer Gulf (SG) cuttlefish was different to the fauna found from cuttlefish collected in other localities. Due to the highly host-specific nature of these parasites, this result gives strong support to the SG cuttlefish representing a distinct sub-set and potentially a distinct species compared to the other populations in southern Australian waters.

DetectionImplications of Environment Gradients, & Alternative eDNA Collection & Extraction Methods

Lindsay CHADDERTON // The Nature Conservancy, Great Lakes Project

Chris Jerde, Matt Barnes, Cameron Turner, Mark Renshaw, Karen Uy, Brett Olds, David Lodge // University of Notre Dame
Andrew Tucker // The Nature Conservancy, Great Lakes Project

The application of reliable and effective surveillance methods is a critical component of invasive and threatened species management. Sampling and detecting rare, cryptic and or mobile fish species across large spatial scales and in deep (>1 m) and or turbid waters is particularly problematic. Environmental DNA (eDNA) monitoring methods appear to offer a surveillance approach that can be applied at broad scales with high levels of sensitivity and potentially low detection errors. However, many parts of the eDNA method are incompletely understood. For instance detection sensitivity is likely to be affected by rates of DNA settlement and degradation that will vary across environmental gradients. In addition, the two contrasting approaches (filtration vs precipitation) that have predominantly been used to collect and extract DNA from environmental water samples appear to offer a tradeoff between sample volume and extraction efficiency, factors that will also likely affect detection sensitivity. Here we use a series of mesocosm trials to quantify the impacts of pH, Chlorophyll and biological oxygen demand on eDNA degradation rates. We also test the relative detection efficacy of a variety of collection and extraction methods across a putative Asian carp abundance gradient in the Chicago Area Waterway System. Based on these results, recommendations that should increase detection sensitivity and interpretation of eDNA sampling methods are provided.

Estimating Stock Size of Orange Roughy on Seamounts in the High Seas: What can We do when We don't know Anything?

Malcolm CLARK // NIWA

Owen Anderson, Ian Doonan, Andy McKenzie // NIWA

Deep-sea fisheries in the High Seas around New Zealand have occurred for several decades, but few have proven sustainable in the long-term. In contrast to fisheries inside EEZs, there is typically little research associated with such fisheries, and few data on which to base effective fisheries management. High Seas fisheries for orange roughy occur largely on seamount features, and in this work we have examined whether the physical attributes of the seamounts themselves (often relatively well known) can inform estimation of likely biomass, and hence sustainable yields. Building on an earlier study, we have compiled information on 91 seamounts in the New Zealand and Australian region, consisting of 15 environmental and physical variables, and reported total catch of orange roughy. Regression modelling indicated that a number of seamount attributes showed strong relationships with the level of orange roughy catch, including depth of summit, latitude, longitude, association (whether the seamount is oceanic or on the continental slope), connectivity (isolated, cluster, or chain), and whether the seamount is a spawning site. The GAM results suggest that knowledge of the physical nature of a seamount can be used to predict the likely total biomass of orange roughy, and hence give managers a basis on which to set provisional catch limits.

Is the Manawatu River Really the Worst in the West?

Maree CLARK // Horizons Regional Council

Logan Brown, Jon Roygard // Horizons Regional Council

Media headlines in late 2009 dubbed the Manawatu River as the worst in the west. Within the Horizons region the Manawatu River is the most intensively monitored catchment. This presentation seeks to show case some of the monitoring results from the Manawatu catchment and place this information within the national context. We will draw comparisons between our monitoring results for the Manawatu catchment and compare with the pool of information available nationally via the Land and Water New Zealand website to answer the question is the Manawatu River really the worst in New Zealand let alone the west?

The Science Behind Successful Freshwater Biosecurity Management

John CLAYTON // NIWA

In 1861 the New Zealand government promoted introduction of foreign species to rehabilitate New Zealand's depauperate fauna and flora and for c. 100 years the Acclimatisation Society imported a wide range of species for this purpose. Today population growth, globalisation, trade treaties, the pet industry & tourism have taken over as key drivers of the escalating biosecurity problems in New Zealand and around the world. The relatively isolated location of New Zealand presents a unique opportunity to implement successful biosecurity management strategies to help protect what remains of our unique fauna and flora. New Zealand has been proactive in using science based solutions to biosecurity challenges. Biosecurity legislation based on scientific evidence has been instrumental in guiding border control, regulating the pet trade and nursery industry, and in formulating government and regional council obligations under the National Interest Pest Response programme and Regional Pest Management Strategies. Species risk modelling developed in New Zealand has helped validate biosecurity policy and this approach has been also adopted in other countries. Quarantine competitive species growth trials and experimental testing facilities for pest control have been critical for validating biosecurity management strategies in New Zealand. Modelling the spread of pest species based on key drivers such as population density, roads and accessibility to freshwater resources have helped guide and prioritise surveillance strategies. Research on the application and refinement of pest control tools has led to more cost efficient use and improved performance.

The Reproductive Cycle of the Freshwater Mussel *Echyridella menziesii* in Lake Taupo, New Zealand

Susan CLEARWATER // NIWA

David Roper, Chris Hickey, Michael Martin, Erica Williams // NIWA

The seasonal cycle of reproduction of a population of the native freshwater hyriid mussel *Echyridella menziesii* (Gray, 1843) (previously *Hyridella menziesi*) in Lake Taupō is described using historic data. Adult mussels were collected from August 1993 to August 1994, and reproductive status was assessed. Eggs are fertilized in the brood pouch of the female mussel gill, where they develop into a glochidia larvae which must parasitize on a fish to develop into a juvenile. Spawning commenced in late austral winter (August) and brooding females peaked in abundance (23 to 30%) from spring to mid summer (September to January), decreasing to a minimum of 8% in early autumn (March). No brooding females were present from mid-autumn to early winter (April until June). Planktonic glochidia were first detected in January coinciding with a seasonal water temperature increase to 20°C, up from ~14°C in late November. Common bullies, *Gobiomorphus cotidianus*, parasitized by glochidia were found in benthic trawls from January to March. The presence of spermiated male mussels and vitellogenic oocytes in the females throughout the year suggests spawning is partial and continuous, however distinct seasonal changes in abundance of brooding females indicate seasonality of successful fertilization, brooding and glochidial release. Seasonal extremes in water temperature and photoperiod preceded the start of both embryo brooding and glochidia release, suggesting these environmental cues synchronise reproduction in this population of *E. menziesii*. Understanding the reproductive cycle of native mussels has enabled our recent evaluation of the contaminant sensitivity of glochidia and juveniles.

Seasonal Movement Patterns of Macquarie Perch in Cotter Reservoir, Australian Capital Territory

Rhian CLEAR // University of Canberra

Jason Thiem // University of Canberra, Carleton University
Ben Broadhurst, Mark Lintermans, Daniel Wright // University of Canberra
Brendan Ebner // University of Canberra, James Cook University

Cotter Reservoir, Australian Capital Territory, is home to a self-sustaining population of the endangered Macquarie perch (*Macquaria australasica*). Enlargement of Cotter Reservoir threatens critical natural habitat (emergent macrophytes) so provision of constructed habitat is crucial to long term persistence of this population. Knowledge of movement of this species was required to guide placement of the constructed habitat. We used radio telemetry to determine seasonal diel movements and activity of adult Macquarie perch in Cotter Reservoir. Macquarie perch exhibited a diel range of 389 ± 46 m, a diel mobility of 769 ± 93 m and diel area use of 24008 ± 5595 m^2 among four seasons. Diel range was significantly higher in winter compared with other seasons. Macquarie perch inhabited deeper water in summer across the diel cycle in comparison with other seasons. Within seasons, remote and manual telemetry identified that diel activity was predominantly crepuscular. Based on results of this study, constructed habitats have been placed in readiness for reservoir filling.

Variable Timing of Hatch & Early Ontogeny in Bluegill Bully (*Gobiomorphus hubbsi*)

Gerard CLOSS // University of Otago

Jonathan Wright, Manna Warburton, Hannah Harland // University of Otago

Timing of hatch from an egg is a critical life history stage in many organisms. Hatch too early, and insufficient development has occurred for survival. Hatch too late, and competitors have a head start in the race for resources. Amphidromous fish face unique challenges in deciding when to hatch. Fish hatching too early may be unable to orientate and survive in turbulent waters during downstream transport to the sea. Fish that hatch too late may have insufficient internal resources to survive downstream transport and develop into an independently-living juvenile fish. Collection of eggs of bluegill bully, a small amphidromous eleotrid that spawns on large cobbles, revealed a surprising degree of flexibility in the hatch timing. Movement of rocks triggered almost immediate hatch of entire egg plaques, with emerging larvae exhibiting considerable variation in their ontogeny. Development at hatch varied from being little more than a yolk sac with a tail, to relatively well formed larvae. Analysis of the behaviour and development of these larvae indicated strong positive phototaxis and delayed development in freshwater. Hatching in response to movement suggests that hatching occurs in response to flood-related disturbance, although this raises the question as to what cues are used to initiate hatching in the absence of floods. Delayed development saves energy during the downstream migration, but how long can development be delayed before resources are too depleted to allow further development is unclear. The implications of variable hatch in amphidomrous fish will be discussed.

Are Macroinvertebrates Effective Indicators of Environmental Stress in Large Rivers?

Kevin COLLIER // The University of Waikato

Mark Hamer // Waikato Regional Council
Stephen Moore // Landcare Research

Macroinvertebrate community responses to contrasting human stressors were measured at three locations during spring and autumn along a 45-km section of the Waikato River, Hamilton, New Zealand, to determine the utility of littoral and deep-water macroinvertebrate communities as an indicator of large river health. Industrial organic discharges increased phosphorus levels above recommended ecological guideline values at the upper location, sediment inputs from a large tributary increased turbidity up to four times above upstream levels at the middle location, and cooling water discharge from a thermal power station elevated maximum summer water temperature by around 3oC over ambient at the lower location. Overall, macroinvertebrate communities comprised 89 taxa and were dominated numerically by the amphipod Paracalliope fluviatilis (29% of total numbers) and naidid worms (26%) which were strongly associated with littoral and deep-water benthic habitats, respectively. Nested PERMANOVA analyses indicated that community composition was strongly influenced by location along the river, sampling habitat (littoral or deep-water) and season (spring or autumn). Comparison for sites or seasons when the full complement of samples was collected indicated a significant effect of stressor type (upstream vs downstream), and within locations there was a significant effect of ranked stressor intensity for organic enrichment and turbidity. Broadscale surveys of other non-wadeable rivers in the region suggest that the macroinvertebrate community in this large river did not reflect generalised land cover patterns evident in other non-wadeable rivers, reinforcing the need to characterise stressor types when interpreting macroinvertebrate responses in large rivers.

A Simple Method For State of The Environment Reporting & Assessing Compliance Against Numerical Limits of Water Quality Standards

Jim COOKE // Streamlined Environmental Ltd

There is wide variation in the methods that Regional Councils use to report on surface water quality in State of the Environment reports. Many of these methods use complex metrics and are designed to report on the state of water classes, rather than individual sites. As part of a review on Southland's surface water quality I developed a simple method using box and whisker plots, to compare confidence intervals about the median value of a contaminant measured at individual sites with the numerical limit of the objective or standard used for the water class in question. This enabled me to construct a 'report card' based on confidence intervals about the median in which sites are graded red (95% CI exceeds standard) through green (all connected data meets the standard). The method is simple, robust, and transparent. It readily allows comparison of individual parameters (e.g. DRP, NNN, black disk clarity), and for the rapid identification of problem sites where numerical limits of standards are routinely exceeded for several parameters. By grouping sites according to water class, or catchments, visual comparisons between these groups can also be made. The rapidity of the data analysis means that it is quite feasible to produce annual report cards that report on progress to improve regional water quality, and to galvanise action where sites persistently exceed the standard.

Near Real-time Water Quality Monitoring in Shellfish Growing Waters

Chris CORNELISEN // Cawthron Institute

Jonathan Banks, Kirsty Smith, Lesley Rhodes // Cawthron Institute
Kevan Yamahara // Center for Ocean Solutions
Christine Preston, Scott Jensen, Brent Roman, Chris Scholin // Monterey Bay Aquarium Research Institute

Excellent water quality with low risk of microbial contamination is critical to sustaining a productive aquaculture industry. Shellfish growing waters often lie within the influence of catchment runoff and associated contaminants. To minimise pathogen risk and meet food safety standards, shellfish sanitation programmes manage harvests around rainfall/river flows and monitor faecal indicator bacteria (Escherichia coli) for compliance. Prolonged closures greatly compromise farm productivity and there are lags in obtaining *E. coli* results, which provide no information on sources of contamination. The in situ Environmental Sample Processor (ESP) presents exciting new prospects for managing aquaculture resources by providing results in near real-time. We trialled an ESP in Tasman Bay that remotely collected and analysed water samples for quantitative PCR (qPCR) markers specific to faecal contamination. The ESP was deployed adjacent to aquaculture areas and transmitted data over a 30-day period. Field surveys were carried out during and after deployment to assess the spatial extent of contamination. The ESP deployment occurred during a dry period and detected low levels of faecal pollution. Water samples collected from rivers within the catchment and analysed using a lab-based ESP frequently had elevated levels of ruminant and human contamination, particularly following rainfall. Bench-top qPCR analysis of mussel samples also indicated presence of ruminant contamination following elevated river flows. The ESP represents a powerful technology for the surveillance of water quality contaminants in shellfish growing waters. When placed in "proxy" locations, ESPs also have the potential to greatly augment and strengthen operational models for forecasting water quality.

Spatially Explicit Ecological Risk Assessment to Inform Fisheries Management: Methods, Inferences, & Pitfalls

Martin CRYER // Ministry for Primary Industries

Rohan Currey, Ben Sharp // Ministry for Primary Industries

Recent developments in ecological risk assessment offer the promise of understanding risks and threats to protected species in a spatially and temporally explicit framework that can be used to identify the times, places, and activities that pose most risk. We use two recent semi-quantitative, spatially explicit ecological risk assessments to show the opportunities offered by this approach and some of the limitations and pitfalls. Risk assessment is central to implementation of New Zealand's recently-revised National Plan of Action to Reduce the Incidental Catch of Seabirds in New Zealand Fisheries (NPOA-Seabirds). The risk assessment used is designed to assess the likelihood that the biological risk objective of the NPOA-Seabirds will not be met as a result of commercial fishing in New Zealand waters. Of 70 seabird species considered, 10 were assessed as being at high or very high risk and 44 were assessed as being at very low risk. Another risk assessment was used to inform the review of the Threat Management Plan for Maui's dolphin *(Cephalorhynchus hectori maui*), a critically endangered sub-species endemic to New Zealand. This assessment considered 23 human and non-human-induced threats likely to affect population trends within the next 5 years. An expert panel's scores suggested a median of 5.27 total human-induced mortalities per annum (0.97–8.40), a high proportion of which was attributable to fishing. In both cases, disaggregated estimates of risk and uncertainty can be used to target and prioritise both management responses and collection of new information, including research.

Riding an Oily Wave: Impacts of the CV Rena on Bay of Plenty Surf Clams

David CULLIFORD // The University of Waikato

Rex Fairweather, Chris Battershill // The University of Waikato

During the breakup of the CV RENA, an estimated 355 tonnes of fuel oil spilled into the sea, a large portion washing ashore on Bay of Plenty beaches. As part of the long term Rena recovery program, we investigated the impacts of the spilled fuel oil on intertidal open coast invertebrates. Specifically, we focused on the surf clam Paphies subtriangulata (Tuatua), which is generally abundant on sandy open coasts in the Bay of Plenty characterising the open beach habitat. It is also an important kai moana species. Tuatua abundance, length frequencies, biomass, invertebrate diversity and environmental variables were compared across thirteen locations from Bowentown to East Cape which spanned high and low oil impact areas. Chemical and demographic data was analysed in the context of the degree of oiling across the region. No catastrophic die offs were observed, but population and PAH profile attributes varied considerably within and among locations and also with degree of beach oiling. Decreases in abundance and biomass were noted at the most heavily oiled locations. Abundance and biomass decreased from winter to summer sampling programs, believed to be related to environmental factors. Long term effects on the recovery of the exposed soft shore were not detected

Mating Behaviour of Clownfish in a Tank Based System

Norsila DAIM // Universiti Teknologi MARA (Perlis), Malaysia

Zulkifli Hamzah // Universiti Teknologi MARA, Malaysia

Clownfish or anemonefish is one of the famous and demanded ornamental fish in aquarium trade industry worldwide. Coral reef fish including clownfish from family Pomacentridae live in warm water habitat. The demand of wild-caught ornamental fish keeps increasing and sometimes the supply is unable to satisfy the demand. Captive breeding of marine ornamental fish might be a solution to overcome this problem and the observation on mating behaviour of coral fishes is very crucial for a successful breeding process. In this study, four pairs of false percula clownfish Amphiprion ocellaris, a pair of spinecheek clownfish Premnas biaculeatus, a pair of tomato clownfish Amphirion frenatus, and a pair of pink clownfish Amphipirion perideraion were reared as broodstock in 30 L tanks. The flat surface and hard items (tiles and live rock) were provided as a suitable place for egg laying for the broodstock. Frozen blended fish meal consisting of fresh fish meat, squid and shrimp was used to feed the broodstock five times a day. Frozen bloodworms were also included in the diet and fed to the broodstock, singularly. Water quality parameters (temperature, pH, salinity, nitrate, nitrite, ammonia, phosphate, and carbonate hardness) were observed and maintained throughout the experimental period. The mating behaviour of clownfish broodstock was observed day and night around full moon and recorded between January and June 2012. All of the broodstock pairs exhibited two distinct types of courtship behaviour, which are spawning rise and body scrubbing with each other. The mating behaviour was used as an indicator to observe and predict successful breeding process.

Integrated Catchment Management – Striking the Balance Between Sports Fisheries, Biodiversity & Community Values in the Cardrona Catchment

Matt DALE // Otago Regional Council

Matt Salmon // Otago Regional Council

Located in the upper reaches of the Clutha catchment, the Cardrona River is one of the most water short catchments in Otago. The complex interaction between groundwater and surface water, combined with a variety of instream and socioeconomic values, pose unique resource management challenges. The Cardrona River supports a large spawning run of rainbow trout and is the most significant spawning tributary of the upper Clutha River. As well as being an important source of recruits for the upper Clutha fishery, the Cardrona River also supports an early season recreational fishery before the spent fish return to the main stem of the Clutha River. Although trout have invaded most of the tributaries in the Cardrona catchment, some creeks still support isolated populations of Clutha flathead galaxias, which are one of the most threatened non-migratory galaxiids in New Zealand. The lower reaches of the Cardrona River are dewatered for much of the irrigation season due to a combination of water abstraction and losses to the underlying Wanaka-Cardrona aquifer. As well as providing a source of groundwater for domestic and agricultural use, the Wanaka-Cardrona Aquifer also augments surface flows for the lower Cardrona River and the nearby Bullock Creek. The Otago Regional council is currently undertaking a series of workshops with the aim of setting a minimum flow and allocation limits for the Cardrona River and the Wanaka-Cardrona Aquifer. When combined with targeted management tools such as residual flows and trout migration barriers, it is hoped that the socioeconomic, recreational and biodiversity values of the Cardrona catchment will be maintained and enhanced.

Fish Communities of Shallow Waikato Lakes. Where are the Longfins?

Adam DANIEL // Fish & Game New Zealand

Brendan Hicks, Nicholas Ling // The University of Waikato

Lakes Mangahia, Kaituna, Ohinewai and Serpentine were intensively sampled during non-native fish removal operations conducted between 2010 and 2013 to monitor for changes in species composition of large-bodied fish. Native [longfin eel (*Anguilla dieffenbachii*) and shortfin eel (*Anguilla australis*)] and non-native fish [koi carp (*Cyprinus carpio*), goldfish (*Carassius auratus*), catfish (*Ameiurus nebulosus*) and rudd (*Scardinius erythrophthalmus*)] were marked via fin clip to determine species biomass using a capture-mark-release-recapture study design. The biomass of fish in lakes Mangahia, Kaituna and Ohinewai were dominated by non-native fish (range 104–228 kg ha^{-1}) compared to native fish (range 34–57 kg ha^{-1}). Lake Serpentine, the only lake with a non-native fish control program, had a low biomass of non-native fish (1 kg ha^{-1}) and a moderate biomass of eels (32 kg ha^{-1}). Longfin eels were captured in low numbers (range 1–7 kg ha^{-1}) in all four lakes compared to shortfin eels (range 31–55 kg ha^{-1}) composing just 2% of the individuals captured.

Rope Beats Slope: Mussel Ropes Improve Fish & Shrimp Passage Through Culverts

Bruno DAVID // Waikato Regional Council

Jonathan Tonkin, Hayden Hokianga // Bay of Plenty Polytechnic
Kris Taipeti // Waikato Regional Council

We investigated the installation of mussel spat ropes as a potentially rapid and cost effective tool for improving passage of freshwater biota through culvert pipes where internal barrel conditions impede passage. We assessed passage success for two fish species, juvenile *Oncorhynchus mykiss* (Walbaum 1972; rainbow trout) and adult *Galaxias maculatus* (Jenyns 1842; inanga), and one migratory shrimp, *Paratya curvirostris* (Heller 1862). We hypothesized that ropes would enhance passage of all three species but that success rates would differ dependent on swimming ability and trial combinations of culvert length (3 and 6 m), gradient (1.5 and 3°) and flow (0.24 and 0.75 L s^{-1}). Ropes resulted in reduced water velocity within culvert barrels and significantly improved passage success for all three species. Shrimp benefited most by the presence of ropes, being unable to negotiate any of the pipe combinations in their absence, but exhibiting varying rates of success across all combinations with their presence. Both *G. maculatus* and *O. mykiss* were able to negotiate some of the non-roped pipe combinations but as the level of difficulty increased, successful passage was only achieved with ropes present. We conclude that this relatively inexpensive tool has potential to substantially improve passage for a range of aquatic biota through a range of culvert scenarios. Application of ropes would be particularly useful in situations where internal culvert access is difficult and where various culvert parameters (slope, flow, length) result in internal barrel hydraulics that would normally limit or exclude passage of aquatic biota.

What is It Worth? An Exploration of Estuarine Ecosystem Services & Human Well-being

Kathryn DAVIES // The University of Auckland

Simon Thrush // NIWA
Mark Dickson, Karen Fisher, Richard LeHeron // The University of Auckland

Estuaries are complex social-ecological systems that cover a diverse cross-section of habitats, support a wide range of human activities and values, and are an integral part of the New Zealand cultural identity. Estuarine systems provide a range of services that benefit humans; a few examples include food production, recreational opportunities, contaminant processing, and storm protection. Some of the services provided by estuaries, such as food production, can be valued in monetary terms and incorporated into decision-making with relative ease, but many other services are difficult to express in monetary or other quantitative terms and are therefore under-valued if they are considered at all in decision making. Social values of estuaries, and factors which underpin ecosystem service provision such as ecosystem processes, the diversity of habitats within estuaries, and the connections between habitats within estuaries, are particularly difficult to capture and incorporate into decision making but are a vital part of any ecosystem service implementation process. The difficulties associated with incorporating ecosystem services into decision making combined with the complex relationships governing the delivery of services suggest that a precautionary management approach is necessary to prevent critical failures in service delivery, but as yet there is no regional or national stocktake of estuarine ecosystem services or their associated processes. Current research using a case study from Mangere Inlet, Manukau Harbour, explores ways to identify and value ecosystem services provided by estuaries.

The Many Voices of Manukau: a Participatory Approach to Mapping Ecosystem Services

Kathryn DAVIES // The University of Auckland

Karen Fisher, Mark Dickson, Richard LeHeron // The University of Auckland
Simon Thrush // NIWA

Ecosystem services are the benefits that people obtain from ecosystems. The development and implementation of ecosystem service frameworks is perceived as a way to cope with environmental problems that are characterised by high levels of complexity and uncertainty. Ecosystem service frameworks aim to encourage the consideration of links between natural systems and human well-being; facilitate the assessment of feedbacks and trade-offs that occur among services and human beneficiaries; and incorporate values into decision making processes. Extensive stakeholder participation is needed to guide the development, implementation, and maintenance of ecosystem service frameworks if these ambitious goals are to be realised. This research explores the use of a participatory mapping methodology in an urban estuary, and shows how the application of this methodology can contribute to the identification and valuation of ecosystem services in areas where problems are complex and futures are uncertain. Mangere Inlet, an estuary located in Manukau Harbour, is the case study for this research.

Assessing Boat Electrofishing Injury on Shortfin Eels, *Anguilla australis*

Joshua DE VILLIERS // The University of Waikato

Brendan Hicks, Adam Daniel // The University of Waikato

Electrofishing is standard practice for most freshwater fisheries monitoring programmes and has been a valuable sampling technique for over half a century. However, electrofishing can potentially cause a number of injuries, most commonly dermal burns, haemorrhaging and spinal damage, and we examined injury rates in shortfin eels (*Anguilla australis*). Eels were captured by fyke netting and boat electrofishing with a Smith Root 5 GPP unit (60-Hz pulsed direct current, 45–60% of range, 3–4 amps RSM output) from two Waikato lakes. The incidence and severity of injuries resulting from each method of capture was assessed by radiographic imaging and bilateral filleting immediately after capture and following a 30-day holding period; also, mortality rates were determined after 30 days. Survival of shortfin eels after 30 days was high for both capture methods (90% for fyke netting and 94% for boat electrofishing). Rates of internal haemorrhaging immediately after electrofishing were inconsistent (0% in Lake Areare and 28% in Lake Rotongaro); in Lake Rotongaro, this was significantly greater than those captured by fyke netting, in which only 8% had haemorrhages. The incidence of haemorrhaging in electrofished eels was lower after the 30-day holding period than immediately after capture, i.e., 28% in Rotongaro eels at capture but only 4% after 30 days in captivity. Spinal injury rates in eels captured by electrofishing ranged from 8% in Lake Rotongaro eels to 12% in Lake Areare eels. In contrast, the rate of spinal injury in eels captured by fyke netting was 0% in Lake Areare eels and 4% in Lake Rotongaro eels.

Developing Freshwater Objectives from Values: an Example from New Zealand Freshwater Fisheries

Neil DEANS // Fish & Game New Zealand

Martin Unwin // NIWA
Kay Booth // Lindis Consulting

Giving effect to NZ's new National Policy Statement on Freshwater Management requires Regional Councils to identify freshwater values in catchments and set objectives to provide for them. Limits, targets and standards may then be established to provide for critical values and enable community decisions on what would be provided for. Deciding what level of significance and hence weight to be given to particular values in each case requires a rigorous, consistent and defensible approach towards comparing within and between values in particular locations. Few national datasets are available to analyse and develop consistent frameworks to assess values; one such is Fish and Game NZ's National Angler's Survey undertaken at seven year intervals. An approach using the River Values Assessment System (RiVAS) to establish relative significance of freshwater angling values across NZ's 1150 rivers and lakes is outlined.

Water Quality in Pegasus Bay: From the River to the Sea

Fiona DEATH // Aquanet Consulting Limited

Olivier Ausseil // Aquanet Consulting Limited
Lesley Bolton Ritchie // Environment Canterbury

A number of freshwater bodies flow into Pegasus Bay at various points along the coastline. Wastewater from both the Waimakariri District and Christchurch City also enter the bay via ocean outfalls. Inputs of contaminants, in the form of nutrients, sediment and micro-organisms from all of these sources have the potential to adversely affect the water quality of coastal Pegasus Bay. A survey in which water quality data were collected at locations on fourteen Canterbury rivers (as close to the coast as possible but without being affected by tidal influence); as well as at 10 beaches along Pegasus Bay was undertaken between 1 July 2010 and 30 June 2011. Data collected allowed an assessment of the state of water quality at river sites that feed into Pegasus Bay; as well as at nearshore and offshore water quality sites. Total annual loads of nutrient (nitrogen and phosphorus) entering Pegasus Bay were estimated using a number of methods and the relative contribution made by each river and outfall was quantified. Results have highlighted the contribution of the Christchurch City Council ocean outfall to the total loads of both TN and TP entering Pegasus Bay. The findings of this study would assist in identifying key nutrient sources and prioritising their management, should actual or potential algal growth issues be identified in Pegasus Bay.

The State of the Taupo Fishery & Its Impact on the Level of Angling Participation

Michel DEDUAL // Department of Conservation

The level of participation in angling has traditionally been thought to be strongly correlated with the state of the fishery. When fishing is not good (low catch rate and/or small fish size) anglers move somewhere else, the licence sales drop and the associated drop in fishing pressure allows for the fishery to recover. It is this general observation that leads to the supposition that recreational fisheries tend towards self-regulation. If this supposition is true we would expect to see a cyclical trend in participation following the ups and downs in fish number and/or size. However, the evidence that this is occurring in Taupo is not fully convincing. The trend in participation estimated by the number of fishing licence sales has peaked in the late 1980s but has been consistently going down since then despite the fact that the fish caught in the late 1990s were on par with those from the golden years of the fishery. Google Trends is used to illustrate the global decline in participation to freshwater angling in New Zealand and in other parts of the western world. In this presentation we also explore how important are the abundance and the size of the fish to explain the current trend in participation and what this means for the management of the fishery.

Temperature Limits to Early Development of the New Zealand Sea Urchin *Evechinus chloroticus* (Valenciennes, 1846)

Natalí DELORME // The University of Auckland

Mary Sewell // The University of Auckland

Seawater temperature is an important environmental factor for the early life stages of marine invertebrates. In this study we evaluated and described the effects of temperature during early development of E. chloroticus, identifying the optimum temperature range and upper thermal limit for successful development. The temperature range evaluated was between 15–24°C which included the normal seawater temperatures during the spawning season in northern New Zealand, as well as the highest temperature projected by the IPCC for this region due to global warming (1–3°C by the year 2100). Gametes from several females and males were used in the experiment. Fertilization was carried out at different temperatures and development was monitored at different time points after fertilization in each temperature. The development rate of E. chloroticus increased with an increase in seawater temperature. However, at temperatures higher than 21.5°C the amount of abnormal development reached ~30%. The optimum temperature for early development was between 15–21 °C, whereas the upper thermal limit was ~24 °C. Therefore, early development of E. chloroticus is negatively affected by an increase in seawater temperature of ~3–4°C above current seawater temperature levels in northern New Zealand. The thermal sensitivity of early life stages of E. chloroticus could affect survival rates during early development of this species in a global warming scenario, which could impair recruitment in populations which are exposed to higher temperatures, leading to possible distributional shifts of this species.

After the Outfall (and fallout): Sediment Fluxes of Nutrients & Oxygen in the Avon Heathcote Estuary, Christchurch

Craig DEPREE // NIWA

John Zeldis, Catherine Congol // NIWA
David Schiel // University of Canterbury

Up until March 2010 when Christchurch City diverted its waste to a new ocean outfall, the Avon Heathcote Estuary received approximately 160,000 m^3 per day of effluent from the Bromley treatment ponds, accounting for around 90% of the nitrogen load to the estuary. The legacy of nutrient discharges have resulted in a eutrophic estuary characterised by low species diversity and excessive growth of nuisance macroalgal species over much of the intertidal area of the estuary. As part of a larger ecological programme to track the recovery (or at least response) of the estuary, since 2007, every summer and winter, sediments from five locations around the estuary (including the discharge site, Avon and Heathcote River mouths) have been analysed to determine to what extent, and how quickly, sediments from a eutrophic system respond to an 'overnight' reduction in water column nitrogen. And importantly, whether the sediment 'reservoir' of organic matter could continue to fuel nuisance algal growth via nutrient fluxes to the overlying water and delay recovery. Key parameters that will be presented include a sediment timeline of oxygen fluxes (as proxy for carbon respiration), trophic status (production/respiration ratio), and nutrient fluxes. Superimposed on the 'recovery trajectory' however are the three major Christchurch earthquakes that caused significant physical upheavals (bed tilting, liquefaction) and prolonged pulses of raw effluent discharged to the estuary via the Avon and Heathcote Rivers.

Macrophytes & Monitoring – What does LakeSPI say about New Zealand Lakes?

Mary DE WINTON // NIWA

John Clayton, Tracey Edwards // NIWA

Use of submerged macrophytes as ecological indicators is gaining acceptance for inventory and monitoring purposes world-wide. LakeSPI (Submerged Plant Indicators) is a biomonitoring tool developed for New Zealand lakes. It involves measurement of 11 vegetation metrics at representative sites in a lake. A Native Condition Index (NCI) combines metrics for the functional diversity, depth extent, cover and occupancy of native submerged plants. An Invasive Impact Index (III) reflects the degree of development by invasive weeds, and ranks the perceived severity of impact and habitat tolerances of invasive species that are present. Aspects of these are incorporated into a LakeSPI Condition Index (LSI). Indices are expressed as % of what the lake could or should score (pristine state). LakeSPI results are available for c. 250 lakes, with 87 lakes surveyed on more than one occasion. These results show less than 15% of assessed lakes possess a submerged vegetation close to the expected pristine state (LSI >75%). Approximately 15% of assessed lakes were dominated by exotic water weeds (III >75%), and 25% of lakes had such a low abundance of submerged vegetation they were categorised as 'non-vegetated'. Of 87 lakes that were re-surveyed, 44% showed a significant change in LakeSPI Indices, deterioration was shown by 37% and an improvement in 7% of lakes. Changes included retraction/extension in the depth of plants (28%), new incursions of worse exotic weeds (17%), and shifts between vegetated and non-vegetated states (11%).

Development of Molecular Tools for the Detection & Discrimination of Potentially Invasive Mussel Species of the Genus *Perna*

Joana DIAS // Western Australia Fisheries and Marine Research Laboratories

J. P. A. Gardner // WA Fisheries & Marine Research Laboratories
Michael Snow // Victoria University of Wellington

Marine mussels of the genus *Perna* include three species: *Perna canalicula, Perna viridis* and *Perna perna.* While *P. canalicula* appears to be greatly restricted to its endemic range of New Zealand, *P. perna* and *P.viridis* introductions have been recorded outside their native ranges in several regions of the globe. Such introductions have often resulted in significant negative ecological, economic and social impacts. *Perna perna* and *P.viridis* are exotic to Australia and are listed under the Australian Government National System for the Prevention and Management of Marine Pest Incursions as high priority species. Rapid detection of marine pests such as *Perna* species remains fundamental to their effective containment and control. The present study reports on the development and validation of both conventional and real-time PCR assays suited to the rapid identification and discrimination of juvenile and adult specimens of *P. viridis, P. canalicula* and *P. perna.* The development of a sensitive high-throughput real-time PCR assay offers further potential for the efficient detection of the presence of single *Perna* specimens in mixed populations of native mussel species, and for early detection of larval stages in ballast water and plankton samples. This assay offers considerable advantages over traditional identification methods and represents an important step in developing capacity for efficient identification and management of *Perna* species incursions in Australian waters.

Length-Weight Relationship in the Goby, *Parapocryptes serperaster* (Richardson, 1864), Caught from Mekong Delta, Vietnam

Minh Quang DINH // Flinders University, Australia

Jian Qin, Sabine Dittmann // Flinders University, Australia
Dac Dinh Tran // Can Tho University, Vietnam

Parapocryptes serperaster is one of two amphibious fishes of the genus Parapocrytpes (Gobiidae), and of commercial interest in Southeast Asia. A study on the goby P. serperaster was carried out along the muddy shoreline of the Mekong Delta, Vietnam, to establish some basic population biology parameters. To determine the length-weight relationship of this species, a total of 822 individuals were caught in mud flats of the study area by dip net and hand. After determining sex via external features, total length (TL in cm) and body weight (W in g) of this goby were measured. This study ran for six months, from October 2012 to April 2013. The mean lengths for total fish, male, female and unsexed individuals were 15.84±3.47, 17.84±2.76, 15.31±3.02, and 10.76±0.69 cm respectively. The average body weights for total fish, male, female and unsexed individuals were 16.39±8.20, 20.68±7.55, 15.16±7.12, and 5.99±1.07 g, respectively. The length-weight relationships of male, female, unsexed and total fish were highly correlated. Correlation values of b were 2.370, 2.524, 2.302 and 2.605 for total fish, male, female and unsexed, respectively; and regression coefficients of R2 share nearly the same pattern which were 0.974, 0.963, 0.968 and 0.826. The correlation value of unsexed was slightly higher than that of male and female, whereas the opposite was true for the regression coefficient. However, they were not significantly different ($p<0.005$) based on Tukey method in Minitab software package. The growth relationship of this species shows positively allometry, which means that this goby could be a potential fish for future aquaculture.

Cultural Relationship & Mana of Water with & within the Maori World

Ngahuia DIXON // AM² & Associates

The Maori world as tangata whenua of Aotearoa has seen its relationship with water, especially in terms of waterways, used in political debates by governments including Labour and National. Maori relationships with water have been visible since traditional times. Although the debate regarding its use has been an ongoing, in-depth issue for nigh on five – six years Maori tribes still recognize and acknowledge the mana of water and those relationships to waterways. This presentation discusses those relationships and the mana of water to Maori tribal groups, irrespective of the tensions imposed through colonial constructs promoted by organisations such as central government.

The 'Land & Water New Zealand' Web Tool – Where We've Come From & Where We are Heading

Katharina DOEHRING // Cawthron Institute

Jo Bailey // Massey University
Nina von Westernhagen // Hawke's Bay Regional Council
Kit Rutherford // NIWA
Olivier Ausseil // Aquanet Consulting Ltd

Regional Councils, the Cawthron Institute, Massey University and MfE are working to evolve the current Land and Water New Zealand (LAWNZ) website, which provides information on New Zealand's river water quality. Funding has been provided by the Tindall Foundation and design development is being undertaken by Open Lab (Massey University). The vision for the project is to develop a new 'freshwater tool' that is respected, accessible and easy to use, which will act as a hub for water information in New Zealand. The tool should engage multiple user-groups with freshwater issues, enable the translation of scientific data so it can be easily understood by all water users, and thereby increase engagement with water issues. Moreover, the tool should facilitate the sharing of water quality information between interested groups, support and link initiatives working to improve freshwater quality and ultimately affect behavioral change in terms of how New Zealanders relate to water. This presentation summarises the team's progress to date, which mechanisms were used to get there, as well as where we are planning on taking the website in the future.

Where does all the Strontium go? Otolith Chemistry Insights from the Australian Synchrotron

Zoë DOUBLEDAY // University of Adelaide

Hugh Harris, Christopher Izzo, Bronwyn Gillanders // University of Adelaide

Strontium (Sr) is the most extensively used element in otolith chemistry research and is used to reconstruct the movement and environmental histories of fish from freshwater to hypersaline environments. It has long been assumed that trace elements, like Sr, randomly substitute for Ca within the aragonitic calcium carbonate ($CaCO_3$) lattice of otoliths; however, this has never been tested, and Sr may form Sr-rich phases of the mineral strontianite ($SrCO_3$) or be bound within the interstitial spaces or organic (protein) component of the otolith. If this is the case, otolith chemistry data may be misinterpreted, which could have critical consequences for how fish and fisheries are understood and managed. Using X-ray Absorption Spectrometry (XAS) at the Australian Synchrotron, we explicitly tested how Sr binds within fish otoliths by examining the Extended X-ray Absorption Fine Structure (EXAFS) region of the XAS spectrum, which enabled the structural state(s) of Sr to be distinguished. Aragonitic otoliths from several native Australian species, representing freshwater, estuarine, marine and hypersaline environments, and hence a range of Sr concentrations, were examined. A squid statolith, coral skeleton, cuttlebone and shark tooth and vertebra were also analysed for structural comparison. For all otolith samples, the results consistently indicated that Sr substitutes for Ca within aragonite regardless of Sr concentration, and that the substitution is random, rather than forming clusters of strontianite. This research further validates Sr as a useful chemical tracer in otolith chemistry, and confirms, for the first time, that Sr replaces Ca in otolith aragonite.

Experimental & Modelling Studies of Fine Organic Particle Dynamics in Streams

Jennifer DRUMMOND // Northwestern University, NIWA

Aaron Packman // Northwestern University
Rob Davies-Colley, Rebecca Stott, Sandy Elliot, Graham McBride // NIWA

Fine organic particle dynamics are important to stream biogeochemistry, ecology, and transport of contaminant microbes. These "biocolloids" migrate downstream through a series of deposition and resuspension events, which results in a wide range of residence times. This retention influences biogeochemical processing and in-stream stores of contaminant microbes that may mobilise during flood events and present a hazard to downstream uses such as water supplies and recreation. We are conducting studies to gain insights into organic particle dynamics in streams, with a campaign of experiments and modeling. The results should improve understanding of nutrient (C, N, P) spiraling and fine sediment movement in streams, and have particular application to microbial hazards (Drummond *et al.*, POSTER, this conference). We developed a stochastic model to describe the transport and retention of fine suspended particles in rivers, including advective delivery of particles to the streambed, transport through porewaters, and reversible filtration within the streambed. Because fine particles are only episodically transported in streams, with intervening periods at rest in the bed, this transport process violates conventional advection-dispersion assumptions. Instead we adopt a stochastic mobile-immobile model formulation to describe fine particle transport. We apply this model to measurements of particle transport from multiple tracer experiments in an agricultural stream, and use the model to improve interpretation of baseflow particle dynamics.

Dynamics of Reef Communities Situated Close to Salmon Farms

Robyn DUNMORE // Cawthron Institute

Nigel Keeley // Cawthron Institute

Salmon farming in New Zealand has historically occurred over soft sediment habitats in low-flow environments, and nearby reef communities have not been in the depositional footprint of waste products. Hence, the literature pertaining to enrichment effects is strongly dominated by research on soft sediment habitats and very little is known about the effects on reef communities. In Tory Channel, Marlborough Sounds, two salmon farms in high-flow sites are situated in close proximity to potentially sensitive rocky reef habitats. As part of their consents, New Zealand King Salmon have monitored the sites for any signs of effects from farm related enrichment or sedimentation. This was achieved by establishing permanent quadrats, photographing them through time and analysing the images for percent cover and/or numbers of conspicuous invertebrates, algae and triplefins.

Multivariate analyses using PERMANOVA showed that overall, there was no farm-related impact in comparison to reference sites, but there were highly significant changes at some sites through time and some sites and replicate quadrats were highly significantly different to each other. Examination of individual and groups of taxa generally showed high variability through time, and no distinct trends were observed across impact and reference sites. Distinct declines and increases in taxa were observed over all sites, and these were most likely related to natural recruitment, migration and mortality events.

The Interaction Between Habitat & Fisheries: the Case of Deep-sea Seamounts

Matthew DUNN // Victoria University of Wellington

Seamounts and other underwater features throughout the world's oceans can support diverse and exceptionally abundant faunal communities. These areas are also the focus for commercial fisheries. The conflict between biodiversity conservation and fisheries makes management difficult. To ensure sustainable fisheries, highly precautionary feature-based catch limits, and credible and timely stock assessment advice are required. Interpretation of catches from commercial fisheries as indicators of underlying stock dynamics is all that is available in many stock assessments, but using these data is highly problematic. A better understanding of the ecology of seamount fishes, and their use of such habitats, is needed to better understand stock dynamics, and so the signals contained in commercial fishery catch data. Using orange roughy, the value of seamounts to fish populations is illustrated using demographic data, and hypotheses for habitat connectivity are considered using spatially-stratified population models. The results question some hypotheses about the value and use of seamount habitats.

Evaluation of the Use of Elastomer & Paint as Methods to Mark Lowland Longjaw Galaxias

Nicholas DUNN // Department of Conservation

The purpose of this study was to evaluate three products for use as subcutaneously (under the skin) injected marks for individual or batch identification in studies involving the nationally critically threatened lowland longjaw galaxias (*Galaxias cobitinis*: Galaxiidae). The three materials assessed were visual implant elastomer, acrylic paint, and fabric paint. Over the three months of the study, survival of marked fish was high, and no mortality was attributed to the presence of marks. Growth and relative condition of *G. cobitinis* were not adversely affected by the injection of subcutaneous elastomer or acrylic paint material, even when receiving multiple marks. All elastomer and acrylic paint marks were retained, however fabric paint did not perform as well and its use is not recommended. Digital image analysis was used to determine mark area at monthly intervals to assess absorption rates. Elastomer marks were more stable than acrylic paint marks. Extrapolation of these data suggest that acrylic paint marks may be visible for 24 months, and elastomer marks even longer, possibly for the life-time of *G. cobitinis*. However, elastomer marks were more likely to fragment than other materials, although this did not affect overall visibility. In conclusion, long-term marking of *G. cobitinis* can be achieved with either elastomer or acrylic paint without adversely effecting fish. These results are also likely applicable for use in population monitoring studies of other small galaxiid species

Management of Biodiversity on the High Seas – Using Ecologically & Biologically Significant Areas (EBSA) to Examine the Overlap of Values & Pressures on the High Seas

Piers DUNSTAN // CSIRO

Nicholas Bax, Mike Fuller // CSIRO

The oceans cover 70% of the Earth's surface, and the majority of this area (or half the Earth's surface) is in Areas Beyond National Jurisdiction (ABNJ). The international community provided a program of action for achieving sustainable development of the oceans, coastal areas and seas at the Rio Earth Summit in 1992, however sustainable use of living resources on the high seas has been challenging and remains a major concern for the international community. In 2008, the Conference of the Parties to the CBD adopted seven scientific criteria to identify ecologically or biologically significant areas (EBSAs) to enhance conservation and management measures and encouraged competent parties to conduct regional workshops. The first regional workshop, convened by the Secretariat of the Convention on Biological Diversity (SCBD) in November 2011 was to identify potential EBSAs in the western South Pacific region. Subsequent workshops have been held in the Western Atlantic, Southern Indian, Eastern Pacific, and Southeast Atlantic and North Pacific oceans. We report on the results of those workshops here and the types of EBSA that have been identified. We discuss their progress through the international negotiations at the 16th meeting of the CBD Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) and COP11. We briefly highlight some of the pressures to marine biodiversity beyond national jurisdiction and examine the potential for using EBSA to identify values on the high seas and how different pressures might interact with those EBSA. We also provide a brief summary of the current negotiations for a new implementing agreement under UNCLOS for biodiversity beyond national jurisdiction.

Stunning Sicydiines in The Australian Wet Tropics

Brendan EBNER // CSIRO, James Cook University

Recent research efforts have revealed the presence of *Amphidromous sicydiine* gobies in short and steep coastal streams of the Australian Wet Tropics. Generally, earlier fish surveys in Wet Tropics catchments failed to detect this assemblage, although, occasionally specimens were collected. I aim to provide a brief background to the discovery and ecology of seven species for which published information is available in the Australian context, and demonstrate that the highly localised distribution of this fauna largely explains why they eluded us for so long. I also present the first records of an eighth species in the region. Conservation requirements of the group are discussed amid a backdrop of peri-urban and agricultural development as well as the potential for direct harvest by aquarists.

Whitebait Population Dynamics in a Dynamic World

Eimear EGAN // University of Canterbury

Michael Hickford, David Schiel // University of Canterbury

Anecdotal reports suggest that the whitebait fishery is in decline. A thorough understanding of the population dynamics of *Galaxias maculatus*, the most common whitebait species, is central to informed decision making by managers, ecologists, policy-makers and whitebaiters. Recent restoration efforts have focused on rehabilitating spawning habitat and increasing egg production, with little knowledge of the consequences for larval production and subsequent population dynamics. *Galaxias maculatus* crosses multiple ecosystems during its life history and is vulnerable to the conditions experienced in each, which can positively or negatively influence populations. The dynamics of a population are closely related to its age structure, spawning stock biomass and egg/larval production among other factors. In the initial phase of my PhD, I am developing techniques for gauging the larval production of waterways in relation to egg production in their spawning habitat. I intend to use a suite of field and laboratory techniques to assess the age and condition of *G. maculatus*. Taken together, condition indices, larval production and population parameter studies will give us a greater understanding of the processes impacting at the population and sub-population levels of this species, and aid in preserving its ecological, cultural and economic value.

So What Now

Janise EKETONE // Maniapoto Maori Trust Board

The Nga Wai o Maniapoto (Waipa River) Act passed into legislation on 6th April 2013. It took 5 years to reach this point and the legislation marked the 'official' beginning of the co-governance, co-management and collaborative clean-up journey in the Waipa River catchment. So what does this mean for Maniapoto? For those directly involved in discussions it all makes perfectly good sense. For those that live with, in and alongside the Waipa it means...The session presents a practical view of clean-up opportunities and challenges.

Satellite Tagging of Blue Sharks in New Zealand to Assess Critcal Habitat Use & Migration

Riley ELLIOTT // The University of Auckland

This project investigates patterns in habitat use and migration of blue sharks across a range of spatial and temporal scales within New Zealand (NZ) waters. Large scale migration and habitat use is assessed using long term historical catch data, via the New Zealand fishery observer program. Catch composition (size/sex) is assessed for correlation with habitat type and significant marine systems. Satellite tagging assists in identifying large scale spatial/temporal trends. Small scale diurnal patterns are investigated inshore (<1000 m depth) using active telemetry tracking of acoustic tags with temperature and depth sensors. Simple stomach content analysis will reveal possible foraging stimulus for diurnal movement. Collaboration of the above will give a broad, baseline understanding of the behaviour, habitat preference and migratory cycles of the blue shark; a species lacking research but fundamental to NZ's marine ecosystem. Justification for this project is that sharks are apex predators, evolved over millions of years, holding trophic levels of marine ecosystems in balance. Globally, however, shark populations are in significant decline due to overexploitation. Highly migratory species, such as blue sharks, are inherently hard to manage and sufficient knowledge is lacking for effective management and awareness. So far 8 blue sharks have been tagged, returning the first ever data on these animals in this area of the world.

Lessons from Applying Regional & National Contaminant Load Models to Support Land-Water Managment

Dr Sandy ELLIOTT // NIWA

Dr Annette Semadeni-Davies, Dr Ude Shankar, Dr Chris Palliser, Dr Aroon Parshotam // NIWA

At large catchment to national scales, predictive models of mean annual loads serve as a means to assess the outcome of future land use change and interventions on water quality. The CLUES catchment model, which is driven by a simplified version of Overseer and is calibrated to water quality data nationally, has been applied in various ways for this purpose. This process has identified various strengths and weaknesses of the approach, some of which are being addressed. Valication against new regional datasets, is that local refinement of model parameters is often useful to more accurately reflect local catchment behaviour in a particular application region. This requires measured loads for calibration, however. Prediction of nutrient loads to estuaries has been used to assess estuarine eutrophication impacts, but to improve such models, seasonality of nutrient inputs needs to be addressed. Regional groundwater effects (flow bypassing surface catchments, reduced stream attenuation, lags) have been identified as important effects not yet captured in CLUES, so that further modifications are required for general applicability nationally. Model predictions of nutrient concentrations entail high uncertainty; normalisation to measured concentrations or direct empirical predictions of current concentrations has proven to be a useful measure to reduce this uncertainty. Such models have been useful in identifying catchment level responses to mitigation measures, and for identifying potential limitations on land development before minimum state levels are breached. However, more work is required to fully leverage the benefits of such predictive models in collaborative catchment processes.

Downstream Services in Support for the EU Marine Strategy Framework Directive: Combining Observation Technologies for Optimal Ecosystem Mapping

Anders ERICHSEN // Danish Hydraulic Institute

Ben Tuckey // Danish Hydraulic Institute

Achieving good environmental status (GES) of the EU's marine waters requires detailed knowledge about the current status. Some of the key goals are mapping the current environmental state as well as establishing monitoring programmes to measure progress towards GES. Open water monitoring is traditionally done sampling at a limited number of sites at a frequency of weeks to months, providing time series of different parameters at one or few location in each water body. These data are used for evaluation of the overall state of the sea. However, the accuracy of this type of monitoring is debatable, especially with the arrival of new technologies extending the possibilities of exhaustive monitoring programmes, e.g. earth observation, ferry box, continuous buoy measurements, and modelling. These technologies have different advantages and disadvantages that add valuable knowledge as they increase the temporal and spatial coverage significantly. A question is: how they can be applied to help assessing the state of the sea? Through two FP7 projects, Aquamar & CoBiOS, the Danish Hydraulic Institute (DHI) is developing the infrastructure to make use of the different technologies and integrate them into a combined on-line monitoring and information system providing a holistic assessment of the state of the marine environment. Hence, it addresses the past, the present, and the future through different 'products' presenting 'raw' and aggregated data, and then supports and facilitates the implementation of Marine Strategy Framework Directive. This presentation will discuss advantages and disadvantages related to the different technologies and present the status of integrating these into dynamic models.

Happy Snapper: Home is Where the Seagrass Sways

Tegan EVANS // The University of Auckland, NIWA

Ian Tuck // NIWA, University of Auckland
Mark Morrison // NIWA

Snapper (*Pagrus auratus*) are the most important inshore commercial fish species in New Zealand. Their nursery grounds are known to be associated with biogenic habitats such as seagrass meadows, which are vulnerable to land-based impacts. Rangaunu and Parengarenga harbours (upper East Northland) are heavily utilised as snapper nursery grounds. They contain extensive seagrass and other habitats that vary in their environmental and physical characteristics, resulting in a range of habitat qualities for juvenile fish. They are also under a range of increasing human pressures, despite being relatively pristine compared to most other New Zealand estuaries. This study aims to use juvenile snapper (<6 months old, c. 30–60 mm) daily growth rates as a measure of juvenile snapper fitness, and link this to habitat quality effects. High rates of juvenile growth are assumed to result in higher survivorship to adulthood and other fitness benefits to fish. To determine growth rates, daily growth rings will be counted and measured on the snapper's sagittae otoliths. Growth rates and condition indices will be compared across different habitat types and associated environmental variables, to assess juvenile snapper fitness, and how it relates to adjacent land-based activities influences (i.e. associated sediment and other inputs into the harbours). Results will be used to help identify how and where negative impacts are occurring on juvenile snapper production, which can be used to help resource managers in moving towards a more ecosystem based management of fisheries and marine systems.

Environmental Consequences of Management Decisions on the Footprint of Wild Capture Seafood

Anna FARMERY // University of Tasmania

Caleb Gardner, Bridget Green, Sarah Jennings // University of Tasmania

Maintaining the ecological foundation of food systems is essential for achieving food security. Current concepts of seafood sustainability – ending overfishing of target species, protecting ecosystems and non-target species – can be broadened to include impacts stemming from the energetic and material demands of the fish capture phase and supply chain. We used life cycle assessment (LCA) to measure the environmental footprint of the supply of Southern rock lobster, *Jasus edwardsii* (SRL). International airfreight of live lobsters was the major contributor to the global warming potential (GWP) and cumulative energy demand (CED) indicators, while the fishing stage accounted for the majority of impacts to eutrophication potential (EP), water use and marine aquatic ecotoxicity. We examined a series of management scenarios to determine impacts of marine resource management decisions on the SRL environmental footprint. Changing the management objective from maximum sustainable yield to maximum economic yield decreased the carbon footprint by 80% or 11 kg CO_2e kg^{-1} of lobster at capture. Increasing the coverage of marine protected areas to levels applied in an adjacent jurisdiction increased the fishery's carbon footprint by 24% or 3 kg CO_2e kg^{-1} of lobster at capture. Fisheries management decisions can be a tool to reduce environmental impacts of seafood production and maintain food supply. Given the predicted impacts of climate change on fisheries, the unintended consequences of management changes on carbon emissions suggest that marine resource decision making should not be made in isolation of these broader environmental impacts.

Does Fishing Selectively Remove Snapper (*Pagrus auratus*) Fish with Bold Personalities?

Courtney FARTHING // The University of Auckland

Swastika Lal, Neill Herbert // The University of Auckland
Darren Parsons // NIWA

Previous studies at the Leigh Marine Laboratory demonstrate that snapper (*Pagrus auratus*) show consistent individual differences (CIDs), otherwise known as "personality", with respect to their physiology and behaviour. For example, individual *P. auratus* differ in willingness to take risks, and show different rates of resting metabolism (standard metabolic rate, SMR). Most importantly, these features of physiology and behaviour are correlated; *P. auratus* with high SMR (>145 mgO2. kg-1 hr-1) are quick to explore potentially dangerous environments and are therefore more bold. Conversely, fish with low SMR take less risk and are more timid. The implication of personality differences for fisheries management and marine reserves is not entirely understood, however there is concern that fishing may selectively remove bold personalities first, leaving behind timid personalities. This would render future fishing effort more difficult and could potentially reduce biomass, as timid personalities often grow slower. If fishing leads to a predominance of timid personalities within fished areas it is plausible that marine reserves act as a refuge for bold personalities, and could thus provide a buffer against fishing pressures. To test this, *P. auratus* will be angled sequentially in the Leigh area and their behaviour and physiology assessed within laboratory conditions to determine whether bold personalities are angled first. A further comparison of fish angled in this way from reserve and non-reserve areas will help to resolve whether reserves contain more bold fish. This study will provide important information on the effects of individual variation for fisheries management and conservation.

Progress with the Manawatu River Accord & Projects Funded by the Fresh Start to Freshwater Clean-up Fund

Lucy FERGUSON // Horizons Regional Council

Jon Roygard, Josh Markham, Alesha Cooper // Horizons Regional Council

The Manawatu River has been widely reported in the media over the last few years to have poor water quality values. As a result, stake holders within the catchment including industry, local authorities, iwi and interest groups formed a leaders' forum to address the issues attributing to a decline in water quality. An action plan was developed with the goal of improving the mauri of the Manawatu River catchment such that it sustains fish species and is suitable for contact recreation, in balance with the social, cultural and economic activities of the catchment community. The Manawatu River Leaders' Forum was successful in its bid to the central government's Fresh start to Freshwater Clean-up Fund in 2012, with funding going toward eight clean-up fund projects. The projects include: (i) upgrades to sewage treatment plants in three districts within the catchment; (ii) stream fencing; (iii) native fish habitat restoration; (iv) whitebait habitat restoration; (v) environmental farm plans on dairy farms to address nutrient management issues; and (vi) community engagement. The Manawatu clean-up fund is a two-year project that commenced in July 2012. This presentation will cover progress made to date in the projects and how we have engaged with stake holders to implement these works.

Non-human Charisma and its Role in Science Communication

Sophie FERN

As scientists, we seek to communicate our research in ways that are both relevant and interesting to a lay audience. The results of this communication are now woven into grant and promotion applications. We are given to believe that, if the public doesn't know about our research, then it cannot be important. The scholarship on non-human charisma explores what it is about the non-human, be it animal, vegetable, landscape or rock, that attracts an audience. This includes work on species indices, flagship species, the charisma of landscape and the reasons for our attraction to certain species, places and things. These ideas are transferable to the field of science communication. As the communicator, we are able to highlight the aspects of our research that will hook an audience. This paper outlines some of the main findings from the research into non-human charisma and outlines ways in which this information can be used to enhance the communication of our own research.

Bringing Social Theory to Social-ecological Systems Research: New Zealand's Marine Futures

Karen FISHER // The University of Auckland

Richard Le Heron, Nick Lewis // The University of Auckland
Simon Thrush // NIWA, University of Auckland

Research utilising social-ecological systems thinking provides a framework that crosses social theory and ecological sciences. In investigating possible marine futures in New Zealand, social theory enables the complicated relationships between humans and the ecosystem to be explored and diverse understandings of sustainability to be revealed. This paper reports on the approach taken to engage people in a process to investigate grounded understandings of sustainability in diverse contexts. We discuss the significance of conducting this research in an indigenous landscape, and explain how institutional, investment and ecological trajectories influence thinking about ecological and social possibilities for the marine environment and the possibilities narrated through the development of future scenarios.

Oceanographic Inter-annual Variability on the Campbell Plateau

Aitana FORCEN-VAZQUEZ // Victoria University of Wellington, NIWA

Michael Williams // NIWA
Melissa Bowen // The University of Auckland
Lionel Carter // Victoria University of Wellington

Ocean water properties such as Temperature and Salinity over the Campbell Plateau, south of New Zealand, are relevant to ocean climate and may have a significant impact on fluctuations in fish and sea lions populations. Water properties formed over the plateau are potentially influential in setting the characteristics of the Pacific Ocean intermediate waters. Two data sets are investigated to identify the oceanographic inter-annual variability on the Campbell Plateau. Approximately 70 CTD (Conductivity-Temperature-Depth) profiles were collected in December of each year from fisheries research cruises between 2002 and 2009 and were analysed and comprised. Remotely sensed SSH (Sea Surface Height) data from 1992 to 2012 were averaged to create a time series of the ocean variability. Preliminary results from CTD data show inter-annual variability over the Campbell Plateau. Conservative Temperature and Absolute Salinity profiles reveal high variability in the upper 200 m of the water column and a homogeneous water column from 200 to 600 m depth. Temperature variability of about 0.7°C, on occasions between consecutive years, is observed down to 900 m depth. First inspection of the SSH data reveal variability over the whole time period, with a slightly increasing trend in the late 90's. A minimum SSH anomaly of -4 cm over the mid 90's and a maximum of 6.5 cm towards the end of the last decade are observed.

The Impacts of Aquaculture on Ecology in New Zealand; a Literature Review

Rich FORD // Ministry for Primary Industries

The Ministry of Primary Industries commissioned a literature review of the impacts of aquaculture on ecology; this was completed by collaboration of staff from NIWA and the Cawthron Institute. The review has been recently released as part of a package of work that also includes a document with guidance for Regional Councils on how this information can best be used. Chapters in the literature review aim to cover the full range of potential impacts: pelagic, benthic, marine mammal, wild fish, seabirds, biosecurity, escapee, hydrodynamic, and from genetic modification and polyploidy or additives as well as cumulative effects. This talk will discuss the key findings from each chapter and provide some insight into relative importance of these effects and how they might best be utilised by Regional Councils in the aquaculture consenting process.

Applying Enrichment Stage Tools for Large Offshore Mussel Farms

Reid FORREST // Cawthron Institute

Dana Clark, Emma Newcombe, David Taylor, Nigel Keeley // Cawthron Institute

Large-scale 'offshore' marine farming has the potential for significant effects to the seabed environment, and therefore, the wider ecosystem. Accordingly, robust environmental monitoring is needed to evaluate and track the condition of the seabed. Monitoring of such 'offshore' sites is expensive and produces a large amount of environmental information. For resource management proposes that information then needs to be placed in context by determining the level ecological effect (from minor to adverse), a process which has also highlighted the need for sound environmental quality standards (EQS). Benthic EQS have been developed for feed-added finfish farms using an Enrichment stage (ES) gradient (from 1 natural, to 7 azoic). However, this approach has not previously been applied to mussel farms, which tend to be associated with less severe levels of enrichment. Recent monitoring of two large-scale 'offshore' farms included assessments of sediment physico-chemistry, infauna communities, epifauna and shellfish health. At the conclusion of the first stage of development, areas beneath farm fell within in a relatively narrow band towards the lower end of the gradient (ES 1.5–3), with some associated stimulation of infauna and epifauna communities. Effects were constrained to within 100m of the farms, and overall, differences between within and outside farm areas were overshadowed by larger bay-wide processes. Although minor benthic effects were evident, the ecological consequences were potentially positive in terms of the bays biodiversity and productivity.

Changes in the Spatial Structure of South Australia's Snapper Fishery – Relate to Recruitment

Anthony FOWLER // South Australian Research & Development Institute,, Aquatic Sciences

The latter 2000s has been a period of dramatic change for South Australia's (SA) snapper fishery. SA's annual catches have increased to record levels, and now account for >50% of the national commercial catch. Concomitantly, the spatial structure has changed as catches in traditional snapper regions such as Spencer Gulf have crashed, whilst having increased dramatically in other regions, particularly Northern Gulf St. Vincent. In order to manage this State fishery, it is necessary to understand the demographic processes behind such dramatic changes. This is possible based on results from a market sampling program that has provided regional, annual estimates of fish size and age since 2000. Such data are the basis for regional estimates of size and age structures, recruitment histories, growth functions and estimates of longevity. This presentation considers such demographic information in the context of the recent changes in the status of regional fisheries and their catches. The age structures reflect considerable variation in year class strength (YCS), which is the consequence of inter-annual variability in recruitment. Estimates of YCS were temporally correlated amongst regions, but the relative sizes of strong year classes varied considerably amongst regions. Such regional differences account for the changes in regional catches. Therefore, the spatial pattern in recruitment has changed dramatically in recent years with profound consequences for populations and local fisheries. Research can now be focussed on why this has occurred.

Life at the Edge or the Best of Both Worlds: How do Pelagic Sharks & Rays Straddle the Interface Between Neritic & Oceanic Waters?

Malcolm FRANCIS // NIWA

Clinton Duffy // Department of Conservation
Mahmood Shivji // Nova Southeastern University
John Holdsworth // Bluewater Marine Research
Warrick Lyon // NIWA

Oceanic pelagic species are known to migrate large distances in the open ocean, but they also frequently encounter and enter neritic waters around islands and along continental shelves. Little is known about how they navigate, where and when they travel, and the extent of their presence in coastal waters. Electronic tagging offers the potential to unlock the secrets of their behaviour and to generate hypotheses about what factors drive that behaviour. Tagging data from four pelagic shark and ray species, shortfin mako shark (*Isurus oxyrinchus*), porbeagle shark (*Lamna nasus*), great white shark (*Carcharodon carcharias*) and spinetail devilray (*Mobula japanica*), were analysed to identify patterns of horizontal and vertical movement behaviour in neritic New Zealand waters and the south-west Pacific Ocean. At least three of the four species undergo extensive oceanic migrations, but the four species have varying levels of residence within neritic waters. Relationships between horizontal and vertical behaviour are discussed, and four quite different niches are identified.

Habitat Modification Or Migration Barrier? Tide Gates & their Effects on Freshwater Fish Communities

Paul FRANKLIN // NIWA

Michelle Hodges // Waikato Regional Councill

New Zealand's native fish fauna is characterised by a high proportion of diadromous species, meaning that fish communities are sensitive to the presence of migration barriers. This case study describes the effects of tide gates on the fish community of Kurere Stream in the North Island of New Zealand. Results indicated that the tide gates were not acting as a significant physical barrier to upstream fish migration, with populations of key migratory fish species present in suitable habitats in the upper reaches of the catchment. However, the presence of the tide gates significantly modified the physico-chemical characteristics of instream habitat in the low gradient reaches immediately upstream of the tide gates. Dissolved oxygen was low, water temperatures high, aquatic macrophytes abundant and siltation high. These modified conditions are sub-optimal for native species typical of lowland reaches, such as inanga (*Galaxias maculatus*) and smelt (*Retropinna retropinna*), and this was reflected in the low abundance of these species throughout the impacted reach. Conversely, several undesirable introduced fish species including tench (*Tinca tinca*), catfish (*Ameiurus nebulosus*) and gambusia (*Gambusia affinis*) were relatively common, reflecting their greater tolerance of elevated water temperatures and low dissolved oxygen. To investigate the potential for mitigation of the physico-chemical impacts on instream habitat, the effects of partially opening one of the tide gates was tested. Hydrological effects were evident throughout the reach and improvements in dissolved oxygen and water temperatures were detected in some parts of the impacted reach.

Marine Spatial Planning: Managing the Use of Marine Space through Participation

Greig FUNNELL // Department of Conservation

Carolyn Lundquist // Department of Conservation, NIWA

Marine Spatial Planning (MSP) offers a framework where you can maintain marine biodiversity values while allowing sustainable use of marine resources. As a process it incorporates international principles of ecosystem-based management, and increases integrated management of all sectors using [or valuing] the marine environment. This talk will give a brief overview of the Marine Spatial Planning process, and the application of MSP to a New Zealand case study. We describe a web-based geospatial tool called SeaSketch that the Department of Conservation is developing to engage and facilitate involvement of stakeholders in MSP projects. The SeaSketch tool will allow for active stakeholder participation in the marine spatial planning process, promote conflict resolution by resource [users], and ultimately result in 'ownership' of the integrated outcomes delivered in a mariner spatial plan. In addition, SeaSketch will enhance understanding of the marine environment and the marine spatial planning process by the public, through visualisation and quantitative reporting of marine information such as habitat types, species distributions, and the location of various uses of the marine environment such as fishing, aquaculture, shipping lanes, and sand extraction.

eDNA Detection Parameters

Elise FURLAN // The University of Canberra

Dianne Gleeson, Richard Duncan // The University of Canberra
Chris Hardy // CSIRO

The utility of environmental DNA (eDNA) for low-density species detection has been demonstrated in a number of studies and offers great potential for the control of invasive species or the conservation of endangered species. To determine the value of this relatively new technique as a management tool, detailed studies are required to evaluate detection probabilities for various species under a range of environmental conditions. Controlled aquarium manipulation experiments allow us to measure the influence of variables contributing to changes in eDNA concentration and detection probabilities. We have selected several taxa that are listed as invasive in Australia and for whom low-density detection is likely to provide economic and/or environmental benefits. These taxa will be used to parameterise a detection framework. I will present data from initial aquarium experiments on the Oriental weatherlaoch, *Misgurnus anguillicaudatus*, that determine the relationship between the number of individuals and eDNA production, the distribution of eDNA throughout the water column and eDNA accumulation and degradation over time. We aim to develop a framework for eDNA detection probabilities that will ultimately provide clear information for natural resource managers on the utility of eDNA to address environmental questions.

Development of a Sports Fisheries Quality Index for Assessing Effects of Agricultural Intensification

Rasmus GABRIELSSON // Cawthron Institute

Robin Holmes, John Hayes, Roger Young // Cawthron Institute

Agricultural intensification is increasingly affecting stream ecosystems and recreational fishery values worldwide. Difficulty in managing cumulative effects has resulted in a need to develop science-based tools to better understand how multiple stressors affect recreational fishery quality. This will allow concepts like "resource capacity" and ecosystem "tipping points" to be used as a vehicle for managing cumulative effects of contaminants. However fishery managers and regional councils first need tools that quantify the multivariate quality of New Zealand recreational trout fisheries before researchers can investigate how in fact rivers and trout fishery quality is affected by a gradient of agricultural land use/dairy stressors. We reviewed the scientific and grey literature on fishery quality indices to summarise the current knowledge, and then used this to develop a New Zealand Fishery Quality Index (FQI) specifically for this purpose. Indices of biotic integrity (IBIs) or fishery quality (FQ) are used worldwide for assessing ecological health or condition of fish populations, by combining multiple variables into a single number that is more easily comprehended by end users. The proposed FQI offers a quantitative approach to assessing FQ. It defines fishery quality as the sum of one or more salmonid species quality index scores, which in turn incorporate population measures of recruitment, maximum size, overall abundance, and abundance of individuals above the size of interest to recreational anglers. We intend to apply this index to fishery data collected from 50 sites around New Zealand over the next few years for identifying tipping points to agricultural intensification.

Reproduction & Larval Ecology of the Toheroa *Paphies ventricosa* in Southland, New Zealand

Kendall GADOMSKI // University of Otago

Miles Lamare, Henrik Moller // University of Otago
Mike Beentjes // NIWA

The toheroa, *Paphies ventricosa* (Bivalvia:Mesodesmatidae), has experienced significant population declines over the past 40 years. To identify possible causes of decline and better manage the recovery of the populations, we studied the reproductive cycle and larval development of southern toheroa. The reproductive cycle of the toheroa was studied from February 2011 to December 2012 at Oreti Beach, Southland, New Zealand. Monthly samples were obtained from a stable toheroa bed and histological sections of the gonad were analysed using light microscopy. The sections were sexed and classified into one of four stages of gonadal development – early active; late active; ripe; and partially spawned or spent. The proportion of clams per developmental stage present each month was used to determine periods of spawning. During late 2011 and early 2012, samples of toheroa were collected from the same stable bed and transported back to Portobello Marine Laboratory (PML) in Dunedin. At PML the toheroa were tagged using Hallprint FPN 4 mm x 8 mm external shellfish tags and placed into flowing seawater tanks containing sand from Oreti Beach. The kept clams were conditioned with a mixed algal culture. Adult toheroa were injected with a 2mM solution of 5- hydroxytryptamine into the anterior adductor muscle to induce spawning. Larvae were reared at PML and their development tracked using light microscopy. Toheroa larvae settled out of the water column around 21 days as pediveliger larvae, and at 28 days, had yet to undergo metamorphosis.

Identifying Morpho-functional Groups for Lake Geneva – a Key First Step to Model Phytoplankton Dynamic Succession

Nicole GALLINA // The University of Waikato

Deniz Özkundakci, David Hamilton // The University of Waikato
Orlane Anneville // INRA, UMR 042 CARRTEL

Predicting the stochastic pattern of the phytoplankton community remains a challenging task when modelling lake ecosystems due to their extremely diverse behavior. Grouping phytoplankton into functional groups not only has the advantage to better represent their ecological behavior and succession, but moreover reduces the number of assessing entities allowing a more representative overview of the entire community. This study represents a first dynamic modelling approach of functional groups of the phytoplankton community in deep, mesotrophic Lake Geneva using the General Lake Model (GLM) – Framework for Aquatic Biogeochemical Model (FABM). Lake Geneva plays an important environmental role as it is the largest lake in central Europe in the peri-Alpine region, representing an essential resource for drinking water supply. It is hypothesized that climate change will affect the phenology of the phytoplankton communities and promote an increase in biomass. Furthermore, the emergence of potentially toxic cyanobacteria is forecasted, with potential to contribute to considerable deterioration of water quality. Our aim was to produce an accurate predictive management tool for Lake Geneva and to assess the ecological state of the lake under present as well as under future climatic conditions, with focus on the phytoplankton community and its successional sequence. For this purpose, morpho-functional groups of phytoplankton specific for Lake Geneva were identified. Beforehand, a clustering method was applied, based upon species having similar occurrence patterns. The resulting groups were separated based on their functional ecological behavior but also on their morphology, as well as links to abiotic seasonal conditions. The groups were also compared to those derived for similar lake ecosystems. Physiological parameters were defined for each of the groups, with morphological traits (e.g., surface area to volume ratio) being an important consideration in the selected parameter values. The simulations demonstrated the close relationship of successional sequences of functional groups with mixing and stratification in Lake Geneva, which were strongly seasonally driven. Morpho-functional groups appear to be an appropriate level of state variable representation in this type of modelling approach to enable valuable insights into emerging environmental drivers such as climate change.

Looks DO Matter – Simple Visual Communication Helps Sell your Science

Bronwyn GAY // EOS Ecology

Retailers, service providers and people selling useless plastic junk spend on average 3–10% of their annual income ensuring their target market is aware of what they are up to. This spend is predominantly on different forms of visual communication (e.g., print adverts, packaging, websites etc.). Yet within the world of science, we continue to undervalue the role good visual communication has to play in project outputs. If you want others to engage with your work you need to plan for successful communication outcomes. Apportioning time and budget for qualified graphic designers can be appropriate, however not all situations warrant this form of investment. There are simple, but important, decisions you can make to take advantage of the rare opportunities you have to influence and inform your colleagues, managers, Ministers, funders and the general public. Topics covered include: the importance of knowing who you are really trying to communicate with; what you want them to do with the information; how this knowledge lets you tailor your visual communications for maximum effect. We will consider the appropriate use of typography, photography, infographics, colour, iconography and other basic design techniques, and how these can be applied across any 2D medium i.e., posters, reports, powerpoint presentations, graphs, etc. The aim is to help you realise the potential and impact of simple visual communication, and improve the efficacy of the media you currently use. Making your outputs as visually accessible as possible is vital in todays uber-visual world...how your work looks DOES matter.

Biology & Behaviour for Modelling – Behaviour & Swimming Ability in Larval Black Bream (*Acanthopagrus butcheri*)

Eleanor GEE // The University of Melbourne

Stephen Swearer, Andrew Western // The University of Melbourne

Coupled biophysical-hydrodynamic dispersal models are useful for testing hypotheses about the relative influence of environmental and behavioural factors on the dispersal of fish eggs and larvae. In light of recent drought and declines in catches of black bream (Acanthopagrus butcheri) in the Gippsland Lakes estuary in southern Australia, questions were raised about the role of dispersal in year-class strength in black bream. A dispersal modelling approach was proposed, however existing information on the development of environmental preferences and swimming abilities in black bream larvae was insufficient to inform a dispersal model of early life stages of black bream. This paper therefore details a laboratory study of developmental changes in critical swimming speed, halocline response and depth response of black bream larvae using swimming flumes, salinity stratified cylinders and pressure tanks. Larvae 35 days or older showed a barokinetic response and could swim at speeds up to 26 cm/s. Larvae 13 days or younger had limited swimming abilities and were surface attracted. The depth response of young larvae was influenced by the presence of a halocline. Our results show that late stage larvae have the potential to influence their dispersal, particularly in a strongly-stratified estuary. Our results suggest that including swimming ability and depth preference in a dispersal model of black bream could help predict dispersal paths. Our study demonstrates how laboratory studies can be used to develop biological and behavioural algorithms for larval dispersal models in the absence of existing information on the biology of a species.

The Management & Conservation of Freshwater Fish and Crustaceans of Polynesian Streams

Philippe GERBEAUX // Department of Conservation, French Ichtyological Society

Philippe Keith, Gerard Marquet, Clara Lord // Museum National d'Histoire Naturelle, Paris

Eric Vigneux // Onema and French Ichtyological Society

Polynesia is made of 9 Pacific Island countries and territories. The results of several decades of freshwater fish and crustacean surveys in the regions have been recently compiled in our book "Polynesian Fresh Fish and Crustaceans of Polynesia: taxonomy, ecology, biology and management". This presentation will outline some of the key findings of our work in the region, with a particular focus on conservation and management issues.

pH to P

Max GIBBS // NIWA

Christopher Hickey, John Quinn // NIWA

pH is a parameter often overlooked when monitoring lakes and rivers, yet it could be the key to understanding why cyanobacteria blooms proliferate in the edge waters of a lake or as attached mats in a stream bed. During the diurnal cycle, photosynthesis within the bloom or mat removes the CO_2 and carbonate from the water column and the pH rises. At pH values above 9.2, phosphorus (P) bound to mineral oxides of iron and manganese in the surficial sediments desorbs and is released as dissolved reactive P (DRP) into the water column where it can be used by the cyanobacteria for growth. High pH release of P may be sufficient to sustain cyanobacterial growth allowing the bloom or mats to persist for long periods. In lakes, the phenomenon is most likely to be seen in the afternoon because of the time lag for the pH to rise as the CO_2 is assimilated from the water. In streams and rivers, the effect may be confined to the bottom of the mat in contact with the rocks and sediment. However, if large enough areas of the bed are covered, the pH of the whole water column may be affected. This presentation looks at examples of where pH release of P may have occurred and investigates the implications for the use of P-inactivation agents for the management of internal P cycling in shallow lakes. It also examines the side effects of high pH on the form of nitrogen released from the sediments.

Wind Forced Circulation in Lake Rotorua

Max GIBBS // NIWA

Jonathon Abell, David Hamilton // The University of Waikato

Wind forcing on the surface of a lake can generate currents and circulation patterns in the water column that affect mixing and transport processes in the lake. Transfer of wind energy to the lake bed can suspend sediments releasing nutrients in the sediment pore water into the water column, thereby affecting the water quality of the lake. Sediment resuspension may negate the use of sediment capping with phosphorus (P) inactivation agents to reduce internal P loads. Consequently, it is important to understand the hydrodynamics of the lake and the depth to which wind-induced mixing currents can penetrate before implementing such a management strategy. In this presentation we use Lake Rotorua as a case study to examine the circulation patterns produced by the different wind flows and the magnitude of the lake currents relative to wind strength. The interpretations are based on Acoustic Doppler Current Profiler (ADCP) measurements and a computer simulation of the lake during the mixed phase in winter. The results indicate that the circulation patterns in Lake Rotorua are strongly influenced by the lake bathymetry. North-easterly winds across the eastern side of the lake cause clockwise circulation around the mid-lake island (Mokoia Is) and a second counter-clockwise gyre between Mokoia Is and the western shore. A shift to a south-westerly wind causes these circulation patterns to reverse direction. Current velocities vary with wind speed and were measured at up to 20 cm/s through the full 20 m depth of the water column during a storm event.

Towards Integrated Coastal Monitoring in the Waikato Region

Hilke GILES // Waikato Regional Councill

Barrie Forrest, Chris Cornelisen // Cawthron Institute
Vernon Pickett // Waikato Regional Council

State of the environment (SOE) monitoring and environmental monitoring of consented activities can provide early warning of environmental problems, illustrate where environmental management has been effective and inform decision-making, regional planning and policy development. Under the RMA, regional councils are required to monitor their region's state of the environment. Regional councils can also require resource consent holders to carry out environmental monitoring to provide information on the environmental effects of their activity. Our coastal marine area is exposed to many pressures arising from a variety of water and land-based activities. The effects of these pressures cannot be managed in isolation and instead an integrative management approach is required. To achieve integrative environmental monitoring, Waikato Regional Council (WRC) is reviewing and improving its approach to coastal monitoring by (1) developing a framework for coastal monitoring that integrates SOE and consent monitoring; (2) improving SOE monitoring by investing in new technologies that will enable an increase in spatial and temporal coverage of monitoring information and facilitate systematic prioritisation of issues; and (3) improving the effectiveness of environmental consent monitoring. This presentation will provide an overview of the integrative coastal monitoring approach WRC is currently developing, including the conceptual approach of an integrated SOE and consent monitoring framework, examples of numerical modelling applications (including the Waikato Marine Management Model) and plans for a coastal monitoring buoy in the Firth of Thames.

Linking Otoliths of Fish from Indigenous Middens to Modern Day Species: a Novel Approach Based on Otolith Morphology

Bronwyn GILLANDERS // University of Adelaide

Christopher Izzo, Morgan Disspain, Matthew McMillan, Liangwen Xu // University of Adelaide

Fish ear bones (otoliths) from indigenous middens contain considerable environmental, ecological and cultural information. Midden otoliths can usually be identified to a family level based on otolith shape, however species level identification can be difficult if there are multiple species within the family. Our aim was to identify the species of midden otoliths using quantitative analyses of otolith shape. Shape of midden otoliths suggested that they were from the family Sillaginidae (or whitings). Sagittal otoliths of three species of whiting distributed in southern Australia were used as baseline data of known species identity. Otoliths (modern day and midden) were photographed and normalised elliptical Fourier descriptors of the outlines of otolith shape determined. Canonical analysis of principal coordinates was used to test the ability of otolith shape to discriminate modern day species. Midden otoliths were then assigned species identifications by treating them as unknowns. Fourier descriptors were significantly different among the three modern day species and each species was correctly classified with a high degree of success. The majority of midden otoliths were assigned to a single species, although all three species were represented. This approach provides a cost-effective means of species identification. By linking midden otoliths to specific species will allow comparisons over long time scales to be made and the effects of changing environmental and anthropogenic factors to be determined.

DNA Versus Microscopy – can Molecular Techniques Replace Morphology for Cyanobacterial Analysis?

Gemma GIMENEZ PAPIOL // Cawthron Institute

Marcia Maier, Daniel Dietrich // University of Konstanz
Susie Wood, Xavier Pochon, Jonathan Puddick // Cawthron Institute
David Hamilton, Craig Cary // The University of Waikato

The intensity and regularity of toxic cyanobacterial blooms is escalating globally. There is a corresponding need for rapid, reliable and high-throughput methods to identify these microorganisms and their toxins in complex environmental samples. Recent advances in molecular technologies provide opportunities for the development of innovative diagnostic tools. Our current research is focused on developing a Next-Generation Sequencing (NGS) method that will enable simultaneous detection of multiple cyanobacterial species. In this study contrived communities were created using varying concentrations of DNA and PCR products from 12 cultures to assess the limits of detection of the methodology. The contrived communities were analysed by NGS (IonTorrent platform), producing >70,000 sequences per treatment. Analysis of the data demonstrated that this technique is semi-quantitative and can detect species present in very low abundance. Additionally, during the summer of 2013 a survey of planktonic cyanobacteria from 150 lakes across New Zealand was undertaken. Each sample was analysed using a range of molecular techniques. Samples were screened for genes involved in toxin production and results confirmed using chemical methods. Forty percent of the samples tested positive for toxins genes. A DNA fingerprinting technique was used to explore cyanobacterial diversity among lakes and selected samples were analysed using NGS to obtain a snapshot of cyanobacterial species present across New Zealand.

Challenges With Aquatic Weed Control: an Operational Perspective

Marcus GIRVAN // Boffa Miskell Limited

Managing aquatic weed control operations within large water bodies can be a logistical challenge where weed, water and weather conditions dictate when, where and how control can be carried out. Shrinking budgets, adverse public perception, onerous consent conditions and a lack of cost effective control tools adds to the challenge of effectively controlling hornwort and lagarosiphon within New Zealand's lakes. For decades the herbicide diquat has been used to control aquatic weed in New Zealand waterways with reasonable success. However, weed and water conditions can reduce the effectiveness of diquat sometimes resulting in 'hit-and-miss' outcomes. Consequently, it has been near impossible to eradicate these aquatic invaders. A new herbicide, Endothall, has had a positive impact in more recent years, but is not always effective in larger water bodies. We have found that a mixture of herbicide application, and diver-based suction dredging and hand weeding is effective, however, due to high costs diver-based methods are not always viable options for large infestations. Grass carp have been touted as an effective bio-control tool, but their environmental costs may outweigh their benefits. It's obvious in some water bodies that significant progress is being made using traditional methods of aquatic weed control, although in others this is less so. Under the current economic climate the Crown has the mandate of doing more with less. Collaborative management initiatives aim to improve efficiencies and ensure transparency of aquatic weed control, however, at the coal face currently available technology is failing to effectively manage hornwort and lagarosiphon in all water bodies. The aquatic weed control toolbox is well overdue for the development of innovative, cost effective tools!

Response of Temperate Intertidal Benthic Assemblages to Mangrove Detrital Inputs

Rebecca GLADSTONE-GALLAGHER // The University of Waikato

Carolyn Lundquist // NIWA, University of Auckland
Conrad Pilditch // The University of Waikato

Tropical mangroves have been shown to deliver an important organic subsidy to coastal ecosystems through the production, decay and export of leaf litter. In New Zealand, mangrove (*Avicennia marina* subsp. *australasica*) distribution has shown recent increases in many estuaries and management plans have aimed to reduce this expansion through tree removal. However, current knowledge of the services provided by temperate mangroves to estuarine ecosystem functioning is limited. We examined the role of mangrove detritus in structuring benthic assemblages at two intertidal sites (sandy and muddy) in the Whangamata Harbour. In late summer, we added mangrove leaf detritus to surficial sediments (260 g DW m^{-2}; equivalent to the measured summer leaf fall) and followed changes in the macrofaunal community and sediment properties for three months. Additions drove subtle changes in the relative abundances of a few dominant taxa, rather than whole-scale shifts in assemblage composition. Muddy and sandy communities responded similarly with the same dominant taxa (mainly polychaetes, e.g., *Prionospio aucklandica*) changing at both sites. The subtle responses to the relatively large detrital addition suggest that temperate mangrove detritus plays a minor role in shaping intertidal soft-sediment communities. Our data indicate this may be due, in part, to relatively low production and slow decay rates of temperate mangrove litter, making benthic communities less reliant on this form of detritus than tropical counterparts.

Eradication of Invasive Species from the South Island: are We there Yet?

Natasha GRAINGER // Department of Conservation

David West, Alastair Fairweather // Department of Conservation

In 2000, koi carp (*Cyprinus carpio*) and gambusia (*Gambusia affinis*), were detected in the South Island of New Zealand for the first time. They were found associated with the Noxious fish; rudd (*Scardinius erythropthalmus*) and Sports Fish tench (*Tinca tinca*) and perch (*Perca fluviatilis*) which were not known from the Nelson/Marlborough region before this. A delimitation survey was undertaken before an eradication programme commenced.

This programme has required intensive survey, eradication and monitoring by field staff as well as the development of tools such as rotenone, best practices and survey and monitoring guidelines to support the programme and to ensure that these tools are effective in New Zealand conditions.

Twelve years later, it is time to evaluate what has been achieved, what remains to be done, as well as examining the reasons for successes and failures at various sites.

Linking an Otolith-based Marine Biochronology With Environmental Parameters to Explore Climate-related Changes in Coastal Upwelling Strength

Gretchen GRAMMER // University of Adelaide

Christopher Izzo, Peter Hawthorne, Bronwyn Gillanders // University of Adelaide

Multi-decadal growth chronologies based on hard structures from long-lived aquatic organisms (biochronologies) can be used as a proxy to provide a long-term record of the seasonality of climate-growth relationships and the effects of environmental variability within a region. The research presented here compares otolith chronologies based on patterns of fish growth between upwelled and non-upwelled regions along the coast of southern Australia. We constructed growth-increment chronologies using otoliths from the ocean perch (Helicolenus percoides), a long-lived, deeper water, benthic fish found along the continental shelf of southern Australia and New Zealand. Sagittal otoliths were extracted from the fish, thin sectioned, polished, and ages estimated. Growth increments were further examined and measured using high-resolution digital imagery in conjunction with image analysis software. Annually resolved chronologies were produced by assigning the correct calendar year to each growth increment in the otolith through crossdating; this dendrochronological (tree-ring dating) method cross-matches synchronous patterns of growth increment widths among multiple samples at a given time and place. A mixed-model approach was also used to compliment the crossdating. The resultant master chronology was correlated with various environmental climate indices to examine climate-growth relationships in relation to upwelling strength along southern Australia as well as the effects of climate variability on fish growth.

Porirua Harbour – Part 2: Clarity by Setting Sediment Limits

Malcolm GREEN // NIWA

Leigh Stevens, Barry Robertson // Wriggle Coastal Management
Keith Calder // Porirua City Council
Megan Oliver, Juliet Milne // Greater Wellington Regional Council

Having decided on a target annual-average sedimentation rate of 1 mm/year to manage degradation of Porirua Harbour (see the first of two talks on managing Porirua Harbour), it remains to, firstly, calculate catchment sediment load limits to achieve the target sedimentation rate and, secondly, develop a suite of mitigations to achieve the load limits. An obvious inclination is to uniformly reduce sediment runoff from the catchment in an effort to uniformly reduce sedimentation rates throughout the estuary. However, this is bound to fail, since it will never be cost-effective or even possible to reduce sediment runoff uniformly over an entire catchment and, in any case, it would usually not be necessary to set a goal of uniform reduction in sedimentation to achieve ecological and human-amenity objectives. We present a method of calculating sediment load limits that is smarter than the obvious. The method is based on manipulating the sediment budget and takes advantage of the inherent complexity of the estuary and its connections to different sediment source regions in the catchment. Results show explicitly that there is never just one way of achieving any given estuary sedimentation target or targets, which management can exploit to its advantage. We will describe how this is presently playing out in Porirua Harbour, where targets, load limits and mitigation strategies are being juggled to find an optimum way of managing the catchment to deliver objectives in the harbour.

Marine Spaces: Thought for Food

Bridget GREEN // University of Tasmania

Reg Watson, Robert Parker, Caleb Gardner, Colin Buxton, Klaas Hartmann, Sean Tracey, Sarah Jennings // University of Tasmania
Ray Hilborn // University of Washington
Tony Smith, Beth Fulton // CSIRO
Nathan Pelletier // JRC Institute for Environmentand Sustainability, Italy
Brett Molony // Western Australian Fisheries
Jake Kritzer // Environmental Defense
Adrian Kitchingman // Department of Environment & Sustainability, Victoria

Concurrent with the goal to achieve 10% global marine protected area coverage of all marine and coastal ecological regions by 2020 are goals to maintain fisheries production as a vital part of global food security. Motivation to create MPAs is partly based on the expectation that they are the best solution to conserve the marine environment while protecting and even expanding fish stocks. Some present MPA networks are enormous in scale and multinational in nature, indicating wide belief that there will be significant future benefits. Notwithstanding this, a billion people depend on fisheries for protein, and concerns over food security continue to mount, with global population projections of 9 billion by 2050. Closing marine spaces need a wide base of national and local support, and areas are often selected to minimise current conflicts including those with fishing operations. Fishing fleets are, however, expanding their fishing ranges and target species. Areas currently unfished could be tomorrow's fishing grounds, contributing to the sustainable supply of marine protein. We examine potential conflict in the use of marine spaces by looking at overlaps between MPAs and fisheries production. We look at the current and future potential impacts on marine food security by examining mapped global catches associated with MPAs with varying IUCN categories. Following this global analysis we examine in detail a range of MPA's representing different sizes and conservation goals. This study explores whether the creation of MPA's compromise or complement future food security.

Unravelling the Mystery of Hutt River Cyanobacterial Blooms: Nutrient Inputs & Management

Summer GREENFIELD // Greater Wellington Regional Council

Mark Heath // Victoria University of Wellington

Susie Wood // Cawthron Institute

The Hutt River is one of the most popular rivers for recreational use in New Zealand. However, in recent years risks to recreational users from blooms of the benthic cyanobacterium *Phormidium autumnale* have become increasingly prevalent. Since 2005, 11 dog deaths have been reported following contact with cyanobacteria in the Hutt River. During the summer months, signs along the river bank warning people not to walk dogs near or swim in the river have become a common occurrence. Over the last five years Greater Wellington Regional Council in partnership with Victoria University, the Cawthron Institute and, more recently, Upper Hutt City Council, have undertaken research to understand the environmental drivers of benthic cyanobacterial blooms. Recently it has been suggested that nutrients, in particular the relative concentrations of nitrogen and phosphorus, may be a key factor driving the occurrence of benthic cyanobacteria blooms in the Hutt River and other New Zealand rivers. Work undertaken to quantify nutrient sources within the Hutt River catchment, which include both rural and urban inputs via both surface water and shallow groundwater, will be presented. We will also briefly discuss the implications for future management of cyanobacterial blooms – both for the Hutt River and other rivers in New Zealand.

Influences of Hydrological Regime on Traits & Availability of Adult Aquatic Insects to Terrestrial Consumers

Michelle GREENWOOD // NIWA

Doug Booker // NIWA

Adult aquatic insects emerging from waterways provide an important food resource for many terrestrial consumers. Understanding how river flow and catchment land-use affect the identity, supply and availability of these potential prey to terrestrial consumers is an important step in understanding when anthropogenic alterations to rivers may have impacts on terrestrial communities. Changes to aquatic larval communities alter the taxonomic identity and thus abundance, frequency and timing of adult aquatic insect emergence into the terrestrial environment. As adults of different aquatic taxa vary in their dispersal ability and flight height, the ability of terrestrial consumer taxa to benefit from the aquatic food resource may also vary. We used a large national dataset that incorporated multiple visits per site to investigate whether river flow regime and catchment land-use are likely to affect the supply of adult aquatic insects to terrestrial consumers. Specifically we hypothesised that the abundance of larval aquatic insects and their taxonomic identity (and thus dispersal behaviour as an adult) would be affected by hydrological regime and by the intensity of catchment land-use. For example, aquatic insect communities in flood-prone streams were predicted to have a higher proportion of taxa with smaller adult sizes, multiple generations per year and relatively poor flight abilities, thus providing terrestrial consumers with an abundant supply of small prey items close to the river. We provide evidence that the larval supply, adult size and 'catchability' of adult aquatic insects are affected by hydrological regime and catchment land-use, thus likely affecting their suitability as a prey resource to terrestrial consumers.

Management Strategy Evaluation of Alternative CPUE Based Harvest Control Rules for Abalone

Malcolm HADDON,
Fay HELIDONIOTIS // CSIRO

A Management Strategy Evaluation (MSE) framework has been produced that can simulate an abalone fishery zone made up of an array of statistical reporting blocks each containing an array of essentially independent populations. This cannot be fitted to a natural fishery because, given the spatial heterogeneity of abalone populations, the data requirements would be prohibitive. Rather, the simulated zone is conditioned to have properties similar to a given area of coastline and to produce fisheries data that is similar to the real thing. The assumption is made that the management of such a fishery involves a zone wide TAC and a zone wide legal minimum length (LML). We have used this MSE simulation framework to compare two alternative CPUE based harvest control rules (HCRs), one of which has a small variant. One of these compares the current catch rates against a predetermined target catch rate, modifying the present total allowable catch (TAC) so as to manage the fishery towards the target. The second alternative, and its variant, uses the gradient of the proportional changes in CPUE over the last X number of years and adjusts the TAC with respect to whether the gradient is positive or negative. The variant is identical except that on the inception of the HCR the TAC is markedly reduced, for example by 25%, and then the standard HCR is applied in future years. There are many alternative states of initial depletion, alternative LML, and alternative initial catch levels (irrespective of state of depletion), and natural variation is expected in recruitment, and in the process of recruitment (such that not all populations are equally successful each year), there is variation in catch rates between statistical blocks, and variation in how the divers distribute the TAC among the various blocks. The analyses we present illustrate the trade-offs that exist between the TAC and LML that can be applied to abalone populations but also how the outcomes depend upon the initial state of depletion. While these analyses cannot be used to set policy they certainly illustrate the options available to the managers and the policy makers.

Recovery Trajectories After Mangrove Removal Using in Situ Mulching

Sarah HAILES // NIWA

Carolyn Lundquist // NIWA

Mangrove removals (both legal and illegal) have occurred in northern New Zealand in recent decades, in response to high rates of mangrove expansion in tidal creeks and estuaries. However, there is limited information on the effects of removal and the pathways and pace of recovery. In Tauranga Harbour, large scale mechanical removal commenced in 2010 (total ~110 ha), providing an opportunity to examine recovery trajectories concurrently at multiple sites subject to the same removal methodology. Here, we quantify the recovery trajectory of benthic macrofaunal communities after "mulching" (mechanical mangrove removal with in situ deposition).
We sampled benthic macrofaunal communities at three sites in each of two estuaries (Waikaraka and Te Puna; Tauranga Harbour) prior to mangrove removal, and at 3, 6 and 12 months post-removal. Waikaraka was also sampled at 24 months post-removal. Macrofaunal cores were collected from mulched and adjacent sandflat and mangrove areas. After 12–24 months post-mangrove mulching, some colonisation by macrofauna had occurred in the removal zone; however, the resulting communities were dominated by opportunistic and disturbance-tolerant taxa including Oligochaeta, Capitellidae polychaetes, and Diptera (fly) larvae, and were not representative of typical sandflat or mangrove communities. While univariate measures such as species richness and number of individuals did show increases over time, multivariate comparisons suggest that the mangrove removal zones did not show expected trends in recovery. We hypothesise that the lack of short-term recovery trends in macrofaunal communities was due to the lack of dispersal and the slow decomposition rate of the mulchate and root material.

Management & Implications of Fishing Down the Slopes & Seamounts within the Tonga EEZ

Tuikolongahau HALAFIHI //
University of Canterbury, Tonga Fisheries Division

Dr Sharyn Goldstien, Dr Alex James //
University of Canterbury
Dr Ashley Williams // Secretariat of the Pacific Community

The Tonga deepwater drop-line fishery is important for the economy and food security of the country, as happens in other Pacific countries; however, the inconsistency in data collection, along with lack of information available on biology and ecology of deepwater fish in Tonga, has affected assessments of the fishery. The fishery started in the 1980s, at slopes and seamounts within the Tonga EEZ. The primary target species are deepwater snapper (*Etelis* spp and *Pristipomoides* spp) which are widely distributed across the Pacific Ocean. A Maximum Sustainable Yield of 350 mt/year, from previous assessments, has been used to manage the fishery since1992. Unfortunately, subsequent landings never reached that point, and there is evidence of poor catch rates and smaller fish sizes observed in certain areas; highlighting the need for stratified data and an updated catch limit. Here we characterized the Tonga deepwater drop-line fishery, revealing that annual landings, catch rates and fishing efforts all increased considerably within a few years of opening the fishery, but have been in decline since 1988. Subsequently, catch rates and the mean lengths for most species have fluctuated, but overall have declined in recent years. To improve management of the Tonga deepwater drop-line fishery and seamount communities, we are collecting disaggregated data by location, and by depth. In addition, we aim to better understand the biology and spatial ecology of the deepwater fish species such as *Etelis coruscans*. Lesson learned from the Tonga drop-line fishery is applicable to drop-line fisheries in other Pacific countries.

Population Structure of Freshwater Mussels in the Raglan Catchment

Mark HAMER // Waikato Regional Councill

Kevin Collier // Waikato Regional Council, The University of Waikato
Jen Iles // Waikato Regional Council

Freshwater mussels are in decline throughout New Zealand. Factors causing this decline include predation, water quality changes, erosion, declines in dispersal vectors (e.g., changes to fish passage) and potentially water takes. We designed a survey to estimate population density and size structure of *Echyridella menziesii* and *Cucumerunio websteri* at 17 stream and river sites in the Raglan catchment, northern New Zealand. We undertook visual surveys consisting of an initial 30 minute visual search of likely habitats with underwater viewers to establish presence. If mussels were found a 50 m reach was intensively searched over all habitats present. Mussels were counted and the first 50 individuals of each species were measured. When mussels were seen a tactile search through the substrate was undertaken to find any buried individuals present in that area. We also recorded the presence of dead mussels and bank middens indicating predation by introduced mammals. If less than 50 mussels were found a further 30 minute search of likely habitat was undertaken to try and locate 50 individuals for size measurement. *E. menziesii* was found at 88% of sites and *C. websteri* at 59%. Mussel density ranged from 0.005 per m^2 to 2.5 per m^2. Relative abundances of small mussels (E. menziesii <40 mm, *C. websteri* <50 mm) were highest in the Waingaro catchment for both species. Population size structure followed a normal distribution for *E. menziesii* but was skewed for *C. websteri* suggesting an aging population. The implications of these findings for freshwater mussel conservation will be discussed.

Recruitment of Snapper in Port Phillip Bay, Australia: Patterns & Processes

Paul HAMER // Department of Environment and Primary Industries, Fisheries Victoria

Kerry Black, Greg Jenkins, Hannah Murphy, Steve Swearer // University of Melbourne

Snapper, *Pagrus auratus* are the most valued recreational and commercial inshore fish species of south-eastern Australia. In Port Phillip Bay, they are of iconic status. Each year, in late spring, spawning migrations enter the bay from coastal waters and so starts another frenzy of fishing activity. Historically catch rates have varied considerably and our research has been aimed at predicting and explaining this variation and the links between the environment and production of the fishery. Over the past decade, through the application of otolith chemistry and sampling of the early life-stages, we've come to fully appreciate the importance of the spawning aggregations in the Bay for broad-scale fishery replenishment. This has underpinned the ongoing monitoring of 0-age recruitment in the bay as a leading indicator of fishery replenishment. Over twenty years of pre-recruit survey data is now available, along with age composition and catch rate data to clearly show the link between spawning success in the bay and variation in fishery production. Our focus is now on understanding the processes that influence spawning success. We have demonstrated a close relationship between the abundance of larval and 0-age life stages across 7 cohorts. Understanding survival during the first few weeks of life in the bay is clearly the key to understanding interannual recruitment variation. This presentation summarises our previous research and monitoring of snapper recruitment in Port Phillip Bay, more recent research on larval feeding ecology and progress towards modelling of larval food dynamics in the bay.

Exploring the Ecological & Social Interface: Effective Engagement of the Native Fish Strategy

Fern HAMES // Arthur Rylah Institute, Department of Environment and Primary Industries

The Native Fish Strategy (NFS) aimed to restore native fish populations in the Murray-Darling Basin (MDB) back to 60% of their pre-European settlement levels. To achieve this, the NFS worked with multiple stakeholders to transfer its research outcomes into local plans and onground actions, and build long term advocacy to support native fish recovery across the Basin. A key distinguishing feature of the Native Fish Strategy was genuine, targeted partnerships and effective, planned engagement. State-based Native Fish Strategy Coordinators worked with a Community Stakeholder Taskforce to plan Murray-Darling Basin-wide programs, adapting and implementing activities to their own local contexts. Building partnerships was a constant and active priority, with multiple and diverse methods used to engage stakeholders. Engagement delivered key messages to a range of targeted audiences, across a range of scales, and in a range of contexts. This approach was highly effective in building support, ownership, empowerment and long term advocacy with the local community and relevant stakeholders. This approach also highlighted the need for staff with a particular set of personal attributes or values (such as trust, patience and persistence), as well as professional skills and behaviours (such as reliability, consistency and credibility). For the future, we recommend increased effort in monitoring and evaluating the social elements of riparian rehabilitation programs, and a more integrated approach to exploring interconnected socio-ecological systems.

Limits to Relying on Phosphorus to Control Periphyton Growth: Stuff Happens At the Interface With Algae

Keith HAMILL / River Lake Ltd

This paper looks at the ability to use nutrient limitation to control periphyton growth in the Manawatu River. It discusses why removing dissolved phosphorus from Palmerston North City Waste Water (PNCC WWTP) has had only limited successes in reducing the rate of downstream periphyton growth. Particulate phosphorus was found to be readily available to periphyton under conditions of diurnally high pH in the river water and within the periphyton mat. Periphyton was found to trap river sediments within its mat and derive phosphorus from these sediments by diurnal increases in pH (measured up to 9.6 at the periphyton surface). Increases in pH more readily released phosphorus from sediment trapped by periphyton downstream of the Palmerston North wastewater treatment plant compared to upstream. The downstream sediment quality was consistent with the settling of alum flocculants. The Manawatu River upstream of PNCC WWTP discharge exhibits flow related dynamics in the nutrient concentrations and potential nutrient limitation of periphyton growth. During the early stages of a flow recession phosphorus is potentially limiting periphyton growth but as flow further reduces nitrogen concentrations drop and become potentially limiting. After an extended period of low flow dissolved phosphorus concentrations in the river increased and periphyton bioassays confirmed that nitrogen was the primary limiting nutrient. The results of this work has direct implications for the choice of treatment process used to remove phosphorus from wastewater effluent, and wider implications for river managers wishing to control periphyton growth by focusing on phosphorus limitation.

Effects of Climate Change on New Zealand Lakes

David HAMILTON // The University of Waikato

Chris McBride, Deniz Özkundakci, Chris Hendy, Wei Ye // The University of Waikato
Marc Schallenberg // University of Otago
Mary de Winton // NIWA
Dave Kelly // Cawthron Insititute

The potential impacts of climate change on NZ lakes are examined together with a consideration of how these effects may be mitigated. We briefly outline the origin and nature of NZ lakes, consider the historical climate, and examine the potential impact of a future climate, up to 2100. In providing a context with which to evaluate the impacts of climate change in NZ lakes we draw comparisons with the massive landscape changes that have occurred in the past 150 years as a result of human settlement and widespread conversion of forests, wetlands and lakes to agricultural land, or use of freshwater for other economic benefits such as hydro power. There is little evidence of any long-term changes in lake water temperature but ENSO events can have major impacts on mixing regimes of deep lakes. The effect of climate change on NZ lakes is likely to be a synergistic one, with major existing pressures from alien species, water extraction and eutrophication, acting in tandem with additional pressures from forecasted increases in irrigation and water impoundment as well as new alien species introductions, to negatively impact upon lake ecological integrity and biodiversity. Actions to improve land management will be necessary to reduce nutrient and sediment loads to lakes and provide greater resilience to storm events, whilst also increasing surveillance, control and eradication efforts for noxious alien freshwater invaders.

Population Structure & Connectivity in New Zealand Coastal Marine Organisms: Contrasting Patterns in Two Surf-clam Species

Danielle HANNAN // Victoria University of Wellington

Peter Ritchie, Jonathan Gardner, James Bell // Victoria University of Wellington

Understanding how patterns of migration connect populations of marine organisms and ultimately determine their population structure is important for sustainable fisheries management, establishment of marine protected areas and for biosecurity purposes. Pipi (*Paphies australis*) and tuatua (*P. subtriangulata*) are common and widespread bivalves found in harbours and on beaches around New Zealand. They form popular recreational and customary catches, with much potential for expanded commercial catches. Yet little is known about stock structure of these species or how populations might be connected – my research addresses these questions using highly variable microsatellite DNA markers. Pipi populations were found to have high levels of differentiation and gene flow was low among some parts of the country. In contrast, most tuatua populations showed less differentiation and gene flow was higher. These results highlight the different ways that populations of marine species can be structured, even when comparing closely related species. Furthermore, by teasing apart the physical processes that are responsible for producing observed patterns of population structure, it is easier to understand how the physical complexity of the New Zealand coastal marine environment might influence population structure and dispersal pathways for marine species.

Interactions Between Microphytobenthos & Macrofauna Regulate Intertidal Sediment Stability

Rachel HARRIS // The University of Waikato

Conrad Pilditch // The University of Waikato
Simon Thrush // NIWA, University of Auckland
Judi Hewitt, Andrew Lohrer, Samantha Parkes, Barry Greenfield, Michael Townsend // NIWA

Biological activities within sediments affects its stability. But the interactions between sediment stabilising microphytobenthos (MPB) and destabilising bioturbating macrofauna has rarely been tested experimentally *in situ*. In a large-scale field study we manipulated 56 (1 m^2) plots on an exposed intertidal sandflat limiting MPB activity using shade cloth and creating a gradient (0-200 ind. m^{-2}) in the bioturbation/grazing pressure exerted by the deposit-feeding bivalve *Macomona lilliana*. Three months after the manipulation, sediment stability (erosion threshold and rate) in the plots was measured using a core-based device (EROMES) and the sediment properties and macrofaunal community composition ascertained. Although shading did not impact MPB biomass, differences in macrofaunal abundance were detected between shaded and non-shaded areas. Distance-based linear regression models indicated 23–35 % of the variation in erosion data could be explained by a combination of sediment grain size (10–20%, $p \leq 0.03$), MPB indicators (ratios of diatoms:cyanobacteria ≤ 8%, $p = 0.05$ and chlorophyll *a*:phaeophytin ≤ 8%, $p = 0.04$) and macrofauna (abundance 19%, $p = 0.002$ and richness 11%, $p = 0.02$). As expected MPB indicators were positively correlated with sediment stability whereas a decrease in sediment stability was correlated with increased macrofaunal abundance. Our results demonstrate that even for sandy sediments exposed to frequent reworking by tidal currents and wind-generated waves, biological interactions significantly impact sediment stability.

The Development of a Maximum Count Aerial-access Survey Method to Estimate Harvests from Large Scale Boat-based Fisheries

Bruce HARTILL // NIWA

Helena Armiger, Nicola Rush, Richard Bian // NIWA

Marine recreational harvests from New Zealand's fish stocks are often taken along coastlines in excess of 1000 km. Observing and estimating levels of fishing effort and harvesting at this scale is therefore problematic, as catches are usually landed at a large number of access points over highly varying degrees of intensity. In these situations aerial survey methods are often used to scale up interview data collected at a subsample of access points, to estimate the harvest landed at all locations on that day. Although the use of planes considerably increases the spatial scope of on-site survey techniques, the cost of operating these aircraft and the need to cancel flights because of low cloud on some days is problematic. We have developed a novel form of maximum count aerial-access methods to minimise aircraft operating costs and ensure that estimates of total fishing effort are still available for those days when flights are cancelled. This approach has been applied to survey several of New Zealand's large scale recreational fisheries, most recently in 2011–12, between North Cape and the eastern Bay of Plenty. A comparison of the estimates provided by this survey, with those provided by two other independent and concurrent surveys suggests that these estimates are reliably accurate and fit for management purposes.

Reproductive Biology & Early Life History Traits of the Eastern Blue Spot Goby, *Pseudogobius* sp

Kathryn HASSELL // University of Melbourne

Evan Hallein, Jessica French, Vincent Pettigrove, Stephen Swearer // University of Melbourne

The Eastern blue spot goby, *Pseudogobius* sp. is a small benthic species native to south-eastern Australia. Here we describe differences in size and condition of juvenile and adult gobies collected from Victorian estuaries within Port Phillip Bay, Westernport and the St George river, Lorne. The selected estuaries differ in levels of anthropogenic impact and surrounding land use. Gobies from multiple estuaries have been acclimatised in the laboratory and suitable conditions to stimulate spawning have been achieved. Blue spot gobies are pair breeding, multiple spawners that produce large egg clutches (>200 eggs) at intervals of one to two weeks under optimal conditions. Embryonic development occurs over 5-7 days (22–25oC) and larvae hatch at a body length of 2-3 mm. Upon hatching, blue spot goby larvae have well developed eyes, some pigmentation, a single oil globule and a small yolk-sac that is exhausted within 24-48 hr. By day 28 post hatch, fin rays are well formed, metamorphosis is completed and body length is 5-6 mm (average growth rate ~0.1 mm/day). Gonad development has been observed as young as two months old in lab-reared fish, and mature gonads have been observed in wild caught fish as small as 25 mm TL. The Eastern blue spot goby is widely distributed and abundant throughout it's range, and may represent a valuable model species for biomonitoring studies and ecological research.

Trout Bioenergetic Drift Foraging Models for Interpreting Habitat Suitability for Instream Flow needs Assessment

John HAYES // Cawthron Institute

Nina von Westernhagen // Hawke's Bay Regional Council
Kit Rutherford // NIWA
Olivier Ausseil // Aquanet Consulting Ltd

Hydraulic-habitat based models (e.g. RHYHABSIM) are the main means by which instream flow requirements for fish, and other aquatic life, are assessed in New Zealand and elsewhere. Predictions are most sensitive to the habitat suitability curves (HSC), the biological component of the models. HSC's are usually empirically derived from frequency of occurrence, or density, data. Because they are costly, river specific empirical HSCs are rarely used when applying hydraulic-habitat models; instead existing empirical HSCs are transferred between rivers. A short coming is that some studies have found that habitat selection by fish can vary between rivers, season, and flow – putting into doubt the transferability of empirical HSCs and predictions of hydraulic-habitat models. A response to this problem is to develop general HSCs, from data sets gathered across of range of rivers, varying in size and form, hopefully without bias. I will present generalised HSCs for adult drift feeding rainbow trout based on data from three New Zealand rivers. At the core of the problem of transferability of HSCs though is an inadequate understanding of the functional basis for habitat selection. Bioenegetics drift foraging models provide such functional understanding and can be used to construct depth and velocity HSCs. They allow HSC to be predicted as a function of fish size, water temperature, food supply (drift density and size) and water clarity. I will show how the habitat suitability predictions of a rainbow trout drift foraging model can be used to interpret empirical HSCs and to substitute for them.

Food Preferences for newly caught Common Clownfish (*Amphiprion ocellaris*) In Captive Condition

Zulkifli HAMZAH // University Technology MARA, Perlis, Malaysia

Assoc. Prof Norsila Daim, Nawwar Zawani Mamat, Assoc Prof Abol Munafi Ambok Bolong // University Technology MARA (UiTM) Perlis, Malaysia

In ornamental fish trade industry around the world, most of the supply of ornamental fish was originated from the wild. This may lead to depleted of ornamental fish in the coral reef area. Many parties and fellow researcher is developing method to cultivate ornamental fish in captive condition. To start captivating ornamental fish, fellow breeders need fresh ornamental fish originated from the wild. Wild fish never ate pallet before and breeders must prepare feed, and this study objective is to observe and identify their preferences towards the feed. Four different of feed were given for 20 days to 20 pairs of wild-caught common clownfish *Amphiprion* ocellaris. The feed were given and their reaction and eating action were observed and recorded. From initial observation, fish do have a different preference towards different feed. From data collection, fish show different appetite towards different feed, the texture of the feed might have affecting the fish preferences. Preferred feed have higher amount of intake by the fish, and less preferred feed were often less eaten. At the end of the experiment, fish who eat more appear healthy than the fish that ate less. Conclusion, the fish preference towards different feed was important to maintain good fish condition. This study will hopefully be able to help fellow breeders to give proper type of feed towards newly caught fish. If ornamental fish were successfully captivated, hopefully in the near future, this will help reduce the environmental stress especially in the coral reef area.

Are Low Water Column Dissolved Reactive Phosphorous Concentrations Essential for Benthic *Phormidium* Blooms & Toxin Production?

Mark HEATH // Victoria University of Wellington

Susie Wood, Roger Young // Cawthron Institute
Ken Ryan // Victoia University

Benthic mat forming cyanobacteria of the genus *Phormidium* are abundant in many New Zealand rivers. When conditions are optimal *Phormidium* can proliferate, forming extensive mats across large expanses of river substrate. *Phormidium* can produce a range of neurotoxic compounds known as anatoxins. These are of considerable concern when rivers are used as drinking water supplies or for recreational activities. The relative contribution of nitrogen (N) and phosphorous (P) in regulating *Phormidium* biomass and anatoxin production in lotic systems are not well understood. In this study the roles of N and P in growth and anatoxin production were investigated using batch cultures and in-situ nutrient substrate plate experiments. Five different nutrient treatments were investigated in the culture experiments. *Phormidium* biomass was reduced significantly under low N treatments ($p<0.001$) and to a lesser extent P ($p<0.05$). Anatoxin concentrations were significantly higher in P limited treatments ($p<0.05$) and peaked in the early growth phase in all treatment. Nutrient substrate plates were deployed in the Hutt River (Wellington). The greatest biomass was observed on the N and P, and P treatments. This result reflected the nutrient water testing, which suggested the system is P-limited. Collectively these data suggests that *Phormidium* is adapted to thrive in low phosphorus environments where other algal species struggle to compete. Reasons for this require further investigations but could include: luxury uptake of P, access to alternative P sources or from bacterial processes in the mat that increase the biological availability of phosphorus.

Designing a National Panel Survey – Avoiding Historic Failures & Integrating Technology

Andy HEINEMANN // National Research Bureau Ltd

Jeremy Wynn-Jones // National Research Bureau Ltd
Alistair Gray // Statistical Research Associates

The national panel survey aimed to measure the marine harvest by recreational fishers over the period October 2011 to September 2012. The methodology for achieving this entailed a two-phase population survey. The first phase drew a nationwide random probability sample of approximately 30,000 dwellings and physically visited each of these to screen the adult residents for participation in marine fishing. From this step, a reporting sample of fishers and non-fishers was enrolled for the purpose of monitoring their marine fishing over one year. The monitoring system utilised systematic periodic texting and phone contact over the year to determine whether the sample marine fished or not, followed by a computer assisted phone interview to those who marine fished, in order to gather detail of their fishing activity for the period. The contact pattern was designed to account for all 52 weeks of the year for each monitored survey respondent.

The National Panel Survey 2011–12 – It's Mostly Snapper

Andy HEINEMANN // National Research Bureau Limited

Jeremy Wynn-Jones // National Research Bureau Limited
Alistair Gray // Statistical Research Associates

The national panel survey has delivered harvest estimates for a range of stocks across New Zealand. Note that concurrent sampling of fish weights was required to convert the numbers collected in this survey to weights. At a national scale just over half the total number of fish harvested were snapper. The survey outputs include: estimates of harvest (numbers and weight) at a QMA level for all stocks sampled, profiles of participation in fishing by standard demographic parameters, profiles of fish harvest by fishing method, estimates of proportions harvested by all fishing methods, fishing immigration and emigration between regions and various other profiles of fishing activity. A range of outputs will be presented from fish stocks around the country.

Management Strategy Evaluation of the Robustness of Alternative Management Responses for Abalone

Fay HELIDONIOTIS, Malcolm HADDON // CSIRO

A Management Strategy Evaluation (MSE) framework has been produced that can simulate an abalone fishery zone made up of an array of statistical reporting blocks each containing an array of essentially independent populations. This cannot be fitted to a natural fishery because, given the spatial heterogeneity of abalone populations, the data requirements would be prohibitive. Rather, the simulated zone is conditioned to have properties similar to a given area of coastline and to produce fisheries data that is similar to the real thing. The assumption is made that the management of such a fishery involves a zone wide TAC and a zone wide legal minimum length (LML). We have used this MSE simulation framework, with a harvest control rule that attempts to achieve a target CPUE, to compare how an abalone fishery might respond if managed with alternative strategies ranging from risk averse to risk prone. This has been implemented through simulating a fishery zone similar to Tasmania's east coast abalone zone, first fishing it to different depletion levels and then managing that simulated fishery with alternative combinations of total allowable catch (TAC) and legal minimum length (LML). Some of the questions addressed include whether apparently risky strategies, such as a relatively high TAC, could be mitigated by other management actions such as increasing the LML, or, visa-versa, can the apparent risks of a small LML be mitigated by a lower TAC? Using an MSE to test alternative strategies, which intuitively appear sensible, can help identify unintended consequences relating to other aspects of the fishery such as CPUE or the size distribution of the catch

Warming Climate, Cooling Lake: the Changing Thermal Regime in Lake Namunamu over 25 Years

Ian HENDERSON // Massey University

Namunamu is a small deep lake in central North Island hill country that is currently exhibiting extreme behaviour in several respects. It remains thermally stratified for most of the year, mixing in winter for as little as two weeks. Anoxia below the thermocline is present whenever the lake is stratified and a dense layer of anoxygenic photosynthetic bacteria develops annually. Recent measurements indicate that densities of green-sulphur bacteria are higher than any ever recorded in a non-saline holomictic lake. The lake also recently experienced an event of total anoxia throughout the water column. Despite this, the surface waters usually support a diverse zooplankton community and a stocked rainbow trout fishery. Data collected from the lake in the mid 1980's shows that the severity of stratification and anoxia has increased over this period but, surprisingly, the lake is now cooler overall. The potential roles of climate warming and afforestation of the once pastoral catchment in this change will be explored.

Local Factors Drive Macrobenthic Species Richness in Intertidal Areas Across Scales

Judi HEWITT // NIWA

Silvia de Juan // NIWA

We analysed diversity patterns at six intertidal habitat types in eight locations in the New Zealand Auckland region (North Island). Analysis aimed at investigating the relative effects of regional species pools, habitat types and local environmental factors on species richness. The potential for effects to be scale dependent was explored by comparing the results for species richness at α (local average species richness) (total species richness within a location) and (within-location heterogeneity) scales. Results showed that differences in the effect of habitat types on, and diversities were not consistent across locations, but habitats with structuring fauna (cockles, tubeworms and seagrass) were more likely to have higher average numbers of species (α diversity) than mud and sand habitats. Cockle and tubeworm mat habitats were also more likely to have higher total numbers of species (diversity). Increasing the spatial scale at which diversity was measured (α to γ) did not result in local factors becoming less important; patch size and habitat fragmentation were important at α and γ scales. Patch size generally had a positive effect on species richness, and number of patches and habitat fragmentation indices generally had negative effects. The decrease of species richness across scales linked with habitat fragmentation underline the importance of minimising habitat loss and fragmentation for the conservation of marine soft sediments.

Overview of Marine & Estuarine Habitat Mapping Approaches & Spatial Modelling

Judi HEWITT // NIWA

Andrew Lohrer // NIWA

Mapping the biodiversity and ecology of benthic soft-sediments in shallow coastal areas poses a number of challenges. Large intertidal areas require use of different sampling strategies to those of deeper subtidal areas (>5 m at low tide), but sampling both of these is easier than sampling the intermediate depths. The type of sampling utilised also depends on the study rationale, whether it be, for example, predicting distributions of particular species, baseline surveys of habitat type or mapping ecological integrity. Here we discuss a number of problems arising from trying to map/model in such areas, the types of strategies used and how to integrate results from different sampling strategies, especially when resolution differs.

Defining the Risk of Cumulative Impacts to Marine Biodiversity

Judi HEWITT // NIWA

Simon Thrush, Graeme Ingliss // NIWA
Melissa Foley // Stanford University

Scientists, resource managers and planners are all aware of the potential for cumulative effects to occur as evidenced by reference to them in many important environmental policy documents. However, to date cumulative effects assessments have been based on simply adding up stressors with little consideration of differential responses, interactions or impacts on ecosystem dynamics. Here we utilise a novel framework based around assessing the potential for a threshold response to occur. Stressors on the marine environment are broken down into 8 general categories of disturbances and empirical results and theoretical studies are utilised to generate a matrix of cumulative effects interactions between these disturbances (additive, multiplicative, synergistic or antagonistic). Predicted responses of biodiversity at three different spatial scales (site, estuary, region) to individual categories are determined using expert opinion analysed by Point of Truth calibration and generate the initial probabilities. These probabilities are then adjusted for the cumulative stressors occurring within an area using the cumulative effect matrix to give the probability of a threshold response occurring at any particular spatial scale. This process although still 'under construction' has the potential to assist in marine spatial planning and making trade-offs between different resource users.

Degraded Inanga Spawning Habitat: Mending a Fishy Achilles Heel

Mike HICKFORD // University of Canterbury

David Schiel // University of Canterbury

Inanga, *Galaxias maculatus*, are the basis of the modern whitebait fishery. Throughout most of New Zealand, >95% of the whitebait caught are inanga. Despite massive habitat loss through coastal wetland drainage and intense fishing pressure of recruits, the threat classification of inanga is only 'Declining' with "moderate to large populations" having "low ongoing or predicted Decline". Inanga appear to be resilient to these impacts because of large numbers of returning whitebait to most rivers, and their generalist feeding and habitat preferences. However, we have shown that a major threat to inanga populations occurs at the spawning stage where often the obligate riparian habitat is greatly degraded. Inanga have adapted to using now ubiquitous exotic grasses for spawning, but the limited spatial extent of spawning sites makes populations within individual rivers vulnerable. Furthermore, our data show that adults don't move between rivers so if spawning habitat in a river is absent, that river is a sink population. Here we present results of short- and long-term spawning habitat rehabilitation experiments using fencing and artificial habitats. Each technique has produced increases in egg production, but severely degraded habitats have considerable inertia when long-term rehabilitation tools are applied, and so require intervention over at least a few years. The good news is that rehabilitation of spawning habitat can transform sink rivers to source rivers and improve the long-term viability of inanga populations. Combined with preservation of pristine spawning habitats, this will provide an added 'insurance policy' to

Temperature & Mass Dependence of N & P Excretion by Common Carp: Implications for Lake Nutrient Regimes

Brendan HICKS // The University of Waikato

Dai Morgan // The University of Waikato

We used a metabolic theory of ecology (MTE) to explore scaling of metabolic rates by body size and temperature, and to predict nutrient excretion by common carp (*Cyprinus carpio*). At high biomasses, common carp have negative impacts on water quality, and one mechanism is excretion of the nutrients N and P. We measured whole-body and mass-specific excretion rates during summer and winter for fish of different sizes (wet mass range 28–1,196 g) to produce an allometric scaling model capable of predicting excretion at different temperatures. We found positive relationships between both dissolved and total nutrient concentrations and fish wet mass in summer and winter, with greater excretion rates in summer (mean water temperature 24.2°C) than in winter (mean water temperature 9.2°C). Mass-specific excretion rates decreased with increasing fish size, consistent with the MTE, and the temperature-adjusted model explained more variation for N excretion than for P. The proportion of dissolved nutrients (NH_4 and PO_4) to total nutrients increased with increasing fish size. The significance of these models is that they can be used to predict population-based nutrient excretion by common carp when thermal history, fish density and size distribution in a water body are known.

Te Awaroa – is There a Place for Waikato?

Dan HIKUROA // Ngā Pae o te Māramatanga

Dame Anne Salmond // The University of Auckland

Te Awaroa is a movement, a project, a vision that by 2050 more than a thousand of Aotearoa's rivers and their catchments will be healthy, supporting a full range of aquatic and terrestrial indigenous biodiversity and meeting the cultural, social and economic needs of all New Zealanders. The bold idea was born following a presentation by Dame Anne at the Transit of Venus conference in Gisborne in 2012 that linked ideas about the Age of Enlightenment and Maori philosophy and knowledge to our present ecological crisis and ways to restore balance. Although fencing and planting riparian strips is not a new idea, the boldness of aiming for collaborative, concurrent, considered effort defies the inherent simplicity of the idea.

The evolving project plan has 5 key, inter-related and integrated strands:

I. Science-based: Restoration of riverside bush based on, and responsive to the findings of conservation biology and freshwater ecology. This would take research on a wide range of topics into schools and communities, making scientific methods and insights widely accessible.

II. Environmentally clever production: A step towards socially and environmentally responsible production in industry, forestry, agriculture, horticulture etc. by planting bush buffers, fostering innovation in strategies and ideas. Iwi innovation.

III. 'Mucking In': Bring people together – town and country, different generations; scientists and the wider community – to take care of our rivers. Reconnect people with their rivers, learn to take care of them

IV. Visionary: Use cutting edge communication techniques to transmit a kai-tiaki vision, ideas, findings, tool kits; to recruit support and investment of time and resources.

V. Viral: An idea that spreads across New Zealand, engaging people in new and innovative ways of caring for native plants and animals, rivers and the ocean, based on cutting edge science and ideas of guardianship.

The opportunity for the Waikato and its kaitiaki to lead the way forward for New Zealand by playing a role is ripe and for the taking, and the intention of this presentation is to catalyse discussion.

Mauri ora!

Impact of Epibiota & Parasites on Life History Parameters of Cockles in a Recovering Estuary

Thomas HILDEBRAND // University of Canterbury

Mads Thomsen, David Schiel // University of Canterbury

Austrovenus stutchburyi (the New Zealand cockle) is a shallow-burrowing, suspension-feeding bivalve that occurs in sedimentary estuaries throughout New Zealand. *A. stutchburyi* plays a crucial role for benthic invertebrates by providing attachment space on its shell in habitats that often lack other hard substrata. *A. stutchburyi* also is a major 'habitat' for internal parasites, especially *Curtuteria australis*. This trematode that can reduce the cockle's ability to burrow by replacing foot tissue with metacercariae, resulting in infected cockles spending more time on the sediment surface and exposing them to greater predation and their shells to colonization by epibiota. The aim of my MSc study is to test facilitation mechanisms involving cockles, epibiota and parasites. The ecological performance of the cockle (density, size, and condition index) is likely to depend on external epibiota and internal parasite loading. Sites are sampled throughout the Avon-Heathcote, quantifying cockle density, size structure of populations, condition index and trematode and epibiota loadings. These relationships will then be tested in the field. This will be discussed in the context of facilitation, intermediate hosts and the ecology of the estuary, particularly with respect to ecologically important epibiota such as nuisance macroalgae.

Inanga Reproduction: Putting Fewer Eggs into Multiple Baskets

Jessica HILL // University of Canterbury

Michael Hickford, David Schiel // University of Canterbury

Galaxias maculatus (inanga) occurs throughout the southern hemisphere and is one of the most widely distributed fishes in the world. Juvenile inanga (whitebait) are the basis of a culturally and recreationally important fishery. The reproductive success of *G. maculatus* is closely linked to the availability and composition of dense riparian vegetation, which comprises their obligate spawning habitat. The quality of vegetation, reproductive output and egg laying interact to provide the swarms of larvae associated with whitebait, but we know little about the specifics of these critical interactions. It has previously been assumed that *G. maculatus* is an annual species with most fish dying after spawning and that the timing of reproduction does not differ throughout New Zealand. Here we present results from adult fish collections over 14 months from multiple rivers of the south island. Histological analyses indicate a slight offset in the timing of reproduction between the east and west coasts, much lower fecundity values than previously reported and clear evidence of repeated spawning by individuals. It appears that significant numbers of inanga survive post-spawning, but more work is needed to confirm the age structure of adult populations. This study highlights region-specific differences in *G. maculatus* populations which have implications for effective management.

Revisited: Effects of Thin Terrestrial Sediment Deposits on Recruitment

Aysha HOHAIA // Auckland University of Technology

Kay Vopel // Auckland University of Technology
Conrad Pilditch // The University of Waikato

Coastal urbanization, rising sea level and extreme rainfall events increase the supply of terrestrial sediments to coastal habitats via waterways or from landslides. Eventually these fine clay sediments are deposited on the seafloor. Previous experiments with defaunated intertidal sediment suggested that the negative impacts of clay deposits on the burial rates of juvenile bivalves was due to a decrease on oxygen concentrations in the underlying sediments. We challenged this link hypothesising that terrestrial clay deposits will negatively affect burial rates regardless of the oxygen concentration. We observed the behaviour of juvenile *Macomona liliana* on four sediment surfaces in a laboratory flume: intact, bioturbated intertidal sediment (C), intertidal sediment depleted of organic matter by combustion (D), and clay deposits over C (CTS) and D (DTS). Porewater analyses revealed that the diffusive impedance of the clay deposit significantly decreased the oxygenation of sediments in treatment CTS but not DTS, due to high oxygen concentrations in D. Behavioural observations revealed that (i) clay deposits significantly increased the probability of burial, irrespectively of treatment, and (ii) juveniles were more likely to burry into C than into D. We reject our hypothesis and attribute our failure to document a negative effect of clay deposits on the recruits' burial to the macrofaunal irrigation of the sediment (CTS) and the absence of organic matter (DTS). Our study emphasises the importance of identifying thresholds for the response of the benthic ecosystem to stress: what level of sedimentation will alter the macrofaunal activity sufficiently to affect recruitment?

Amateur Harvest Estimates for Scallop & Rock Lobster in Bay of Plenty, New Zealand 2010–11 & 2011–12

John HOLDSWORTH // Blue Water Marine Research Ltd

Bryan Manly // Western EcoSystems Technology Inc

Fishers using specialist methods such as SCUBA or lobster pots usually form a small proportion of all fishers in large scale harvest surveys. An on-site survey of recreational fishers using boats and access points between Port Charles and Maketu in the Western Bay of Plenty estimated the boat based amateur harvest and fishing effort for scallops (*Pecten novaezelandiae*) and red rock lobster (*Jasus edwardsii*) in the survey area. Interviewers stationed on 6 main ramps and 4 marinas intercepted returning vessels. Thirty six secondary ramps were covered in 6 areas (routes) using the bus route method and roving interviewers. Over the two years 83 % of boat trips involved some fishing activity. Harvest estimates for boat based amateur fishers during 2010–11 were 13.7 t of rock lobster and 36 t of scallops. Poor weather over summer, biotoxin warnings and the Rena grounding with subsequent oil spill all had a negative effect on fishing effort in 2011–12, especially in the Tauranga area. Harvest estimates were 7.8 t rock lobster and 24 t of scallops in the survey area for 2011–12. These results are compared to the national panel survey for the same area in 2011–12 conducted by NRB.

Broad-scale Stream Habitat Mapping in a Best-practice Dairy Catchment – a GIS Based Approach

Robin HOLMES // Cawthron Institute

Eric Goodwin, John Hayes // Cawthron Institute

Practical catchment-scale survey methods are needed to monitor the effects of best-practice farm management on stream habitat. We trialled a broad-scale riparian and instream habitat mapping protocol (BHMP) on the Waikakahi Stream (a South Canterbury best-practice dairy catchment). In total, 8.5 km of the riparian zone and 2.7 km of in-stream habitat were surveyed. Riparian survey results were interpreted using a GIS based index of riparian habitat quality (RHQI). Instream survey results were interpreted separately with indices of fish habitat quality. Index scores are displayed on catchment maps using a georeferenced traffic light system. High riparian habitat scores were positively correlated with high trout and tuna (eel) habitat quality, demonstrating that good on-farm riparian management can maintain habitat to support freshwater fishery species in dairy streams. In addition, the RHQI highlighted areas where simple riparian mitigation/restoration measures could be targeted to further improve stream habitat condition. Farmers and resource managers have responded positively to the survey method and simple scoring system. We anticipate that with further development these tools could be applied autonomously by stream stakeholders to inform and monitor catchment-scale rehabilitation initiatives.

Kina, Ocean Acidification & Sensitive Males

Michael HUDSON // The University of Auckland

Daniel Baker, Mary Sewell // The University of Auckland

Marine environments are experiencing large-scale change through increasing levels of atmospheric CO_2 driving both increasing seawater temperatures and ocean acidification (OA). The resulting changes to carbon chemistry and seawater pH have direct implications for marine life with varied and contrasting outcomes. In general, species are suggested to be optimally adapted to the environmental conditions they are exposed to over evolutionary time, and as a result have limited capacity to tolerate change. As the early life stages are reportedly the most sensitive to environmental perturbations, the critical first step of fertilisation success (FS) of the broadcast spawning sea urchin, kina (*Evechinus chloroticus*), was examined here across a CO_2 gradient from present day to IPCC predicted future levels (380 to 1800 ppm). The results show kina to be resilient to near future OA (1,000 ppm) followed by a population level decline in FS towards 50% as atmospheric CO_2 increases to levels predicted for the year 23,00 (1,800 ppm). Closer investigation shows that tolerances at the individual level (single male:female crosses) are highly variable, with evidence of differential male/female sensitivities to environmental CO_2. At 1,800 ppm inter-male variability and sperm performance characteristics, not eggs, drive lower FS levels. This research expands our limited understanding of the vulnerability of New Zealand rocky reef species to OA by describing levels and sources of sensitivity in kina; an ecologically, recreationally and culturally important species.

Application of Light as a Bycatch Reduction Device (BRD)

Darcie HUNT // Australian Maritime College

Nick Rawlinson, Prof John Purser, Prof Giles Thomas // Australian Maritime College
Dr Jenny Cobcroft // Institute for Marine & Antarctic Studies
Dr Troy Gaston // University of Newcastle

Bycatch is defined as the part of the catch that is returned to the sea due to regulations or lack of commercial value. Benthic trawling is responsible for majority of the world's bycatch and represents a threat to the sustainability of global fisheries. Bycatch reduction devices (BRDs) are modifications to the prawn trawl system to reduce the capture of bycatch species. However, most BRD's are modifications to the posterior of the trawl system, with little emphasis placed on preventing the fish from entering the net and modifying the anterior of the trawl system. This research presents a relatively novel concept of using light as a BRD to prevent fish entering the trawl net by increasing the visual warning. The BRD consists of LED lighting in a housing that can withstand the rigours of benthic trawling. Preliminary results show that most species experience a decrease in catch with the use of a light BRD attached to the headline. To understand the reasons for this result, the visual acuity of several common species was determined. Furthermore, the estimation of burst swimming speed can be used to depict a fish's ability to avoid the trawl system. Being able to predict the biological factors behind a species' reaction to the BRD will be an important tool for establishing the effectiveness of light as a BRD in other benthic trawl fisheries.

Fate & Effects of Estuarine Contaminants as Tracked by Stable Isotopes in Tauranga Harbour, New Zealand

Julien HUTEAU // The University of Waikato

Tauranga Harbour, covering an area of 210 km^2 and protected along its seaward border by Matakana Island is one of New Zealand's largest estuaries. Fast development of Tauranga city, particularly in the coastal areas has seen the resident population grow by 16.9% since the 1996 census. Unsustainable land management practices such as intensive agriculture and horticulture in the northern region (accounting for 46% of the land catchment) is also increasing pressure on the health of the Harbour. In the last 20 years, the Tauranga Harbour has been associated with extreme ecological changes; a loss of biodiversity as indicated by a decline in seagrass (*Zostera marina*) and the mud snail (*Amphibola crenata*), in association with an increasing abundance and fast expansion of opportunist species such as sea lettuce (*Ulva* spp). In this paper, we examine, for the first time, the link between trace element abundance in surface sediments and estuarine indicator species and the use of stable isotope labelling as a complementary tool to track nutrient sources. Isotopic research was successfully used as a complementary method to understand the origin (terrestrial vs more oceanic input) of metal concentration. Abundance of aluminium, arsenic and copper were closely related to freshwater input. Sites depleted in 13C signature were closely located to freshwater input and displayed higher %TOC, also aluminium, arsenic and iron levels. Concentrations of these latter elements decreased with the distance from the outlet. Opposite trends were measured for potassium levels, necessary macronutrients for plants and other species.

Freshwater Fingerprints: Using Otolith Increment Biochronologies to Assess Broad Influences of River Inflows into Estuarine Habitats

Christopher IZZO // The University of Adelaide

Greg Fergusonn // South Australian Research & Development Institute of Aquatic Sciences
Tom Barnes, Zoe Doubleday, Morgan Disspain, Bronwyn Gillanders // The University of Adelaide

The River Murray estuary is the largest estuarine system in temperate Australia and supports a diverse fish assemblage, represented by species with a suite of biological and ecological niches. This study aimed to assess the influence of long-term freshwater flows on the growth of estuarine associated teleosts. Using mulloway as a model species, this study contrasts otolith based multi-decadal biochronologies between estuarine and non-estuarine populations in South Australia. Biochronologies were generated for additional species of marine and freshwater teleosts, which inhabit the River Murray estuary, to assess the broader effects of river inflows. Biochronologies were based on otolith increment width measurements and analysed using mixed effects models. Modern day biochronologies were also broadly compared to biochronologies developed from indigenous midden otoliths, to infer if patterns of growth and river flows seen today are similar to those in the past. Our results show variation in growth between mulloway populations, with flows influencing the growth of the estuarine associated population. More broadly, the effect of river inflows appeared to be consistent among the teleost species examined. These findings provide important insights into the relative effect of river inflows on estuarine associated fish populations, which has direct management implications. More generally, this study aids in identifying shifting baselines in life histories of fish and the environments in which fish live and breed.

Status of Australian Snapper Stocks & Associated Fisheries

Gary JACKSON // WA Fisheries and Marine Research Laboratories, Department of Fisheries

Anthony Fowler // South Australian Research & Development Institute
Bonnie Holmes // Department of Agriculture, Fisheries & Forestry, Queensland
Jodie Kemp, John Stewart // Department of Primary Industries, New South Wales

Snapper (*Pagrus auratus*) is an iconic, high value species in all the mainland Australian states. The species has a long fishing history in many locations and continues to support important commercial and recreational fisheries from the Gascoyne region in Western Australia, around the south of the continent, to northern Queensland. The 13 separate stocks that are now recognized contribute to a national annual catch of around 3,500 tonnes per year. The biological sustainability of these snapper stocks and the associated fisheries was recently assessed against a nationally agreed framework using standardized terminology and reference points and recently reported in the Status of key Australian fish stocks reports. These assessments and a follow-up national workshop held in Adelaide have identified a number of priority areas for snapper research and management including: need for improved understanding of stock structure; need for fishery independent methods of estimating snapper biomass; need for cross-jurisdictional stock assessments in some cases; need for improved estimation of recreational catch; improved understanding of effects of climate change; increased formalization of harvest strategies for snapper fisheries. This paper is intended to complement a similar overview of snapper stocks and fisheries in New Zealand that will provide background for a conference special session on snapper.

Redmap: an Online Database & Mapping Resource for Observational Marine Species Data – Marine Monitoring, Community Engagement & Collaborative Research

Gary JACKSON // WA Fisheries and Marine Research Laboratories, Department of Fisheries

Gretta Pecl, Jemina Stuart-Smith, Stewart Frusher // University of Tasmania
Dianne Bray // Museum Victoria, Melbourne
Natalie Moltschaniwskyj // University of Newcastle
Melissa Nursey-Bray // University of Adelaide
Keith Rowling // PIRSA Fisheries & Aquaculture
Marcus Sheaves // James Cook University

Climate driven changes in the distribution of marine species are being reported from around the globe. Redmap (Range Extension Database and Mapping project, www.redmap.org.au) is an online database and mapping resource that allows members of the public to submit observational data (including photographs) of marine species occurring outside their known distribution (i.e. species that may be undergoing range shifts). Following a successful 3-year pilot in Tasmania, the project has now scaled-up to an Australian-wide long-term biodiversity monitoring system designed to be a low-cost, citizen science based approach to assess changing marine species distributions. Australia has over 3.5 million fishers and divers – many equipped with consumer electronics and the capacity to record verifiable observations. However, one challenge to the adoption of such datasets is the perception of bias or low quality. In addition to extracting geo-tag information from photographs (validating location), species identifications are verified by a large national panel of expert scientists using a semi-automated validation workflow. This initiative has the potential to generate large amounts of valuable quality data, engage communities in climate science and raise awareness of ocean warming and its consequences. Redmap is an early warning system for changes occurring in the marine environment, and has the potential to play a key role in informing future management actions around Australia.

Marine Stewardship Council Certification of Western Australia's Fisheries

Gary JACKSON // WA Fisheries and Marine Research Laboratories, Department of Fisheries

Dan Gaughan // WA Fisheries & Marine Research Laboratories, Department of Fisheries
Guy Leyland // Western Australian Fishing Industry Council

The Western Australian Department of Fisheries has recently embarked on a program that will provide the opportunity for all of Western Australia's commercial fisheries to seek Marine Stewardship Council (MSC) certification. The MSC is an international and independent organisation that sets standards for well managed and sustainable fisheries that include detailed consideration of the effect of fishing on both the targeted fish stocks and the broader ecosystem. The MSC's standards are widely recognised as the most complete and comprehensive and are entirely consistent with the Food and Agricultural Organization's Code of Conduct for Responsible Fishing, which requires credible fishery certification schemes to include: independent fishery assessment using scientific evidence; transparent processes with built-in stakeholder consultation and objection procedures; and assessment of the sustainability of target species, ecosystems and management practices. An overview of the process by which the Department of Fisheries intends to pursue independent assessment of the state's 40+ commercial fisheries will be provided. Initially, MSC pre-assessments will be undertaken at a bioregional level; within each of the state's four marine bioregions (North Coast, Gascoyne Coast, West Coast and South Coast) the fisheries will be considered as part of one assessment process. This will consist of evaluating (i) how well each of the main target species/stocks is being managed for sustainability, (ii) ecosystem impacts across all commercial fisheries in the bioregion and (iii) the effectiveness of the management systems being used.

Conventional Research-management of Western Australian Snapper Leading to Successful Stock Conservation & Fishery Outcomes

Gary JACKSON // WA Fisheries and Marine Research Laboratories, Department of Fisheries

Corey Wakefield, David Fairclough // Western Australia Fisheries & Marine Research Laboratories

Snapper are commercially and recreationally important in Western Australian fisheries. A significant amount of biological research has been conducted on Snapper in WA over a long period, along with stock assessments, to drive conventional fisheries research-management systems. In the Gascoyne Bioregion, the commercial fishery targeting the oceanic Snapper stock has been managed using a Total Allowable Commercial Catch/ Individual Transferable Quota system since 2001. Significant reductions in TACC have assisted breeding stock recovery following prolonged poor recruitment. The fishery has been twice assessed against the EPBC Act 1999, and is scheduled for Marine Stewardship Council pre-assessment this year. Recreational catches of three separate inner Shark Bay stocks have been significantly reduced since 1998, to rebuild breeding stocks and maintain recruitment via management measures including a TAC and seasonal and spatial closures. Weight of evidence assessments (which determine risk to stocks using a combination of biological knowledge and fishing mortality assessments) in the West Coast Bioregion in 2007 identified overfishing of key demersal indicator species including Snapper. Significant management measures were introduced to reduce catches by at least 50%. Management changes for the commercial fishery included limited entry, Individual Transferable Effort Units and a large spatial closure and for the recreational fishery, a seasonal closure, a spawning closure in Cockburn Sound and reduced bag limits. There are early signs of stock recovery. In addition, climate change has the potential to impact the distribution and stock productivity of Snapper in WA. The current management framework has capacity to adapt as necessary.

Revitalising New Zealand's Most Urbanised River – Putting Theory into Practice

Alex JAMES // EOS Ecology

Shelley McMurtrie // EOS Ecology

The damage wrought by the 22 February 2011 earthquake has provided an unprecedented opportunity to redesign parts of Christchurch. Part of the earthquake recovery involves ten central city anchor projects. The first of these to progress was the Avon River Precinct (ARP), which involves the redesign of a 30 m wide strip on either side of the Avon River for 3.2 km through the central city, and aims to improve river health. Based on the priniciples we developed during the concept design phase (see Shelley McMurtrie's presentation) the ARP showcase "Watermark" construction project has recently been completed in the most upstream part of the ARP. Here we have put our design theory into practice by undertaking substantial instream enhancements along 200 m of the Avon River. The condition of instream habitat has been improved by narrowing the base flow channel to increase water velocities and riffle habitat length; cleaning riffle gravels of silt and sand; removing sediment from key depositional zones; adding boulder clusters to increase habitat heterogeneity and fish cover; reconnecting the river to its flood plain; and allowing the river to 'self cleanse'. We anticipate trout spawning (which has not occurred here for over 20 years due to siltation) will return this winter, and the locally uncommon bluegill bully should colonise the reinvigorated riffle. Prior to the instream works we undertook a comprehensive habitat, fish, and invertebrate survey against which to compare future monitoring that will ultimately determine the outcomes of the project.

Does Flow Variability Mitigate the Effect of an Invasive Alga (Didymo) on Stream Fish Communities?

Phillip JELLYMAN // NIWA

Jon Harding // University of Canterbury

Exotic species have irreversibly altered the New Zealand freshwater fauna and when the invasive alga didymo was discovered in 2004 there were suggestions that it might completely alter freshwater food webs. Surprisingly, the impact of didymo on multiple trophic levels is largely unknown as studies to date have only focussed on a single trophic level (e.g., invertebrates or fish). We conducted a survey of 20 South Island waterways across a didymo biomass gradient to determine (1) the impact of didymo on multiple trophic levels and (2) whether this impact was influenced by flow variability. Periphyton, invertebrate (Surber and drift) and fish data as well as gut-content data were collected at each site. The frequency of flood events and the time since the last major flood were the most important variables in determining didymo biomass across all sites. Didymo biomass strongly affected invertebrate density and community composition which was not surprising given the findings of previous studies. Fish biomass decreased with increasing didymo biomass although didymo biomass also had indirect effects on fish communities. The relationship between didymo biomass and fish communities was complex and indicative results suggest that it is linked to prey availability and fish feeding mode. Our results show that didymo has a detectable effect at all trophic levels although the strength of that effect is likely to be dependent on didymo biomass and trophic level.

Ocean Circulation Under the Ross Ice Shelf & its Impact on the McMurdo Sound Region

Stefan JENDERSIE // University of Otago, NIWA

Pat Langhorne // University of Otago
Mike Williams // NIWA
Robin Robertson // University of New South Wales

The formation of sea ice in McMurdo Sound is dominated by interaction with the ocean, with currents importing water masses that have been produced and modified beneath the Ross Ice Shelf (RIS) and in the Ross Sea Polynya. A modified version of the Regional Ocean Modeling System (ROMS), a free surface, terrain-following, primitive equation model, is used to numerically simulate the circulation of the Ross Sea including the RIS cavity and, expanded to the north to include parts of the Antarctic Circumpolar Current. The strategy is to recursively adjust lateral boundary conditions and forcing at the surface in order to resemble the large scale circulation of the Ross Sea aim at establishing behavior that agrees with observations. The objective is to move solution-constraining boundaries as far away as possible from the region of interest; i.e., the ocean underneath the RIS. The circulation within the cavity is allowed to evolve without forced exchange at the ice shelf front which enables processes of ice-ocean interaction at the base of the RIS and polynya evolution in the Ross Sea to provide boundary properties for a nested high resolution ocean model of McMurdo Sound. The aim is to study the origin of oceanographic signals in the McMurdo Sound region.

The Role of Community in Whitebait – It's a Two Way River

Kim JONES // Whitebait Connection, Mountains to Sea Conservation Trust

Vince Kerr // Whitebait Connection, Mountains to Sea Conservation Trust

For many Kiwis, the word 'Whitebait' is closely associated with 'fritter'...but our educational programme, the Whitebait Connection, is changing that association for many New Zealanders, young and old. We offer unique ways in which all New Zealanders can come to understand and become involved in the life and future health of our freshwater systems. Te aki i te hunga tangata te tiaki inanga. The Whitebait Connection is an inquiry-led community-based action programme that takes the lifecycle of the humble whitebait as an analogy to communicate the need for a caring/holistic approach to our freshwater systems. It's a fact – the way we use our land directly affects the health of our streams, rivers, estuaries and the sea. The story of the Whitebait Connection brings home the reality of our freshwater sources. It provides knowledge about freshwater ecology and the effects of land management on freshwater quality and quantity. We take the community out to experience their local freshwater environments first hand. This experience gets them connected and often inspires or empowers them to take action. Action takes shape in many different forms including; riparian planting, Inanga spawning site restoration, ongoing monitoring projects, fencing of waterways, stream cleanups and labelling of stormwater drains. The programme engages the community through; school programmes, regional facilitated hui & national conferences, displays at regional field days, running community plant nurseries, and involvement in wide collaborative networks on community led restoration projects, hosting World Wetlands Day events, and involvement in international virtual field trips.

Do Life History Strategies Drive Trout Interactions in a Species Complex of Non-migratory Galaxiids?

Peter JONES // University of Otago

Gerry Closs // University of Otago

Life history traits become specialised through natural selection to optimise reproductive success within environmental constraints. Fluvial systems represent a continuum from low productivity headwater creeks to relatively productive lower catchment watercourses. Life history theory predicts that fish inhabiting such different environments will display divergent reproductive strategies. This study examined life history variation in a species complex of non-migratory galaxiids, distributed across a range of contrasting habitat types on the South Island of New Zealand. Species occurring predominantly in high altitude, headwater creeks were characterised by a large egg, low fecundity and a late onset of maturity. Species associated with lower catchment systems displayed markedly smaller egg size, higher fecundity and matured at smaller sizes. Post-hatch larval counts in stream reaches suggest these differences in adult reproductive traits lead to substantial differences in recruitment dynamics. Larvae were abundant in streams occupied by lower catchment species whereas recruitment was severely limited for headwater species. Preliminary findings also suggest larvae of lower catchment species disperse far more widely than those of headwater species. These profound differences in reproductive strategies, recruitment and larval dispersal appear to be important factors influencing species' responses to invasive salmonids. Interspecific variation in distributional overlap with salmonids relate to observed differences in life history traits. These findings are highly relevant for conservation initiatives aiming to mediate impacts of invasive fish on native communities.

Oil Dispersal Modelling: Re-analysis of the Rena Oil Spill & Open-source Modelling Tools

Hannah JONES // The University of Waikato

Karin Bryan, Julia Mullarney, Willem de Lange // The University of Waikato

Oil spill forecast modelling is typically used immediately following a spill to allow effective mobilisation of response operations. Such models have two components, a hydrodynamic driver and a particle tracking model, but can provide widely varying predictions depending on how wind and coastal currents are incorporated. Accurate predictions require careful model calibration and verification against observations (of both currents, and oil dispersal and shoreline accumulation). The aim of this work was to undertake modelling of oil dispersal following the grounding of the container ship "Rena" on Astrolabe reef (on the approach to Tauranga Harbour) and verify the results against information on oil accumulation collected by Maritime New Zealand. We modelled tidally driven currents on the shelf (using Delft3D) and in the harbour (using ELCOM) and used the modelled currents as forcing in the NOAA oil-spill model GNOME, along with observed wind speed and direction collected at Tauranga Airport. Model predictions were broadly consistent with survey data provide by Maritime NZ, with the exception of some hot spots of oil accumulation that occurred on open coast beaches, likely due to surf-zone and rip-current circulation not being well represented in this implementation of the model. Oil dispersal is highly dependent on prevailing wind patterns, and more accurate prediction would require better observations of local wind patterns. Nevertheless, comparison of predictions with observations indicated that the GNOME modelling approach was an effective low-cost tool and both Delft3D and GNOME are open source and freely available software packages, which could facilitate collaborative and progressive coastal hazard management.

The Meeting of the Waters: Tidal Dynamics & the Limit of Saltwater Influence in the Waikato River

Hannah JONES // The University of Waikato

Kevin Collier, David Hamilton, Kohji Muraoka // The University of Waikato

The hydrodynamics of the Waikato River estuary and delta area appear to be relatively unknown compared to many other North Island estuaries. Data from a single survey in 1976 indicated that the saltwater influence extended just 6 km upstream of the mouth of the river, and the presence of a vertical front, rather than a salt wedge, at the interface between marine and freshwater. Measuring spatial and temporal variability in ecologically relevant variables has previously been identified as crucial when attempting to predict fish habitat. However, there appears to have been little attempt since then to quantify spatial and temporal variability in fundamental (and relevant) variables such as temperature, salinity and dissolved oxygen, despite the importance of this area as habitat and recreational fishery for many native fish, such as whitebait species and eels. This survey was part of a wider study that attempts to identify and manage whitebait spawning habitat in the delta area of the Waikato River. We used a combination of sensor technologies (Biofish™ horizontal profile readings, CTD casts, and deployment of high-frequency temperature, salinity and dissolved oxygen loggers) to capture spatial and temporal variability in relevant variables over a spring-neap tidal cycle. Results from the survey suggest that the saltwater influence can extend much further than previously described, i.e. 10–13 km upstream on the neap and spring tide, respectively. Furthermore, there is substantial lateral, longitudinal and temporal variability in temperature, dissolved oxygen and fluorescence, reflecting the highly dynamic nature of the interface between this large river and the saltwater/estuarine environment.

Quantifying Benthic Enrichment From Salmon Farms

Nigel KEELEY // Cawthron Institute

Barrie Forrest // Cawthron Institute
Catriona Macleod, Christine Crawford // University of Tasmania

This talk outlines recent studies relating to understanding, evaluating and predicting benthic enrichment – using salmon farm aquaculture as a case study. A quantitative benthic enrichment gradient was development using best professional judgement methods, which unifies information from biological and physic-chemical variables. The resulting seven stage bounded continuous variable was used to assign enrichment tolerance groups to benthic taxa using quantile regression splines. A number of key indicator taxa were discriminated, including several that were responsive to low-level changes in *ES*, but not necessarily %*OM*, and 10 taxa for which ecological understanding was otherwise limited. The gradient was also used to evaluate the performance of five benthic and ten biotic indices for defining organic enrichment under different flow regimes. The most versatile indices were BQI>M-AMBI>AMBI>log(N)>BENTIX. M-AMBI best catered for different flow environments, while the BQI was the most effective under highly enriched conditions. A subset of variables was recommended comprising: two biotic indices (based on alternative taxa classification schemes), total abundance, and a geochemical variable (redox or S^{2-}). A subsequent, related study revealed pronounced flow-related differences in the magnitude and spatial extent of benthic enrichment. Total macrofaunal abundances at high flow sites were nearly an order of magnitude greater than at comparable low flow sites, representing a significant benthic biomass, and occurred in conjunction with moderate-to-high species richness, and the absence of appreciable organic accumulation. The atypical ecological conditions were attributed to i) minimal accumulation of fine sediments, ii) maintenance of aerobic conditions in near-surface sediments, and iii) an abundant food supply.

Duck Creek Realignment: Fish Rescue

Vaughan KEESING // Boffa Miskell Ltd

Tanya Blakely, Stephen Fuller, Barbara Risi, Leigh Bull, Matiu Park

A residential developer sort and received permission to divert Duck Creek, a small coastal waterway in Whitby, Wellington Region. An in-depth design and construction process was undertaken to create the new channel, and enable the diversion of Duck Creek. Duck Creek supported a number of threatened and ecological significant native fish species, including giant and banded kokopu, inanga, and longfin and shortfin eels. Prior to closure of the main channel and the subsequent livening of the diverted channel, we fished approximately one kilometre of Duck Creek. We used a range of fishing techniques, over four days, to trap, record and transfer all native fish from the affected reach. The 'de-fishing effort' caught nearly one fish per meter, however, there were no signs of a diminishing catch over time or effort. The clearance of the substantial macrophyte beds along Duck Creek had a distinct effect on capture efficiency. While the variety of methods used produced differing results, and different methods favoured different fish taxa, the best taxa richness and frequency of taxa caught came from EFM after macrophytes were cleared from the stream channel.

Finding the Spawning Sources of Victoria's King George Whiting

Jodie KEMP // Department of Primary Industries, Fisheries Victoria

Gregory Jenkins // The University of Melbourne
Paul Hamer // Department of Primary Industries, Fisheries Victoria
Anthony Fowler // South Australian Research & Development Institute

King George whiting is the most valuable finfish species in Victoria, and is the second most valuable in South Australia; supporting major recreational and commercial fisheries. Despite the importance of this species, there are still major gaps in our knowledge of the life-cycle of King George whiting, particularly our understanding of movement and how the stock is distributed across south-eastern Australia. The lack of knowledge is a significant impediment to determining whether single jurisdictional management is suitable for this species. The recreational and commercial fisheries that harvest King George whiting in Victorian waters are primarily based on sub-adult whiting (two to four years of age) found in bays and inlets. Despite significant efforts, King George whiting in spawning condition have rarely been recorded in Victorian waters; the only known significant spawning areas for the species are in South Australian waters. We use otolith trace-element chemistry and daily increment analysis of post-larval whiting to assess whether sub-adult whiting in Victoria are spawned in the area of the South Australian adult fishery. Significant variation in Mg:Ca ratios and early larval growth rates suggest the environmental conditions that Victorian whiting were exposed to at spawning were different to those experienced by the South Australian whiting. This variation could be the product of either geographically separate spawning locations or temporal variation of spawning. We discuss these results further along with methods we are using to elucidate the cause of the observed variation.

Isolation & Invasion: Gudgeons & Gobies in the Australian Arid-zone

Adam KEREZSY // Griffith University

Scattered populations of purple-spotted gudgeon and western carp gudgeon occur in isolated springs and river catchments of the endorheic Lake Eyre Basin in central Australia, suggesting the family was more widespread – and possibly represented by more species – in wetter times. Similarly, gobies of the genus *Chlamydogobius* occur in disjunct populations: the endangered species Edgbaston goby, Elizabeth Springs goby and Dalhousie goby are only found in the Great Artesian Basin spring complexes alluded to in their names, whereas the Finke goby occurs only in the Finke River system in the Northern Territory and the desert goby has a more widespread distribution in the rivers and springs of arid South Australia. All are closely related, and their speciation is a result of their isolation: small populations of small fish marooned in small but permanent oases. The much larger golden goby, *Glossogobius aureus*, is only found in the remote Georgina and Diamantina catchments in the arid zone, despite a widespread distribution throughout the Indo-Pacific. It seems entirely likely that populations of this species crossed the Basin divide in the north and have adapted to desert living over time. In contrast, the most recent bottom-dweller to arrive in the arid zone is a fast-adapting translocated species, the sleepy cod, *Oxyeleotris lineolata*. Most likely originating from escapees from aquaculture, sleepy cod were first detected in the wild in the Cooper catchment in 2008 and since then have become more widespread. Priorities for management in the Australian arid zone include all endangered species of gudgeons and gobies in their respective watery 'islands' and preventing the liberation of other potential pest species such as sleepy cod.

Estuarine Environments of New Zealand: Forgotten Ecosystems or Places of Future Opportunities for Conservation?

Helen KETTLES // Department of Conservation

Philippe Gerbeaux // Department of Conservation

Estuaries are nationally rare ecosystems, they contain habitat for a wide range of indigenous fauna and flora including numerous threatened species. They are an essential link between catchments/rivers and the marine environments and provide important ecosystem services, including mahinga kai. But estuaries are under many direct and indirect pressures, from climate change, modification to margins and from human activities in the surrounding catchments. A focus on these ecosystems is therefore regarded as a high priority for conservation gains. Very few estuarine and catchment areas are contained in conservation areas so to protect estuarine values requires supporting and working with Iwi, councils, communities, science providers and other interested parties. This presentation will outline Department of Conservation's collaborative approach and some of the key directions proposed to help address these issues including development of an online resource, compilation of spatial data and development of a spatial decision support tool for catchment management, revision of the national classification system, supporting the consideration of estuaries as receiving environments for freshwater within the water reform work, an exercise of ranking sites and quantifying natural capital value, and exploring protection options.

Are You What You Eat? Do *Pleurobranchaea maculata* Obtain their Tetrodotoxin (TTX) Via a Dietary Source?

Serena KHOR // The University of Waikato

Susie Wood, Paul McNabb, Dave Taylor // Cawthron Institute
Lauren Salvitti, S. Craig Cary // The University of Waikato

Pleurobranchaea maculata (grey side-gilled sea slugs) are opisthobrachs commonly found in shallow sub-tidal areas around New Zealand. In 2009, a series of dog poisonings in Auckland revealed the presence of the potent neurotoxin tetrodotoxin (TTX) in this species. In the North Island, high concentrations of TTX were detected in *P. maculata* populations in Auckland, Whangarei and Tauranga and low concentrations in Wellington. By contrast, South Island populations had non-detectable concentrations. Within toxic populations there was significant variability (up to 60-fold differences) in TTX among individuals. The origin of TTX is highly debated with researchers citing either an endogenous or exogenous source with the host accumulating TTX symbiotically or via food chain transmission. The aim of this study was to determine, using three different approaches, whether *P. maculata* obtain TTX via dietary means. Firstly, a biopsy technique was developed to enable a non-lethal method for tracking TTX concentrations during laboratory-based experiments. Secondly, non-toxic *P. maculata* were maintained in aquariums and fed spiked food in order to investigate their ability to accumulate TTX and in which tissues it was sequestered. TTX was detected within 1 hr and was rapidly transported to the mantle and gonad. Average percentage uptake decreased throughout the experiment. The final study involved a series of preference experiments to determine if *P. maculata*, from both toxic and non-toxic populations, preferred TTX-containing food to non-TTX containing food with results indicating strong preferences for spiked samples. This study supports a dietary source of TTX in *P. maculata*.

Southern Maori Perspective on the Management & Knowledge Needs for Kanakana (*Geotria australis*)

Dr Jane KITSON // Te Ao Marama Incorporated

Fish are of great cultural, social and economic significance to Ngāi Tahu Whānui (NZ's Southern most Māori). Mahinga kai, the use of foods and resources, gathered from freshwater bodies is a cornerstone of Ngāi Tahu culture, identity and well-being. Mahinga kai is also viewed as a principle indicator of environmental health. Southland is a Ngāi Tahu stronghold for customary harvesting of kanakana/lamprey. Kanakana are considered a threatened species and although there is little data, their decline has been noticed by customary harvesters. From 2007 customary harvesters in Southland have been using traditional ecological knowledge to try and determine relative abundance. In 2011 and 2012 adult runs of kanakana migrating back into freshwater were affected by a 'lamprey reddening syndrome' which resulted in significant mortalities of affected fish in Southland rivers. The cause of this condition, and the effects on kanakana abundance (both in Southland and Nationally) remains unknown and is frustrated by knowledge gaps of the fundamentals around this species' life history and ecology. The recent National Policy Statement on freshwater management requires increased Māori involvement in decision-making. Meaningful collaboration will necessitate a synthesis of values-based knowledge of taonga (treasured) species with contemporary environmental science. This presentation suggests some of the likely information requirements, from a Southern Māori perspective, to inform limit setting on water quantity/quality and freshwater management, including Mātauranga Māori/traditional knowledge, using kanakana as an example.

High-seas Demersal & Pelagic Monitoring, Co-operative Approach With Industry, Technology & Methods

Rudy KLOSER // CSIRO

Graham Patchell // Sealord NZ Research
Tim Ryan, Gordon Keith, Mark Lewis // CSIRO

Management of high seas demersal and pelagic fisheries requires an understanding of the targeted species and the structure and function of their ecosystem. Obtaining the necessary spatial and temporal data to assess resource status and ecosystem vulnerability is expensive and difficult on the high seas. Harnessing the data gathering capability of the fishing industry through appropriate collaboration, management and policy frameworks would be a cost effective solution. Development and application of technologies for industry can assist in the assessment of biomass of targeted species, habitats and the potential ability to avoid non target species and habitat at fine scales. Long term monitoring by acoustic sensors can begin to document variability and change in the functioning of the broader pelagic ecosystem. This has recently been done by collecting acoustic data from industry vessels at ocean basin scales www.imos.org.au. At these scales it is possible to relate patterns in acoustic scattering to the broader physical environment and surface inferred primary production. Another recent technological development has been a net attached multi-frequency acoustic optical system (AOS) that has the capability to measure species biomass and obtain optical measures of species and habitats. Using fishing vessels we show how this technology has been applied to pelagic high seas and deep-water demersal habitats including seamounts in Australia and New Zealand. Developing methods to collect high seas information incorporating fishing vessels, acoustics, nets and net attached AOS technology is discussed.

Aquaculture Effects Models to Inform Resource Management in the Firth of Thames

Ben KNIGHT // Cawthron Institute

Brett Beamsley // MetOcean Solutions Ltd
Hilke Giles, Vernon Pickett // Waikato Regional Council

Development of aquaculture in an economically and environmentally sustainable manner requires a good understanding of farm-scale effects on the environment and the ability to forecast potential cumulative effects of increased development within a wider regional context. Cawthron Institute and MetOcean Solutions Ltd worked collaboratively with Waikato Regional Council (WRC) to construct an open-source code 3D hydrodynamic model for use in a number of applications, including the planning and management of aquaculture in the Firth of Thames. Application of transport information from the hydrodynamic model provides predictions of mixing and transport processes, which in turn were used to estimate cumulative effect gradients from dissolved and solid wastes from finfish and shellfish farms in the region. Benthic and water column results for possible finfish operations under varying tide and wind conditions highlight potential enrichment gradients at local to regional scales. An important aspect of the project has been ensuring accessibility to the model and hindcast datasets by WRC staff, which in turn can be used in the development of robust regional resource management and monitoring frameworks and future modelling applications.

Recovery of the Endangered Trout Cod: What have We Achieved in More than 25 Years?

John KOEHN // Arthur Rylah Institute for Environmental Research

Mark Lintermans // University of Canberra Canberra
Jarod Lyon, Charles Todd // Arthur Rylah Institute for Environmental Research
Brett Ingram, John Douglas // Fisheries Victoria
Dean Gilligan // Fisheries NSW

Recovery of threatened species is often necessarily a long-term process. This paper details the progress towards the recovery of trout cod *Maccullochella macquariensis*, an iconic, long-lived fish species first listed as threatened in the 1980s. The objectives, actions and progress over three successive national recovery plans (spanning 18 years) are assessed and it documents changes in population distribution and abundance of and updates ecological knowledge. Increased knowledge (especially breeding biology and hatchery techniques, movements, habitats and genetics) has greatly influenced recovery actions and the use of a population model was developed to assist with management options and stocking regimes. Key recovery actions include: stocking of hatchery-produced fish to establish new populations; regulations on angling (including closures); education (particularly identification from the closely related Murray cod *M. peelii*); and habitat rehabilitation (especially re-instatement of structural woody habitats). In particular, the establishment of new populations using hatchery stocking has been a successful action. The importance of a coordinated long-term approach is emphasised and whilst there is uncertainty in ongoing resourcing of the recovery program, much has been achieved and there is cautious optimism for the future of this species.

Spawning Season Movements of a Threatened Native Fish, Macquarie Perch, in the Yarra River, Australia

Wayne KOSTER // Arthur Rylah Institute for Environmental Research

David Dawson // Arthur Rylah Institute for Environmental Research
David Crook // Charles Darwin University
John Morrongiello // CSIRO

Macquarie perch *Macquaria australasica* is an endangered fish species that inhabits rivers and impoundments in the southern Murray-Darling Basin, Australia. An upstream spawning migration during spring-summer has been documented for populations that have become established in impoundments. Whether riverine populations of Macquarie Perch undertake a similar upstream migration associated with spawning remains unknown. This study tests the hypothesis that riverine populations of Macquarie Perch exhibit synchronised migrations during the spawning season. Thirty fish were radio-tagged in the Yarra River, Victoria, and their movements tracked over 10 months between May 2011 and February 2012. Radio-tagged fish typically occupied small (e.g. < 500 m) reaches of stream throughout the study. Movement behaviour of fish was complex, including localized movements in both upstream and downstream directions, but there was no evidence of synchronised migratory behaviour. These results highlight the potential for variation in behaviour among lacustrine and riverine populations of fishes which needs to be considered when planning for their conservation.

Spatial Perspectives in Ecology

Casper KRAAN // NIWA, University of Freiburg

Andrew Finley // Michigan State University
Carsten Dormann // University of Freiburg
Simon Thrush // NIWA

Following over-harvesting, pollution, and the direct and indirect impacts of climate change, many species distributions shift. Therefore, understanding current and forecasting potential distributions of species is fundamentally critical for evaluating management options, and can lead to a better integrated management of ecosystems. Hitherto, most broad-scale research on mapping species distributions ignores spatial patterns, scale-dependent variability, and biotic interactions. Such omissions affect statistical analyses and the ecological inferences drawn from them. Here we review recent methodological advances which encompass these shortcomings and address their benefits. Abandoning the single-species vacuum, incorporate environmental variation and cross-scale processes, allows addressing questions whether relationships between abundance patterns and different biotic and environmental processes change depending on spatial scales, as well as improve ecological interpretation.

Haliotis iris Demography & Habitat Associations within & Outside Five New Zealand Marine Reserves

Alix LAFERRIERE // Victoria University of Wellington

Rob Davidson // Davidson Environmental Ltd
Jonathan Gardner // Victoria University of Wellington

Marine Reserves in New Zealand are defined as complete "no-take" and were established under the Marine Reserve Act, 1971. Marine reserves are one management tool that allows us to examine if and at what rate populations recover after being depleted. This enforced cessation of extractive activities may allow the populations of formerly exploited species to recover to a more natural state. *Haliotis iris*, commonly referred to as the black-foot paua, inhabits shallow subtidal rocky reefs and is the focus of important customary, recreational and commercial fisheries. Paua are long lived species with limited larval dispersal and adult movement patterns, which are life history characteristics that predict a positive response to marine reserve implementation. It has been shown that size composition of paua populations can be highly variable on a small spatial scale, and habitat has been suggested to influence the demography of the population. The small scale variation in abundance patterns, calls for detailed investigations of habitat and abalone abundances within marine reserves and their associated control areas. In the New Zealand summer of 2013, we conducted *Haliotis iris* and habitat surveys via SCUBA within and outside Long Island-Kokomohau, Horoirangi, Tonga Island, Taputeranga and Kapiti Island Marine Reserves. We present here data about *Haliotis iris* density and size distributions and their associations with physical and biogenic habitat. Results from all five marine reserves will be synthesized to determine the local biological response of paua populations to marine reserve implementation, in particular as this relates to duration of protection.

Fancy Meeting You in a Place like this – Fish Communities in the Waikato Land Drainage Network

Mike LAKE // Waikato Regional Council

The Waikato Regional Council is responsible for maintaining land drainage schemes throughout the region. The River Catchment Services (RCS) group has recently obtained a comprehensive resource consents to carry out drain maintenance. As part of this process RCS identified those drains that were likely to contain high fisheries values. The large extent of the land drainage network precluded the use of targeted surveys so values were determined based on historic survey records as well as predictive models and prioritisation tools contained within the FENZ geodatabase. RCS now undertakes an ongoing programme of fish surveys where planned maintenance works overlap with sites considered likely to contain high value fish communities. The purpose of these surveys is to confirm whether "Threatened" or "At Risk" species are present so that appropriate mitigation can be put in place. The results of these surveys have helped better describe the fish communities supported by the land drainage network and the role that lakes play in structuring these communities. The results have also allowed us to reassess our ability to predict the presence of "Threatened" or "At Risk species in large modified stream networks.

"Weed Cordons", are they an Effective Biosecurity Tool?

Hamish LASS // Bay of Plenty Regional Council

A two part trial was undertaken to test whether netted "Weed Cordons" are likely to reduce the risk of invasive aquatic plants establishing in two of Rotorua's cleanest lakes, Rotom and kataina.

Invasive plants represent a significant biosecurity threat to our pristine environments. To reduce this threat "Weed Cordons" (a netting fence anchored to the lake bed) have been installed at boat ramps in Lakes Rotomā and Ōkataina. These lakes currently contain very few invasive species but have a high risk of incursions from neighbouring "weedy" lakes such as Lake Rotoehu and Rotorua.

A trial was designed to test the effectiveness of the "Weed Cordons" via a simulated incursion from a boat and trailer or fishing equipment. The trial was replicated in an un-netted area (non-treatment) next to each "Weed Cordon" referred to as the "Ghost cordon". The aim of the non-treatment was to test what would happen if there was no Weed Cordon present. The trial was undertaken by releasing a total of 2880 weed fragments during a range of wind directions to gain an accurate understanding what would happen to the released fragments in a variety of conditions.

The results revealed that overall the boat ramp "Weed Cordons" in the 3 locations retained 84.9% of all fragments released in all wind conditions. In contrast where no "Weed Cordons "were present 85.2% of all fragments released were either not found or were found outside of the "Ghost Cordon" range. The effect that wind direction had on fragment transportation produced some surprising results which warrant further investigation to determine whether future weed cordons can to be altered to maximise their effectiveness.

Overall it was concluded that the "Weed Cordons" in these lakes are working effectively as a biosecurity tool but should be complimented with other initiatives such as portable wash down facilities, public awareness, pest surveillance and lake weed spraying.

Detecting Recruitment Cross-subsidy: Snapper Dispersal from Leigh Marine Reserve

Shane LAVERY // The University of Auckland

Agnès Le Port // Leigh Marine Laboratory
Adrian Croucher, John Montgomery // The University of Auckland

The benefits of marine reserves as a conservation tool are now widely recognised. However, whether they can substantially enhance surrounding fished populations through increased larval export and provide a buffer against overexploitation remains a major research gap in marine reserve science. In New Zealand, snapper (*Pagrus auratus*) support important commercial and recreational fisheries. A multi-disciplinary approach including 3D hydrodynamic modelling of larval dispersal and parentage analysis is being undertaken to quantify the extent of connectivity, dispersal, self- recruitment and local retention of snapper from a well-established marine reserve (Cape Rodney to Okakari Point marine reserve). We will present an overview of our research programme, and preliminary results from hydrodynamic modelling and DNA parentage analysis, to address the importance of this reserve as a source of juveniles to fished populations.

Small-scale Variation in Bacterial Community Structure & Function within Freshwater Ponds

Gavin LEAR // The University of Auckland

Julia Bellamy, Brad Case, Hannah Buckley // Lincoln University

The extent to which bacterial communities exhibit small-scale biogeographic patterns in their distribution and function remains unclear. In this study, we investigate small-scale variability in bacterial community structure and function within a patchwork of shallow alpine tarns. Using a grid-based sampling design, we collected 100+ water samples located between 4 and 60 m apart. For every sample, variability in bacterial community structure was monitored using a DNA-fingerprinting methodology (ARISA) whereas differences in bacterial community function (i.e. carbon substrate utilisation patterns) were recorded from Biolog Ecoplates. The exact spatial location and dominant physico-chemical conditions (e.g., pH, water temperature, depth) were simultaneously recorded from every sample location. Results of multivariate Mantel correlograms showed that, on average, bacterial community structure and function became significantly different comparing samples located 20 m or more apart. Variance partitioning revealed that purely spatial variation accounted for the more of the observed variability in both bacterial community structure and function than the combination of purely environmental variation and spatially structured environmental variation. Contour plots of bacterial community similarity revealed greater spatial structuring in bacterial community structure than function suggesting that some of the changes in bacterial community structure are functionally 'redundant'. Our investigation, which is one of the smallest scale studies of bacterial biogeography conducted within lentic freshwater, reveals the presence of distinct bacterial communities across unexpectedly small spatial scales. We suggest that even within relatively mixed ponds, bacterial communities separated by distances of >20 m may be dispersal limited, differentiating at a rate which is faster than they are mixed together due to ecological drift.

Triple Jeopardy in the Tropics: Assessing Extinction Risk in Australia's Freshwater Biodiversity Hotspot

Matthew LE FEUVRE // University of Melbourne

Freshwater ecosystems are under threat globally from habitat destruction, salinisation, pollution, invasive species and climate change. As a result many freshwater species are threatened with extinction. Predicting which species are most vulnerable is complex, requiring knowledge of distribution, population size, and niche and life-history specialisation. Species with small ranges, small population sizes and narrow ecological niches are thought to be subject to a 'triple jeopardy' risk of extinction. Within Australia, almost 20% of freshwater fishes are listed as threatened by the Commonwealth government. The pristine Kimberley region is a hotspot of freshwater fish biodiversity, with 50 species of freshwater fish recorded and 17 endemic species. The endemics are highly range-restricted; eleven are known from single rivers, two are found in single river reaches, and all have little corresponding ecological data. Thus, the conservation status of Kimberley fishes is unknown and none are listed. By comparing range extents, population sizes and niche and life-history specialisations among range-restricted endemics and widespread co-occurring congeneric species, I aim to quantitatively assess their extinction risk. Also, I plan to determine the physiological capacities of these species to assess their persistence under predicted future climates. Using collections from six months fieldwork in the Kimberley during the wet and dry seasons, I will discuss the distributions and relative abundances in Kimberley fish species and results for their degree of specialisation. With the Kimberley threatened by development, invasive species and future climate change, these endemic species may indeed be more vulnerable to extinction than their widespread co-occurring congenerics.

Mulloway Movement within the Glenelg River Estuary within South-western Victoria & Beyond

Jason LIESCHKE // Arthur Rylah Institute, Department of Environment and Primary Industries

Twenty-eight Mulloway (*Argyrosomus japonicas*) were tagged with internal acoustic transmitters within the Glenelg River estuary in South-west Victoria. The Mulloway were tracked via twenty receivers placed throughout the estuary. This presentation will focus on: Mulloway movement within the estuary, entry and exit times between the estuary and the southern ocean, the influence of freshwater flows (salinity levels) on Mulloway locations and larger movements outside of the estuary to the Murray Mouth (Coorong) in South Australia. The presentation will also highlight the extreme angling pressure on Mulloway within the Glenelg River estuary.

A Review of On-ground Recovery Actions for Threatened Freshwater Fish in Australia

Mark LINTERMANS // University of Canberra

Freshwater fish are a highly threatened group and recovery of these threatened species is an increasingly difficult ecological and social challenge. There are many different on-ground recovery actions available to managers, but no synthesis of what, how or why these recovery actions have been deployed. Even though taxa may be nationally listed, implementation of recovery actions is usually the responsibility of individual states. A questionnaire was distributed to a variety of fisheries managers, researchers and private individuals involved with threatened fishes. Details of on-ground recovery actions since 1990 were sought, along with the reasons that initiated the action, and whether or not they had an associated monitoring program. Recovery actions were grouped into 12 categories with the most commonly utilised recovery categories being harvest control, translocation, habitat enhancement and stock enhancement. The number of recovery actions grew significantly in the decade beginning 2000 as the impacts of prolonged drought in southeastern Australia intensified. 58% of recovery actions occurred in the Murray-Darling Basin, although this region only holds 27% of the 74 listed threatened freshwater fish in Australia. Few or no recovery actions were reported for many species, and few actions occurred in northern or western parts of the country. More than 80% of recovery actions reportedly had some form of monitoring. The diversity of management interventions is reviewed, and patterns and issues identified to guide future recovery efforts.

Spatial Patterns in Functional Redundancy & Ecological Resilience in Wairoa Embayment, South Eastern Tamaki Strait

Drew LOHRER // NIWA

Sarah Hailes, Katie Cartner, Sanjay Wadhwa, Scott Edhouse, Judi Hewitt // NIWA

We undertook spatially intense sampling of intertidal and subtidal soft-sediment habitats in Wairoa Embayment (south eastern Tamaki Straight) with the objective of identifying ecological community types and their spatial arrangements. Wairoa Embayment is roughly 41% intertidal and 59% subtidal, with a total area of 21.2 km^2. Water from a relatively large and predominantly rural catchment flows down the Wairoa River and directly into the Wairoa Embayment via a permanently opened channel. Suspended sediment concentrations in the Wairoa River appear to be high, and the lower Wairoa River channel has thick mangroves on both banks. There are extensive sand and shell-dominated intertidal flats in the embayment, particularly north of the Wairoa River channel, with slightly elevated muddiness in the southeastern portion. No seagrass habitat is apparent in the embayment at present. It is important to recognize that ecological community types can vary substantially within single physical classifications (e.g., intertidal sand, subtidal mud). Based on observed differences in the spatial distributions of abundant taxa within the Wairoa Embayment, we were able to identify 8 reasonably distinct community types (4 intertidal and 4 subtidal). We also explored the data to examine the spatial distribution of functional redundancy (which relates to ecosystem resilience) and key ecosystem services such as carbon sequestration by shell-forming bivalves.

Juvenile Snapper & Their Seagrass Nurseries – a Tail of Undersea Meadows & Roving Small Fish Packs

Meredith LOWE // NIWA

Mark Morrison, Crispin Middleton, Dane Buckthought, Matthew Smith, Emma Jones // NIWA
Tegan Evans // The University of Auckland, NIWA
Melanie Vaughan // Auckland Council, NIWA

Snapper (*Pagrus auratus*) are a key coastal commercial and recreational fisheries species in New Zealand. Recent work has shown that juveniles (c < 90 mm, <1 year old) are often associated with biogenic habitat types, including seagrass, horse mussels, and sponges, within estuarine and sheltered water areas; all vulnerable to degradation/loss through human activities, both land-based and marine. Sub-tidal seagrass meadows in particular support disproportionately high densities relative to other habitat types. We examined juvenile snapper habitat usage for the three largest remaining seagrass meadow areas in northern New Zealand (southern Kaipara, Parengarenga, Rangaunu harbours). Seagrass areas were mapped (aerial photography in Kaipara, satellite imagery in East Northland), and these maps used to allocate fish sampling using beach seines (n = ~200 sites) across the harbours. High juvenile snapper (11–80 mm) densities were caught extensively in association with lush sub-tidal seagrass, and higher tidal velocities. In the Kaipara, catches ranged from the multiple tens to low hundreds, with apparent increasing juvenile size with water depth (c 5 m range); in East Northland catches ranged from several hundred up into the thousands. Baited/un-baited cameras also revealed substantial numbers of juvenile snapper. The remote sensing data appeared to correlate well with differing juvenile snapper catch rates. In East Northland, field observations strongly suggested that sub-catchments with less run-off/development/more native vegetation cover had better seagrass cover/condition and higher juvenile snapper densities. These survey data are being used to assess how land-based impacts cascade into juvenile snapper production, and ultimately coastal fisheries productivity.

Managing Mangrove Expansion in Northern New Zealand Estuaries

Carolyn LUNDQUIST // NIWA, University of Auckland

Mangroves in New Zealand are increasing in distribution, and have responded favourably to changing land-use and increased rates of sediment deposition in estuaries. Many coastal communities view native mangroves as pest species that have decreased coastal access and reduced amenity values, and there is widespread support for estuarine restoration projects that result in removal of mangrove forests. Consent decisions for mangrove removal projects are often based on historical mangrove abundance, prevention of coastal erosion, flood protection and drainage, and the potential to restore human uses of the marine environment such as cultural or recreational access. However, the likelihood of successful restoration, and the time required for habitat recovery to occur, are rarely considered in consent decisions. Key information needs to assist decision-making for restoration activities that involve mangrove removal include: 1) what defines recovery, and should we expect sandflats to return where historical impacts have changed the underlying habitat; 2) what physical attributes (exposure, tides, sediment type, catchment, freshwater influx) and biological attributes are associated with limited (or fast) recovery; 3) what methods (both machinery used, and spatial and temporal scale of removals) are associated with speed of recovery; and 4) are long-term costs of maintaining a restoration site free from mangroves linked to physical and biological attributes? Compiling scientific evidence on where mangrove removals have (and have not) been successful can assist in estuarine restoration projects in identifying areas either too expensive to maintain, or unlikely to benefit from restoration efforts.

Impacts of Humans on New Zealand Marine Ecosystems Since First Settlement: Synthesis of Major Findings & Management Implications

Alison MacDIARMID // NIWA

New Zealand was the last major land mass to be settled by humans, occurring sometime in the period 1230–1280 AD. Consequently, New Zealand has a short and reasonably complete archaeological, historical and contemporary record of human exploitation of marine resources. The collaborative, multi-disciplinary, Taking Stock project exploited these natural advantages to examine the effects of climate variation and human impact on the structure and functioning of New Zealand shelf ecosystems over the timescale of human occupation. Two regions, the Hauraki Gulf and the Otago-Catlins shelf, were chosen as case studies of the broader New Zealand wide changes as they were both settled by Māori at about the same time, but have since experienced contrasting trajectories in human population size and marine resource use. This paper synthesises the major findings of the project and provides some overall implications for marine conservation and management gained from taking a long view of human impacts on New Zealand shelf ecosystems.

Alexandriun catenella Blooms are a New Problem for the Aquaculture Industry in the Marlborough Sounds

Lincoln MACKENZIE // Cawthron Institute

Ben Knight // Cawthron Institute

In March 2011 saxitoxins were detected in mussels from Tory Channel, Queen Charlotte Sound (QCS). This signaled the beginning of a bloom of the toxic dinoflagellate *Alexandrium catenella*, which over the next two months progressed throughout the sound and resulted in lengthy shellfish harvest closures. *A. catenella* had never previously been identified in this region and the event appeared to be due to a recent incursion. It was feared that *A. catenella* would spread to the major mussel growing areas within Pelorus Sound, Port Underwood, Tasman and Golden Bays and become a serious and chronic constraint on the productivity of the industry. Subsequent sediment surveys have revealed that *A catenella* benthic resting cysts are widespread within QCS, with particularly high numbers within the Onepua/Opua inlet extending off Tory Channel and this location is the origin of seasonally recurrent blooms. Analysis of sediment core strata from Opua Bay has shown that *A. catenella* has been resident at this location for at least several decades. Detailed observations on the progression of the annual *A. catenella* blooms in Opua Bay have been made over the 2012 and 2013 summers and data collected on physical, nutrient chemistry and biological factors that influence the timing, magnitude, duration and distribution of the bloom from year to year. Research is ongoing to improve current monitoring technologies, understand the autecology of *A. catenella* in the sounds and develop bloom prediction and tracking tools to enable management and mitigation of its effects in the future

Marine Reserve Resilience in Response to Sedimentation

Diana MACPHERSON // The University of Waikato

Prof Chris Battershill, Prof Cam Nelson // The University of Waikato

Te Angiangi Marine Reserve protects 446 hectares of coastline in southern Hawke's Bay. During a severe storm event in April 2011, a significant area of the coast including the reserve, was subjected to a large-scale sedimentation event due to mass wasting of the adjacent coastal hills. The hills are characterised by weak, highly jointed mudstone that is rich in smectite clay minerals making them prone to erosion during rainfall, resulting in extensive landslides. A large proportion of the landslide debris consists of the soft mudstone, which rapidly weathers into fine sediment, therefore facilitating its easy dispersal and deposition offshore at depths >30 m. Rapid weathering and subsequent offshore transport of the fines suggests there was a relatively short period in which intertidal organisms were subjected to the effects of sedimentation. Nevertheless an ecological intertidal survey carried out after the sedimentation event on key species (paua (*Haliotis* spp), kina (*Evechinus chloroticus*), and seagrass (*Zostera capricorni*)) indicated an impact in both reserve and non-reserve populations. A faster recovery pattern demonstrated by reserve populations was unexpected, given the small area of protection and suggests some degree of resilience. Significant differences in paua and kina demographics were observed between reserve and non-reserve populations, with larger numbers of juveniles recruiting within the reserve. The reserve continues to fare better. Importantly, the event permitted a comparison of responses to severe sedimentation inside and outside of a marine reserve, where good 'before impact' time series data afforded a unique opportunity to examine whether protection has increased ecological resilience to sedimentation.

Effect of Salinity on Growth of Juvenile Yarra Pygmy Perch (*Nannoperca obscura:* Percichthyidae)

Hillary MAHON // Flinders University

James Harris // Flinders University

The threatened Yarra pygmy perch (*Nannoperca obscura*, Klunzinger 1872) is endemic to the south-eastern coast of Australia, where its native river systems have been heavily modified since European settlement. The purpose of this study was to explore the relationship between the growth rates of juvenile *N. obscura* and salinity. Growth trials were conducted using five salinity treatments (0.3–10.0 ppt) representing perceived and potential salinity values within *N. obscura*'s environment. After eight weeks of exposure, growth was recorded as weight (g) and standard length (mm). Growth was optimal when N. obscura was exposed to moderate salinity concentrations (3.0–8.5 ppt), therefore identifying the ideal salinity range for *N. obscura*. During this study, juveniles from two brood-groups were trialed simultaneously in an attempt to quantify intraspecific variation in phenotypic response to salinity, however no significant differences in the genetic composition of the two groups was detected. This indicates a limited genetic variance which may restrict the adaptability of *N. obscura* and impair its ability to survive continuing salinity modifications occurring in its native habitat.

Habitats At the Interface of Estuaries & their Catchments: how to Consider Them in Coastal Marine Spatial Planning for the Kaipara Harbour

Leane MAKEY // Auckland University of Technology

Nina von Westernhagen // Auckland University of Technology
Deborah Harding, Alyssce Te Huna // Te Uri o Hau Settlement Trust

Mangroves, seagrass, sandflats, mudflats, saltmarsh-wetland complexes, tidal rivers, coastal forest, and coastal scrub are all habitats at the interface of catchments and estuaries. These habitats are all currently represented in the Kaipara Harbour and there were most likely other habitats present prior to land-use changes such as cockle, horse mussel and scallop beds. Isolated remnants of highly biodiverse areas still persist in the Kaipara Harbour. Coastal marine spatial planning is a tool used to pro-actively manage the use of resources, spatial conflicts, population growth, protect or restore ecosystem services and ensure benefits for future generations. My doctoral research investigated concepts where spatial planning for the Kaipara Harbour considers habitats at the interface of harbour and catchment to promote ecological and physical processes, address local socio-economic needs and cross-system threats and stressors. Habitat data collected at 400 sites in the Kaipara and other data sources, such as wading seabirds and freshwater ecosystems of New Zealand, were considered to promote land-sea planning. This will be presented and how they were incorporated into the coastal marine spatial planning software Marxan with Zones.

Some Issues Encountered With Catch Rate Standardisation for Demersal Scalefish Fisheries in Western Australia

Ross MARRIOTT // Department of Fisheries Western Australia

Commercial catch per unit of effort (cpue) information is often used to develop an index of historical fish abundance, typically when no other, more reliable data are available. Standardizing cpue data for the influence of variables other than the relative abundance of the fish population typically involves the application of Generalized Linear Models (GLMs), of some form or another, to such datasets. Fishery-dependent measures are often biased, however, and sometimes a conventional GLM cpue standardization will not be sufficient in correcting for these biases. Two such sources of bias are: (i) cumulative fleet-wide increases in fishing efficiency over time and (ii) the influence of spatiotemporal fleet dynamics on cpue. Both can result in violating direct proportionality between cpue and relative fish abundance if not properly accounted for, with potential implications for advice arising from stock assessments. I present some case studies for recent stock assessments of demersal scalefish fisheries in Western Australia to illustrate both scenarios, and some methods that have been implemented for addressing these issues. I then outline a Masters (Research) study that aims to address an issue that can compound difficulties in dealing with issue (ii): incomplete spatiotemporal data structures.

Has Intertidal Mudflat Biodiversity Changed as a Result of Earthquake Disturbance?

Islay MARSDEN // University of Canterbury

Earthquakes are extreme natural events and with tsunamis can result in large scale changes in estuarine escosystems. In September 2010 and February 2011, Christchurch in the South Island of New Zealand was rocked by several large earthquakes. Sand volcanoes, formed from liquified sediment, appeared on the surface of the Avon-Heathcote Estuary/ Ihutai. Much of the city sewerage system infrastructure failed and large quantities of raw sewage were discharged into the estuary. There were also coseismic shifts in elevation with some areas lifted by up to 0.5m and others subsided by 0.5 m. This presentation describes the changes that occurred in intertidal mudflat benthos as a result of earthquake disturbance and evaluates whether these resulted in changed functional relationships. Communities have been followed over time and the disturbance effects found to be site and shore level specific. Some habitat types recovered quickly while others are still showing the effects of the disturbances. This presentation discusses the resilience of estuarine communities to earthquake disturbances and highlights the need for remediation in some cases.

Controlling Nuisance Algae by Single Limiting Nutrient: Where's the Evidence?

Kate McARTHUR // The Catalyst Group

Control of nuisance growths of algae in rivers, lakes, estuaries and coastal waters is a significant resource management concern internationally, and in New Zealand. Increasingly, land use intensification, fertiliser application and animal stocking rates are causing eutrophic effects in freshwater and marine ecosystems. Eutrophication not only affects the structure and function of aquatic ecosystems, sometimes with pervasive effects on local biodiversity and ecosystem health, but can also degrade human aesthetic, recreational and cultural values for water. The macronutrients nitrogen and phosphorus are key contaminants of concern for managing aquatic systems at risk of or suffering from eutrophication. Optimum uptake of these nutrients for growth in aquatic plants has been shown to occur in a specific ratio (known as the Redfield ratio). Theories for limiting algal growth through controlling the availability of a single nutrient in an aquatic system (the nutrient in most limited supply) have been adopted into management strategies and policy in the past (e.g. the Manawatu River Water Quality Plan and others). But there is little evidence to suggest that historical management through control of a limiting nutrient has been successful. Single nutrient control of algal growth is making a come-back in water resource management in New Zealand. We examine the international evidence around the use of nutrient limitation as a control tool and discuss the risks, advantages and disadvantages of this approach for water management in the context of freshwater and marine systems.

Water Quality & the Lake Waikaremoana Trout Fishery: Satellite Imagery & High Frequency Water Quality Monitoring

Chris McBRIDE // The University of Waikato

Mathew Allan, David Hamilton // The University of Waikato
Matthew Osborne, Rob Pitkethley // Fish & Game New Zealand

Lake Waikaremoana, a deep, monomictic and relatively pristine lake in the North Island of New Zealand, is an ecosystem of cultural, economic, and conservation significance. However, water quality in the lake has been infrequently monitored over recent decades. In late 2009, a high-frequency monitoring buoy was deployed, to improve understanding of water quality dynamics in the lake, with specific reference to the potential for lake light climate to impact the trout fishery.

We used monitoring buoy data to gain insight into the thermal and mixing regime, hypolimnetic oxygen demand, turbidity, light climate and linkages with water level, as well as algal production in Waikaremoana. Satellite images (MODIS, MERIS, LANDSAT7) were used to examine lake turbidity, including 'hindcasting' turbidity in the lake. High rainfall events transported large quantities of sediments and/or organic matter and nutrients to the lake. Historic satellite images showed that turbid inflows generally come from the north (Hopuruahine arm) and east of the lake, and may result in spatial heterogeneity of the light climate in the lake. Monitoring buoy data suggest that turbid plumes may insert at density dependent depth in the water column. These insertions can occur at depths of the lake preferred by trout, and may impact primary production by reducing euphotic depth. Satellite images suggest that surface turbidity following a flood in October 2005 was especially high. These events, along with the lake light climate dynamics shown by the monitoring buoy, are consistent with current thinking that severe flood events can impact the Waikaremoana fishery.

Using a Microbial Water Quality Stream/Sediment Model to Explain Low-flow Microbial Persistence: those Bleeding Sediments

Graham McBRIDE // NIWA

Sandy Elliott // NIWA

Observations of faecal bacteria in streams most usually finds them at persistent low concentrations during dry-weather low flows, when deposition is most likely to be occurring. This can be a challenge, for example detailed modelling of *Campylobacter* in the Toenepi catchment had difficulty in accounting for this phenomenon. Since drainage inputs don't seem to be the answer, we should consider whether microbial deposition and "sediment bleeding" be occurring simultaneously. It would seem from a recent study (Yakarevich *et al.* 2013, Water Research 47: 2675) that this may be possible. It would require that the critical bed shear stress for entrainment should be less that its counterpart for resuspension. Using realistic values of key model parameters we explore the conditions under which this can occur and speculate on the need to modify "standard" models to account for this phenomenon.

Assisting Water Resources Management Using Quantitative Microbial Risk Assessment

Graham McBRIDE // NIWA

Dr Rebecca Stott, Dr Chris Palliser // NIWA

Hearings of discharge consent applications commonly consider results obtained from Quantitative Microbial Risk Assessment (QMRA), directly considering pathogens as well as traditional faecal indicator bacteria. Examples are: Manukau, Hamilton, Picton, Timaru, Napier, and the 2003 national freshwater recreational guidelines (based on *campylobacter*iosis). In some cases the decisions of a Hearing may call for subsequent confirmatory evidence (Napier, New Plymouth). Yet in many ways QMRA falls into the category of "young science"; there are therefore traps for the unwary. In this presentation we will first define the essential QMRA steps: (i) Select the appropriate pathogen(s); (2) Identify human exposures to those pathogens; (3) Analyse dose response; (4) Characterise risks. This sets the stage for clarifying at least some of the traps. For example: (1) The most important pathogen(s) may not be identified if the QMRA team does not include a microbiologist or a public health specialist, and discussion with them is needed to clarify whether to focus on infection or on illness as the end-point; (2) Recent exposure studies have refined (and in many cases reduced) the magnitude of exposures (e.g., how much water is ingested during a swimming event?); (3) Some literature on clinical trials and outbreak studies can be rather contradictory (e.g., for *Campylobacter* and *Norovirus*), and care is need to harmonise dose units; (4) Incorporation of various forms uncertainty is a challenging task. None-the-less, with careful application, QMRA can be very instructive in identifying risks to recreational water user and shellfish consumption, particularly for waters close to discharges.

Rock Snot on Solid Ground: Long-term Stream Bed Stability & Didymo Blooms

Jonathan McCALLUM // University of Otago

Globally, the diatom *Didymosphenia geminata* (didymo) is recognised as a nuisance species in freshwaters as it forms mass growths on the benthos. Research has shown that didymo growth is controlled by the concentration of dissolved reactive phosphorus, assisted by a stable flow regime. The purpose of this study was to provide a greater understanding of the relationship between long-term stream bed stability and didymo growth. I performed a stream survey at the reach scale (50 metres along the bank) across the South Island of New Zealand comparing didymo standing crop and cover proportion to the Pfankuch index, a qualitative bed stability assessment tool. Pfankuch values, dissolved reactive phosphorus concentration and turbidity measurements were compared as predictors of didymo standing crop and cover using an information-theoretic approach. Models containing Pfankuch bed stability to predict didymo standing crop and cover were the most parsimonious. These results suggest that long-term stream bed stability is an important environmental variable controlling the formation of didymo blooms.

South Island Rudd – just how Old are they, & when are they Spawning?

Helen McCAUGHAN // Department of Conservation

Léo Godard // Department of Conservation

Currently there is no published information on rudd (*Scardinius erythrophthalmus*) populations in the South Island of New Zealand. From 2011 to 2013 the Department of Conservation has been collecting otolith and gonad data from selected Canterbury and West Coast rudd populations as part of its ongoing Pest Fish Programme. Otoliths were flat ground to enable annuli to be counted, using reflected light and a black background. Gonads were weighed and compared to body weights to assess their ripeness peak/s. Preliminary data shows that the oldest rudd were six years and the West Coast fish grew faster than the Canterbury fish. Gonad analysis so far showed two clear ripeness peaks for female fish, but only one for males. Ongoing work is needed to collect more gonad data and to compare this with age to show when they first spawn in the South Island. This information will assist with better targeting of control and eradication operations.

Microsatellite Analyses Reveal Recruitment Relationships in New Zealand's Blackfoot Abalone (Paua), *Haliotis iris*

Tom McCOWAN // Paua Industry Council Ltd

Gerard Prendeville // PAUMAC7
Neil Gemmell // University of Otago

Understanding recruitment patterns in marine species is important for effective fisheries management strategies. New Zealand's blackfoot paua (*Haliotis iris*) is a species of customary, recreational and commercial fishing importance. Paua are broadcast spawners that have a planktonic larval phase, meaning recruitment patterns are largely determined by the extent of larval dispersal. The microscopic size and typically large quantities of larvae produced by broadcast spawning marine species means larval dispersal is difficult to trace in situ. However, using genetic tools, specifically parentage analyses, it is possible to identify the parental origins of new recruits. These relationships can be used to draw conclusions about the extent of larval dispersal and corresponding recruitment patterns. We investigated recruitment patterns using genetic methodologies based on ten microsatellite markers in paua populations in Tory Channel, Marlborough Sounds, New Zealand. Parentage analyses between samples of 200 adult and 200 juvenile paua returned up to seven positive parent-offspring matches. These findings revealed events of 'self-recruitment' back to the same reef at scales of 10s of metres, and several events of longer-range dispersal up to 4 km. Information about the larval dispersal potential and recruitment in paua can be used in management strategies such as determining the scales and potential utility of protected areas.

A West Coast Whitebaiter's Perspective

Des McENANEY // President of West Coast Whitebaiters Association

This presentation gives a short history of the growth of a lifestyle and an industry on the South Island's West Coast, including subsistence living of the early gold miners and the first commercial endeavours of the Chinese gold miners. With the establishment of the industry came whitebait factories, which grew over time. Improvement of transport options and rail links had an impact on the whitebaiters. The legendary figures of the Haast opened a whitebait canning factory at Okuru, and set up New Zealand's first commercial flying operation. Challenges were met in an isolated and unforgiving land, including issues with rail transport. The opening of the Haast highway brought changes, as did improvement in refrigeration. With changes to the industry there was development of whitebaiting regulations. Issues facing both our lifestyle and the industry today include the rapid expansion of dairy farming and its impact, with compliance rules evolving as we learn. Some of the steps being taken to address gravel extraction impacts, consent shortcomings, and compliance issues include a restoration project at Greymouth. I will consider a future review and simplification of the whitebaiting regulations as a conservation measure.

Responses of Three New Zealand Native Fishes to Floods in a Small Stream

Amber McEWAN // Riverscapes Freshwater Ecology

Mike Joy // Riverscapes Freshwater Ecology

Floods are an integral part of flowing river systems yet our understanding of freshwater fish behaviour during floods is limited. In 2008, 67 redfin bullies (*Gobiomorphus huttoni*), 22 shortjaw kōkōpu (*Galaxias postvectis*) and 29 kōaro (*Galaxias brevipinnis*) were tagged with Passive Integrated Transponder (PIT) tags and monitored in a 100 m study reach before, during or after three floods. Detection patterns of tagged fish indicated that they may be displaced or may move to areas with large substrates during floods. Two individuals returned to the same locations during multiple floods, suggesting that previous experience may influence refuge selection for some individuals. While small changes in community composition occurred that could be attributed to concurrent habitat changes, overall a remarkable level of persistence of individual fish was observed in the tagged community.

Data Analysis & Modelling to Assist Management Decision Making for South Australian Snapper

Richard McGARVEY // South Australian Research and Development Institute

Paul Burch, John Feenstra, Anthony Fowler // South Australian Research and Development Institute

Snapper catches and indices of abundance in South Australian waters show dramatic fluctuations in time and space. Not all of this variation appears to be recruitment driven, and snapper appear sensitive to levels of fishery exploitation. The fishery in South Australia is managed by a flexible toolbox of effort controls. Prior to 2012 these included temporal closures during the spawning season (no fishing in November), gear restrictions (no netting), size (38 cm TL minimum size), and bag limits for recreationalists. In this talk, we summarise a suite of additional measures that were evaluated to reduce overall levels of human exploitation. A length- and age-based fishery model for the three main gulf fisheries is described. This was used to test additional management measures: extensions of the November closure, commercial fishing trip limits, reductions in the number of hooks longline fishers can deploy, and quota. A new method to visually display the relative performance of each strategy as a single point on a 'management scatterplot' to quantify the trade-off of increases in egg production with losses of catch will be described. Other more direct data analyses were undertaken to compute the likely impact of various effort controls and their respective levels, as percentage reductions in state-wide exploitation rate. In 2012, the Minister and PIRSA Fisheries managers implemented a comprehensive suite of enhanced effort control measures to reduce exploitation of snapper in South Australian waters.

Bioeconomic Decision Making for a Lobster Fishery: Comparing Four Fishery Management Approaches

Richard McGARVEY // South Australian Research and Development Institute

André Punt // CSIRO
John Feenstra, Paul Burch, Janet Matthews, Adrian Linnane // South Australian Research & Development Institute
Klaas Hartmann, Caleb Gardner // University of Tasmania

In Australasian fisheries, and worldwide, tools of increasing sophistication are being developed to account for the economic impact of management decisions. Two effects of management decision making can increase fishery profitability: catch, and thus revenues can rise, or effort, and thus variable costs of fishing, can be reduced. In the Australian southern rock lobster fishery, landed price also varies by month of the fishing season, and by lobster size. In these fisheries, an existing length-based stock assessment model, whose parameters are estimated by fitting to multiple data sources using maximum likelihood, has been developed for yearly stock assessment. This model has now been extended to allow projections going forward in time, predicting catch rates, total catches, revenues, variable and fixed costs, and thus overall fishery profit, under a wide range of possible management strategies. Four common fishery policies have been examined with this decision making tool: minimum size and maximum size limits, constant quotas, and quotas which vary yearly to approximate a constant exploitation rate. The performance of these four policies are compared. Maximum size yields the lowest future average profit (as net present value, NPV), but raising minimum size improves NPV in the South Australian Southern Zone model. Constant quotas greatly improve on size limits. The highest profits (as NPV) were predicted for the management approach which varies quota under a harvest control rule that mimics constant exploitation rate. Management scatterplots permit an easy visual way to see, at a glance, which strategies are the best performers.

Forty Years of Monitoring the New Zealand Snapper Fisheries; What We Know We Don't Know

Jeremy McKENZIE // NIWA

With over 40 years of fisheries data collection, snapper (*Pagrus auratus*) is one of New Zealand's most intensely monitored commercial fish species. The wealth of snapper monitoring data, in addition to enabling fisheries scientists to better determine stock status, also provides valuable insight into snapper biology and ecology. Understanding the distribution and abundance of a fish species in time and space is a fundamental to both fisheries management and the broader realm of coastal marine ecology. In this presentation I investigate the snapper fisheries monitoring data for evidence of spatial and temporal heterogeneity, focussing primarily on growth, movement, and recruitment. I also discuss some possible future research directions for snapper, i.e. "what we know we don't know".

Planning for a Healthy Avon River – the Avon River Precinct Anchor Project

Shelley McMURTRIE // EOS Ecology

Alex James // EOS Ecology

The destructive effect of the 22 February 2011 earthquake has resulted in a complete reimagining and rebuild of the Christchurch CBD. First delineated in the 'blue print' for the Christchurch Central Recovery Plan, the North/East Frames and Avon River Precinct (ARP) (collectively called The Frame) are arguably the most significant of the anchor projects to the people of Christchurch. Extending for 3.2 km along the Avon River as well as a 12 ha block of previously commercial land, The Frame provides an unprecedented opportunity to match the community's desire for a 'green' city and improve the health of the Avon River – the 'jewel in the crown' of Christchurch City. Given the current degraded state of the Avon River, improving its health required a design approach that was more than surface deep, with ecology becoming a cornerstone of the concept design process. Through using the past and present state of the river to inform restoration potential, and an understanding of urban ecology, landscape dynamics and waterway restoration design, we were able to develop a set of key design criteria for improving the health of the river. The integration of these critical habitat and stormwater management features in the concept design will mean we are well placed to realise the overarching vision of a biodiverse and functioning river ecosystem that is balanced with multi-use, outdoor space essential to a modern city. The design approach and ecological enhancements planned for The Frame is an exemplar of what we can achieve in our urban centres to improve the health and wellbeing of both environment and people.

Sensitivity Analysis of a Catchment Model (SWAT) to Simulate Flow & Loads of Nutrients & Sediments in the Puarenga Stream, Rotorua

Wang ME // Hohai University

Jonathan Abell, David Hamilton // The University of Waikato

The Soil Water Assessment Tool (SWAT) is a process–based catchment model designed to simulate water quantity and quality in streams and rivers. The model provides a tool to evaluate the effects of different land management practices and subsequently inform the design of policy to achieve water quality targets. Although SWAT has been used extensively overseas, it has yet to be widely trialled in New Zealand. In this study, SWAT was configured for the Puarenga Stream catchment (77 km^2; Rotorua, Bay of Plenty) which contains numerous point and diffuse pollution sources. The model simulates stream flow and estimates nutrient and sediment loads exported into Lake Rotorua downstream. Values for parameter values were either calculated using measured data or derived using both manual and automated calibration. A Sequential Uncertainty Fitting (SUFI) approach was then used to rank the most sensitive model parameters. Based on this sensitivity ranking, a manual 'one at a time' routine was applied to investigate how parameter sensitivity varied for different components of the stream hydrograph. Results showed that the sensitivity of some parameters greatly depended on the relative contribution of base flow and quick flow, whereas some parameters were invariant to flow regime. The results can help SWAT modellers to streamline model calibration and have important implications for quantifying uncertainty when modelling scenarios such as climate change which involve altered flow regimes.

Of Fat & Fish: Do Limitations in Membrane Remodelling Capacity Contribute to Narrow Temperature Tolerances of Polar Fish?

Victoria METCALF // Lincoln University

Vanita Malekar // Lincoln University

Climate change models predict widespread loss of biodiversity and extreme change in polar regions. Whilst we know that impacts are dictated by an organism's ability to alter gene expression in response to environmental variation, we still lack understanding of mechanisms by which organisms adapt to thermal change. Antarctic biota and in particular, notothenioid fish are an ideal system to explore thermal adaptation, especially limitations in gene expression capacity in organisms that exhibit narrow thermal tolerance (stenotherms). I will provide an overview of thermal adaptive theory and outline key findings on the effects of AGW on Antarctic biota. Lastly I will outline my own research interests in this area. Embedded within the accepted paradigm of thermal limitation are changes in lipid saturation to maintain membrane fluidity and oxygen movement. Desaturases are key regulators of membrane lipid composition and exhibit temperature regulation, suggesting they play central roles in thermal adaptation. Delta-9 desaturase (SCD), our principal target, catalyses an initial, rate limiting step in unsaturated fatty acid formation. Notothenioid fish favour unsaturated fatty acids for metabolism and within membranes, invoking a key role for SCD. Our hypothesis is that membrane remodelling, a universal temperature response, occurs at reduced capacity in stenotherms, contributing to narrow thermal tolerances, and limiting their adaptive potential. We are determining SCD cDNA sequences in eurythermal and stenothermal notothenioids, and SCD tissue distribution and expression level differences. Tissues from a thermal acclimation study on stenotherms are allowing us to test whether as temperatures increase, SCD mRNA levels are thermally unresponsive.

Sediment Impacts on Paua (*Haliotis iris*) & Kina (*Evechinus chloroticus*): Building Indigenous Marine Science Capability

Sonja MILLER // Victoria University of Wellington

Peter Edwards, Shane Parata, whina VUCEL Incubator Team // Victoria University of Wellington

New Zealand comprises only 0.2% of the world's land area, yet inputs of sediments to the coastal zone approach almost 1% of world sediment yields. Sediments can negatively impact benthic species such as pāua (*Haliotis iris*) and kina (*Evechinus chloroticus*). Both species comprise significant fisheries with over 40% of commercial pāua quota in Māori ownership, while kina is an important customary fishery. The Āwhina VUCEL Incubator, at Victoria University's Coastal Ecology Laboratory (VUCEL), has been investigating the impact of suspended sediments on reproduction, growth, and oxygen consumption for pāua and kina. However, we take an alternative research approach. Our kaupapa (goal) is to produce Māori and Pacific marine scientists who will contribute to leadership and development in their communities. Our team comprises a Māori postdoctoral fellow, and undergraduate and postgraduate students who are Māori or Pacific or non-Māori / Pacific but support our kaupapa. We all have backgrounds in the biological sciences and statistics, and belong to Te Rōpū Āwhina (Āwhina) at Victoria University. The focus of Āwhina is to produce Māori and Pacific scientists to contribute to Māori and Pacific community development and leadership. Our unique approach is important for future Māori and Pacific development and tino rangatiratanga (self-determination). More importantly, our work is ground-breaking as we are creating a model for indigenous peoples and universities to successfully work together to build indigenous science capability, while at the same time increasing knowledge around the impacts of sediment on important invertebrate fisheries. We discuss our research results in this context.

Will I Get Sick if I Swim? Updating the National Microbiological Water Quality Guidelines for Recreational Waters

Juliet MILNE // Greater Wellington Regional Councill

Brent King // Ministry for the Environment

Most regional and unitary councils throughout New Zealand undertake annual recreational water quality monitoring programmes in collaboration with Territorial Local Authorities and the Public Health Units of District Health Boards. Monitoring is carried out over the summer months to assess the microbiological water quality of freshwater and nearshore coastal areas commonly used for contact recreation. The monitoring results are compared to 'trigger levels' in the Ministry for the Environment (MfE) and Ministry of Health (MoH) microbiological water quality guidelines (2003). Monitoring data collated over time are also used to calculate a Suitability for Recreation Grade (SFRG) for each monitoring site. Ten years on from their implementation, a comprehensive review and update of the existing national guidelines is now underway. The review is focussing on a number of key areas, including site selection and sample number requirements, the methodology for deriving SFRGs, the use of rainfall-related monitoring data, roles and responsibilities, and reporting frameworks and communications. Complimentary guideline documents (eg, cyanobacteria in fresh waters) will also be looked at with consideration given to how these guidelines can be used together to provide a more comprehensive view of water quality for recreational uses. This presentation will touch briefly on these areas and bring you the very latest update on the process and progress underway to review the microbiological water quality guidelines.

Assessing the Potential of Morphological & Pigmentation Larval Development Characters for Phylogenetic Analysis of Gobiidae

Tony MISKIEWICZ // Wollongong City Council

The Gobiidei are a very diverse group of fish comprising nine families with about 270 genera and 2,210 species. There have been a variety of studies undertaken using morphological, osteological and molecular characters of adults to investigate phylogenetic relationships within the group. Larval developmental series collected from southern Australian waters of seven genera of Gobiidae (210 genera, 1,950 spp.) *Arenigobius, Afurcagobius, Favonigobius, Gobiopterus, Paedogobius, Psuedogobius* and *Redigobius* and two genera of Eleotridae (35 genera 155 spp.) *Hypseleotris* and *Philypnodon* were assessed. For larval development series of these nine genera, ontogenetic changes in body shape and pigmentation patterns and the size at development of fins, notochord flexion and transition to juveniles for each genus were documented. There was considerable variation in these larval characters between the two families and between genera. The larval development characters were assessed to determine similarities and differences between genera and then compared with the proposed lineages for these genera based on adult characters.

Waikato Taniwharau: Competing Needs in the Management of the Waikato River

Dr Kepa MORGAN // The University of Auckland

Dr Linda Te Aho // The University of Waikato

The Waikato River has significant spiritual relevance for the Waikato-Tainui people and other river iwi, who regard it as an indicator of their mauri or well-being, and central to their identity. The Waikato is also the focus of on-going tensions between Māori cultural and spiritual values and beliefs, and national engineering objectives. The river system is a strategic asset for power generation and the flow has been extensively modified with the engineering of dams, lakes, tunnels and canals used to generate one sixth of New Zealand's total electrical generating capacity. These power generation assets are now for sale. An analysis has been carried out using the Mauri Model Decision Making Framework. The Mauri Model is unique in its approach to the management of water resources as the framework offers a transparent and inclusive approach to considering the environmental, economic, social and cultural aspects of decisions being contemplated. The Mauri Model is is capable of including multiple-worldviews and adopts mauri (intrinsic value) in the place of money based assessments of pseudo sustainability using Cost Benefit Analysis. An assessment is presented within the context of new co-management aspirations that require decision making to reflect the values of both the Government and the Waikato-Tainui peoples. How might the Mauri Model contribute in the complex context of co-management of the Waikato River? Three existing resource uses are assessed to illustrate the contribution that alternative frameworks can make to an enhanced understanding of the challenges that the new co-management regime will need to overcome.

Grey Mullet Nurseries & Connectivity – Where did I Come From, Where will I Go?

Mark MORRISON // NIWA

Bronwyn Gillanders // University of Adelaide
Jeremy McKenzie, Crispin Middleton, Marie Jordan, Dane Buckthought, Catriona Paterson, Emma Jones, Darren Parsons, Keren Spong, Holly Ferguson, Meredith Lowe, Matthew Smith, Andrew Miller // NIWA
Cameron Walsh // Stock Monitoring Services Ltd

Grey mullet (*Mugil cephalus*) occur globally from warm temperate to tropical waters in both hemispheres. In New Zealand its distribution is focussed around the northern half of the North Island, where it is managed as one stock (GMU 1), with circa 900–1000 t extracted p.a. by commercial and recreational fishers. However, Catch Per Unit Effort (CPUE) analyses suggests that substantial smaller scale spatial structure may exist, with possibly 5–6 distinct sub-populations, some of which are declining in abundance. Adult movement dynamics are complex, with 'polymorphic' behaviours including both estuarine residency and seasonal coastal migrations (partial migration) including along surf beaches; and movement into freshwater systems including the Waikato River and associated lakes. However, juvenile grey mullet are estuarine-dependent, making their nursery grounds relatively well-defined. To assess potential spatial population structure, in 2010 we sampled 0+ fish (c 30–80 mm) from all putative nursery estuaries in northern New Zealand (n=80), with site (n=176) replication in the larger systems. These fish are being analysed using otolith chemistry to assess whether distinctive elemental 'signatures' exist for individual and/or groups of estuaries. Field data on catch rates/rates of detection are also being used to semi-quantitatively assess which estuaries hold most of the recruits. If the otolith approach is successful, then the 2010 year class will be resampled in 2014/15 as adults; to quantify dispersal and spatial mixing of fish from different natal estuaries; assess possible source-sink dynamics between estuaries; and to better understand the different behavioural morphs contributing to the overall population/s.

Within & Among – Individual Variation Underpins Population-level Responses to Temperature in a Marine Fish

John MORRONGIELLO // CSIRO

Ron Thresher // CSIRO

In ecological studies the data we collect is usually hierarchical. Repeated measurements are taken from each of many individuals, which in turn span overlapping time periods, cohorts and populations. Traditionally, we aggregate this data and explore biological responses to environmental variability at the within or among population level. Such an approach, whilst valid, limits our ability to explore the underlying mechanisms driving population responses. The expression of phenotypic traits, like growth, varies within an individual (adaptively, non-adaptively or neither) depending on the environmental conditions experienced. Investigating phenotypic plasticity through individual reaction norms provide a means of decomposing population level variation into its within- and among-individual components. This in turn aids ecological and evolutionary interpretation of historical patterns, and facilitates more accurate prediction of biological responses to future environmental change. Here we apply novel statistical techniques, that explicitly account for the data's underlying hierarchical structure, to decompose population-level variation in tiger flathead growth (as inferred from otolith analysis) into its within and among individual components. Our results indicate that projected ocean temperature rises will result in spatially differentiated changes in fishery productivity, but that the underlying causal mechanisms for this temperature response are spatially variable. We show that what appear to be consistent among-population patterns in temperature-related growth are underpinned by varying levels of phenotypic plasticity and potentially micro-evolved directional change.

A Fish in the Desert: Ecology & Behaviour of the Desert Goby *Chlamydogobius eremius*

Krystina MOSSOP // Monash University

David Chapple, Bob Wong // Monash University

A region of unique biogeographic history, the already extreme arid environment of the Lake Eyre Basin of central Australia is currently subject to change due to human activities, yet the implications for native aquatic species are little known. Here, we focus on the behaviour, ecology and distribution of the desert goby (*Chlamydogobius eremius*), a small, bottom-dwelling fish that inhabits fragmented habitat patches in the form of ephemeral rivers and desert springs. Using a comparison of populations inhabiting different habitat types, I will present experimental data on i) morphology and ii) exploration and dispersal behaviour within a phylogeographic framework. The results provide insights into the evolution and persistence of a desert-adapted fish, and implications for the management of two closely related but endangered species, the Elizabeth Spring and Edgbaston gobies.

Resolving Small-scale Flows & Turbulence: Novel Measurements From Surface Fronts At Biologically Relevant Scales

Julia MULLARNEY // The University of Waikato

Stephen Henderson // Washington State University

Freshwater plumes play a critical role in the nearshore transport and dispersal of nutrients, pollutants and sediments. However, in shallow environments such as tidal flats, it can be difficult to resolve small-scale flow features, particularly on biologically-relevant spatial and temporal scales. We present a novel design for a surface drifter, mounted with a pulse-coherent Acoustic Doppler Profiler (ADP) for measuring near-surface (depths 0.18–1 m) flows. This new design allowed high-quality and high-resolution Lagrangian measurements of velocities and turbulence in depths as shallow as 0.4 m. During repeated drifter deployments over the tidal flats of Skagit Bay, Washington, drifters were advected towards, and subsequently trapped on a convergent surface front. The front was clearly marked by a surface scum line and propagated across tidal flats at the head of a freshwater plume. Depth-dependent velocities revealed regions of vertically sheared currents and wave motions not resolved by surface drifters alone. Near-surface turbulent kinetic energy dissipation rates were enhanced near the front at the plume's leading edge, whereas dissipation measured in the stratified plume behind the front was suppressed. Moreover, high levels of backscatter, often accompanied by intensified turbulent dissipation were observed to briefly penetrate throughout the depth of the water column when the drifter propagated across small subtidal channels.

Effects of Short Term Exposure to Rena Heavy Fuel Oil & the Dispersant Corexit 9500 on the Early Life-stages of *Seriola lalandi*

Simon MUNCASTER // Bay of Plenty Polytechnic

Fenna Beets // The University of Waikato

Early life stages of marine fish often exist in a temporary planktonic phase which leaves them vulnerable to the effects of oil spills. Few studies in New Zealand have investigated the toxic effects of oil and dispersants on marine fish embryos and larvae. This study exposed the early life stages of kingfish, *Seriola lalandi* to a dilution series of heavy fuel oil from the Rena wreck as well as the commercial dispersant Corexit 9500. There was no trend evident between concentration of oil or dispersed oil and survival over 24 hours. There was, however, macroscopic evidence of physical deformities in larvae that had been exposed to the higher concentrations of the water-soluble fraction of oil over a 48 hour period. Sublethal damage of contaminant exposure on DNA strand length is under investigation. Implications of this study will be discussed along with possibilities for further research.

Wind Force – Stratification Interaction Time Lag Depends on Lake Morphology

Kohji MURAOKA // The University of Waikato

David Hamilton // The University of Waikato
Piet Verburg // NIWA

Density stratification in lakes influences an array of biogeochemical processes. Strong wind drags surface water and creates water column instability. This effect of wind energy on overall lake stratification usually involves a time lag. The mechanisms responsible for this concept are generally accepted, but have not been well quantified. This study examined wind shear stress with emphasis on determination of the relationship between lake morphology and the scale of wind driven energy inputs. High frequency (< 1 hour interval) thermistor measurements from five lake were investigated; Lakes Feeagh (42 m maximum depth, 3 km^2 surface area, the USA), Rotoehu (13.5 m, 7 km^2, NZ), Rotorua (26 m, 80 km^2, NZ), Taupo (160 m, 616 km^2, NZ). The Lake Analyzer software was applied to calculate the lake physical stability metric Schmidt stability using temperature and hypsographic data. Schmidt stability was used as the response variable of the wind stresses. Unique sensitivity analysis was carried out for both the scale of wind speed and the scale of temporal representation of wind speed. We found that the morphological features of the lakes were correlated with the time and energy required to weaken stratification, as described by Schmidt stability decline.

Population Genetic Structure in Freshwater Fish from Southwest Western Australia

Jonathan MURPHY // Murdoch University

Population connectivity that maintains morphological species similarity is largely believed to be due to the historic coalescence of river basins in a period continuous enough to counteract genetic population divergence. However, individual species biology and ecology suggests that not all species are equally able to take advantage of these connections. Populations may be differently isolated and thus represent different levels of evolutionary significant units. Ecological indices may suggest trends in population connectivity though it is only with the use of molecular markers that population structure can be accurately analysed. Two species of freshwater fish endemic to the Southwest of Western Australia (SWWA), *Galaxias occidentalis* and *Nannoperca vittata*, represent species that suggest population structures defined by river basin coalescence. Both species are less than 200mm in length but they differ markedly in other biological traits. Preliminary genetic results indicate vastly different population genetic structures. *Galaxias occidentalis*, the more dispersedly potent species due to greater swimming prowess and other behavioural attributes, possesses a population genetic structure that is highly varied within individual populations, whilst possessing little differentiation between populations. *Nannoperca vittata*, however, is a polar opposite. These species, that possess concurrent ranges, indicate that ecology and biology may have a larger impact on their genetic population structure than geological opportunity would suggest. Climate change projections for SWWA predict a reduction in available freshwater habitats. As this increases, populations of species will disappear. Species such as *Nannoperca vittata* will be at greatest risk of degradation due to a reduction in species genetic diversity.

Study of Shear Stress Effect in *Maccullochella peelii peelii* Larvae

Anna NAVARRO-CUENCA // Charles Sturt University

Craig Boys, Wayne Robinson, Lee Baumgartner // Department of Primary Industries, NSW
Max Finlayson // Charles Sturt University
Daniel Deng // Pacific Northwest National Laboratory, USA

The construction of dams and weirs in the aquatic systems can have a negative effect on native fish requitement. Early stages of Australian native fish may be susceptible to injury or death as they pass through turbines or weirs during their downstream drift.

The understanding of the influence of these mechanisms on the survival of larvae fish is important to the management of fish populations and infrastructure design. Murray cod (*Maccullochella peelii peelii*), has suffered a decline in its population during the last decade, which has resulted in an increased concern that this specie could be vulnerable to turbines and weirs passage during its downstream drift. Early stages of Murray cod were exposed to shear stress environments in the laboratory to establish injury and mortality threshold based on estimates of shear stress rate. Larvae were exposed to a submerged jet with exit velocities from 0 to 10 m/s, providing shear stress of up to 1,296.87 cm/s/cm. Major injuries and total mortality showed a significant increase related with the magnitude of shear stress, but negatively related with the age of the larvae. The onset of injuries and mortality occurred at nozzle velocities of 3.13 m/s with mortalities between 11.9% and 13.64%. These results suggest that shear stress is an important mechanisms affecting survival of larvae Murray cod when passing though weirs and hydropower facilities.

Marine Protected Areas – Where are We At? Progress in Implementing the New Zealand MPA Policy

Don NEALE // Department of Conservation

The New Zealand MPA Policy spells out ten tasks within a three stage implementation plan. Stage 1 is complete with a national classification based on depth, substrate and energy categories (Task 1), a protection standard that defines which areas – including marine reserves – qualify as MPAs (Task 2), and mapping of existing management tools within a GIS framework (Task 3). Stage 2 has progressed with the development of an MPA inventory (Task 4) and the identification of network gaps (Task 5) that show there are many large gaps in the current MPA network in most biogeographic regions and for a range of habitat types. This second stage is nearing completion with the priorities for establishing new MPAs (Task 6) presently being determined to identify future opportunities. Stage 3 will implement MPA planning: in the nearshore environment using regional Marine Protection Planning Forums such as have been most recently undertaken in the Subantarctic and South Island West Coast biogeographic regions (Task 7); and in the offshore environment using an expert panel (Task 8). These tasks are combined with designating new MPAs in both the nearshore and the offshore environments (Task 9). Monitoring and evaluation of the MPA network (Task 10) will continue to evolve as technologies and scientific understanding of MPA design develops. Future progress in the remaining stages will need wide-ranging support from the marine science community and others in order to achieve the Biodiversity Strategy objective to establish a representative network of MPAs throughout New Zealand's marine environment.

Characterisation of Subtidal Rhodolith Beds in Northern New Zealand & their Associated Biodiversity

Wendy NELSON // NIWA

K.Neill, N.Barr, R.D'Archino // NIWA
T.Farr // Royal Society of NZ
S.Miller // ESR

Subtidal rhodolith beds were studied in northern New Zealand, examining their structure and physical characteristics and documenting their associated biodiversity. Field work was conducted at two locations in the Bay of Islands, Kahuwhera Bay and Te Miko Reef, in February and October. The rhodolith beds were mapped using a combination of techniques, and physical characteristics of the habitats were assessed. The rhodolith beds differed significantly in terms of water motion, sediment characteristics and light levels. Two species of rhodolith forming coralline algae were found, *Sporolithon durum* and *Lithothamnion crispatum*, and their distribution and physical attributes were measured. The associated diversity of the rhodolith beds was investigated, sampling (1) invertebrates at three levels of association (epifauna, infauna, cryptofauna), (2) macroalgae, and (3) fishes, as well as recording the biogenic and non-biogenic substrates. A total of 1,088 lots of invertebrates (2,093 individuals) were collected and 82% of lots and 87% of individuals were identified to species level. Rhodolith beds provide three-dimensional habitat for associated biota, and collections made during this study included new records of marine algae and invertebrates for New Zealand and Northland, as well as new discoveries of both genera and species. Significant differences were found in the species composition inside and outside the rhodolith beds at both Kahuwhera Bay and Te Miko Reef.

Past & Present Location of the Subtropical Front South of New Zealand

Helen NEIL // NIWA

Bruce Hayward, Ashwaq Sabaa // Geomarine Research
Mike Williams // NIWA
Rob Smith, Ross Vennell // Otago University

The subtropical front (STF) is the northern extent of the Southern Ocean and is a major frontal zone that separates the warm, low nutrient, salty subtropical surface waters (STW) from the cold, high nutrient, fresh subantarctic surface waters (SAW). As a result of the mixing between these two water masses, the STF is a region of high productivity. Over the last few years several voyages on the RV *Tangaroa* have been dedicated to studying the oceanographic fronts and collecting a transect of sediment cores from the southern tip of New Zealand (46.5°S), down the Solander Trough to a latitude of 50°S, crossing the STF and sitting just north of the subantarctic front (SAF). The hydrographic data has allowed us to define the location of the STF, and show that it is bathymetrically constrained in this region by the Macquarie Ridge and features on the Campbell Plateau. Data from the sediment cores suggests that this has not always been the case, and the location of the STF has shifted over glacial/interglacial cycles. Sea surface temperature proxies suggest the STF did not pass south of New Zealand during the last glacial maximum, 21,000 to 18,000 years ago, but moved in to the Solander Trough very early in the deglaciation. The STF was at its most southerly position ~50°S during the early Holocene, 10,000 years ago. The shifts in the position of the STF over the last 30,000 years had a major impact on New Zealand's climate.

Undersea New Zealand

Helen NEIL // NIWA

New Zealand sits astride an active plate margin, which results in a highly complex and diverse seascape from submarine trenches to underwater volcanoes, to active submarine canyons and channels. Undersea New Zealand provides a unique insight into the deep-sea, and for the first time since its original release in 1997, NIWA is publishing an updated product. Using a Kongsberg EM-302 multi-beam echo-sounder, and its predecessor (EM300), which have now been used for mapping the New Zealand realm from the Equator to the Antarctic for over twelve years, an additional 500,000 km^2 of the New Zealand seafloor has been mapped in high resolution by NIWA. The inclusion of this data, and fifteen years of additional survey data has resulted in a new digital elevation model that reveals, for the first time, many features that have remained hidden beneath the waves. This vast submerged continental region comprises a variety of geomorphological and geological structures. A combination of seabed maps, characterising the shape and composition of the seafloor, and deep-sea photography, allows us to illustrate and describe the morphological features of the SW Pacific in New Zealand's waters, providing a unique view of the topography of the seafloor, its ecological characteristics and biodiversity hotspots. This mapping product provides significant benefit for all New Zealanders and for all users of the marine environment, revealing potential for fisheries, environmental management, conservation, hazard mitigation, and energy and mineral opportunities, iwi and recreational use, as well as providing key baseline knowledge on which to build well targeted future scientific research.

The Marine Reservoir Effect in the East Tasman Sea & Ocean-atmosphere Carbon Exchange

Helen NEIL // NIWA

Rewi Newnham, Gavin Dunbar, Ashley Pocock // Victoria University of Wellington
Helen Bostock, Lisa Northcote // NIWA
Quan Hua // Australian Nuclear Science & Technology Organisation

Ocean waters have an apparent 14C age that ranges from several hundred to several thousand years older than coeval terrestrial 14C ages. This is the result of deep water upwelling and delay in exchange rates between atmospheric CO_2 and ocean carbon. However, the amplitude of offset has not remained constant over time, or remained the same between different ocean water depths. New Zealand lies at the critical junction between northern-tropical climate influences and those of the Southern Ocean and its sedimentary archives may hold the key to understanding complex climate interactions back many thousands of years beyond historical records. It has been suggested that the Southern Ocean is the most likely area of exchange between the oceanic and atmospheric reservoirs, with intermediate water carrying the 'old' signature to lower latitudes. Evidence from the SW Pacific has shown a rapid increase in benthic foraminiferal 13C at the start of the deglaciation at intermediate depths, indicative of a ventilation event. However, other studies from the SE Pacific have precluded the influence of an old carbon source from the Southern Ocean and indicate that the deglacial 14C depletion previously identified must have involved other contributions, either an expanded influence of a 14C-depleted North Pacific carbon reservoir or an alternatively sourced abyssal reservoir. A depth transect of cores collected in the east Tasman Sea off the west coast of New Zealand, sit at the boundary of northern-sourced and southern-sourced waters. These stratigraphically constrained cores are ideal for assessing deglacial 14C changes in sub-Antarctic mode water, Antarctic Intermediate Water, and upper and lower Circumpolar Deep Water. Here preliminary results of reservoir age variations and ocean ventilation are presented showing variability with time and water mass.

The Density Dependent Effects of Two Key Macrofauna Species on the Breakdown of *Ulva*

Clarisse NIEMAND // The University of Waikato

Agnes Karlson // University of Otago, Stockholm University
Candida Savage // University of Otago
Conrad Pilditch // The University of Waikato

Macroalgal blooms such as *Ulva*, are a common disturbance to estuarine benthic fauna worldwide. As large quantities of macroalgae break free from the growing substrate, drifting mats are formed that eventually deposit in low energy environments including intertidal sandflats. Once these mats start to decompose, the detritus is incorporated into the benthic foodweb, however, the ability to process detritus is likely to depend on the species present. In this study, we examined the density dependent effects of two key intertidal bivalve species (the deposit-feeder *Macomona liliana* and the suspension-feeder *Austrovenus stutchburyi*) on the breakdown, loss and burial of *Ulva*. We collected 72 cores from an intertidal sandflat that spanned natural gradients in bivalve densities and returned them to a laboratory facility that mimicked tidal inundation periods. Labelled (13C and 15N) *Ulva* detritus was added to the surface of each core and 12 days later the sediment was sampled to determine the depth distribution of *Ulva* and the amount remaining (using chlorophyll a (chl a) and isotopes signatures). Initial results showed strong vertical variations in the chl a distribution with community type and bivalve density. Chl a was mixed deep into the sediments in cores dominated by high *Austrovenus* numbers whereas in *Macomona* cores it remained at the surface. These differences in burial depths and mixing are likely to influence detrital processing rates which will be examined using isotopic signatures. Knowledge of *Ulva* detritus processing as a function of community type will aid in our understanding of resilience to the disturbances caused by *macroalgal* blooms.

Barra Gone Wild: Investigating the Genetic Consequences of a Large-scale Escape of Farmed Barramundi (*Lates calcarifer*)

Tansyn NOBLE // James Cook University

Carolyn Smith-Keune, Dean Jerry // James Cook University

Expansion of sea-cage aquaculture has increased incidences of large-scale escapes of farmed fish. Aquaculture stocks commonly differ in genetic profile from wild populations due to few broodstock being used to produce progeny and artificial selection pressures imposed by the culture environment. When mixed with wild populations, farmed fish can significantly affect the genetic profile of the natural population. Escape events are well-characterised for temperate fishes but few studies have reported the occurrence and persistence of tropical fish escapees in the wild. In 2011 a cyclone destroyed a barramundi sea-cage facility in the Hinchinbrook Island region, Queensland, releasing ~280 tonne of fish. One year after the escapee event genetic samples were collected from 403 barramundi within Hinchinbrook Channel. Fish were assigned as farm escapees or wild by matching multi-locus microsatellite genotypes to those of the hatchery broodstock used to produce progeny stocked into the sea cages. DNA parentage analyses confirmed escaped barramundi had become established in the Hinchinbrook population, with 31% of fish sampled of farm origin. A single male-female pairing accounted for 32% of these escapees. Lower levels of genetic variation, high relatedness, and deviations from Hardy-Weinberg expectations were evident among escaped fish. If these fish reproduce then the genetic integrity and level of relatedness of the receiving population may be affected over the longer term. Results emphasise the need to monitor for genetic changes in this population into the future.

Stuck in the Mud: Biogeochemical Processes in Subtidal Sediments in the Firth of Thames, New Zealand

Scott NODDER // NIWA

Craig Depree, John Zeldis // NIWA

Previous NIWA modelling and field investigations of the Firth of Thames, New Zealand, shows that it exhibits a distinct shift from being predominantly heterotrophic in the shallow parts of the embayment that are affected by run-off from agricultural land, to autotrophic in the outer parts of the Firth, where more nutrients are sourced from offshore. In summer 2012, a research voyage onboard RV *Kaharoa* was undertaken to gather information along this heterotrophic-autotrophic gradient to obtain direct estimates of sediment denitrification and oxygen consumption rates in order to corroborate the previous investigations. Two shallow sites (7-8 m, FoT1 and 2) were sampled in the inner part of the firth, where previous fieldwork has observed high air-sea *p*CO2 fluxes (i.e., high community respiration), and two sites sampled in the outer firth (~37 m, FoT3 and 4) at the location of relatively low *p*CO2. Sediments in the inner firth varied markedly, with coarse shell hash at FoT1 and well sorted olive-grey mud at FoT2. Sediments at FoT3 and 4 comprised fine muddy sand to silty clay, with common bivalve fragments. Although the sediments were strongly heterotrophic at all locations, sediment oxygen consumption in the inner firth was almost double the rates in the outer firth. Pore-water concentrations of NH_4 were high at the inner sites, although the anaerobic flux of NH_4 was low suggesting that organic matter in the sediments is mineralised via oxic and suboxic (ie denitrification and Mn/Fe cycling) processes. The results were consistent with predictions regarding the impacts of terrestrial runoff to this key New Zealand coastal area.

Cage-scale Dissolved Oxygen Variability: Clay Point Observations

Joanne O'CALLAGHAN // NIWA

Craig Stevens // NIWA

Dissolved oxygen (DO) is a relative measure of how much oxygen is carried in a fluid. Low DO concentrations are an indicator of poor water quality with major implications for a number of ecosystem functions. In the context of finfish aquaculture, sufficient DO concentrations are necessary for fish respiration and their overall health. Using observations from an experiment at Clay Point, Marlborough Sounds in 2011, cage-scale variability of DO will be discussed. Lower DO concentrations were seen inside a stocked cage when compared to vertical profiles adjacent to the cage, i.e. 75% saturation compared to 90%. Concurrent temperature, salinity and flow observations will explore the physical-biological coupling of cage-scale dynamics.

Porirua Harbour – Part 1: Desperately Seeking Clarity

Megan OLIVER // Greater Wellington Regional Councill

Juliet Milne // Greater Wellington Regional Councill
Mal Green // NIWA
Keith Calderl // Porirua City Council

Porirua Harbour lies on the south-west coast of the North Island, and is regionally significant comprising two largely subtidal estuaries, the Pauatahanui and Onepoto inlets. Despite high ecological, cultural and recreational values, both estuaries have suffered from contamination and habitat loss due to catchment run-off and reclamation. Since 2011, Greater Wellington Regional Council (GWRC) has convened annual Porirua Harbour and catchment science workshops to discuss environmental pressures and research and monitoring priorities to support the management of these estuaries. In 2012, the Porirua Harbour and Catchment Strategy and Action Plan was launched to address the three main environmental issues: sedimentation, pollution (toxicants and nutrients) and habitat loss. This strategy is a collaboration between Porirua City Council, Wellington City Council, GWRC and Ngati Toa and outlines a set of initiatives to address the issues. Following the first science workshop, sedimentation was identified as the biggest issue facing the harbour and the one, which if reduced through improved catchment management, would also lower pollution and enhance habitat restoration efforts. Subsequently, a target areal sedimentation rate of 1 mm/year has been agreed, which lies between the pre-human and present-day sedimentation rates. In this presentation, which is the first of two talks on managing sedimentation in Porirua Harbour, we discuss the sedimentation issue and how the target sedimentation rate has been arrived at.

Managing Water Quality & Allocation in the Waianakarua River

Dean OLSEN // Otago Regional Council

The Waianakarua River is a medium-sized river in North Otago that flows out of a catchment that supports a diverse range of land uses including extensive pastoral farming (35%), intensive farming (9%), and plantation forestry (9%). In addition, there is substantial consumptive abstraction of water for agriculture. Recent surveys indicate that the Waianakarua catchment supports a very diverse and abundant fish community and good water quality, although the presence of benthic cyanobacteria mats during summer has resulted in the warning signage. Otago Regional Council has implemented several planning instruments that will affect how the Waianakarua catchment is managed in the future, including the establishment of a minimum flow and allocation limit as well as water quality standards for the catchment, discharge limits and limits on nitrogen leaching rates.

Fine-tuning the Rotorua Lakes Stocking Program

Matt OSBORNE // Fish & Game New Zealand

The Rotorua Lakes Selective Breeding Program has been working for around 35 years to produce and liberate quality stock to the Eastern Fish & Game Region. Lack of sufficient spawning tributaries dictates a requirement for stocking to meet high angler demand. But can we work smarter to maximise returns for the angler's dollar. Recently undertaken research suggests that spreading liberations over a wider timeframe is beneficial to survival and angler return rather than one off mass-release's that have been the norm in the past. Utilizing the 'datawatch' tagged fish monitoring program, 500 'T-bar' tagged rainbow trout (*Oncorhynchus mykiss*) were liberated into Lake Tarawera each month during 2010. Subsequent angler and fish-trap tag-returns have illustrated the importance of timing trout liberations to avoid the incidence of early and/or late onset winters that may affect yearling trout survival. The results obtained to date will be discussed.

Kakanui River, Otago Implications of Groundwater-Surface Water Interaction

Rachel OZANNE // Otago Regional Council

The Kakanui River's water resource is heavily used for irrigation purposes. The river has three minimum flow sites to manage water quantity, but concern has been expressed about degradation of the water quality, particularly since the introduction of irrigation water which has allowed for agricultural intensification. A significant input of nitrogen (N) occurs between the upper and lower Kakanui which changes the main-stem of the Kakanui from N-limited to P-limited. This change in chemistry is a result of high N-groundwater input, sourced mainly from animal waste. The drying up of a tributary of the Kakanui during the summer months increases the proportion of nutrient-rich groundwater contribution to flow. As a result of the input of high N-groundwater, the lower Kakanui is unlikely to achieve low enough concentrations of N to prevent the recent proliferation of benthic algae biomass.

Energy use in Australian Fisheries: Economic Performance, Environmental Impact, & Implications for Management

Robert PARKER // University of Tasmania

Anna Farmery, Klaas Hartmann, Bridget Green, Caleb Gardner // University of Tasmania

Energy inputs to fisheries production are of increasing concern, as they represent both a growing cost to fishermen and a source of greenhouse gas emissions. Measuring and improving energy performance of fisheries is critical to efforts to transition the industry into a world of increasing fuel prices, emissions-based regulations, and consumer demands for low-carbon production. We assessed a range of Australian fisheries on the basis of fuel consumption as a driver of both environmental impact and operational costs. We compared fisheries operating in different regions, targeting different species and employing different gears. This enabled us to identify those fisheries which are most dependent on the input of fossil fuels, and therefore may be most vulnerable to volatility in fuel commodity prices. Many Australian fisheries, particularly crustacean fisheries, which have historically been more energy-intensive, have demonstrated the ability to adapt to increasing fuel prices, with some decreasing their consumption by more than 50% over the past decade. Numerous factors influence the energy performance of fisheries, and decisions made at the regulatory level may have significant impacts – both positive and negative – which should be taken into consideration to ensure long-term economic and environmental sustainability. We explore some of these management implications in relation to observed patterns and trends in fuel use by Australian fisheries.

A Life History Review for New Zealand Snapper

Darren PARSONS // NIWA

Carina Sim-Smith // ClearSight Consultants Ltd

Tom Trnski // Auckland War Memorial Museum
Martin Cryer // Ministry for Primary Industries
Malcolm Francis, Bruce Hartill Emma Jones, Agnès Le Port, Jeremy McKenzie, Mark Morrison, Keren Spong, John Zeldis // NIWA
Larry Paul // NIWA (formerly)
Craig Radford // The University of Auckland
Phil Ross // The University of Waikato
Natalie Usmar // Saltwater Science
Cameron Walsh // Stock Monitoring Services

Snapper populations have contributed to important fisheries in New Zealand for hundreds of years and also form a crucial part of inshore ecosystems. As a result, more research has been conducted on snapper than nearly any other New Zealand fish species. A growing dimension to this research is the consideration of a broader ecosystem context to all impacts on snapper populations (also known as an Ecosystem Approach to Fisheries). As such, it is timely that ten years on from a previous workshop on snapper, the life history and environmental interactions of snapper in New Zealand are being reviewed. Here I present highlights from a workshop of New Zealand snapper researchers that addressed the life history and threats to snapper populations going forward.

The International Framework Governing the Role of Science in High Seas Fisheries

Rosemary PATERSON // Ministry of Foreign Affairs and Trade, New Zealand

An outline of the development of the international framework governing the role of science in fisheries management for high seas fisheries, as well as for fisheries within areas of national jurisdiction. The fundamental obligations in the 1982 United Nations Convention on the Law of the Sea (UNCLOS) have been elaborated through the Rio processes (Agenda 21 and the Convention on Biological Diversity). The UN Fish Stocks Agreement further advanced the role of science, and this has been reflected in modern Fisheries Management Organisations such as the new South Pacific Regional Fisheries Management Organisation. Rules and guidelines governing sustainable management of fish stocks as well as to protect vulnerable marine ecosystems have been developed through the various UN processes, via the Food and Agriculture Organisation (FAO), the CBD and relevant UN Resolutions. In particular, the annual UN General Assembly Resolution on Sustainable Fisheries and the 2008 FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas directly impact the application of science in this area.

A Big Body Essential to Inhabit Estuaries: a Study on Mysids of Southern New Zealand?

Sourav PAUL // University of Otago

Gerry Closs, Keith Probert, Jolyn Chia // University of Otago
Mackenzie Gilliam // University of California Davis

In temperate estuaries, mysid distribution could be limited by an interaction between physiological tolerance and life-history, specifically mediated by body size. We tested such ideas by contrasting up-downstream distribution of two common estuarine mysids (*Tenagomysis chiltoni*: large bodied, dominant in upstream, one cohort per year and *T.novaezealandiae*: small bodied, dominant in downstream, multiple cohorts per year) species in southern New Zealand. Previous work has indicated limited survival in fresh or sea water in cold conditions (< 5°C), particularly for juveniles. In this study, we examined growth and fecundity in relation to distribution. Our field study indicated that fecundity of gravid females was positively related to body size, with larger bodied *T. chiltoni* being the most fecund. Environmental control of fecundity was also evident: Gravid *T. novaezealandiae* were larger and more fecund in spring than autumn, and both species were larger and more fecund in intermittent estuaries which have agricultural and urban influence. In a subsequent growth experiment, salinity and food quality interact to influence growth of sub-adults. We are building different growth models to explore their maturity time under different habitat conditions. We suggest that cold freshwater in the upper reaches of estuaries may restrict *T. chiltoni* to spawning once per year, and to overcome such fecundity constraints they must grow larger than *T. novaezealandiae* which can take advantage of more saline and probably productive conditions downstream to grow faster and produce >1 cohort per year.

Global Expectations & Requirements for science to Support High-seas Management

Andrew PENNEY // Australian Bureau of Agricultural and Resource Economics and Sciences

The adoption of UN General Assembly Resolution 61/105 on Sustainable Fisheries in 2007 dramatically changed international expectations regarding protection of vulnerable marine ecosystems and low productivity fish stocks in the high seas, and the information required to do so. In parallel, conferences of the Convention on Biodiversity have established increasing requirements to assess and protect high-seas biodiversity, resulting in an ongoing process to identify Ecologically or Biologically Significant Areas. While the FAO and CBD have provided guidelines on how these requirements might be met, many of the details of how this should be done have intentionally been left vague. This has provided scientists participating in RFMOs or CBD processes with substantial challenges on how to interpret these requirements, how to clarify the aspects that have been left vague, what information is required to provide the necessary advice and what methods are appropriate for generating reliable analyses under circumstances of low information and high uncertainty. This presentation will briefly identify these challenges; give a brief overview of what science has so far been attempted; and what gaps remain in providing the advice and evidence needed to support wise management decisions for the high seas.

Flood Protection & Aquatic Ecology: Investigating the Effects of Gravel Extraction on the Hutt River

Alton PERRIE // Greater Wellington Regional Council

Flood protection works involving channel realignment and gravel extraction are common activities in the beds of rivers and streams across the Wellington region (and elsewhere). However, the ecological effects of these works are largely unknown. To further our understanding, in 2012 Greater Wellington Regional Council commenced a series of investigations, one of which was to assess the effects of gravel extraction from the wetted channel on the aquatic ecology of the Hutt River. Quantitative backpack electric fishing, macroinvertebrate sampling and habitat assessments were undertaken from riffle habitat at the 'impact' site prior to gravel extraction, immediately after gravel extraction and approximately seven weeks later. Two 'non-impact' sites, located approximately 1 km upstream and 1 km downstream of the gravel extraction site, were assessed in the same manner. Of data analysed so far, gravel extraction resulted in changes in substrate size and a decline in abundance in the most commonly caught fish prior to the extraction (bluegill bully). However, this decline in abundance was mirrored at the site located upstream of the gravel extraction activity, whereas abundance of bluegill bullies increased downstream. Changes in the river flow path as a result of the extraction activity also resulted in the stranding of hundreds of fish, including a number of threatened species. The results of the investigation are discussed in the context of managing a river with significant ecological values alongside the need for ongoing engineering intervention to protect people and property from flooding.

Integration of Biological Traits into Regional Biomonitoring Programmes

Ngaire PHILLIPS // Streamlined Environmental

Kevin Collier // Waikato Regional Council
Martin Neale // Auckland Council

Regional councils generally employ metrics based on macroinvertebrate taxonomic composition to describe the ecological health of the region's aquatic resources. An alternative approach is to use the biological traits of macroinvertebrates, as these reflect changes in ecosystem function rather than just changes in macroinvertebrate composition. Trait-based biomonitoring would fit readily into existing biomonitoring frameworks employed by regional authorities, as the basic information (site-by-species composition matrices) is already collected. For traits (categories or modalities) to be considered for integration into existing biological monitoring programmes, they would ideally need to satisfy the following criteria: (a) display low levels of variation within categories of land-use intensity, and significant power to discriminate medium from low or high levels of development; (b) display greater discriminatory power than that achieved by standard metrics; and (c) possess the ability to diagnose causal factors. In this presentation, we combine data from 2 regional councils to examine the potential application of traits to biological monitoring, using the land uses of native vegetation and rural development. We also present the outcomes of a more detailed analysis of a native vegetation-to-urban development gradient, using Auckland Council's Freshwater Ecology Programme. We discuss the outcomes of these analyses, identifying a core set of traits that could be integrated into existing biomonitoring programmes run by regional authorities.

Effects of the Antihistamine Diphenhydramine on Algae & Biofilm

Chuyen PHUNG // Monash University

Michael Grace, Terence Chan // Monash University
Lawton Shaw // Athabasca University

This study investigated the impacts of an antihistamine medication, diphenhydramine, on the algae *Scenedesmus* sp. and on naturally occurring biofilm. Diphenhydramine, as other pharmaceuticals and personal care products, typically presents in surface waters at trace concentrations, and has also been identified in sediment and fish tissues. However, its ecological effects are largely unknown, especially at the low level concentrations, which have been found in the natural environment. In terms of the effects of diphenhydramine on algae, experiments for determining acute and chronic toxicity were conducted at environmentally relevant concentrations, for up to 11 days. Growth rate, respiration rate and gross primary production of the *Scenedesmus* sp. were measured. The results show that chronic effects were more likely to appear than acute effects. There was no detectable impact on the growth rate of the algae, while there was evidence of suppressive effects on both respiration rate and gross primary production of *Scenedesmus* sp. Pharmaceutical Diffusing Substrates (PHADS) were used to examine the impacts of chronic exposure of diphenhydramine on biofilms, a more ecologically complex and environmentally representative system of microorganisms. These substrates were deployed in Jock Marshall Reserve Lake (Victoria, Australia) for three weeks to allow biofilms to colonise and grow. After recovery, the biofilms were analysed in terms of chlorophyll a, respiration rate and gross primary production. Changes in these variables help characterize biofilm's responses to diphenhydramine. The most striking results were that diphenhydramine strongly suppressed biomass (chlorophyll a) and gross primary production, compared to the controls.

Modelling –Developing a Strategic & Dynamic Management Tool for the Marine Environment

Vernon PICKETT // Waikato Regional Council

Dougal Greer, Jose Borrero, Ed Atkin // eCoast
Cathy Liu // Waikato Regional Council, University of Waikato
Hilke Giles // Waikato Regional Council

Having a good understanding of the nearshore environment is of critical importance to achieving sound resource management practice. A truism, right? However in the rough and tumble of policy making and implementation pragmatism often rules, time frames for decision-making are often short, and existing information and resources are often extremely limited. Consequently high reliance is placed on professional judgement and general theories (research based or otherwise), sometimes leading to high levels of uncertainty, that can lead to conservative and sometimes misdirected decision-making. In order to address these problems and improve the level of applied science surrounding Council's functional activities, Waikato Regional Council has embarked on developing the use of digital technologies to improve their understanding of the marine environment. One element of this work involves the use and development of numerical modelling as a decision support tool to address needs within the organisation and the community. This paper will address our experiences to date in developing this technology using various estuarine and coastal model outputs as examples to illustrate its potential use in areas as diverse as natural hazard management, sediment and contaminant transport, bio-security assessments, and surf break protection. This presentation will also address the need for improved data acquisition technologies, such as monitoring buoys and remote sensing, as well as collaboration among organisations and access to open data in order to achieve larger scale integrated marine management approaches. One such approach is the Waikato Marine Management Model, which will be briefly introduced here but presented in more detail in following presentations.

High Intensity Survey & Multivariate Statistics Reveal Zones Along the Longitudinal profile of the lower Waikato River: Implications for Food Webs

Michael PINGRAM // Department of Conservation, University of Waikato

Kevin Collier // Waikato Regional Council, University of Waikato
David Hamilton, Brendan Hicks // The University of Waikato
Bruno David // Waikato Regional Council

The importance of environmental heterogeneity and discontinuities in lotic ecosystems is well recognised and continues to underpin studies of hierarchical patch dynamics, geomorphology and landscape ecology. These patterns and features can be important drivers of river food webs and ecological function. The primary aim of this study was to locate and characterise zones of potential ecological importance along the lower Waikato River in North Island, New Zealand, using a combination of high-frequency, along-river water quality measurements collected in four seasons, and river channel morphology data derived from aerial photos. Multivariate analyses were implemented to classify river reaches in an a priori unstructured manner along the 134-km surveyed distance and to then identify zones. The resulting clusters of physico-chemical and morphological descriptors identified zones that represent useful spatial units for management and to underpin ecological studies such as the development of food web models. These zones were shaped by the physical complexity and channel character of constituent river reaches, and shifts, sometimes transitional, of physico-chemical variables. Changes in water clarity, chlorophyll fluorescence and specific conductance were driven by tributary inflows and chlorophyll fluorescence increased in the tidal freshwater section of the lower Waikato River. The results highlight the dynamic spatial and temporal properties of these zones which respond over different scales to climatic and hydrological changes, and which are likely to lead to differences in carbon flow and other aspects of food web structure in the lower Waikato River.

Foodweb Modelling of the Hauraki Gulf: Integrating Archaeology, History, Fisheries Science & Ecology

Matt PINKERTON // NIWA

Alison MacDiarmid // NIWA

Foodweb modelling was used to explore how the structure and functioning of the Hauraki Gulf ecosystem has changed during human occupation. We developed 5 food-web models: (1) present day; (2) 1950 AD, just prior to onset of industrial-scale fishing; (3) 1790 AD, before European whaling and sealing; (4) 1500 AD, early Maori settlement phase; (5) 1000 AD, before human settlement in New Zealand. Each model quantifies the flow of organic matter through the marine food-web over an annual period. The model has groups representing biota from bacteria to whales. As part of this project, 10 expert groups provided information to help estimate an initial set of over 700 parameters. Biomass and catch parameters were derived from information including historical reconstructions of catch histories, fisheries stock modelling, historical evidence, archaeological information (middens), reconstructions of past climate, or evidence gleaned from narratives. A semi-objective balancing method was used to adjust simultaneously all parameters, minimizing changes in parameters while taking into account relative uncertainties. Trophic levels in the present day model agreed well with stable isotope data taken in the study area. The historical ecosystem models reveal substantial changes in the pattern of ecological importance during human occupation. In the models, marine mammals, sharks and crayfish have declined in ecological importance, while birds, smaller fish (large reef fish, kahawai, snapper), and crabs have increased in ecological importance.

Enhancing Environmental Biomonitoring Using Next-generation Sequencing (NGS) Tools

Xavier POCHON // Cawthron Institute

Kirsty Smith, Nigel Keeley, Susanna Wood // Cawthron Institute
Nathan Bott // South Australian Research Institute
Jan Pawlowski // University of Geneva

Recent technological advances in molecular methodologies provide opportunities to develop innovative diagnostic tools that can streamline and reduce costs associated with biological monitoring. Next-Generation Sequencing (NGS) is a relatively new technique that can produce enormous volumes of DNA or RNA sequence data cost effectively. This provides potential for sensitive and rapid detection of all organisms present in any given environmental sample (water, soil, sediment). The technique can be applied to a huge range of organisms expanding the scope of monitoring programs into biota and/or habitat groups that are currently not being surveyed due to technical limitations or poor taxonomic knowledge. Two ongoing research projects will be showcased to illustrate the pros and cons of using NGS for monitoring aquatic ecosystems in New Zealand. The first project investigates the detection limits of NGS (using the 454 pyrosequencing platform) with direct implications for the early detection of a range of key-threats marine invasive species. The second project explores the capacity of NGS (using Illumina and IonTorrent sequencers) for environmental monitoring of bioindicator foraminiferal communities around fin-fish farms. Once validated, NGS-based tools have tremendous potential for improving New Zealand's environmental management of a variety of freshwater and marine ecosystems.

Measuring & Modelling Water Column Nutrients & Sea Lettuce Blooms in Tauranga Harbour

Alex PORT // The University of Waikato

Karin Bryan, Conrad Pilditch, Kai Bischof, David Hamilton // The University of Waikato

Nuisance blooms of sea lettuce (*Ulva* spp.) have been occurring in Tauranga Harbour since at least the early 1990s, but it is still unclear which environmental factors control or trigger these events. We examine over 20 years of available monitoring data of intertidal sea lettuce abundance, water column nutrients and related parameters, as well as observations from a recent field campaign. The latter provides previously unavailable data on the spatial (distinctive subregions within the estuary) and temporal (consecutive tides to seasonal) variability of water column nutrients as well as on the drifting population of sea lettuce (estimates of biomass standing stock and flux from / to a subregion). Preliminary results show differences in absolute concentrations of dissolved water column nutrients between subregions (e.g., catchment-, intertidally- and subtidally-dominated). Net fluxes over consecutive tides also vary considerably over a season and between sites, and fortnightly sampling at selected sites is ongoing to investigate the consequences for time-averaged import/export balances. Drifting sea lettuce biomass at times reaches levels high enough to warrant consideration as both a separate pool and flux pathway of nutrients bound in macroscopic tissue fragments, whose hydrodynamic transport is most likely quite different from dissolved and fine particulate water column nutrients. Using process-based / mechanistic mathematical models, we determine the likely interactions and relative importance of these environmental factors in controlling sea lettuce blooms.

The Effects of Short-term Increases in Turbidity on Intertidal Microphytobenthic Productivity & Nutrient Fluxes

Daniel PRATT // The University of Waikato

Conrad Pilditch // The University of Waikato
Andrew Lohrer, Simon Thrush // NIWA

Turbidity is a major factor limiting benthic primary production and nutrient uptake on estuarine intertidal sandflats during immersion periods. Estuaries can exhibit a wide range of suspended sediment concentrations (SSC), however, few studies have quantified the effects of on benthic primary producers. Here, we report on an in situ experiment examining the effects of short-term increases in SSC on sandflat primary production and nutrient fluxes. Fine sediments (< 63 µm) were added to sunlit and darkened benthic chambers (0.25 m^2) at concentrations ranging from 16–157 mg L^{-1} and kept in suspension for a 4–5 h incubation period. In addition to solute fluxes we also measured macrofaunal composition, sediment photopigment concentrations and physical properties. In sunlit chambers, we observed a three-fold reduction in net primary production (NPP) with increasing SSC (NPP, R^2 = 0.36, p = 0.05) and stronger reductions when NPP was standardised by sediment chlorophyll-*a* content (i.e., photosynthetic efficiency, $NPP_{chl\text{-}a}$, R^2 = 0.62, $p \leq 0.01$). Concurrent with reductions in photosynthetic efficiency, there was a four-fold increase in nutrient efflux from the sediment to the water column (NH_4^+, R^2 = 0.44, $p < 0.01$). SSC had no effect on solute fluxes in darkened chambers. Changes in primary production and NH_4^+ efflux were only correlated with SSC and light intensity. Our results imply that increased exposure to sedimentation and frequency of storm events may severely impair benthic primary productivity and increase the flux of inorganic nutrients from benthic to pelagic systems.

'Toxic in Crowds' – Mapping Cyanotoxin Production Across a Eutrophic Lake

Jonathan PUDDICK // Cawthron Institute

Susie Wood // Cawthron Institute
Daniel Dietrich // University of Konstanz
Shelly Rogers, Michèle Prinsep, Craig Cary, David Hamilton // The University of Waikato

Toxic cyanobacterial blooms are increasing in prevalence globally. Of the known cyanobacterial toxins the hepatotoxic microcystins are the most notorious. Laboratory studies have shown correlations between the amount of microcystin produced per cell and a multitude of physiochemical variables including nutrients, temperature and pH. Whilst these laboratory based experiments allow environmental conditions to be stringently controlled, studying cyanobacteria in these 'artificial' environments may alter or remove variables that regulate microcystin production. Over the past three years, our group has been performing experimental manipulations using mesocosms (55-L polythene chambers suspended in a lake) to study toxin production in a more natural environment. During these studies we mimicked the formation of a cyanobacterial bloom or scum by adding concentrated suspensions of cyanobacteria to the mesososms. These experiments demonstrated a strong correlation between microcystin production and cell density in the mesocosms. This year we profiled a small eutrophic lake (Lake Rotorua, Kaikoura) to explore whether this same phenomenon occurred naturally with spatial variation in cell density around the lake. Cyanobacterial density was assessed fluorometrically and spatial/depth samples were collected to determine cell and microcystin concentrations, examine the expression of genes involved in toxin production and to ascertain nutrient levels. This whole lake profile is being used to elucidate how interactions between abiotic and biotic variables influence microcystin synthesis and may ultimately help to predict parts of a lake or periods of greatest health risk.

One Size Fits All? A Regulatory Approach to Utilising Discharge Limits to Achieve Improved Environmental Outcomes

Justine QUINN // Auckland Council

Leon Blackburn // Auckland Council

It is common knowledge that intervention is necessary to mitigate the ongoing effects of urban contamination on our waterways. Intervention is usually achieved via discharge consents, granted only if appropriate management practices are implemented to avoid, remedy or mitigate effects on the receiving environment. However, insufficient data exist to determine whether the proposed controls and limits are achieving environmental outcomes. In particular, not enough is known about specific receiving environments, which makes setting discharge limits 'guesswork'. Industrial and Trade Activities (ITA) within the Auckland region often rely on the perceived performance of 'standard' treatment devices rather than providing a full AEE which considers their specific receiving environment. Relying on the perceived performance of a device is only a suitable approach if all receiving environments are the same. The need to review and set water quality limits at a catchment level is gaining momentum with the advent of the NPS: Freshwater Management, the Auckland Council Unitary Plan and the proposed 'super catchment' Network Discharge Consents. With this in mind, better information about the likely tolerances of specific receiving environments is required to inform the consent process. Moving forward, environmental improvement cannot be achieved if councils and businesses continue to operate in an isolated manner. All parties need to recognise the constraints and opportunities and work collaboratively to achieve the best environmental outcomes possible.

Periphyton & Nutrient Interactions Along the Tukituki River Under Drought, Wet & Normal Summers

John QUINN // NIWA

Kit Rutherford, Bob Wilcock // NIWA
Roger Young // Cawthron Institute
Troy Baisden // GNS Science
Sherry Schiff // University of Waterloo
Michael English // Wilfred Laurier University

Nutrient-periphyton interactions were investigated during summer under normal (2011), wet (2012) and drought (2013) conditions along a 90 km long, nutrient gradient in the mid-lower Tukituki River, that is driven by nutrient attenuation below upstream inputs of enriched groundwater and treated sewage. Steep gradients in dissolved N and P concentrations occurred over the top 30–40 km below nutrient inputs under normal and drought conditions, whereas in wet 2012 the gentler gradient extended over 90 km. These patterns were related to spatial and temporal differences in flow, temperature, periphyton biomass and ecosystem metabolism. In situ recirculating chamber studies showed contrasting patterns of uptake/release of dissolved inorganic and organic nutrients between light and dark conditions that were reflected in whole river observations at dawn vs daytime. Periphyton abundance and community type (filamentous greens (FGA) vs cyanobacterial/diatom mats (mats) were related to flow pattern, local velocity, nutrients, substrate size and invertebrates. Nutrient flux influenced the dominant community type along the gradient and reach scale distribution among different habitats. Under moderate-high nutrient conditions upstream, % cover by mats increased with velocity, whereas FGA decreased. In contrast, at very low nutrient levels, downstream under drought, mats were absent and FGA were strongly associated with high velocity. Periphyton nutrient content (N/C and P/C ratios) decreased with distance downstream, a pattern that was accentuated under drought conditions when nutrient depletion was greatest. The findings have fed into the Tukituki River Integrated Management Model (TRIM).

The Effect of Suspended Sediment on Oxygen Consumption in *Haliotis iris*

Taputukura RAEA // Victoria University of Wellington

Dr Sonja Miller, Dr Joe Zuccarello // Victoria University of Wellington

In New Zealand sedimentation is the most important land-based stressor on the coastal marine environment. The effects of suspended and deposited sediments on marine organisms include suffocation, reduced foraging efficiency and clogging of the gills of filter feeders. The blackfoot abalone, *Haliotis iris* (more commonly known as paua) is endemic to New Zealand, comprising highly valued customary, recreational and commercial fisheries. Suspended sediment has been shown to increase mortality in *H. iris* larvae, while juvenile *H. iris* are known to avoid deposited sediment. However, little else is known about the effects of sedimentation on *H. iris*. It has been suggested that high concentrations of suspended solids may block the gills of *H. iris* incurring a metabolic cost due to increased mucous production to clear suspended solids from gills. I carried out preliminary work to examine whether suspended sediment affects oxygen consumption in *H. iris*. Oxygen consumption was significantly reduced when *H. iris* was exposed to elevated suspended sediment loads. I present further work in progress that looks at the effect of suspended sediment on oxygen consumption in *H. iris* and suggest possible implications for pāua fisheries in New Zealand.

Communicating Science Across the Marae

Hannah RAINFORTH // Ngāti Rangi Trust

Iwi and hapū experiences of western science have not always been characterised by positive interactions. There have been misunderstandings. Knowledge systems have not always been respected, on both sides. Yet iwi remain deeply interested in developments that assist in understanding and caring for their rohe and environment. When these developments have arisen primarily out of a western-science framework, there is a need for western-based scientists to communicate the new knowledge across the marae. Similarly, western-based scientists need to know how to listen to the science held by iwi and hapū. In a context where iwi and scientists are seeking to work more closely together, communication needs to be a gateway, not be used as a gatekeeper. This paper explores how to communicate science – both western and iwi-based – between communities and practitioners. Examples of how to translate between iwi and western science languages will be presented, along with an exploration of the differences and similarities in the underlying frameworks and how to find the common ground that will spark interest, trust, and respect.

Molecular Tools to Ensure Safe New Zealand Seafood – Harmful Algae Bloom Species

Lesley RHODES // Cawthron Institute

Kirsty Smith, Janet Adamson, Viliami Langi, Mandy Edgar // Cawthron Institute

Two decades have passed since a major harmful algae bloom (HAB) in the Hauraki Gulf led to a New Zealand-wide ban on shellfish harvesting until monitoring programmes were instigated. Since that time the identification and quantification of HAB species has been carried out routinely by Cawthron Institute's Micro-algae Laboratory. The analyses are labour intensive and molecular tools are seen as the logical future of phytoplankton monitoring.

Fluorescent in situ hybridisation assays have been available commercially for more than a decade to differentiate between neurotoxin producing and non-toxic species of the diatom genus *Pseudo-nitzschia*. Sandwich hybridisation assays (SHA) are available commercially for the fish-killing raphidophytes and this chemistry is used in the autonomous in *situ* Environmental Sampling Processor (ESP), developed by the Monterey Bay Aquarium Research Institute, USA. Quantitative PCR (qPCR) assays have been developed for neurotoxin producing *Karenia* species and paralytic shellfish poisoning *Alexandrium* species (including resting cysts). QPCR technology has also been adapted for use in the ESP, which was successfully deployed in Tasman Bay, Nelson, in 2012. A SHA array for the simultaneous detection of multiple HAB species was included in that deployment. In the future it is expected that, with climate change and predicted HAB range expansion, monitoring programmes will need to include the identification of potentially toxic tropical and sub-tropical species. As these species are often benthic or epiphytic, internationally accredited sampling protocols are currently being developed. Future work will also focus on the use of Next Generation Sequencing technologies for the detection and enumeration of multiple species from complex environmental samples.

Taking Strength from our Partnerships

Tom ROA // Waikato-Tainui

Opportunities to reinforce the principles and visions of tuupuna (ancestors) and past tribal leaders to restore the mana (prestige) of te tupuna awa o Waikato (the ancestral river of Waikato), have recently become a reality with the introduction into legislation of the Waikato River Settlement Deed. Opportunities include korero (discussion) and mahitahi (working together) with other iwi (tribes) on key matters of local, regional and national importance, and at the forefront of that korero and mahitahi, is the whakatauki (saying), ko au te awa, ko te awa ko au (I am the river and the river is me). The positives that emerge for Waikato-Tainui apart from the strengths of mahitahi is the ultimate realisation that restoring the mauri (life force) or health and well-being of te tupuna awa (ancestral river), will enable Waikato-Tainui and other river iwi to move forward as an iwi.

Matauranga Maori, Science & Health of the Toreparu Wetlands

Mahuru ROBB // The University of Waikato

Ian Duggan // The University of Waikato
Shaun Awatere // Landcare Research – Manaaki Whenua

Wetlands provide critical habitat for native flora and fauna, along with a range of ecosystem services. With the loss of over 75% of original wetland extent in the Waikato, and continued degradation of many that remain, these habitats urgently require management plans that engage and communicate effectively with local communities and encompass a variety of values. Much of our understanding of wetland function and "health" is from studies based on western science methods. However, there is a wealth of knowledge to be gained from other methods of measuring health. Cultural knowledge and the development of cultural value-based indicators actively engage indigenous communities and provide effective tools to assist in wetland management. The Wetland Cultural Health Index (WCHI) was developed to encompass these values when assessing wetlands. The Toreparu wetland covers 223 ha and is located between Raglan and Aotea Harbour, along the Waikato west coast. The Toreparu is classified as a 'swamp' and is of high conservation value. It is very important to the people of Mōtakotako marae, playing an integral part in their cultural wellbeing; it has a rich history and is home to many taonga species. Working with tangata whenua we are developing a site-specific WCHI, and seek to understand how WCHI's and western science methods can work together to assess the health of the Toreparu wetland. We present preliminary results of this work which illustrates that western science based knowledge alone may be insufficient for the successful management of culturally important sites such as the Toreparu wetland.

Gold Coast Seaway SmartRelease: a Smarter Way for Managing Releases from Wastewater Treatment Plants

Colin ROBERTS // DHI

Anna Symonds // DHI

The Gold Coast water agency Allconnex Water is responsible for the release of excess recycled water into the Gold Coast Seaway. To meet future service levels, Allconnex Water required a solution capable of improving water quality in the intra-coastal waterway while accommodating increasing loads on treatment plants. A "SmartRelease" strategy was implemented to improve the timing of each release to coincide with the non-symmetrical fluxes out of the Seaway. This is managed through an operational decision support system ensuring a solution that is not only more cost-effective but gives the best possible outcome for the natural environment. The decision support system provides a shell around a detailed computational modelling suite that collects external data, schedules the model simulations, presents the results on an intranet page and stores information in a database for further reference. The computational modelling suite includes a high resolution 3D model representing the outfall plume dynamics and a 2D model representation of hydrodynamic variations due to wind, wave and tidal forcing (produced from a Pacific Ocean spectral wave and hydrodynamic models) for the Seaway area. The system is designed to optimise the release taking into account the operational requirements at the waste water treatment plant, the water quality in the natural receiving waters and the energy consumption while pumping out the recycled water. The award winning Seaway SmartRelease system improves water quality and defers the need for $60m in infrastructure to cope with the increased load on the wastewater treatment plant from the growing population.

Engaging Ways to Present Information from Computational Hydro-ecological Models

Colin ROBERTS // DHI

Computational models describing the movement of water and behaviour of hydro-ecosystems are valuable tools in understanding, assessing and managing the effects of impacts on the systems. More importantly, these tools have the potential to provide an excellent way of presenting complex information on hydro-ecosystems to the public. This paper will present an overview of some of the different and more engaging ways in which our data and information can be communicated. As examples it will include 3D visualisation of water movement, animated display of aquatic species behaviour and the role of serious gaming in communicating science.

Behaviour of the Australian Lungfish (*Neoceratus forsteri*) During Flood Releases in a Large Impoundment Habitat

David ROBERTS // Seqwater

Hamish Campbell, Ross Dwyer // University of Queensland
Kris Pitman // Pitman Consulting

The Australian lungfish (*Neoceratodus forsteri*) is a nationally listed vulnerable species. This listing reflects numerous threats that occur within its restricted natural range, including potential negative impacts from riverine impoundments. Flood releases at impoundments can result in increased mortality risk due to physical damage of fish passing over spillways. For this reason information on how lungfish interact with spillway structures is needed to provide adaptive management responses to mitigate these risks. This study investigates the behavioural patterns of lungfish associated with controlled releases of flood water from a gated spillway. Horizontal and vertical movements of 14 individual lungfish were compared before, during and after a series of flood events of variable magnitude and duration to assess behavioural patterns. Lungfish were tracked using acoustic transmitters and an overlapping array of omnidirectional acoustic receivers to provide accurate position estimates every three minutes. These telemetry data were combined with spatially explicit environmental information (i.e. bathymetry, distance to dam wall, distance to lake margin) to assess changes in behaviour and habitat utilisation patterns associated with flood events. In general, lungfish preferred shallow water (<8 m) regions, rarely spending time in open water areas. Activity levels increased during flood events with some individuals ranging over large distances. Of the fourteen individuals tagged, one fish survived passage downstream over the dam spillway. This study provides greater understanding of lungfish behaviour within large impoundments, particularly dam spillways during flood events. Results will be used to inform management actions to mitigate impoundment-related risks on lungfish populations.

Restoration of Large-scale Wetland Ecosystems: Understanding the State, Functioning & Trajectory of Whangamarino Eetland

Hugh ROBERTSON // Department of Conservation

Paula Reeves // Wildland Consultants

Wetlands associated with large riverine systems are subject to a range of human-induced pressures. In New Zealand the intensification of land use and river regulation has altered ecological processes through modifications to hydrological regimes and nutrient and sediment inputs, changing the biological composition, physico-chemical state and resilience of downstream wetlands. While improved wetland management is increasingly advocated, science-driven projects that restore large-scale systems are relatively uncommon. The Department of Conservation initiated the Arawai Kākāriki wetland restoration programme in 2007 at three of New Zealand's foremost freshwater sites, including Whangamarino wetland. Whangamarino forms part of the Lower Waikato River Flood Control Scheme (FCS) making it susceptible to periodic flooding. Our hypothesis was that maximum water levels, and associated pollutant loads, are above the limit necessary to maintain ecological integrity. Ecological assembly rules were applied to determine wetland vegetation response to alternative hydrological scenarios, integrating water balance models, habitat mapping and relationships between plant composition and soil chemistry. Native plant dominance (mean % cover) was directly related to flood extent and soil phosphorus (TP mg/kg) under current conditions (Bog: cover 100%, TP 309 mg/kg; Fen: 75%, 761 mg/kg; Swamp: 25%, 986 mg/kg). Assembly rules indicate introduced taxa resilient to fluctuating conditions (facultative wetland plants, max. plant height > max. water depth, annual life-history) will increase in dominance under existing FCS operation. Mitigation options that consider trade-offs between wetland conservation and river management are compounded by the large-scale and socio-economic values associated with the Waikato River floodplain.

Setting Defensible Estuary Monitoring & Management Priorities Based on Coastal Risk

Barry ROBERTSON // Wriggle Coastal Management

Leigh Stevens // Wriggle Coastal Management

Understanding the distribution and risks to coastal and estuarine habitats is critical to the effective management of ecological resources as it underpins setting defensible monitoring and management priorities. This talk describes the process used to identify habitat vulnerability and coastal ecological monitoring priorities in the Tasman region based on an adapted UNESCO methodology, and a transparent risk-based matrix developed specifically for broad scale assessments of New Zealand beaches, dunes, rocky shores, and estuaries. It builds on previous risk assessments undertaken in Hawke's Bay, Wellington and Southland.The approach has three main components that produce the following outputs: (1) ground-truthed coastal habitat maps in GIS format, (2) vulnerability assessments based on the sensitivity of the receiving environment, human uses, and the upstream catchment specific risk factors (stressors) associated with each section of the coast, and (3) recommended coastal monitoring priorities. Stressors, and criteria for assessing their influence, include: Fine Sediment (muds), Nutrients and Eutrophication, Disease Risk, Toxicants, Climate Change, Drainage and Reclamation, Freshwater Abstraction, Harvesting Living Resources, Invasive Species, Structures that disrupt sediment transport, Off-Road Vehicles, Toxic Algal Blooms, Dune Overstabilisation, Human/ Animal Disturbance of Wildlife, Grazing in High Value Habitat, and Natural Terrestrial Margin Loss. The outputs are the basis for a recommended management programme targeting key stressors. It includes 10 year management targets which, if achieved, will help restore the quality of the various coastal habitats, and indicators to allow easy tracking of management efforts and success in meeting targets.

Graphic Galaxiids: Mapping the Interface between Science & Society

Dr Jenny ROCK // University of Otago

Olga Khomenko // University of Otago

Visual representation is key to effective science communication, particularly when the subject matter is complex and controversial. Mapping, in the broadest application of the method, allows us to represent the interplay of participants (actors), scientific information, motives, geography, chronology, and a variety of social factors. Digital, web-based maps in particular can be non-hierarchical and objective, allowing the user to negotiate their own way to an informed viewpoint. Here we describe a project in progress that maps the issues surrounding galaxiid fish in Otago. We explore some useful tools for representing the challenging interrelationships between government policy, conservation agendas, recreational and traditional fishers, and of course the fish (their biology). We conclude with recommendations for the use of mapping approaches broadly in science communication.

Effects of Warmer Oceans & Reduced Light on Productivity of the Habitat-forming Kelp *Ecklonia radiata*

Kirsten RODGERS // The University of Auckland

Nick Shears, Alwyn Rees // The University of Auckland

The ecological consequences of changing climate are becoming increasingly evident in terrestrial and marine ecosystems. Kelp forests are a highly productive habitat in temperate marine ecosystems. Understanding how future environmental conditions may affect kelp forests and the ecosystem services they provide is an important ecological question. The effect of increasing water temperature and reduced light on photosynthesis and productivity of the kelp *Ecklonia radiata* was investigated in a laboratory experiment. Kelp plants were held in mesocosms at current maximum summertime water temperatures (21°C), and elevated temperatures (24°C), and under ambient and reduced (by 80%) light conditions. Reduced light had a greater effect than increased temperature on kelp, with low light plants having reduced photosynthetic capabilities and greater tissue loss. However, after prolonged exposure to warm temperatures (7 weeks) and an extreme disturbance (17 days of darkness) the kelp in warmed water conditions exhibited much higher mortality. These results suggest that *E. radiata* is relatively resilient to warming ocean temperatures, but under warmer conditions *E. radiata* is likely to be less resilient to further disturbances. These are the first results to show how longer-term exposure to potential future temperature and light conditions, in conjunction with additional disturbance, may affect productivity and survival of this important Australasian kelp species.

Managing the Unmanageable: Whitebait

Hans ROOK // Department of Conservation

Henk Stengs, Chris Annandale, Dave West // Department of Conservation

People in New Zealand have fished for whitebait, inanga, inaka for over a hundred years. In many parts of the country even as late as the 1980s whitebaiting was like the "Wild West". Department of Conservation (DOC) rangers required to enforce whitebaiting regulations faced significant challenges some of which are still violent. Decades later these rangers still ply the rivers of New Zealand doing what they can to achieve what is largely the unmanageable task of looking after whitebait. We will discuss the pragmatic, innovative and collaborative ways DOC staff contribute to managing whitebait. These range from difficult and dangerous whitebait "patrols", to fencing and planting of inanga spawning sites to presenting evidence at Resource Management Act hearings. In this era of co-management we offer our views and efforts to the discussion and work that needs to ensure whitebait and whitebaiting remains a strong part of New Zealand's culture and environment.

The Astrolabe Aftermath: Ecological Impacts of the CV RENA on the Rock Where It all Went Down

Phil ROSS // The University of Waikato

Keith Gregor // Bay of Plenty Polytechnic
Chris Battershill // The University of Waikato

Following the October 2011 grounding and breakup of the CV RENA, access to Astrolabe Reef for research and monitoring purposes was restricted. With salvage activities taking priority over environmental impact assessment it appeared unlikely that researchers would have an opportunity to examine the reef to determine the ecological impacts of the grounding and oil spill. However, in August 2012, ten months after the grounding, University of Waikato and Bay of Plenty Polytechnic divers were able to visit Astrolabe Reef to examine the reef's benthic communities and to collect specimens with which to assess chemical contamination. Here we present chemical analyses of fish and invertebrate specimens collected from Astrolabe Reef and nearby offshore islands; chemical analyses of subtidal sediments collected both on and adjacent to Astrolabe Reef and Motiti Island; and describe the benthic habitats of Astrolabe Reef. As pre oil spill data for this reef is largely non-existent, it is difficult to definitively quantify the impacts of the RENA grounding. However, comparisons with samples collected from nearby control sites are indicative of a significant but localised impact on and around Astrolabe Reef. This data also provides a clear indication of the work that will be required to better quantify and monitor the ecological legacy of the CV RENA.

Green in the Pristine: Extensive Subtidal Bloom of *Microdictyon Umbilicatum* at Great Barrier Island, Northern New Zealand

Sarah Sue ROTH // The University of Auckland

Nick Shears // The University of Auckland
Jarrod Walker // Auckland Council

A nuisance green algae *Microdictyon umbilicatum* has polluted the beaches of Tryphena Harbour, Great Barrier Island, with increasing frequency since 2008. This study aimed to identify the source population and to investigate the potential cause of these blooms. Diver surveys in October 2012 revealed extensive subtidal beds of *Microdictyon umbilicatum* drifting unattached throughout the Harbour. From diver observations and aerial imagery the extent of these drifts was estimated at ~2 km^2 covering most of the sandy bottom throughout the Harbour from a depth of about 5 to 20 m. The thickness of the drifts range from 5–35 cm, with an average biomass of 1.5kg wet weight m^{-2}. Total estimated biomass in the harbour is between 1400 and 4600 tonnes. Preliminary analysis of sea water samples indicates relatively low nutrient levels. Nonetheless, we hypothesise that only a small increase in available nutrients is needed to promote extensive algal growth in this pristine environment.

Such drifts are novel worldwide, especially in relatively pristine waters which characterise the coastal environment of Great Barrier Island. Further research is underway investigating seasonal patterns, potential nutrient sources and consequential effects on the local environment. Laboratory experiments also hope to reveal the role Nitrogen, depth, temperature and turbulence play in growth rates of *M. umbilicatum* to increase our knowledge of this nuisance alga.

Use of Web Cameras to Monitor Long Term Trends in Dynamic Recreational Fisheries

Nicola RUSH // NIWA

Bruce Hartill, George Payne, Andrew Miller // NIWA

There is an increasing recognition that New Zealand's marine recreational fisheries are growing, substantial and dynamic. Although considerable progress has been made in developing reliable methods of surveying recreational fisheries in recent years, these surveys are usually conducted infrequently, because of the cost involved. We describe a cost effective means of continuously monitoring levels of recreational fishing effort over the long term, based on web camera technology. Web cameras have been used to continuously monitor trends in recreational effort on the northeast coast of the North Island since 2005, and the west coast since 2006. The indices of effort provided by these data have given us unprecedented insight into the temporal dynamics of New Zealand's largest recreational fisheries. Although the resources required to operate these systems are relatively low, the effort required to interpret the imagery collected can still be appreciable, and strategies have, and are, being developed to substantially reduce costs and to extend the utility of the information provided.

The Effects of Nutrient Losses on Stream Periphyton – a Modelling Study in Hawke's Bay

Kit RUTHERFORD // NIWA

John Quinn, Bob Wilcock // NIWA
Adam Uytendaal // Hawkes Bay Regional Council
Roger Young // Cawthron Institute

Like many gravel-bed rivers on the east coast of New Zealand, the Tukituki River experiences prolonged summer low flows during which nuisance growths of periphyton occur. A multi-agency study has made field measurements of nutrient fluxes, biomass and productivity during two summer low flows (2011 and 2013). A new, process-based computer model TRIM (Tukituki RIver Model) is being used to help understand the complexity of nutrient transformations, uptake, recycling and loss in the river, and its effects on periphyton growth rate and biomass. Nutrient limitation switches from phosphorus in the middle reaches to nitrogen in the lower reaches, because of denitrification. The model is used to investigate the nitrogen mass balance and to explore whether nitrogen, phosphorus, both or neither should be managed to reduce nuisance periphyton blooms. DRP concentrations did not drop below c. 4 mg m^{-3} during summer low flows in 2011. It is not clear whether this is because phosphorus was being released from bed sediments, recycled from detritus or was simply not being consumed because periphyton were nitrogen limited. The model helps address these questions.

First Report of Anterior Pallial Tentacles in *Solen dactylus* from the Northern Persian Gulf, Iran

Hanieh SAEEDI // The University of Auckland

Mark J Costello // The University of Auckland
Rudo von Cosel // Muséum national d'Histoire naturelle, Paris

Solenidae are deep burrowing bivalves inhabiting intertidal and shallow sub-tidal soft bottom sediments mostly in tropical and sub-tropical areas. *Solen dactylus* has a restricted distribution within the Indian Ocean. *Solen dactylus* is frequently found on the sandy-muddy coast of the northern Persian Gulf, Iran. Specimens of *S. dactylus* were collected since 2006 from Bandar Abbas to study their biology and ecology. During these studies, an unexpected pair of anterior pallial tentacles at the dorsal end of the anterior pallial crest of the mantle was found. In the tentacles, two kinds of epithelial cells (pyramidal and vacuolated) and fibres (radial and longitudinal), and a branch of the pallial nerve located in the centre of a haemocoel, were determined. A possible coherence of a furrow parallel to the anterior shell margin with the presence of anterior pallial tentacles is discussed. All species with long anterior pallial tentacles have anterior shell furrows. Anterior pallial tentacles were found in numerous Solenidae from Asia to the Middle East and Europe. However, more Solen species need to be examined for presence or absence of the anterior pallial tentacles and anterior shell furrows.

Variability in the Importance of the Microbial Food Web Across the Chatham Rise

Karl SAFI // NIWA

Variability in the importance of the microbial food web and its role in carbon transfer to higher trophic levels was evaluated across the Chatham Rise, east of New Zealand, in early winter 2008. Over this well-defined area of subtropical convergence samples were taken in six regions (Boxes) at 23 core sites to assess variability both across and along the Chatham Rise. Clear gradients observed in temperature, salinity and nutrients could not alone explain the complex changes observed in phytoplankton. Only by identifying different areas as having communities at different successional phases could we explain the observed variations. Microzooplankton grazing on phytoplankton standing stocks reflected this variability, ranging from only ~8% removal per day in the high phytoplankton biomass, >2 µm size class dominated South East Rise to ~127% removal in the low phytoplankton biomass, <2 µm dominated North West Rise. These results partly reflected microzooplankton grazing efficiency which was highest on the <2 µm phytoplankton fraction followed by the <20 µm fraction, while grazing was consistently unable to control the >20 µm size fraction. Overall 3.2 times the phytoplankton carbon biomass was grazed by microzooplankton in the Northern Rise compared to Southern Rise waters. This occurred even though the Southern stations had 1.6 times the phytoplankton biomass of the North. This investigation reveals that the subtropical convergence zone is more variable than previously understood and shows that complex and evolving food-web structures occur across the Rise leading to variable transfer rates to higher trophic levels.

Elucidating the Origin of Tetrodotoxin

Lauren SALVITTI // The University of Waikato

Paul McNabb, Dave Taylor, Susie Wood // Hawke's Bay Regional Council
Serena Khor, Craig Cary // The University of Waikato

Numerous cases of human illnesses and death have been attributed to the consumption of tetrodotoxin-containing organisms including pufferfish and gastropods. Long believed to be present only in pufferfish, TTX has now been detected in a wide range of phylogenetically unrelated terrestrial and aquatic taxa including an increasing number of organisms from temperate countries. It is uncertain whether this increase is due to improved testing capability and more intensive sampling, or if there has been a global expansion of a microbial TTX producer. Despite decades of research the exact origin and biosynthetic pathway of TTX remain a mystery. Current literature supports three main hypotheses for the source of TTX; endogenous, symbiotic bacteria or via bioaccumulation through a dietary source. In 2009, the opisthobranch *Pleurobranchaea maculata* (grey side-gilled sea slug) was found to contain high concentrations of TTX in NZ; to our knowledge this is the most southern detection of TTX. Recently we identified TTX in two further New Zealand marine organisms; a flatworm, *Stylochoplana* sp. and the bivalve *Paphies australis*. A triangulated approach has been used to identify the origin of TTX in these organisms. This has involved: extensive environmental surveys, an intensive bacterial culturing effort (over 250 strains), manipulative laboratory feeding studies, localization of TTX within tissues using immunohistological methods, the development of a new chemical method to explore precursor or degradation products and PCR based methods to explore the diet of *P. maculata*. This talk will provide a summary of research findings to date and review strategies to be implemented in future studies.

The Importance of *Austrovenus stutchburyi* for Biodiversity-Ecosystem Functioning in an Intertidal Sandflat

Candida SAVAGE // University of Otago

Agnes Karlson // Stockholm University, SwedenI
Keith Probert // University of Otago
Daniel Leduc // NIWA.
Conrad Pilditch // The University of Waikato

Biodiversity loss in coastal ecosystems worldwide has prompted an urgent need to understand the importance of key functional groups for ecosystem functioning. We investigated the effects of the loss of a key species, the cockle, *Austrovenus stutchburyi*, on critical ecosystem processes, notably nutrient cycling and uptake of detritus in intertidal sandflats. Cockles are harvested commercially and recreationally, yet they are the main suspension-feeding bivalve in New Zealand estuaries. Removal of this key species thus results in the loss of an entire functional group, which is likely to have direct consequences for ecosystem functioning in marine sediments. Using a block design, we manipulated cockle densities (no cockles; 300 m^{-2}) and added ^{13}C and ^{15}N-labelled macroalgae to select high and low density cockle plots in Papanui Inlet, Otago. Nutrient and oxygen fluxes across the sediment-water interface were measured and the uptake of algal detritus by functionally different benthic communities was determined using isotope tracers. Oxygen uptake rates were greater in high density cockle plots and increased with the addition of macroalgal detritus. There was high interspecific variation in uptake of the algal detritus, with highest uptake by a tanaidacean and a nereidid polychaete. This multi-functional and mechanistic approach enabled us to assess the relative performance of species within and among treatments and quantify the feeding niche of the different communities.

Science for Estuary Management in NSW: Combining Monitoring, Research, Modelling & Communication

Peter SCANES // Office of Environment and Heritage, NSW

Jocelyn dela Cruz, Angus Ferguson, John Floyd, Jaimie Potts, Kirsty Brennan, Aaron Wright, Brendan Haine // Office of Environment & Heritage, NSW

Effective management of estuaries relies on sound information about processes and status, good decision making and effective communication to relevant participants. In NSW (Australia) estuary management is primarily the responsibility of local government, with guidance and financial support from the state government. Scientific input comes from a state-wide estuary health monitoring program (including over 130 estuaries) and from a series of specific research projects, generally funded by local government. The data and process understanding from this research has been incorporated into ecological response models at three scales. At the State scale, a eutrophication risk assessment model which uses simple empirical relationships to assess risk from land-use change has been developed to enable land and estuary managers to understand the risk to estuaries resulting from broad-scale landuse intensification (www.ozcoasts.gov.au/nrm_rpt/cerat/index.jsp). More explicit models have been created for different estuary types (e.g. barrier rivers, coastal lagoons). These models link catchment landuse to ecological response via hydrodynamic models. They require more data to run but provide spatially explicit results for threats to seagrass beds and for eutrophication. Nested within these models are sub-models that predict seagrass growth and biomass. The research that has supported the model development includes stable isotope studies that have linked changes in trophic status to changes in the fundamental carbon source for fish and invertebrates; seagrass metabolism and growth; phytoplankton stimulation; nutrient regeneration from sediments and meta analyses of nutrient status for NSW estuaries. Monitoring has been informed by analyses of the efficacy of existing monitoring programs and by development and testing of new indicators of ecological processes (rather than standing stocks). Council and community engagement has been supported through the use of conceptual models and report cards to encourage understanding of ecological processes and the need for local behaviour change.

Adventures in Paradise: Determining the Reference (Pristine) Ecological Condition of New Zealand's Lakes

Marc SCHALLENBERG // University of Otago

There is a paradigm in lake conservation and management that seeks to compare the current condition of lakes to their reference condition, or pre-anthropogenic-impact condition. In this way, the direction and magnitude of departure of the current state of lake from its reference state can be ascertained, potentially facilitating lake management and restoration. Scientifically determining the reference condition of New Zealand lakes is the purpose of this study. Two approaches were used: 1. A present-day assessment using large datasets of lakes which regresses key indicators of ecological integrity (EI includes indicators of pristineness, nativeness, diversity and resilience) against catchment % native vegetation cover and against an independent expert assessment of present lake EI and 2. Inferences about historical lake conditions based on a literature review of palaeolimnological studies on New Zealand lakes. Both approaches were applied to assess reference conditions of shallow lakes, deep lakes and brackish lakes, separately. A number of pristineness, diversity and resilience indicators converged at high % catchment native vegetation cover and at high EI scores, showing that the indicators provide useful information for inferring lake reference conditions. Palaeolimnological studies provide useful narratives of historical changes in lake conditions which are different in nature, but are complementary to the quantitative information obtained from the EI approach based on current lake data. Together, these quantitative and qualitative scientific approaches help us to paint a robust, multivariate picture of what the reference ecological condition of New Zealand lakes was prior to human influence.

Identifying Nutrient Load Targets for Waituna Lagoon: Some Tips when Setting Limits for Shallow Lake & Estuary Systems

Marc SCHALLENBERG // University of Otago

Keith Hamill // River Lake Ltd
David Hamilton // The University of Waikato
Greg Larkin // Coastal Consultant
Jane Kitson, Dean Whaanga // Te Ao Marama Inc
Barry Robertson // Wriggle Coastal Management
Hugh Robertson // DOC
Mike Scarsbrook // DairyNZ
Andy Hicks, Karen Wilson // Environment Southland

Waituna Lagoon is a Department of Conservation (DOC) scientific reserve within a Ramsar listed wetland complex. Ongoing land-use intensification and hydrological modifications within the catchment have been associated with a decline in water quality in both the lagoon and its major tributaries. Evidence of a decline in lagoon ecological values has also been observed, with a decrease in the abundance of keystone macrophyte species, *Ruppia*, and an increase in the abundance of macroalgae. These symptoms of eutrophication prompted an inter-agency response to prevent the lagoon flipping from a clear-water, macrophyte-dominated system to a turbid lagoon dominated by algae. The Lagoon Technical Group was formed, comprising lake experts from around New Zealand to provide scientific advice to managers and stakeholders. Modelling and literature review approaches produced similar loading targets, and the multiple lines of evidence provided the LTG with a more robust manner of recommending load targets. Multiple lines of evidence were particularly valuable for Waituna Lagoon, because complex interactions between sediment, macroalgae, macrophytes and phytoplankton generate considerable uncertainty when predicting the ecosystem response. In view of the need to urgently address nutrient loads that are well above levels required to support healthy ecosystems and in response to the NPS: Freshwater Management, Environment Southland is now in a position of being obliged to set load targets for numerous shallow lake and estuary systems for which there is limited ecological data. Some ideas on how we will approach this, based on lessons learnt during our Waituna response, will be discussed.

Responses of Estuarine Seaweeds to Season, Wastewater Discharges & the Christchurch Earthquakes

Kristin SCHEUER // University of Canterbury

Neill Barr, John Zeldis // NIWA
David Schiel // University of Canterbury

Blooms of the green algae *Ulva* sp. (sea lettuce) and the red algae *Gracilaria* sp. often indicate the effect of nutrient enrichment in coastal ecosystems worldwide. A good example from New Zealand is the Avon-Heathcote Estuary in Christchurch where decades of wastewater discharge have led to regular blooms of these algae, most notably *Ulva*. The diversion of the Christchurch City Wastewater outfall in March 2010 occurred only months before the first of a series of major earthquakes affecting the region. After the most damaging earthquakes in February and June 2011, overflows of raw sewage entered the estuary via its two main rivers for several weeks. Along with this there were also major changes that occurred in the topography of the estuary itself. We used several biochemical indicators from *Ulva* sp. and *Gracilaria* sp. (free amino acids, chlorophyll, tissue-nitrogen, growth and nitrogen stable isotope ($\delta^{15}N$)) to monitor changes in the relative quantity and source of nutrient loading in this changing estuarine system. In addition to this monitoring work, the efficacy of these indicators were validated in a series of multi-factorial laboratory experiments. These demonstrated that interactions between light, temperature and nutrient concentration almost certainly regulate macroalgal growth in the Avon-Heathcote Estuary. However, we also observed that there is possibly an underlying intrinsic property of macroalgal growth during summer months suggesting that 'seasonal' change in the requirements for optimal growth may not be so straight forward.

Revisiting Diversity & Resilience of Coastal Reefs: Why are so Many Species (Usually) Rare & What are the Implications for Sustainable Management?

David SCHIEL // University of Canterbury

Stacie Lilley, Paul South, Leigh Tait, Tommaso Alestra // University of Canterbury

The preservation of habitats and biodiversity are key planks both of "Life in a Changing Ocean" and in sustainable marine futures. We have previously reported on long-term disturbance experiments on algal-dominated reefs. A central theme is the relative rareness of most species in space and time. Yet we also have experimental evidence that these species can be ecologically important. If we are managing for sustainable use of marine resources to meet what is now recognised as one of the ten science challenges "for major and enduring benefits for New Zealand", then we had better work out the drivers of diversity, their natural cycles and how to deal with their long-term natural variation. We discuss these.

CV Rena: Overview of an Approximate BACI Design & Results of a Major Marine Pollution Incident

David SCHIEL // University of Canterbury

Chris Battershill // The University of Waikato

The CV Rena grounded on Astrolabe Reef, Bay of Plenty, New Zealand at 2:20am on the 5th of October 2011. The ship was carrying 1,368 containers, including 32 classified as being 'dangerous goods', and 1,733 tonnes of heavy fuel oil. Approximately 350 tonnes of oil was lost between 5–11 October during a storm. Most of this ended up on adjacent beaches and rocky reefs including a nearby offshore Island. Successful salvage got most of the remaining oil, but 256 containers were lost overboard and around 300 remain on the sunken ship. Two key questions were immediately asked by the public: what is the environmental impact and how long to recovery? Here we discuss the programme development, a quick survey as the oil was just landing, and an outline of the impacts and lessons. These include ecological and chemical surveys, cleanup lessons, environmental response priorities, and the value of baseline monitoring (all in 15 minutes).

A Changing Coastal Climate over the Past Several Decades: the Biophysical Context for Ecological Changes & Marine Futures

David SCHIEL // University of Canterbury

Stacie Lilley // University of Canterbury
Richard Gorman, Craig Stevens // NIWA

This project is mining existing oceanographic and biological data to provide the biophysical context necessary for maintaining sustainability in the face of climate change. Experimental data on biotic thresholds and limits related to oceanographic conditions has demonstrated that changing oceanographic conditions have a significant effect on the resilience of coastal ecosystems. These changes are nested within large scale phenomena such as El Niño and La Niña events. New Zealand collects a wealth of relevant physical data (e.g., sea surface temperature, wave forces, upwelling metrics, riverine output, sedimentation, currents and coastal topography), but this is only partially analysed and barely synthesised. Our coastline is ~11,000 km long, so initially we focussed our analyses to coastal sectors, with the aim of matching these to ecological data over local, regional and national scales Here we discuss the changes to the coastal climate, particularly with respect to SST and waves, and their ecological implications.

Restoring the River "Sky" – Ngaa Karu o Matariki

Cheri van SCHRAVENDIJK-GOODMAN // Waikato Raupatu River Trust

Rangi Mahuta, Julian Williams // Huakina Development Trust
Gannin Ormsby // Waikato Regional Council
Cindy Baker, Paul Franklin // NIWA

Tangata whenua have an intergenerational relationship with freshwater fisheries that is unique and integral to their identity. Unfortunately, once policy is introduced to manage components of a natural resource, cultural lore and common law can clash, with potentially adverse outcomes for both the resource and the people. In 2007, representatives from Te Puuaha o Waikato (Port Waikato) passed a resolution that they would not participate in new Regional Council policy around the notification of whitebait stands. The foundation of this position was twofold: (1) protecting whaanau rights and access to the fishery, and (2) traditional agreements which were being impacted upon by a surge of new fishers as a result of the policy. Swirling around these legislative and statutory impacts are the more, well researched, but just as complex biophysical issues of spawning habitat decline, water quality degradation and other associated environmental impacts on traditional whitebait fisheries. Recently the Waikato Raupatu River Trust has been working with the Waikato Regional Council and NIWA on two different, but very strongly interconnected projects addressing whitebait fishing structures and whitebait habitat restoration and reconnectivity. This presentation will discuss the 'research whakapapa' from the Waikato-Tainui perspective for these two projects, and the need for greater integration of maatauranga, policy and science in addressing the issues being faced by our Tuupuna Awa.

Mechanisms Governing Degradation of Phytoplankton in Fjords

Susanne SCHÜLLER // University of Otago

Candida Savage // University of Otago
Thomas Bianchi // Texas A&M
Philip Boyd // NIWA

Doubtful Sound (DS) in Fiordland represents a model estuarine system to study mechanisms driving the fate of phytoplankton from the water column to the sediment across strong estuarine gradients. Large amounts of freshwater enter DS creating a highly stratified (physical, chemical) upper water column in the inner fjord, and well-mixed water column in the outer fjord. The light environment in DS is dominated by steep fjord walls and freshwater rich in chromophoric dissolved organic matter, which influences phytoplankton production and degradation. In this study, we use phytoplankton pigments to investigate how phytoplankton detritus is degraded, altered, and preserved within the water column and into the sediment record. Degradation and preservation processes within the water column, sediment surface, and in long-term sediment records are evaluated using water samples, grazing experiments, sediment traps, early diagenesis experiments, and sediment cores. Irradiance, wind stress and water column stratification were the most important factors influencing phytoplankton composition in the upper water column and explained 69.7% of the variance in the pigment data. Copepod grazing was a major driver of chlorophyll a destruction and conversion to steryl and chlorin carotenoid esters. Sediment traps and early diagensis experiments revealed great spatio-temporal variability of phytoplankton detritus and its drivers across the fjord, highlighting the importance of a spatially explicit sampling scheme in fjords. Finally, long-term sediment cores indicate that DS is an ideal environment for phytoplankton pigment preservation and hence organic carbon burial.

Long-term Trends & Drivers of Variability in Coastal Turbidity in the Hauraki Gulf

Blake SEERS // The University of Auckland

Nick Shears // The University of Auckland

Increased sedimentation in the coastal environment due to human activities can have negative impacts on biodiversity and ecosystem processes. Deciphering the environmental drivers of sedimentation in the coastal environment is crucial to understanding the influence humans have on sedimentation and how rates may be affected by climate change. The Auckland Council have been collecting monthly water quality samples at various locations in the Hauraki Gulf since 1991 providing an opportunity to analyse long-term trends in turbidity, an indicator of sedimentation in the coastal environment, as well as the primary drivers of variation in turbidity. Trend analysis revealed no increasing or decreasing trends in turbidity over the last 20 years, but rather indicating cyclical patterns potentially related to larger scale climatic processes. Canonical correlation analyses showed that turbidity at wave-exposed open coast sites was most strongly associated with wave action and showed relatively insignificant associations with the other climatic variables. In contrast at Waitemata Harbour sites turbidity was most strongly and positively correlated with rainfall therefore showing much more intra-annual variability. These results clearly indicate that the drivers of turbidity differed among sites and suggest that the effects of climate change on sedimentation in the coastal environment will not be homogenous throughout the region.

Recent Update on Marine Protected Area Planning & Design in the Ross Sea Region (Antarctica) Under CCAMLR (the Commission for the Conservation of Antarctic Marine Living Resources)

Ben SHARP // Ministry for Primary Industrys

Since 2009 New Zealand has been working actively to design and propose a large-scale Marine Protected Area in the Ross Sea region under the auspices of CCAMLR (the Commission for the Conservation of Antarctic Marine Living Resources). This process culminated most recently in consideration by CCAMLR of a joint New Zealand – United States MPA proposal at a special mid-year meeting of the CCAMLR Scientific Committee, in Bremerhaven (Germany) in July.

Dr Sharp in New Zealand's Scientific Committee representative to CCAMLR and has led New Zealand's scientific engagement with CCAMLR to design and propose a Ross Sea region MPA. In this talk he will describe the systematic conservation planning approach utilised by New Zealand and the underlying scientific rationale of the joint NZ-US proposal, which seeks to optimise achievement of multiple ecosystem protection and fisheries management objectives while also considering the needs of the existing CCAMLR science programme that underpins the management of the Ross Sea region toothfish fishery, and providing for ongoing sustainable harvest consistent with the CCAMLR Convention. He will also discuss the recent response of the CCAMLR Scientific Committee to the Ross Sea region proposal and summarize scientific advice emerging from the recent special meeting, to guide designation of a Ross Sea region MPA, an outcome that will require consensus agreement from all CCAMLR Members.

Habitat Suitability Curves for Aquatic Invertebrates in a Small New Zealand River

Karen SHEARER // Cawthron Institute

John Hayes // Cawthron Institute
Dean Olsen // Otago Regional Council

Flow management decisions in New Zealand are reliant on the reliability of the habitat suitability curves (HSC) that are used in hydraulic habitat modelling (e.g. RHYHABSIM). Habitat suitability curves are used for generating predictions of how changes in flow will affect lotic aquatic biota such as native fish, salmonids, and invertebrates. To date, HSCs for invertebrates have been developed on moderate-large rivers. However, a concern is that these may overestimate depth and velocity requirements in a small river. To help address this information gap we have developed HSCs for nine aquatic invertebrate taxa from the Rainy River, a tributary of the Motueka River, Nelson. Higher suitability occurred at shallower depths and slower velocities in the Rainy than in larger rivers studied. This work expands (with two new species) the current library of invertebrate HSCs used in hydraulic modelling of physical habitat. Our curves will increase the reliability of habitat modelling analysis for smaller rivers, and can be accessed through RHYHABSIM (http://www.jowettconsulting.co.nz/).

The Kimberley Ark: Assessing & Conserving Freshwater Fish Biodiversity in Australia's Last Pristine River Systems

James SHELLEY // University of Melbourne

Freshwater ecosystems worldwide are experiencing a period of unprecedented biodiversity loss. Effective biodiversity conservation requires accurate estimates of biodiversity and knowledge of species' threat of extinction. The Kimberley region in remote north-west Australia, which now faces imminent expansion of mining and agricultural operations, is both a biodiversity hotspot and a black hole in scientific knowledge. At least 18 (~40%) of the region's diverse freshwater fish species are found nowhere else and many of these endemics are extremely range-restricted. However, a lack of surveys, and ecological and genetic studies means that current biodiversity estimates are not robust and the risk of extinction these species face is unknown. This project will help to establish the true biodiversity of the Kimberley freshwater fishes and assess their extinction risk using a combination of molecular techniques and ecological analyses. Hypotheses on the causes of diversity in fish communities will be tested by constructing phylogenies for three of the regions major families (Terapontidae, Eleotridae, Plotosidae). Furthermore, microsatellite data will be used to assess gene flow, population connectivity, and population genetic structure within species to evaluate their extinction risk in the face of future impacts. Finally, reproductive and early life-history ecology will be investigated to assess their contribution to the range-restriction and evolution of the Kimberley's endemic species. I will present my project ideas and design, evidence of morphologically distinct fish groups that I have found during my surveys, and the preliminary results of my phylogenetic analysis.

The Secret life of Zombies: Consequences of Co-habitation & Dispersal With the Living Dead

Jeffrey SHIMA // Victoria University of Wellington

Stephen Swearer // University of Melbourne
Erik Noonburg // Florida Atlantic University

Many fishes produce excess offspring, and most individuals will die before they can reproduce. These "living-dead" may persist in populations for extended periods, to shape evolution and exact unknown costs on survivors that successfully breed. The importance of "survival of the fittest" is well recognised across biological disciplines, but what are the consequences of the surviving weak? Demographic "zombies" can compete for resources, attract predators, and alter the fates of the fittest, though they are rarely the focus if investigation. Since Darwin's seminal work, existing paradigms have been preoccupied with winners. Our previous research on a small marine fish, the common triplefin (Forsterygion lapillum), indicates that zombies may be created when young individuals experience unfavourable conditions during larval development. We use LA-ICPMS and image analysis to unlock the "environmental fingerprints" and demographic records preserved within fish otoliths, to infer that: (i) larval fish developing in offshore waters acquire distinct traits that transform them into demographic zombies; (ii) zombies regularly recruit to reefs alongside individuals that are predestined to survive; and (iii) zombies may be more readily shuffled between distant populations. We present results from empirical studies and mathematical modeling, which together, reveal how the presence of demographic zombies can affect local population structure and alter the stability of a reef fish metapopulation.

The Early Life History of Snapper in the Kaipara Harbour – a Special Nursery Area for Snapper

Carina SIM-SMITH // The University of Auckland

Andrew Jeffs, Craig Radford // The University of Auckland

Little is known about the early life history of snapper, particularly on the west coast of New Zealand. We investigated aspects of the early life history of snapper in the Kaipara Harbour, which is the most important nursery area for snapper on the west coast of New Zealand. Gonad analyses showed that recruitment to the harbour must originate from spawning activity outside the harbour. Larvae spent 18–28 days in the plankton before settling in shallow waters of the harbour. The successful spawning period that produced settled juveniles was only 29–63 days, despite a spawning season of ≤4 months, indicating that recruitment to the harbour may be limited by environmental conditions that affect larval survival or transport to settlement habitats. Daily settlement was significantly positively correlated to tidal range and on-shore winds (of the previous day) in 2010 and to temperature in 2011, suggesting that these variables may assist the on-shore transport and survival of larvae. Recruitment may also be affected by growth rate and resource-allocation strategies. Growth of fish from the Kaipara Harbour was faster than growth at other sites. Resource-allocation in post-settlers was found to change from maximising growth in summer to maximising lipid accumulation in mid-autumn. Lipid concentrations in fish during summer and early autumn were very low, making them very vulnerable to starvation mortality. Overall, these results provide us with a better understanding on the ecological processes that affect the recruitment of snapper, which can be used to more effectively manage populations of this important species.

Response of an Estuarine Community & Food Web to Eutrophication & Earthquake-driven Disturbance

Jennifer SKILTON // University of Canterbury

John Zeldisn // NIWA
David Schiel // University of Canterbury

Benthic invertebrate communites are critical in estuaries, affecting sediment structure and function and occupying key food web positions. Eutrophication and disturbances can severely impact the diversity and abundance of primary producers and consumers and, in turn, alter trophic interactions and change the structure of entire food webs. Christchurch's Avon-Heatchcote estuary has been subjected to two types of disturbances over recent years: 1) the diversion of wastewater from the Avon-Heathcote estuary to an ocean outfall in March 2010 that immediately reduced nitrogen loading to the estuary by >90% and; 2) four cataclysmic earthquakes between September 2010 and December 2011 that caused liquefaction (new sediments) to cover 30–65% of the estuary surface and resulted in huge volumes of raw sewage entering the estuarine environment. Field surveys on multiple occasions before the diversion, post-diversion/pre-earthquake and post-earthquake showed that the earthquakes had a significant impact on infaunal and epifaunal communities, reducing taxa richness and abundance. Although effects were site-specific, communities in most areas recovered to pre-earthquake status within two years. The earthquakes did not appear to affect the estuarine food web structure, but stable isotope analysis showed that $\delta^{13}C$ and $\delta^{15}N$ values of food sources and consumers varied spatially, temporally and in relation to the diversion of wastewater. In particular, food sources and consumers from the most eutrophic site showed marked increases in isotopic values during the three year period following the diversion. There was a clear separation of sites but their isotopic signatures are beginning to converge.

Matauranga, Science & Management – a Practical Example on the Te Arawa Lakes

Hera SMITH // Te Arawa Lakes Trust

The Te Arawa Lakes are taonga to Te Arawa and the continued, uninterrupted traditional, spiritual, cultural relationships with the lakes is paramount. Te Arawa Lakes Trust is representative of 62 hapu and iwi of Te Arawa and responsible for managing the funds and assets under the Te Arawa Lakes Settlement Act 2006 which saw the return of 14 lakes to Te Arawa. Implicit in that management is the health and wellbeing of the lakes, formal relationship protocols, decision making in including freshwater fisheries. The settlement recognises and acknowledges the mana of Te Arawa and their holistic relationship with the lakes and provides a vehicle for Te Arawa to be involved in the decision making now and in the future as kaitiaki and landowner of the Te Arawa Lakes. Investing in collaboration and partnerships has unlocked opportunities and recognises that the integration of scientific knowledge and matauranga connects, restores and contributes to improving, protecting and restoring freshwater environment and indigenous biodiversity. The acceptance and use of matauranga in collaborative projects on the lakes has been recognised in future research strategies and enabled kaitiaki and key stakeholders to protect, sustain and restore the biodiversity, health and wellbeing of the lakes.

Development of an Acoustic Method to Distinguish Elasmobranchs from Teleosts in the field

Ross SMITH // Hydrobiology

Clément Bonini, Sean Gallanagh, Dylan Sortino, Dustin Hobbs // Hydrobiology

In response to a desire to develop a method to monitor endangered elasmobranchs near a proposed bauxite mine south of Weipa, north Queensland, Australia, Hydrobiology, with support from Rio Tinto Alcan, examined the potential for dual-frequency hydroacoustics to distinguish elasmobranchs from teleosts in the field. Trial data collection using captive sharks, rays, banjofishes, guitarfishes and sawfishes in the presence of a range of teleosts in the aquaria of SeaWorld and Underwater World in southern Queensland provided training and testing datasets. These were used to develop and test an algorithm to distinguish the two groups. Subsequent field trials in the project area alongside other sampling demonstrated that the hydroacoustic algorithm identified elasmobranchs in areas where they were observed by other means and at average sizes that were realistic. The technique was prone to erroneous classification of other objects, such as mangrove prop-roots, as elasmobranchs, but transect design and post-hoc editing could reduce that error.

An Investigation into Fisheries Interaction Effects using Atlantis

Michael SMITH // University of Melbourne

Elizabeth Fulton // CSIRO
Robert Day // University of Melbourne

Fisheries management is commonly based on the outputs of single-species stock assessment models. While such models are appropriate for tactical issues such as quota setting, they typically omit explicit trophic interactions between different parts of the ecosystem. To successfully manage multiple fisheries in the same ecosystem, we need to understand the knock-on effects of fishing one species. We used a simulation model of the southern Benguela ecosystem, built in the Atlantis framework, to explore fisheries interaction. We measured the impact of fishing different stocks individually at FMSY, the hypothetical level of fishing effort which produces maximum sustainable yield in a single-species model. We then applied FMSY to all stocks simultaneously and compared the simultaneous yield to the sum of yields from the individual applications of FMSY. Contrary to expectations, the total catch was higher under the simultaneous scenario. We explored our results using qualitative models and by studying the trophic interaction between species at different levels of the foodweb, and found that our overall result was driven by two key factors: volumetric dominance of small pelagic fish in the total catch, and asymmetric influences of competition and predation between piscivorous and planktivorous species. The simultaneous increase in fishing pressure across multiple species in the model led to increased effective carrying capacity for small pelagic species (due to reduced competition), but reduced carrying capacity for piscivorous species (due to reduced small pelagic prey). This has important implications for the design of tactical multi-species models for use in ecosystem-based fisheries management.

Developing a Complementary Seed Supply for Year Round Greenshell™ Production

Rebecca SMITH // The University of Auckland

Greenshell™ mussel production in New Zealand is constrained by two main factors. The first being the highly seasonal nature of Greenshell™ mussel production as mussel spawning occurs from July to November and during this period mussels cannot be harvested due to their poor condition. Anecdotal evidence suggests that Hauraki mussels may develop at a different time of the year to Kaitaia mussels. The second is the industry's heavy reliance on spat supply from Kaitaia, as approximately 80% of the spat used in the New Zealand Greenshell™ mussel industry is collected from 90 Mile Beach in Kaitaia. This study implements a series of experiments to determine whether mussels obtained from Kaitaia and the Hauraki Gulf have different condition cycles, and growth rates when grown in Hauraki Gulf and if it is commercially feasible to collect spat in the Hauraki Gulf. Spat-catching ropes are set at two sites and two depths in the Hauraki Gulf and changed every three weeks. To evaluate spat settlement the spat ropes are carefully rinsed and the subsequent material washed through a series of successively finer mesh sieves. The spat are divided into three size classes and then counted under a microscope. Mussel spat sourced from both the Hauraki Gulf and Kaitaia have been seeded onto neighbouring lines in the Hauraki Gulf and are sampled every three weeks to measure growth and condition.

Bryozoans of the Krusenstern Expedition

Abigail SMITH // University of Otago

Mary Spencer Jones // Natural History Museum, London

At the beginning of the 19th century, Tsar Alexander I and Baron Nikolai P. Rezanov commissioned an Estonian Captain called Krusenstern to explore the northern Pacific, establish trade with China and Japan, enhance links in South America, and consider the possibility of using California as a Russian colony. No Russian ship had yet crossed the equator; it was an expensive and ambitious expedition. The *Nadezhda* under the command of Captain Krusenstern and the *Neva* (under Captain-Lieutenant Lisyansky) set sail from Kronstadt (St. Petersburg, Russia) on 7 August 1803. They travelled across the Baltic and Atlantic Oceans, past the Canary Islands and Brazil, round Cape Horn, on to the Hawaiian Islands, Kamchatka and Japan. Krusenstern and the *Nadezhda* arrived back at Kronstadt on 19 August 1806, just over three years after they had left, with all hands safe on board. Upon his return, Krusenstern wrote a detailed report published between 1809 and 1812 in St Petersburg. One of the scientific results of the Krusenstern expedition was the discovery, collection, and naming of many new invertebrates, among them various bryozoans. The bryozoan genera *Pherusa, Krusensterna, Tilesia* are all products of the expedition. In New Zealand only the genus *Hornera,* a widespread and speciose genus of cyclostome bryozoans, commemorates the Krusenstern expedition so far away and long ago.

Do Aquatic Insects lay Their Eggs on One Rock Basket?

Brian SMITH // NIWA

Richard Storey // NIWA
David Reid // New York

Successful reproduction and oviposition of adult aquatic insects may ultimately regulate benthic juvenile biomass, abundance and distribution within a stream. Therefore, the availability of suitable oviposition habitats may be a potential bottleneck to successful recolonisation of restored habitats by aquatic insects. Adult females returning to oviposit may respond to a suite of cues when selecting an oviposition site. If so, the egg mass distribution of different insect species are expected to vary both within and among stream reaches depending on hydrology and land use. What are these cues, and can we quantify them by characterising egg mass distributions? We recorded egg mass distributions at 5 random transects within 50 m reaches at 6 streams (3 native forest, 3 pasture) in spring and summer. At each transect (regardless of whether eggs were present) we recorded a range of physical stream and channel characteristics from overhead riparian cover to substrate embeddedness. Where eggs were present, we also recorded egg dimensions and position on the rock, took photographs, and retained the egg masses for identification via genetic analysis. Initial results indicate that emergent rocks appear more desirable for oviposition than submerged rocks. Desirable rocks were covered by multiple eggs masses belonging to many species, and were predominately laid on the underside of these rocks. Emergent rocks may increase the intensity of the horizontally polarised light reflected from the water surface which may be one of the important visual cues aquatic insects use to find desirable oviposition sites.

20 Years of Stability: Genetic Stock Structure of the Iconic Australian Barramundi (*Lates calcarifer*)

Carolyn SMITH-KEUNE // James Cook University

Shannon Loughnan // Flinders University
Dean Jerry // James Cook University

With increasing pressures on wild fisheries, including predictions of additive impacts of climate change, it is vital we understand the current stock structure of exploited fish species to better monitor and predict future change. The iconic Australian barramundi is an important commercial, recreational and aquaculture target species with a history of restocking and evidence of genetic stock structure. Diverse genetic methods and incomplete spatial sampling of past studies makes a more complete and current day picture of genetic stock structure highly desirable for future monitoring. We have examined the genetic stock structure of *Lates calcarifer* from the southern limits of the species distribution in Queensland across the tropical north of Australia and down the Western Australian coast to the Pilbara region. We utilised sixteen microsatellite markers and examined 1297 individuals from 45 locations across the species range. Nineteen genetically distinct stocks have been identified and the pattern of stock structure is remarkably similar to that revealed by allozyme electrophoresis in the 1990's. Temporally replicated samples obtained from 6 locations indicate stability of allele frequencies for the past 18–20 years, however, a temporary shift in allele frequencies in one Queensland river system coincided with the release of a large number of stocked barramundi. As stocking activities are likely to continue for this species we are continuing to evaluate the environmental and geographic drivers of observed genetic structure. Furthermore, we are turning to powerful next generation DNA sequencing technologies to explore the adaptive potential of discrete barramundi stocks.

An Integrated Systems Approach to Estimating the Harvest of Marine Amateur Fisheries

Neville SMITH // Ministry for Primary Industries

Martin Cryer, Eugene Rees // Ministry for Primary Industries

Reliable estimates of the catch of marine amateur fishers in New Zealand have proved elusive. Telephone-diary surveys were implemented between 1993 and 2001 and seemed cost-effective. However, surveys with apparently small design differences generated radically different catch estimates, often with wide confidence limits. Subsequently, direct observational methods have been applied to some key stocks and areas and are considered reliable, but such surveys can be expensive and cannot be applied nationwide. Following a detailed and comprehensive review over the past 4 years of our bitter historical experience with telephone-diary surveys, we have implemented an integrated catch (harvest) estimation system. In this paper we outline what we consider to be an integrated catch estimation system and show some results from the comprehensive nationwide survey implemented for the 2011/12 fishing year.

Nutrient Enrichment Effects on Photosynthesis in the Wetland Plants *Typha orientalis* & *Phormium tenax*

Brian SORRELL // Aarhus University

Hans Brix // Aarhus University
Chris Tanner // NIWA
Bev Clarkson // Landcare Research

Anthropogenic nutrient enrichment can allow fast-growing species with high photosynthetic capacity to out-compete less vigorous species in freshwater wetlands. We compared the effect of nutrient enrichment on photosynthetic gas exchange in two tall canopy dominants, the inherently fast-growing species raupo *(Typha orientalis)* and slower-growing flax *(Phormium tenax).* Photosynthesis was compared between 9 field locations differing in nutrient availability where the two species co-existed, and in an outdoor growth experiment. Raupo accumulated higher concentrations of nitrogen (N) and especially chlorophyll in its leaf tissue than flax. Photosynthetic rates were significantly higher in raupo than flax in both field and experimental situations, except at very low nutrient availability, where they were similar. Photosynthesis in raupo increased strongly with N availability, whereas there was only a weak relationship between N and photosynthesis in flax in experimental cultures, and no effect at all of N on flax photosynthesis in the field. Both species had significantly higher photosynthesis rates in experimental cultures than in the field; for raupo this was due to N limitation in the field, whereas for flax it was due to lower stomatal conductance in field plants than experimental plants. The differences in photosynthetic physiology between these two species suggest a clear mechanism for the dominance of raupo over morphologically similar species in wetlands subject to nutrient enrichment. The maximum photosynthetic rates achieved by raupo in this study (up to 60 $\mu molCO_2\ m^{-2}\ s^{-1}$) are amongst the highest ever recorded for C3 plants.

Ecological Effects of *Undaria pinnatifida:* What Does Our Not-so-recent Arrival Do?

Paul SOUTH // University of Canterbury

Stacie Lilley, David Schiel // University of Canterbury

Since its discovery in Wellington Harbour in 1987, *Undaria pinnatifida* has spread around New Zealand's coast and it is now a permanent, and often highly abundant, component of low intertidal and shallow subtidal systems. While its geographic spread and the underlying mechanisms of invasion have been well-documented, few studies have examined the effects of this species on coastal ecosystems. *Undaria* is a highly unusual species in New Zealand as there is no analogous native kelp with respect to its annual life history and fast canopy formation. Thus, experiments are needed to determine its effects and, more generally, to incorporate it into our understanding of coastal community structure and processes. Here, we broadly assign ecological effects into two categories; (1) 'interactive effects', whereby we test the role of *Undaria* in community structure and patterns of diversity, and (2) 'subsidy effects', whereby we assess its contribution to coastal primary production and potential nutrient input into coastal systems. We present data from 2-year press removals of *Undaria*, in situ measures of primary production in the resulting communities with and without *Undaria,* and estimates of shore-wide production.

The Role of Food Availability & Predator Pressure on Sea Urchins Sheltering Behaviour

Arie SPYKSMA // The University of Auckland

Richard Taylor, Nicholas Shears // The University of Auckland

The sea urchin *Evechinus chloroticus* is one of the most dominant grazers in subtidal reef ecosystems around New Zealand. Aggregations of these echinoderms have the ability to completely strip away dense kelp forest leaving behind urchin barrens devoid of standing algae. This deforestation only occurs when urchins are out in the open (exposed), actively feeding on live kelp. This research investigates how food availability and predator pressure (not direct predation) affect an urchins sheltering behaviour. Determining what causes an urchin to come out from shelter into the open will help us understand how urchin barrens form and why some areas and not others have constant barrens or constant kelp forests even if they are geographically similar. Two separate experiments conducted in outdoor mesocosms tanks were used to test how subsidies of drift algae (high food availability) and injured conspecifics (predator pressure) influenced urchin sheltering behaviour. Results from the food availability experiment showed no significant differences between overall behaviour in urchins in the control and treatment tanks with both having high exposure rates throughout the day. In contrast, urchins subjected to the scent of an injured conspecific showed significantly high levels of cryptic behaviour compared to control tanks where urchins remained highly exposed. These results suggest that urchins will respond strongly to injured conspecifics and will remain highly cryptic to avoid predation. This suggests that the presence of predators in marine reserve sites may facilitate trophic cascade effects by altering sea urchin behaviour rather than through direct predation alone.

Ecological Effects of a Water take on the Kaipatangata Stream, Wairarapa

Brett STANSFIELD // Environmental Impact Assessments Limited

This presentation investigates the ecological effects of a water take during low flows on a small stream using benthic biological monitoring, fish monitoring, diurnal temperature and dissolved oxygen monitoring and WAIORA (water allocation impacts on river attributes) modeling. A 100 l/s low flow limit has been recommended to safeguard the ecology of this stream. Further concurrent gaugings are recommended down the catchment to have a better understanding of effects below the Wairarapa Fault where significant water loss occurs. Some cross validation of the WAIORA model with real time monitoring is also presented.

Mass-marking Purple-spotted Gudgeon *Mogurnda adspersa* Larvae for Ecological Study

Danswell STARRS // The Australian National University

Brendan Ebner // CSIRO
Stephen Eggins, Christopher Fulton // The Australian National University

Studying the early life history phases of fishes is problematic in part due to limited techniques for tracking individuals through space and time. Gudgeons exhibit a wide range of early life history dispersal strategies, yet unravelling the complexity and consequences of larval behaviour is hampered by limited marking techniques. We examined if TRAnsgenerational Isotope Labelling (TRAIL) could be employed to mass-mark the larvae of female Purple-spotted gudgeon (*Mogurnda adspersa*), a common freshwater Australian eleotrid. We injected mature female *M. adspersa* with enriched ^{137}Ba, ^{87}Sr and a cocktail of both to produce multiple unique markers for larvae. We examined if the marking procedure impacted upon larvae morphology, growth and survival in a series of controlled experiments. We found that TRAIL was a valid means of mass-marking larvae, in addition to minimal impacts on larvae morphology, survival and growth. Application of TRAIL has the potential to quantify the extent and consequences of early life history dispersal, and to inform biogeography and conservation of species of *Mogurnda.*

Considerations in using the Daily Egg Production Method (DEPM) to Provide a Fishery-independent Estimate of Biomass for South Australia's changing Snapper Fishery

Mike STEER // South Australian Research and Development Institute

Tony Fowler, Rick McGarvey, Tim Ward, Nathan Bott // South Australian Research & Development Institute

There has been a dramatic switch in the spatial structure of South Australia's snapper fishery over the past five years. Spencer Gulf (SG) has traditionally yielded the State's highest snapper catches, however, in recent years it has been superseded by Gulf St. Vincent (GSV) and the South East (SE), two regions that had previously attracted little attention from fishers. Commercial fishers rapidly responded to this increase by adjusting their fishing behaviour, shifting from using conventional hand-line gear to adopting improved long-line technology to maximise their fishing efficiency. Catch rates in this sector subsequently appeared to "boom" in NGSV raising concerns about the long-term sustainability of the resource at the current levels of fishing intensity. Management responded by imposing daily trip limits to control catch and plan to implement spatial closures to protect snapper spawning aggregations from the summer of 2013/14 onwards. The recent change in fishing efficiency combined with the aggregative nature of snapper and new management regulations have compromised South Australia's ability to use 'catch per unit of fishing effort' (CPUE) as a reliable estimate of stock biomass. There is consequently an urgent need to develop a fishery-independent estimate of biomass that feeds into the existing stock assessment model and ensures future harvest strategies are developed from unbiased information. The DEPM has been suggested as a feasible technique to fulfil this requirement. This presentation will discuss the considerations underpinning the use of this method, how it will be integrated into the stock assessment process and its additional benefits.

Fishery. What's going on With South Australia's Iconic Cuttlefish Spawning Aggregation?

Mike STEER // South Australian Research and Development Institute

Sam Gaylard // Environmental Protection Authority

Each winter tens of thousands of giant Australian cuttlefish *(Sepia apama)* aggregate on a discrete area of rocky reef in northern Spencer Gulf to spawn. This is the only known dense aggregation of spawning cuttlefish in the world and it has declined from a peak in abundance of ~183,000 animals in 1999 to 18,530 in 2012, representing a 90% reduction over 13 years. The nature and extent of this decline has become a concern for many South Australians and given the iconic status of the species, it has also attracted considerable media attention. The obvious questions that have been frequently asked by the community is "what has caused this decline over the years?" and "will the local cuttlefish population recover?". These are very challenging questions to definitively answer as there most likely a suite of inter-connected factors driving the declines in cuttlefish abundance and biomass. This complexity is apparent when considering the range of factors that have been suggested by the general public, government agencies and non-government organisations, as potential contributors to the decline. Such speculation has included: natural variation; industrial pollution; fishing pressure; environmental irregularities; increased predation pressure; disease; seismic activity; tourism; and local aquaculture ventures. A recent study considered all possibilities and provided a preliminary evaluation upon which further investigation can be based. The results of this study will be presented. The flow-on ramifications of these findings and the current research direction will also be discussed.

The Rapid Expansion of Gross Eutrophic Zones in New River Estuary, Southland (2001–2012)

Leigh STEVENS // Wriggle Coastal Management

Barry Robertson // Wriggle Coastal Management
Nick Ward // Environment Southland

New River Estuary (NRE) is a large (4,600 ha) "tidal lagoon" estuary situated near Invercargill at the confluence of the Oreti and Waihopai Rivers. It drains a primarily agricultural catchment and has had eutrophication and sedimentation identified as problems since at least 1973. Broad scale assessments of sediment, eutrophication, and habitat modification issues have been undertaken in 2001, 2007 and 2012 using the National Estuary Monitoring Protocol and subsequent extensions. Results show large sections of the estuary remain in good condition, but document a significant decline in estuary quality. In particular, gross eutrophic conditions (excessive mud, high nuisance macroalgal growths, poorly oxygenated sediments, toxic sulphides) have expanded from 23 ha in 2001, 49 ha in 2007, to 240 ha in 2012. This has caused a significant (44%) loss of dense intertidal seagrass beds (which now comprise <2% of the estuary). The macro-invertebrate community in these gross eutrophic areas is also severely degraded with little animal life able to establish in the anoxic sediments, and the few surface feeding species limited to those tolerant of poor conditions. The changes clearly show the capacity to assimilate catchment nutrient and sediment loads is currently exceeded in the upper estuary settling basins, and serve a clear warning that problems are likely to continue to worsen if management action is not taken. To that end, work is currently underway to set catchment nutrient and sediment guideline thresholds that, if achieved, will protect against further degradation and ideally help return the estuary to a healthier condition.

Transport Non-linearities in Coastal Seas: Determining Source & Fate of Flow Fhrough Aquaculture Installations

Craig STEVENS // NIWA

David Plew, Joanne O'Callaghan, Mark Hadfield, Jens Petersen // NIWA
Olivier Ausseil // Danish Shellfish Center

An expanded aquaculture industry is seen by many as a key economic focus for New Zealand. Unlike many uses of coastal waters, these activities have a quasi-permanent physical presence that continuously disturbs the flow – and in turn the operation of the installation is influenced by the background transport. There is a natural tendency to simplify representations of coastal transport processes when seeking to quantify impacts on the environment. This is possible but needs to be supported by an understanding of which processes, and when, to ignore. Here I will synthesize our work over the past decade on flow-structure interactions in coastal environments. Our approach is to first consider the basic scaling for any situation to identify likely dominant processes and then record targeted field observations, often with novel techniques. We then seek to model the important facets of the observations and then iterate to improve overall understanding. Questions we consider here are (i) flow distortion of the structure away from the coast; (ii) flow complexity due to variability in the coastal environment and (iii) the effect of the flow on the installation itself. These themes contribute to concepts like "deposition footprint" and "water column depletion". The work not only provides guidance for operation but is also crucial for identifying impacted ecological processes and so is relevant to regional planning strategies as well as industry-focused issues.

Speculation on the Existence of a Victoria Land (Antarctica) Coastal Current

Craig STEVENS // NIWA, University of Auckland

Mike Williams, Natalie Robinson // NIWA
Pat Langhorne // University of Otago
Stefan Jendersie // University of Otago, NIWA

The ocean beneath the Ross Ice Shelf is one of the least known volumes of water on the planet. We do know that: (i) pressure effects cause some of the water in the cavity to be very cold, to the extent that it is colder than its in situ freezing point and (ii) the earth's rotation will cause any outflow to be preferentially steered to the west – i.e., the Victoria Land coast. Consequently it would seem likely that there is some form of coastal current along this coast. Here we synthesize various data to examine this hypothesis. This topic is especially important because any outflow from the Ross Ice Shelf Cavity is likely predisposed to forming sea ice rapidly. This has implications for feedback that can influence ice shelf basal melt rates.

Science on Tap: Using Bayesian Networks to Inform Collaborative Water Planning in Hawke's Bay

Richard STOREY // NIWA

Jim Sinner // Cawthron Institute
Tim Sharp // Hawke's Bay Regional Council
Suzie Greenhalgh // Landcare Research
John Quinn // NIWA

Freshwater management decisions in New Zealand increasingly are made by collaborative stakeholder groups (CSGs) comprising major water users and communities of interest. In the Greater Heretaunga and Ahuriri area (Hawke's Bay), increasing water quality issues and demands for water abstraction led to a review of the regional water plan. A CSG was convened by the regional council to balance competing human and ecological demands for water and propose an agreed set of management decisions. Stakeholders came with different values, perspectives and levels of knowledge about freshwater in the catchments. Their task required a good understanding of the ecological, economic, social and cultural aspects of the river systems. The CSG began by describing how they understood these aspects of the river systems by developing an "influence diagram" (conceptual model) for each aspect. The influence diagrams were refined by a science team and presented back to the CSG. Then they were combined into a Bayesian Network (BN). BNs quantify cause-effect relationships between variables using probabilities to reflect the certainty with which those relationships are known. Scientific theory, empirical studies and expert opinion are all used to describe these relationships. The Bayesian Network was designed to help the CSG understand the effects of different management decisions on key values and choose options with high likelihood of achieving objectives.

Dispersal of the Invasive Oriental Weatherloach *(Misgurnus anguillicaudatus)* in the Lower Murray River Post 2011 Flooding

Lara SUITOR // Department of Environment, Water and Natural Resources

Irene Wegener, Kate Mason // Department of Environment, Water & Natural Resources

Before regulation, flow in the Murray River was highly variable, a trait of lowland rivers in arid regions. In the Lower Murray, this regulation has effectively isolated the river channel from many wetlands and floodplain habitats, and an extreme lack of out-of-channel flows in the past decade resulted in many floodplain areas not receiving adequate flooding water for over 15 years. This has resulted in various forms of ecological degradation occurring within this region. A number of high-flow events occurred along the Lower Murray River between summer 2011 and autumn 2012. During this time, fish sampling was undertaken to elucidate the temporal and spatial variability in fishes using inundated floodplain and wetland habitats. In our sampling, the Oriental Weatherloach *(Misgurnus anguillicaudatus)*, an invasive species previously not documented in the Lower Murray River in South Australia, was captured at a number of wetlands and floodplain sites. This presentation discusses the occurrence and persistence of Oriental Weatherloach across sites within the Lower Murray River after detection and dispersal in 2011. Although the data presented is observational, it demonstrates that between 2011 and 2013 a range of size classes of the species have been captured across a variety of habitat areas between the South Australian and Victorian Border to the Lower Lakes.

BoP Rotorua Lakes Algal Monitoring Programme: linking Science to Policy & Plans

Alastair SUREN // Bay of Plenty Regional Council

Paul Scholes // Bay of Plenty Regional Council
Kit Rutherford // NIWA
Olivier Ausseil // Aquanet Consulting Ltd

Increasing algal blooms in the Rotorua Lakes since the 90's lead to Te Arawa Maori Trust Board, RDC and BoPRC develop a Rotorua Lakes Strategy. Its overall vision is to preserve and protect the lakes for present and future generations. TLI targets were set for each lake and schemes implemented to achieve these including: sewerage reticulation, riparian fencing, land use change. Water quality has improved in Rotorua, Rotoiti and Rotoehu and appears stable in other lakes. BoPRC undertakes monthly TLI monitoring, quarterly phytoplankton monitoring, and weekly cyanobacterial surveillance in summer. These programmes were designed to investigate and report the region's natural resources, provide a snapshot of current condition and detect overall trends. Another requirement was to determine whether objectives of regional plans are being achieved. Clear feedback loops are needed between monitoring and planning/policy. The TLI has clearly defined metrics and measureable targets, and monitoring and feedback are being done. However, for phytoplankton monitoring, no metrics exist, and no measureable targets set. For cyanobacterial monitoring, specific alert level trigger values exist (MfE guidelines) but no targets have been set. It is thus unclear how algal monitoring connects to Lake Action Plans via feedback loops. Does this represent a failure of monitoring to provide timely data to characterise current lake conditions, or a failing of policy and plans to set better objectives? The obvious disconnects between current lake algal monitoring programs and policies and plans will be discussed, which need to be rectified to maximise the benefits of monitoring.

Predicting Inanga Spawning Sites using a GIS Model

Graham SURREY // Auckland Council

Julian Sykes // NIWA

Inanga *(Galaxias maculatus)* are a diadromous freshwater fish that comprise the majority of New Zealand's highly valued whitebait fishery. This species is known to spawn in streams and rivers amongst riparian vegetation inundated by high spring tides, at the interface of fresh and salt water. These locations are increasingly under pressure from disturbances such as stock grazing, land development and erosion, which can severely affect the breeding success of inanga. A key factor in being able to protect these vulnerable spawning areas is to identify where they are located, a task that can be both time-consuming and labour intensive. This paper presents a first-cut GIS model that has been developed to predict where likely inanga spawning areas may be located, based upon modelled tidal values and a LiDAR-derived Digital Elevation Model. This technique shows promise in enabling more targeted surveys to locate areas that inanga currently use to spawn, or that could benefit from environmental enhancement to increase their utility as spawning sites.

Do Mangroves Play a Major Role in the Geomorphic Evolution of New Zealand Estuaries?

Andrew SWALES // NIWA

Catherine Lovelock // University of Queensland
Malcolm Green // NIWA
Vernon Pickett // Waikato Regional Council
Paul Denys // University of Otago

The role of mangrove forests in the geomorphic evolution of estuaries and coasts has historically been of considerable scientific interest. Moreover, the role of biology in landscape evolution is an emerging theme in geomorphology. In autochthonous systems remote from terrigenous sediment inputs, mangroves have a fundamental influence on coastal geomorphology through peat deposition. By contrast, the mangrove forests of continental margins and high islands, such as New Zealand, are supplied with terrigenous sediments. In these mud-dominated systems there are conflicting views about the geomorphic role of mangroves. Is mangrove ecology largely driven by physical processes (e.g., sedimentation), with mangroves colonising intertidal flats after they become ecologically suitable? Alternatively do biophysical feedbacks enhance sedimentation so that mangroves accumulate mud more rapidly than would otherwise occur on unvegetated intertidal flats? This question also has implications for environmental managers. Accelerated sedimentation in North-Island estuaries following catchment deforestation has created opportunities for mangrove-habitat expansion. Concerns regarding the resulting loss of ecological and amenity values has led to mangrove removal in some estuaries. Public debate has sometimes been ill-informed, including the role that mangroves play in estuary sedimentation. Observations from the Firth of Thames made over a range of time-scales relevant to estuary-sediment dynamics, geomorphology and mangrove-forest development are used to address this question. These data include high-resolution radioisotope geochronology from sediment cores (years–decades), sedimentation and surface-elevation dynamics (seasonal) and continuous observations of meteorological, hydrological and estuarine processes driving sediment supply and delivery to the mangrove forest (i.e, river discharges, mudflat resuspension, hydroperiod).

Impacts of Climate Change on Macroalgal Assemblages: Interactions between ocean Acidification & Rising Temperatures in Complex Communities

Leigh TAIT // University of Canterbury

David Schiel // University of Canterbury

Anthropogenic influences on climate and biogeochemistry have the potential to cause drastic changes to the functioning of marine communities. Although there is a growing body of evidence on the responses of species to various forms of climate change, the combined impacts of multiple stressors on more complex assemblages are poorly understood. Through a series of lab and field experiments in New Zealand and Oregon we show that macroalgal assemblages may be more severely affected by ocean acidification and rising temperatures than components of these assemblages alone. Here we show through a series of tests that respiration of naturally structured algal assemblages greatly increases with rising temperature, causing a decline in NPP. The respiration Q_{10} of assemblages (the difference in metabolic rates over 10°C) averaged 2.9 compared to a Q_{10} of 2 often seen in other autotrophs. However, the GPP Q_{10} averaged 2, indicating that respiration was more severely affected by rising temperature. Furthermore, the combined effects of low pH and temperature indicated an enhanced effect of decreasing pH at higher temperatures in coralline algae, showing that multiple stressors have the potential to combine synergistically at further detriment to NPP. In particular, increased respiration rates and rising compensation points have the potential to greatly affect the carbon balance of macroalgal assemblages through declines in subcanopy NPP, the impacts of which may be exacerbated with combining stressors, such as temperature and pH change.

Evaluating Ontogeny & Population Connectivity of Antarctic Toothfish *(Dissostichus mawsoni)* within the Ross Sea Using Otolith Chemistry

Raymond TANA // The University of Waikato

Brendan Hicks, Conrad Pilditch, Stuart, Hanchet // The University of Waikato

Knowledge on the early life history and population structure of Antarctic toothfish (*Dissostichus mawsoni*), a relatively long-lived (max. 50 years) bentho-pelagic species found in waters around Antarctica south of about 60°S, has been particularly elusive. However, several life history hypotheses have been proposed for this species based on ocean circulation models, population genetics and data collected by scientific observers from the Ross Sea Antarctic toothfish fishery. Here we review these hypotheses and outline how we can test them using trace element markers in fish otoliths. Specifically, we used scientific observers on board New Zealand longline vessels to collect otoliths and water samples across four regions within the Ross Sea during the 2011–12 fishing season. Based on the ratios of five elements (Li:Ca, Sr:Ca, Al:Ca, Zn:Ca, and Mn:Ca) in the otolith edge, preliminary jacknife classification results indicate that habitat signatures associated with the Ross Sea shelf, continental slope, northern and north eastern regions showed only weak separation. Possible reasons for this are discussed. Analyses are on-going and will include assessments of otolith natal signatures across different size classes and habitats to determine evidence of population structuring and ontogeny within the Ross Sea. The results of which will have particular relevance towards future management of this fishery.

Toxic Scavengers, Zombies & Alien Invasions: Facilitation from Native & Invasive Bivalves for *Pleurobranchaea maculata*

David TAYLOR // Cawthron Institute

Susie Wood, Shaun Ogilvie, Paul McNabb // Cawthron Institute

David Hamon, Alice Anderson, Larn Wilkinson // Hauraki Maori Trust Board

Jarrod Walker // Auckland Council

Craig Cary // The University of Waikato

Bivalves are ecosystem engineers that can facilitate other species through increased habitat complexity and provision of alternative food sources. These processes were highlighted after a series of dog deaths on New Zealand beaches, where the deadly neurotoxin, tetrodotoxin (TTX), was identified as the causative agent. Populations of sea-slugs, *Pleurobranchaea maculata,* were found to contain high levels of TTX in the range of 5-2450 mg kg^{-1}, with the toxin found in all life-stages. Diver surveys, at beaches where dog deaths had occurred found *P. maculata* reached abundances of 0.9 per m^2 on beds of *Musculista senhousia*, the invasive Asian Date mussel. Large non-toxic populations of *P. maculata* have subsequently been found on offshore mussel farms (growing native Greenshell™ mussels, *Perna canaliculus*) in another part of the country. Results of field experiments and Q-PCR assays suggest that both invasive and indigenous mussel beds facilitate population explosions of *P. maculata* by providing novel egg-laying habitat, ideal settlement and recruitment substrata and an on-going food source for this scavenging species.

Lake Kimihia Restoration Project

John TE MARU // Waahi Whaanui Trust

Lake Kimihia is one of the lower Waikato River lakes, and located in Huntly. It is culturally significant to Maori. The once mighty lake was a food basket for local Maori community providing eels, birds and other resources.

The lake is now less than a third of its original size as a result of mining activities in the 1950s. The modified lake is set to bemodified further as the proposed Huntly section of the Waikato Expressway will be constructed very close to its southern shore.

Despite all this, the tributaries running into the lake are still important habitat for whitebait species, particularly banded kokopu and in 2011, Waahi Whaanui Trust, Solid Energy and NZTA began discussing how Lake Waahi and its tributaries can be restored. This presentation outlines the work to date.

Facilitation Cascades Increase Biodiversity in a New Zealand Estuary

Mads THOMSEN // University of Canterbury

Paul South, David Schiel // University of Canterbury

Evidence is emerging that chains of positive species interactions are common and ecologically important. For example, primary habitat-formers can facilitate secondary habitat-formers to directly and indirectly facilitate habitat-associated plants and animals. Such 'facilitation cascades' are particular important in ecosystems where epiphytic and epizoic life-styles are common (e.g., in tropical forests and estuarine seagrass beds). Here we document that facilitation cascades in the Avon Heathcote Estuary (AHE) increase biodiversity and control community structures of Macroinvertebrates. More specifically, we quantify spatio-temporal variability in the effects of three co-existing habitat-formers (seaweeds, seagrass, cockles) in controlling invertebrate community structures We then compare our results to facilitation cascades from similar ecosystems with different biogeographies (estuaries from different continents) and to different ecosystems inhabited by fundamentally different co-existing habitat formers (e.g., trees-epiphytes and marsh-mussels). Our results show high variability of indirect facilitation in the AHE, comparable to highest and lowest levels of indirect of facilitation recorded from similar habitats on different continents as well as across different ecosystems. Our results also suggest that multiple habitat-formers should be managed and conserved within a system to maximize the system's biodiversity.

Can a Species' Response to Climate Change be Inferred from Analysis of Otolith-based Growth Rates?

Ronald THRESHER // CSIRO

John Morrongiello // CSIRO

A responses of species, populations, and individuals to climate change can range from physiological and evolutionary compensation in sedentary species to migrations by more mobile ones that follow changes in environmental conditions. Determining which strategies are used by a species and the mix within and among its populations is difficult without extensive field studies. We test whether ontogenetic trends in growth rates (reaction norms) for individual fish, when compared with predictions based on temperature change, can be used to infer the mix of strategies used by a species. We test this idea by analyzing and comparing long-term growth rates across the species' ranges for two coastal temperate Australian species: banded morwong, which are strongly site-attached as juveniles and adults, and tiger flathead, which may not be. Both species have been subject to rapid warming over the last half century, providing a robust environmental signal against which the species' responses can be assessed.

Environmental Futures in New Zealand's Marine Ecosystems: a Dynamic Approach Towards Managing for Resilience

Simon THRUSH // NIWA

Judi Hewitt, Ian Tuck, Graeme Inglis // NIWA
Richard LeHeron, Karen Fisher, Nick Lewis // The University of Auckland
Dave Schiel // University of Canterbury.
Jo Ellis // Cawthron Institute

Project Introduction: As we look to the future of our marine ecosystems we can foreshadow many changes associated with a wide range of resource uses and climate. But we would hope to see more benefits also, through integrative management, a better recognition of multiple uses and values, and an understanding of cumulative impacts. New Zealand can gain a strong advantage if we can define the acceptable limits of ecological sustainability and develop new management models, underpinned by robust science. Marine Futures is investigating how we can get better at: developing more future focused decision-making processes; using science to break-down our often siloed approach to use and the stewardship; and incorporating the views, aspirations and values of all stakeholders. A key element of this project is the recognition that understanding social-ecological systems dynamics are important not only in considering marine futures but also in learning how to better engage society in decision making. Our approach to engaging people's creativity and opening up a conversation on the future of marine ecosystems involves the use of environmental future scenarios. By helping make visible constraints, options, and risks to different sectors of resource users, we hope to engender end-users to take responsibility for action. In this 'marine futures' session you will hear some of the science behind the project, but this project is about participation and we want to hear from you about what you would wish the future to be for marine ecosystems.

Space Matters when Counting on Biodiversity to Overcome the Cumulative Effects of Disturbance in Seafloor Habitats

Simon THRUSH // NIWA

Judi Hewitt, Drew Lohrer, Carolyn Lundquist // NIWA

Interaction between the diversity of local communities and the degree of connectivity between them has the potential to influence local recovery rates and thus profoundly affect community dynamics in the face of the cumulative impacts that occur across regions. While such complex interactions have been modeled, field experiments in natural ecosystems to investigate the importance of interactions between local and regional processes are rare, especially so in coastal marine seafloor habitats subjected to many types of disturbance. Defaunation experiments can be used to test the relative importance of local habitat features and colonist supply in influencing macrobenthic community recovery rate. Our results emphasize that the connectivity to the regional species pool influences recovery rate and, while local habitat effects were important, the strength of these effects was affected by broader-scale site characteristics and connectivity. Empirical evidence that cross-scale interactions are important in disturbance-recovery dynamics emphasizes the complex dynamics underlying seafloor community responses to cumulative disturbance.

'Old man Schnapper': Reconstructing 140 Years of the Queensland Pink Snapper (*Pagrus auratus*) Fishery

Ruth THURSTAN // University of Queensland

Sarah Buckley, John Pandolfi // University of Queensland

Pink snapper *(Pagrus auratus)* is an iconic species in southeast Queensland, but in recent years concerns have been raised regarding the long-term sustainability of the fishery. A 2009 stock assessment found that pink snapper was likely overfished, using the year 1945 – the year that statewide landings data first became available – as a historical reference point. However, although landings records are not available prior to 1945, recreational fishing parties have targeted aggregations of snapper in open ocean waters since the 19th century. Furthermore, catch rate data only began to be gathered from commercial and charter fishers in 1988, hence large gaps in knowledge exist prior to this date and still exist for the recreational fishery. Using catch rate data collated from early newspaper reports, scientific surveys and interviews with contemporary fishers, we reconstruct the history of the Queensland pink snapper fishery from the 1870s to the present day. Our findings indicate that significant quantities of snapper were caught prior to the commencement of landings statistics, and that throughout the 20th century snapper populations have undergone localised depletion, with declines masked by technological advancements. These data extend the state of knowledge of the fishery by an additional seven decades and provide a picture of the changing conditions of the snapper fishery over a 140-year period. By collating and analysing these multiple sources of data, we aim to provide essential data for future stock assessment models and develop a broader understanding of how historical data can be successfully integrated into contemporary fisheries management.

The Impacts of Flow & Temperature on Macquarie perch (*Macquarie australasica*) Population Dynamics: Implications for Water Delivery & Threatened Species Management

Charles TODD // Department of Environment and Primary Industries

Zeb Tonkin // Department of Environment & Primary Industries

Macquarie perch (*Macquaria australasic*) is an endangered freshwater species in south-eastern Australia. The species were translocated to the Yarra River as early 1912, resulting in an abundant and self-sustaining population which still exists today. Melbourne Water has an environmental legislative responsibility to manage the Yarra Rivers Macquarie perch population. With concerns over low recruitment success in recent years, Melbourne Water has invested in a population modelling approach to predict future trends and the effectiveness of environmental flow management for the species. This work builds on the Macquarie perch recruitment model by King *et al.* (2011) which combines a number of environmental variables, including flows and temperature. Utilising this model, we used an approach similar to that of Todd *et al.* (2005; Murray cod) to develop a stochastic population model for Macquarie perch including the impacts of flow and temperature and other environmental cues as well as accounting for the impacts of additional threatening processes such as fishing to examine if any of these processes are driving recruitment failure. Using 37 years of flow and predicted temperature data, the population dynamics of Macquarie perch were assessed based upon flow, temperature, and pre-spawning flow requirements. Recruitment failure was observed when accounting for a large increase in flow (greater than twice the previous days flow) during the post-spawning period. The model successfully predicts the observed low recruitment in recent drought years indicating that a sharp increase in flows in the post-spawning period may be the driver for low recruitment. Future use for the model will be to include predicted in-flows to the Yarra River to model potential impacts from climate change.

From Rivers to Reservoirs: Post-impoundment Growth & Recruitment of an Endangered Fish

Zeb TONKIN // Department of Environment and Primary Industries

Jarod Lyon, Graham Hackett, Justin O'Mahony, Glen Johnson // Department of Environment & Primary Industries

The construction of major dams has been a major cause in the collapse of riverine fish populations throughout the world. There are however instances, where the resulting impoundments have created or even enhanced local fish populations, including threatened species. More often than not, any such benefits to local fish populations within or upstream of these newly formed habitats are short-lived, owing to the initial trophic upsurge, followed by a subsequent population crash. Macquarie perch (*Macquaria australasica*) in south eastern Australia, are one such species, with an initial boom in populations within several impoundments, following by a general trend of population decline to very low levels or extinction. The newest of these impoundments, Lake Dartmouth, appeared to be yet another example, with research indicating a sharp decline in population size since its initial boom throughout the 1980's. Given the importance of the population to the overall status of the species, a monitoring program was established in 2008. In addition to this general monitoring objective, the research coincided with the end of the prolonged south-eastern Australian drought, and subsequent refilling of the Lake. This prompted the hypothesis that the refilling phase of Lake Dartmouth would result in another trophic upsurge, and ultimately, an increase in the size of the Macquarie perch population. We present the results of a study which used growth chronologies, to reconstruct Macquarie perch growth rates throughout the three major filling phases of the impoundment. Recent annual netting surveys, coupled with aging data were then used to assess any associated changes in recruitment strength and population size. The results of the study are discussed in relation to Lake productivity, recruitment dynamics and how dam management and climate change may facilitate the preservation of this endangered species.

Mapping Ecosystem Services in the Marine Environment: Dealing with Issues of Scale, Uncertainty & a Lack of Data

Michael TOWNSEND // NIWA

Simon Thrush, Andrew Lohrer, Judi Hewitt, Carolyn Lundquist // NIWA
Megan Carbines // Auckland Council
Malene Felsing // Waikato Regional Council

The 'ecosystem services' (ES) approach has become a powerful tool in environmental management and a way of accounting the many different benefits derived from natural systems. However, use of ES in marine realms is fraught with difficulties: In many areas we lack adequate knowledge of the distributions of habitats and their associated ecosystem functions that, in turn, limits our ability to map and quantify services. Furthermore, the vast areas over which management is needed means that acquisition of detailed information at these scales is untenable. Management is needed today and therefore approaches must be able to use the best available information in conjunction with techniques that facilitate the filling of knowledge gaps. Here we present a synopsis of our work and a demonstration of our 'Ecosystem Principles Approach' in the mapping of three ecosystem services (biogenic habitat formation, nutrient recycling & ecosystem productivity) at the scale of the Hauraki Gulf. We also present the use of rapid assessment techniques to characterise habitats with implicit links to a variety of services in estuarine and harbour systems. We demonstrate the benefits of even basic information in the absence of detailed data and how this can be appropriately used in goods and services assessments.

Murray-Darling Basin Fishes: Phylogenetic Relationships & Distributional Patterns

Peter UNMACK // University of Canberra

Carlos Gonzalez-Orozco, Bernd Gruber, Arthur Georges // University of Canberra
Michael Hammer // Northern Territory Museum
Mark Adams // South Australian Museum

As the second largest river basin in Australia, Murray-Darling Basin has suffered major impacts from human development to the detriment of its fishes and other aquatic inhabitants. The combined effects of flow regulation, riparian vegetation removal, soil erosion and introduced species like redfin, trout and gambusia have decimated the fauna to where the majority of native fishes are now either extirpated, endangered or with significantly reduced ranges. Here we seek to improve our understanding of the evolutionary relationships of fishes, both in terms of their relationships to surrounding drainages and also the relationships within Murray-Darling Basin. Murray-Darling Basin is surrounded by more river basins than any other in Australia and thus has diverse relationships, primarily to the northeastern coastal drainages (primarily Burnett River), southern coastal drainages in western Victoria and northwest with the Lake Eyre Basin. Within the basin most species have low levels of genetic divergence and diversity which could be due to recent origins, bottlenecks and high dispersal abilities. We explore these patterns and highlight the need to understand biogeographic relationships in order to better manage and conserve remaining fish populations.

Lake Taupo & its Catchment: Are We Meeting the Limits?

Bill VANT // Waikato Regional Council

Jon Palmer // Waikato Regional Council

More than 10 years ago, the Waikato Regional Council became concerned about the effects of increasing catchment loads of nitrogen on the water quality of Lake Taupo. Calculations showed that most (>90%) of the manageable nitrogen entering the lake came from areas of pasture in the catchment. A variation to the Regional Plan was developed, and was finally confirmed by the Environment Court in 2011. The Plan aims to maintain the lake's current water well into the future ("by 2080"), by managing loads of nitrogen in the catchment. It aims to do this by (1) capping all manageable sources at their 2001 levels, and (2) reducing some of the manageable sources to offset much of the load that is still in transit to the lake. Over the past 10 years there has been a moderate-sized increase in the concentration of nitrogen in the lake; but concentrations of phosphorus and chlorophyll a have decreased. Over the same period there has been a moderate increase in the load of nitrogen entering the lake from the catchment, and a moderate decrease in the load of phosphorus. Increases in the loads of nitrogen were anticipated in the Plan, and are consistent with the multi-decadal storage of nitrogen in the catchment's groundwater. However, some of the increases have occurred in streams draining areas of native and pine forest, suggesting that the load of nitrogen that was leached from historic land use practices and has been stored underground is likely to be larger than previously-predicted.

Temperature Trends in Rivers & Lakes

Piet VERBURG // NIWA

While air temperatures in New Zealand are known to have increased by about 1°C over the past century, little is known about how the changing climate has affected the aquatic environment. As a part of the Climate Change Impacts and Implications Project time series of water temperatures in rivers and lakes were analysed, using data of monitoring programs carried out by NIWA and by regional councils, respectively, and compared with trends in air temperature. Monthly measured water temperature increased during 1989–2012 in 89% of 77 sites in 34 rivers in the North and South Island. The average change in water temperature was +0.20°C per decade, while air temperatures of the Virtual Climate Network (VCN) at the same locations (at <3 km distance) increased by 0.07°C per decade over the same period. Trends were mainly driven by low values in the 1990's (but temperatures in 1989 and 1990 were high), peak values in 1998 and 1999 and fairly stable temperatures since then. Annual mean stream temperature anomalies correlated strongly with air temperature anomalies (R2 = 0.81). The trends in water temperatures appeared not correlated with (small) shifts in time of day of measurements, or trends in stream flow. The trends in stream temperatures were also not correlated with altitude. For only a few lakes, data sets of temperature exist of similar length. In most of these lakes, no significant trends existed in surface temperatures, with some exceptions.

Brine Communities in Antarctic Sea Ice was Found to have Silica & Phosphorus Limitations

Francisca VERMEULEN // Victoria University of Wellington

Dr Ken Ryan // Victoria University of Wellington

Nutrient status of algae is important in assessing the physiological limits to primary production. Field samples from 3 different Antarctic habitats (seawater, sea ice and brine) were analysed for nutrient limitation by the nutrient induced fluorescence transient (NIFTs) method. This approach is highly appropriate for the study of nutrient limitation in sea ice as it generates a near instantaneous nutrient limitation assessment. A positive NIFTs response was observed in brine communities indicating a silicate and phosphate limitation. In contrast, no immediate responses were observed after the addition of PO_4^{-3} or NO_3- to seawater and sea ice samples, but a delayed response occurred for silicate, and this was likely due to the high demand for silicate by diatoms. Brine communities from the mid-section of the sea ice consisted of diatoms and dinoflagellates, while diatoms dominated seawater and sea ice communities. These 2 different phylogenetic groups have different nutrient requirements and therefore a dual nutrient limitation of Si and P was evident in the brine but not in the bottom ice community nor in the seawater. The brine community was collected early December and these results suggest that it was already nutrient limited. Generally, sea ice primary production can continue until January when the ice breaks up, and it is therefore likely that the nutrient limitation in the brine severely limits primary production in this part of the sea ice.

In Search of Ecological Thresholds – What can We Learn from Stressor-response Relationships to Inform Limit Setting in Streams?

Annika WAGENHOFF // Cawthron Institute

Roger Young, Joanne Clapcott, Eric Goodwin // Cawthron Institute
Cathy Kilroy // NIWA
Ada Pastor Oliveras // University of Barcelona
Kelvin Lau, Gillian Lewis // The University of Auckland

Agricultural land use puts pressure on freshwater ecosystems worldwide, mainly through non-point source pollution. Setting effects-based limits on discharge of the major stressors at the catchment level is a promising policy instrument to prevent or reduce ecological degradation. Limit setting requires knowledge of the assimilative capacity of an ecosystem with regard to those stressors, or in other words, the ecological threshold beyond which ecosystems should not be allowed to move. Scientists have tried to detect ecological thresholds through investigation of stressor-response relationships anticipating an initial period of resistance followed by an abrupt change in an ecological variable along the stressor gradient. However, such response shapes were rarely observed. Consequently, alternative approaches for threshold definition need to be adopted to inform limit setting. Furthermore, in order to set limits protective of ecological integrity, relationships between stressors and a range of biological indicators including multiple trophic levels and structural as well as functional attributes should be considered. Hence, we conducted an extensive field survey collecting benthic samples of macroinvertebrates, algae and bacteria, as well as measuring stream metabolism and cellulose decomposition potential at 58 stream and river sites spanning a wide gradient in catchment land-use intensities. Exploratory analyses showed a range of response shapes to gradients of nutrient concentrations. We will present the statistical approaches, compare the thresholds defined for different biological indicators, and discuss the implications for the definition of an ecological threshold that is likely to protect stream ecosystem integrity and can inform limit setting in streams.

Hapū & Whānau Partnerships in Tuna Research in the Wairua & Mangakāhia River Catchments

Nicki WAKEFIELD // Ngā Kaitiaki o Ngā Wai Māori and NIWA

Allan Haliday, George Tuhiwai, Hona Edwards, Erica Williams, Jacques Boubée // Ngā Kaitiaki o Ngā Wai Māori, NIWA

In January 2012 Ngā Kaitiaki o Ngā Wai Māori (representing Te Parawhau, Te Kahu o Torongare, Te Uri-ro-roi, Ngāti Hau and Te Ore Wai hapū) launched a five year strategic plan with the vision of "Te huarahi hei whakahokia mai te mauri o nga awa" taking in the waterways from the headwaters to the confluence of the Wairua and Mangakāhia Rivers. The aspirations of Ngā Kaitiaki o Ngā Wai Māori are categorised under a number of themes, including Kaitiakitanga, Environment, Cultural, Social and Economic. Ngā Kaitiaki o Ngā Wai Māori actively maintains a variety of internal and external collaborative partnerships to implement research and environmental restoration projects needed to inform the group in freshwater management decision-making processes. For example, tuna [freshwater eels] are an important taonga [treasured] species in the Mangakāhia and Wairua River catchments. Many whānau, marae and hapū harvest tuna from the catchment as part of their regular dietary intake, as well as for hui and tangi. In addition to concerns regarding local land use practices and the associated effects on water quality and fisheries habitat, tangata whenua are also concerned about the reduced availability of tuna. Given that the group is continuing to build the capabilities and capacities required to realise the aspirations contained in the strategic plan, in this presentation we will use tuna as an example of the types of outcomes we have already achieved over a relatively short time period in partnership with NIWA, as well as outline our priorities for future research and environmental improvement.

Swimming in Auckland's Harbour Waters; Can We Predict the Risk to Swimmers

Jarrod WALKER // Auckland Council

Auckland City is hosting national and international water related sporting events which utilise Auckland 's waterfront harbour. Currently there is little consideration for public health related issues. The majority of these events are supported by very little bacteriological information to inform the event organisers and the participants of the relative risks of swimming in the harbour. In this talk I will present enterococci concentrations related to rainfall from sampling done in the Waterfront. Highlight the shortcomings of the current recreational water quality monitoring program and present Auckland Councils bathing beach forecasting model developed by DHI.

What's been Happening to the Lampreys Down South?

Kathy WALLS // Ministry for Primary Industries

Anjali Pande, Jaap Knegtmans, Wendy McDonald // Ministry for Primary Industries

In September 2011, the Ministry for Primary Industries (MPI) was notified of a mass mortality of lamprey, *Geotria australis*, in the Mataura River, Southland. Upon further investigation it became evident that lamprey populations in other Southland rivers were also affected. Lamprey (kanakana) are a taonga species and the mortalities were cause for considerable concern by tangata whenua in Southland. MPI was also concerned that other freshwater fish species may be potentially impacted, such as trout, salmon and native fishes. Affected lamprey were tested for a range of pathogens but no conclusive evidence for a primary pathogen was identified as the cause of the mortalities and it was unclear whether other contributing factors were responsible. Laboratory testing ceased at the end of 2011 because the seasonal kanakana migration upriver had finished and no further specimens could be obtained. In August 2012, MPI was again alerted to dying kanakana in Southland rivers. A surveillance programme was implemented which involved: collection of specimens for laboratory testing, a targeted catch and release data collection programme, gathering observational data from stakeholders; and, receiving public reports via the MPI Pest and Disease 0800 Hotline. By the end of the kanakana migration in 2012, an exotic or emerging pathogen had still not been found in the affected specimens. The results of the investigations into the two mortality events and the findings of a technical advisory group, convened to address options for managing future mortality events in Southland, will be discussed.

Engineering Estuaries to Maximise Biodiversity, Species Protection & Resilience in the Great Barrier Reef Lagoon

Nathan WALTHAM // James Cook University, Australia

Marcus Sheaves // James Cook University, Australia

Desire for coastal living and urbanisation has replaced natural, soft, shoreline habitats with built infrastructure in many places. Among the anthropogenic perturbations affecting coastal processes and resilience (e.g. overfishing, freshwater diversion, sedimentation and dredging) the most tangible is coastal foreshore engineering in response to urban and industrial development. These engineered shorelines can offer extension to existing estuaries, though biodiversity is generally lower compared to the natural habitat replaced. Exactly how well these newly created habitats mimic natural habitat is unknown, and although structures comply with engineering standards, there are few attempts by managers to incorporate biota-friendly features, which results in a complex mosaic of hard, engineered surfaces and habitat (e.g. pontoons, jetties, rock/concrete walls). Understanding the ecology of coastal development and consequences for biodiversity cannot advance by simply documenting change, rather robust experimental programs are needed that yield novel engineering solutions to maximise biodiversity. In tropical systems sea level rise is the greatest climate change risk factor, and consequently expansion of coastal armouring and development is set to increase rapidly. We explored the habitat function of a variety of engineering structures in an urbanised estuary connected to the Great Barrier Reef lagoon. The results show the need for practicable and affordable ecological engineering designs, to achieve conservation planning and policy change. Collaborative, cross continent, research is supported to assess whether the results here are more general.

Anti-cancer Potentials of Fucoxanthin Contents Extracted From New Zealand *Undaria pinnatifida*

Kelvin Sheng WANG // Auckland University of Technology

Dr Jun Lu, Dr Yan Li, Dr Lindsey White // Auckland University of Technology

The brown seaweed *Undaria pinnatifida* (*U. pinnatifida*) (Harvey) is important as dietary foodstuff, and used for medical treatment supplement in East Asian countries. The major component of *U. pinnatifida*, fucoxanthin has recently been found to induce apoptosis in various cancer cell lines. This study investigated whether other potential anti-cancer compounds could be found in fucoxanthin content extracted from New Zealand (NZ) *U. pinnatifida*. Several types of human cancer cell lines were used in this study including lung carcinoma A549, NCI-H522, colon adenocarcinoma WiDr, Lovo, hepatocellular carcinoma Hep G2, breast adenocarcinoma MCF-7, malignant melanoma Malme-3M, cervix squamous carcinoma SiHa, and neuroblastoma SK-N-SH. Anti-proliferative effects were determined by 24hr-72hr. Pure fucoxanthin showed anti-proliferative effects in all cancer cell lines in dose- and time- dependent manners. The ranking of anti-proliferative sensitivity to fucoxanthin was in the order of Malme-3M > SiHa > Lovo, MCF-7, NCI-H522 and A549 > Hep G2 and WiDr > SK-N-SH. Similarly, anti-proliferative effects of fucoxanthin extracted from New Zealand seaweeds were found in all types of cancer cell lines in dose- and time- dependent manners. These three fucoxanthin extracts (purity of fucoxanthin: 0.2%, 43.5% and 60.8%) were achieved through a series of fucoxanthin isolation and purification procedures. Compared with anti-proliferative IC50 of pure fucoxanthin standards, the significant anti-proliferative effects of fucoxanthin extracts were found in some cancer cell lines including WiDr, Lovo, and NCI-H522. In conclusion, fucoxanthin as a type of marine carotenoid possessed effectively anti-proliferative effects to multiple types of cancer cell lines. Thus, fucoxanthin can be the important phytochemical with chemopreventive effects. Furthermore, some of novel compounds with potential anti-cancer effects might be contained in New Zealand *U. pinnatifida*. This suggested *U. pinnatifida* as part of a human diet could possibly decrease the risk of cancer especially for human colon, and lung cancer.

Sustainable Management & Economic Optimization in Australian Commonwealth Fisheries

Na WANG // University of Queensland

You-Gan Wang // University of Queensland

The appealing concept of maximum economic yield (MEY) has been widely adopted to obtain new management strategies. However, the traditional MEY (MEY_t) maximizes the net profit of harvesting fish stock and stops the "rent drain" to the society. It may be more appropriate to use a broad MEY (MEY_{SRM}) which is based on the value chain of the overall fishing sector, to reflect better society's interests. We evaluate the implications of managing fisheries to achieve MEY_{SRM} using a number of the Australian Commonwealth fisheries, and illustrate how this framework incorporates fish chain sectors, employment and other positive externalities. The results show that benefit of extending harvest to a higher level, which still compromises sustainability objectives, overweighs the economic rent loss in the fishery industry.

Abiotic limits on Larval Transport Shape a Species Distribution

Manna WARBURTON // University of Otago

Worldwide, the distribution of amphidromous fishes is associated with high relief landscapes. Recent work has highlighted the association of amphidromous fish distributions with these landscapes on a continental scale. The forces driving these distributions on a continental scale are likely taking place on smaller scales as well within the distributions of single species. We explored the occurrence of the amphidromous New Zealand torrentfish across its distribution, examining landscape features and correlating them with the presence of the species based on the New Zealand Freshwater Fish Database. We found a correlation between specific river features (average downstream slope in lower reaches) and the presence of torrentfish. Torrentfish may be excluded from rivers that possess appropriate adult habitat, but also possess slow moving lower reaches. We propose that abiotic features constraining larval transport in these rivers are excluding torrentfish from occupying or recruiting out of them even though they posses appropriate adult habitat. We further postulate that abiotic larval transport limits may help explain distributions of amphidromous fishes worldwide.

Whe management of diffuse pollution is at the heart of a debate facing the Hawke's Bay Region – how should pressure to intensify agricultural production and the potential effects on the water quality of the Tukituki River be balanced? The National Policy Statement for Freshwater Management 2011 requires Regional Councils to set objectives and limits for both water quality and water quantity. Based on a values assessment of the Tukituki catchment, nutrient limits have been set to meet key management objectives. These limits have been incorporated into a Plan Change for the Tukituki River. HBRC will manage The management of diffuse pollution is at the heart of a debate facing the Hawke's Bay Region – how should pressure to intensify agricultural production and the potential effects on the water quality of the Tukituki River be balanced? The National Policy Statement for Freshwater Management 2011 requires Regional Councils to set objectives and limits for both water quality and water quantity. Based on a values assessment of the Tukituki catchment, nutrient limits have been set to meet key management object.

Great Australian Bight Collaborative Research Science Program: a New Partnership for a New Whole of Ecosystem

Tim WARD // South Australian Research and Development Institute

David Smith // CSIRO
Rod Lukatelich // BP Developments Australia

A new four-year, $20M collaborative research partnership has commenced in the Great Australian Bight (GAB). The science programme will be one of only a small number of whole of system studies undertaken in Australia, and the first for the GAB, of which little is known of this unique ecosystem. The science programme aims to obtain information about the marine environment and potential marine resources within the Ceduna sub-basin. It includes research themes on oceanography, pelagic and benthic ecology, iconic and apex predators, geopetroleum and geochemistry, and socio-economic analysis of potentially affected communities. The data and information obtained will provide qualitative and quantitative models of the structure and dynamics of the GAB ecosystem, and will inform decision makers to support sustainable development in the region and monitor possible future impacts of oil and gas exploration. The programme will involve the collection of the deepest set of samples ever taken from the GAB and will provide an insight into the distribution, diversity, and ecology of the deepwater species of animals, plants and microbes which reside in the central and eastern GAB. This science programme is a collaborative research initiative involving BP Developments Australia, CSIRO and Marine Innovation Southern Australia (South Australian Research & Development Institute, University of Adelaide, Flinders University).

Evidence for Localized Depletion in Fisheries for Small Pelagic Species; Potential Management Responses

T.M. WARD, A. IVEY, P.J. ROGERS & J. EARL // South Australian Research and Development Institute

Localized depletion of target species has recently been highlighted as an issue of public concern regarding the management of fisheries for small pelagic species. This presentation summarizes published evidence of 1) localized depletion of small pelagic fishes through the spatial/temporal concentration of fishing activity and 2) related impacts on populations of predatory species. Evidence of localized depletion is examined for the South Australian sardine fishery (SASF). The SASF is identified as a suitable case study for investigating the potential for localized depletion of a small pelagic species because: 1) fishing effort is concentrated in a small proportion of the total area over which the stock is distributed; and 2) information, both extensive fishery-dependent (e.g. spatially explicit catch, effort and age/size data) and fishery-independent (egg, larval and juvenile surveys, adult age and reproductive data, foraging patterns and reproductive success of key predators), has been collected to support the management of the fishery. Findings are used to identify and assess options for addressing the potential for localized depletion in harvest strategies for small pelagic fisheries. Relevant components of the new harvest strategy for the SASF are described.

Lake Waahi Restoration Project

Erina WATENE-RAWIRI // Waikato-Tainui College for Research and Development

Lake Waahi is very important to the local Maori community and has been for generations. The puhi eel (shortfinned male migrant) is a particular delicacy for the local Maori community.

Waahi Whaanui Trust, Genesis Energy and Waikato Raupatu River Trust are working together to restore Lake Waahi. The project is co funded by the Waikato River Authority. Currently the Lake is highly turbid, nutrient enriched, and full of pest fish including Koi Carp, Perch and Catfish.

This presentation outlines the work completed to date and proposed for future years. There is a special focus on Koi removal, wetland creation and the establishment of a nursery.

Fisheries Ecology, Economics & Culture: getting the mix right for the Sepik-Ramu, PNG

Alan WEBB // Hydrobiology Qld Pty Ltd

Between 1991 and 1997, the Sepik-Ramu, was stocked with eight non-native fish species under two joint FAO and PNG government projects, the rationale being that the existing fishery would not meet the protein needs of a future regional population, the introduced species would occupy "vacant niches", exploit under-utilised resources and not impact upon the native aquatic community. European best practice protocols were used for species selection and quarantine processes and advice provided by a panel of international experts. Fish surveys were undertaken to ascertain the existing fish stocks. Village surveys were undertaken to assess the types of fish exploited and their local economic value. A 2002 preliminary survey found that all introduced species had established populations and some species were contributing to food and income generation. Fish surveys in 2008-2009, however, revealed ecological shortcomings of the project with introduced fish species dominating, some species dispersing beyond expected limits and drastic reductions in several native species including locally preferred food fish. A loss of aquatic vegetation caused by introduced herbivorous species is now a potential threat to culturally and economically important crocodile populations due to a loss of nesting material. Widespread community dissatisfaction also revealed a lack of adequate consultation by proponents regarding species selection and their limited appreciation of traditional economic, fishing and fish preservation practices. While well meaning, the stocking projects revealed the importance at the outset of getting the scientific, economic and cultural mix right to avoid or minimise adverse outcomes.

Tag-Recapture Models & Site-fidelity: What Happens When a Fish goes on its OE?

Darcy WEBBER // Victoria University of Wellington

Richard Arnold, Shirley Pledger // Victoria University of Wellington
Alistair Dunn // NIWA

The assessment models of some fish stocks are informed by tag-recapture data. Good tag-recapture data is generally considered a valuable type of data due to its ability to inform estimates of population size, growth and migration rates. However, tag-recapture experiments are expensive and several assumptions must be made to analyse the data. This talk focuses on one of these assumptions, that tagged fish mix homogenously, and investigates why this assumption may not always hold. The root of the problem lies in the way that fish and the fishers arrange themselves, which is usually far from spatially homogeneous. For instance, fish move, sometimes a lot. They also tend to assort into groups of fish of similar size and aggregate in clumps where food or habitat is available. Some species simultaneously undertake mass migrations to spawning grounds before returning to where they came from, a phenomenon known as site-fidelity. Similarly, gradients of fishing mortality occur across stock assessment boundaries, or fishing mortality can be much higher in spatially aggregated clumps as fishermen exploit the behaviours of the fish they target. We have developed a novel model to simulate some of these characteristics in a fishery and have focused on a fish population that displays site-fidelity. This model attempts to develop data with a realistic injection of variation and spatial complexity in the fish themselves and the way fishers exploit them. The final goal is to develop assessment models capable of eliminating the homogenous mixing assumption in assessments informed by tag-recapture data.

Reconnecting Whitebait to the Places they Need to Be

Dave WEST // Department of Conservation

Bruno David // Waikato Regional Council
Hannah Jones // The University of Waikato
Cheri van Schravendiik-Goodman // Waikato Raupatu River Trust
Paul Franklin, Cindy Baker // NIWA

As with most of New Zealand's native freshwater fish the main whitebait species inanga (*Galaxias maculates*) needs access to and from the sea and lowland rivers, streams, lakes and wetlands at various stages of its lifecycle. Those lowland regions of New Zealand are also sought after by humans to live in or farm. Living in and farming these areas requires extensive modifications of the wetlands and rivers by humans. The end result is inanga do not have free access to large parts of their previous habitat or it no longer exists. Using the lower Waikato River as an example we will show the extent of the loss and ways of identifying priority areas for action to reconnect inanga with the places they need to get to. Specific areas to be identified will be spawning sites and prime lowland inanga habitat. Tools we will demonstrate the use of include: historical and recent records of inanga spawning sites, historical and current wetland, records of inanga occurrence, river and floodplain bathymetry, research on what makes good spawning or adult habitat, spatial maps of barriers and streams and predictive models of fish presence etc. When combined with local and traditional knowledge these methods will highlight priority habitats and actions to restore inanga habitat and populations.

The Sulfide Footprint of Marine Farms

Peter WILSON // Auckland University of Technology

Kay Vopel // Auckland University of Technology

Routine environmental monitoring is a requirement for the operation of mussel and fish farms in coastal waters of New Zealand. One important process that affects the environmental performance of such farms is the enrichment of the seafloor with organic matter. The available tools and techniques to directly or indirectly assess this enrichment, however, are laborious and time-consuming. We have developed a method to derive the concentration of sedimentary sulfides, a product of the microbial degradation of organic matter, from a sediment profile image. Our analyses of sediment underneath and around one mussel farm off the eastern coast of Waiheke Island revealed a strong correlation ($R^2 = 0.95$) between the concentration of acid volatile sulfides and the colour intensity of the sediment. We propose to use this correlation to describe spatial and temporal changes in the organic matter content of sediment underneath marine farms with in situ sediment profile imaging. We will present results from the first trial of our approach and discuss how changes in the depth and size of the farm sulfide footprint can be used to assess farm environmental performance.

Monitoring Cyanobacteria in Recreational Waters – How Effective are the Current Guidelines?

Susie WOOD // Cawthron

Juliet Milne // Greater Wellington Regional Council
Wendy Paul // Wendy Paul Consulting
Wendy Williamson // ESR
Karl Safi // NIWA
David Hamilton // The University of Waikato

In 2009, interim guidelines for managing cyanobacterial risk in fresh waters used for recreational purposes were released in New Zealand. The aim was to help agencies responsible for managing cyanobacteria proliferations develop monitoring protocols appropriate for local conditions, and to encourage the adoption of a nationally unified approach. The guidelines set out a monitoring framework for establishing the public health risk from cyanobacteria in lakes (mainly planktonic) and rivers (mainly benthic). A three-tiered alert level framework that incorporates a monitoring and management action sequence is used. Regulators can use this framework for a graduated response to the progression of cyanobacterial blooms. The guidelines include several major changes from the previous current standard practices; the use of biovolume estimates for planktonic cyanobacteria instead of cell concentrations, and the incorporation of benthic cyanobacteria thresholds based on abundance and the occurrence of detaching mats. Most Regional Councils and District Health Boards around New Zealand are now using the guidelines, although some challenges have been encountered. Case-studies will be used to illustrate their effectiveness and suggestions for possible areas for refinement. The potential to integrate the cyanobacterial guidelines into general recreational water quality guidelines for New Zealand will be discussed.

The Effects of Common Carp (*Cyprinus carpio*) on Zooplankton Diversity & Abundance: a Large-scale Field Experiment

Steve WOODS // The University of Waikato

Ian Hogg, Ian Duggan, Conrad Pilditch
Jonathan Banks // The University of Waikato
Adam Daniel // The University of Waikato, Fish & Game New Zealand

We are undertaking a large-scale field experiment using paired lakes at the Hamilton Zoo to determine the effects of pest fish on lake ecosystems. Following a pre-manipulation period as part of a "before and after, control and impact" (BACI) study design, we will introduce common carp *(Cyprinus carpio)* to determine the effects on the zooplankton population and community dynamics. Pre-manipulation monitoring commenced in August 2012 and finishes in June 2013 with a complete draining of both lakes to ensure non-native fish are absent. In July and August 2013, common carp will be added at a density of 400 kg/ha to the 'impact' lake. The lakes will then be monitored for a further 12 months to determine the effects of the manipulation. We will test the hypotheses that the addition of carp will: (1) increase the concentration of nutrients in the water column; and (2) increase the concentration and particle size of suspended sediments. As a consequence of nutrient changes we predict that the phytoplankton community will shift from one dominated by cryptomonad and green algae to one dominated by cyanobacteria. As a consequence of increased suspended sediments, we predict that large filter feeding cladocerans such as *Daphnia* will decline and that the zooplankton community will be dominated by rotifers.

Can Downstream Riparian Buffer Zones Enhance Pasture Stream Restoration within an Agricultural Landscape?

Aslan WRIGHT-STOW // NIWA

Steph Parkyn, David Reid // Independent
Brian Smith, Kerry Costley // NIWA

In New Zealand the wide spread conversion of forest to agricultural land has caused significant degradation to stream and riparian ecosystems. Re-planting riparian buffers is often one of the first steps taken in an effort to restore stream function and species composition but the factors influencing the magnitude and timeline of success are not well understood. In 2000 we assessed nine Waikato riparian buffer zone planting schemes at sites with wetted widths between 1.3 m and 7.7 m (at that time plantings had been established 2–24 years, buffer lengths ranging from 196–4200 m, buffer widths 7.2–75 m) and compared them with unbuffered control reaches upstream or nearby. At most sites no significant changes in macroinvertebrate communities towards "clean water" or native forest communities was observed. In 2011 we reassessed the same sites. Between 2000 and 2011 invertebrate community metrics (# taxa, #EPT taxa, %EPT taxa, MCI, QMCI) either increased ($P<0.05$, ANOVA) or remained unchanged at all sites. At five sites invertebrate metrics at riparian reaches increased relative to those observed at the control sites. These were generally, although not always, sites with larger buffer areas (width x length). Improvements at three control reaches were likely to reflect improved landuse management within the catchment. Results suggest that downstream riparian buffer zones can enhance pasture stream restoration within an agricultural landscape but that expectations of riparian restoration efforts should be tempered by time scales – good things take time!

Cultivation of the Giant Kokopu (*Galaxias argenteus*)

Matthew WYLIE // University of Otago

Gerard Closs, Mark Lokman // University of Otago

Whitebait has both notable cultural significance as a recreational fishery pastime and considerable aquaculture potential due to the value of its translucent larvae. In New Zealand, this fishery comprises five species that belong to the genus *Galaxias. Galaxias maculatus* (inanga or common jollytail) is the most frequently encountered species contributing up to 99% of the catch. The remaining four species contributing to the fishery are *G. brevipinnis* (koaro), *G. fasciatus* (banded kokopu), *G. postvectis* (shortjaw kokopu) and *G. argenteus* (giant kokopu). Attempts at artificially rearing whitebait have met with limited success both here in New Zealand and in Chile using *G. maculatus*. We hypothesised that using the largest species in the genus (giant kokopu) as an alternative for the production of whitebait could help overcome some of the current barriers limiting large-scale production. In addition, understanding the environmental conditions required for spawning and embryonic development of giant kokopu enable the augmentation of dwindling populations or the reestablishment of extinct populations, thus aiding conservation efforts. We investigated the effects of salinity and temperature on fertilisation and hatching in wild and captivity-acclimated giant kokopu. Fertilisation rate decreased as water salinity increased and results suggest that cooler incubation temperatures appear to be important to yield high hatch rates. We also described the sequential changes during embryonic development and produced juvenile fish in order to establish a captive breeding colony.

Fish Assemblages in the Coorong (2006–2013): the Need for Freshwater Flows

Qifeng YE // South Australian Research and Development Institute

Juan Livore, Luciana Bucater, David Short // South Australian Research & Development Institute

The Coorong is the unique estuary of the Murray-Darling Basin, located at the terminus of the Murray-Darling River. Freshwater flows play a pivotal role in maintaining estuarine habitat and functionality and affecting aquatic biota. The present study investigated spatio-temporal variation in fish assemblage structure and distribution, abundance and recruitment of key species along the Murray estuary, North and South lagoons of the Coorong in the recent drought, flood and high flow years (2006–2013). During drought and low flow conditions (2006–2008), fish assemblages were dominated by marine species in the Murray estuary, and the South Lagoon became unsuitable fish habitat due to its extreme hypersalinity (four times that of seawater). Following substantial freshwater inflows and reconnection of freshwater and estuarine environments, salinities decreased significantly along the Coorong (2010–2013). Consequently, fish assemblage composition changed; species richness, diversity and abundance increased. The freshening of the Coorong also resulted in a southward range expansion and enhanced recruitment of several estuarine and catadromous species including congolli *(Pseudaphritis urvilli)*, greenback flounder *(Rhombosolea tapirina)* and sandy sprat *(Hyperlophus vittatus)*. Smallmouth hardyhead *(Atherinosoma microstoma)* recolonised the South Lagoon with a dramatic increase in abundance following increased flow and salinity reductions to <100‰. This study highlights the importance of freshwater inflows in maintaining and restoring estuarine habitat, facilitating fish recruitment and promoting abundance and diversity in estuarine fish assemblages.

Functional Responses of Stream Ecosystems to Riparian Rehabilitation

Roger YOUNG // Cawthron Institute

Kati Doehring, Joanne Clapcott // Cawthron Institute
John Quinn // NIWA

Changes in land use can have dramatic effects on stream ecosystem structure and function. Concerns about land use change and the degradation of stream ecosystems has led to increasing efforts to rehabilitate these systems. Riparian buffers are a key tool for stream rehabilitation and aim to increase shade and natural organic matter inputs and restrict inputs of sediment, nutrients and other contaminants. However, the effectiveness of rehabilitation programmes is rarely monitored and there is almost no data on changes to ecosystem function resulting from rehabilitation efforts. To address this knowledge gap we measured stream ecosystem metabolism, organic matter decomposition, organic matter retention and stable isotope composition of primary consumers at 11 sites where riparian buffers have been established and at 11 neighbouring control sites which are not buffered from the surrounding pastoral land use. The riparian buffers range in age from 5 to 34 years, with buffer length ranging from 196–4200 m and buffer width from 7.2–75 m. Preliminary results suggest that despite substantial increases in shading of the study reaches, there were minimal changes in any of the measures of ecosystem function. This lack of response to rehabilitation mirrors earlier results for invertebrate communities at a subset of the same sites and indicates that there is considerable hysteresis in response to riparian rehabilitation. Many indicators of stream health are likely to require rehabilitation of substantial lengths of riparian zone rather than just efforts at the reach scale, and improvements in stream ecosystem structure and function will take time.

Climate Change & Water Resources: a Scenario-based Modelling Study in a Dairy Catchment

Christian ZAMMIT // NIWA

Ms Srinivasan, Robert Wilcock, Einar Hrenisson // NIWA

The potential impacts of climate change (CC) on water quantity and quality in a dairy-dominated catchment, Waiokura, of North Island, New Zealand, was investigated. In this scenario-based modelling study, a hydrology/water quality model was calibrated and validated using observed data from 2001–2010. The calibrated model was then used to simulate the impacts of CC over two 20-year periods, 2030–49 ("2040") and 2080-99 ("2090"). Modelled data from these two future periods were compared against modelled simulations from the 1980 to 99 ("Current") period. Under CC scenarios, average annual rainfall was predicted to be similar to that of Current, though the intensities might be higher and frequencies rarer than Current. On average, air temperatures are predicted to increase from 2 to 4°C over Current, and a combination of warmer conditions and infrequent storms under CC conditions may result in dry periods longer than those under Current. Also, more intense storms can potentially increase the occurrence of infiltration-excess overland flow from grazed paddocks compacted by animal traffic. In direct consequence, the stormflows are predicted to be flashier but the average and median streamflows are predicted to be less than those under Current owing to less frequent storms. Larger flood events might result in greater transport of nutrients and sediments from land to water and within streams. Simulation of nutrient (nitrogen and phosphorus) transport indicate that a larger infiltration-excess overland flow may result in larger available transport from land to water than those available under Current.

Feeding, Metabolism, Nutrient Assimilation & Growth of Juvenile Sea Cucumbers (*Australostichopus mollis*) at Different Temperatures

Leonardo ZAMORA // The University of Auckland

Andrew Jeffs // The University of Auckland

In the present study the importance of seawater temperature for the food intake, food utilization and growth of aquacultured juveniles of the Australasian sea cucumber, *Australostichopus mollis*, were examined. The juveniles (16.5±0.5 g, wet weight) were experimentally exposed to four seawater temperatures (15, 18, 21, and 24 °C) for 105 days, during which they were fed mussel waste, a highly effective natural food source, that is utilised by sea cucumbers under co-culture conditions beneath mussel farms. At each temperature treatment the feeding, nutrient assimilation, metabolism, growth and survival of the juveniles were evaluated. Overall, the sea cucumbers responded negatively to an increase of temperature from 15 to 21°C with decreased food intake, and growth rates, and elevated metabolism. The survival of juveniles was compromised when held at 24 °C. Most importantly, the energy available for growth and the food conversion efficiency of juveniles at 15°C were greater than for those growing at 21°C which was reflected in the growth rates (i.e., 0.71±0.05% d^{-1} versus 0.28±0.05% d^{-1}). The results of this study suggest that consideration of ambient temperature regimes will be a critical factor for the selection of suitable aquaculture locations for *A. mollis* due to the risk of mortality at higher temperatures (≥24 °C) and markedly improved growth and food utilization at lower temperatures around 15 °C.

Influence of Climate on Pelorus Sound Mussel Aquaculture Yields: Predictive Models & Underlying Mechanisms

John ZELDIS // NIWA

Mark Hadfield, Doug Booker // NIWA

Multiple regression models were used to predict aquaculture production in Pelorus Sound, which supports 68% of New Zealand's NZ$204 million per annum mussel *(Perna canaliculus)* aquaculture industry. Mussel meat yield was modelled using biological data, including seston (indexed by particulate nitrogen, PN), phytoplankton and nutrients collected over 9 yr (July 1997 to November 2005) by the mussel industry, and physical, climatic data, including Southern Oscillation Index (SOI), along-shelf winds, sea surface temperature (SST) and Pelorus River flow, held in New Zealand national databases. Yield was best predicted using biological data collected locally at the farms inside the sound, but it was also predictable using only physical data collected distant from the farming region. Seston (mussel food) was also predictable using the physical data. Optimal predictor sets for yield and seston differed between summer and winter half-years. In summer, deep water at the sound entrance (which enters the sound through the estuarine circulation) was nitrate (NO_3^-)-rich during upwelling conditions (negative SOI, NNW wind-stress and cool SST). The increased NO_3^- levels, in turn, triggered increased PN within the sound. In the winter, PN was unrelated to upwelling and NO_3^- effects at the entrance and was instead related to river flow. Remotely-sensed SST data showed that in summer upwelling affected the entrance waters of the sound under negative SOI and upwelling-favourable wind-stress, patterns which dissipated in winter. These results show that time-series of physical drivers can be useful for explaining production variation of farmed bivalves and indicate the prospects for using data routinely collected in national databases for predicting mussel yield.

Linking Nitrogen & Carbon Cycling in the Coastal Ocean – Implications for CO_2 Emissions, Ocean Acidification & Land Use

John ZELDIS // NIWA

Kim Currie, Mark Gall // NIWA

The propensity of a coastal water body to emit or consume CO_2 is related to its 'net ecosystem metabolism' (NEM). NEM is positive, or 'autotrophic', where gross primary production (GPP) exceeds community respiration (CR), and dissolved inorganic carbon (DIC) is consumed, and negative or 'heterotrophic' where CR exceeds GPP and DIC is generated. In turn, DIC generation is strongly related to CO_2 efflux at the sea-air boundary (measurable as partial pressure of CO_2 or pCO_2). Coastal NEM is controlled by the supply of organic matter to the system, either as direct loading of fixed material or from excessive inorganic nitrogen loading which fuels fixation and respiration in subsurface water. A potentially serious consequence of the evolution of DIC is lowered pH (acidification). Thus, there are important links between carbon and nitrogen cycles in coastal systems and inputs from land, which affect NEM, CO_2 balance, and acidification. In this talk we describe NIWA coastal nutrient budgets for the Hauraki Gulf and Firth of Thames, the latter of which receives high runoff from Waikato region farming and is highly net-heterotrophic. We describe our recent ship surveys of the carbonate system of the Hauraki Gulf/Firth region which show high pCO_2 and significant acidification in the Firth. We describe regional (Firth-Gulf-continental shelf) and seasonal variation in these properties, and how we are combining nutrient budget and carbonate system surveys with sampling of bio-optical properties, firstly, to understand the drivers of NEM and secondly, to determine if we can assess them using remote sensing.

What is the Future for Fisheries?

Shijie ZHOU // CSIRO

Tony Smith // CSIRO

Oceans are under pressure: the scientific literature describes overfishing, bycatch and discards, loss of biodiversity, ecosystem deterioration, ocean acidification, etc. Commercial fisheries are also under pressure: more stringent regulations (on gear, season, space, quota, bycatch, etc.), expansion of marine protected areas, increases in fishing costs, social license to operate. What is the future for fisheries? There are many questions at both strategic and operational levels. How can we conserve marine ecosystems on which fisheries rely? What does biodiversity really mean in relation to fisheries? Why do we want to reduce bycatch? Is indiscriminate bycatch reduction consistent with the principles of responsible fisheries? What species should be harvested at an ecosystem level? How should we harvest the age and size structure of a population? Can we increase fisheries production while reducing negative impacts on the environment? How can we determine ideal fishing pattern and intensity to maximize food production while minimizing environmental impacts? Can a target species be sustainably harvested while catch of other species are minimized? Can we simultaneously optimize conservation, food production, and social and economic benefits? How can society accept and utilize currently low-valued components and non-target components? Can industries add value to currently low-valued components? Can cultural exchange and development of seafood processing techniques influence people's dining habits? How can eNGOs, food industry professionals, media, educators, and retailers play a role in implementing balanced harvest and supporting sustainable fishing? We will discuss some of these questions that are shaping the future of fisheries.

A Cross-sampling Method for Estimating Abundance & Detectability for Aggregated Populations With Varying Local Abundance

Shijie ZHOU // CSIRO

Neil Klaer, Ross Daley, Mike Fuller, Anthony Smith // CSIRO
Zhengyuan Zhu // Iowa State University

Fish and wildlife often exhibit an aggregated distribution pattern while local abundance changes constantly due to movement. Estimating population size and survey detectability (i.e., gear efficiency) for such elusive species is technically challenging. We developed a statistical method to deal with this difficult situation, particularly for fish populations where gear efficiency is almost never perfect. The method involves a mixture of two statistical models: a negative binomial function for modelling animal distribution between- and within-grid cells, and a binomial function for modelling detection (catching) of animals. The innovative approach is to use more than one fishing gear to simultaneously catch the same population in each grid cell at the same time. We carried out computer simulations on a range of scenarios and estimated the relevant parameters using a Bayesian technique. We then applied the method to two fish species, Tiger Flathead and Draughtboard Shark, to demonstrate its utility. Simulation results indicated that the models can accurately estimate both abundance and detectability. For the four gear types that caught Tiger Flathead and Draughtboard Shark – longline, Danish seine, gillnet, and trawls, gear efficiency varies between species and gear types, ranging from 0.08 to 0.77. This cross-sampling method can evaluate gear efficiency cost effectively using existing fishery catch data or survey data, reducing reliance on costly field experiments. More importantly, it provides a means for estimating gear efficiency for gear types that are extremely difficult to study by field experiments.

POSTER ABSTRACTS

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Preliminary Characterization of the Population Dynamics of Redfin Perch (*Perca fluviatilis*) from Lake Wainamu, New Zealand

Fiona BANDA // Auckland University of Technology

Armagan Sabetian

A baseline study was conducted in 2012 and 2013 at Lake Wainamu (West Auckland) as an initial step in characterizing the population dynamics of redfin perch in New Zealand. A total of 124 fish samples in 2012 and 151 fish samples in 2013 were histologically analyzed and sagittal otoliths examined to obtain estimates of reproductive, age and growth parameters. Results indicated a population age range of (0–6) years with an average of 86.15% of population between (0–2) years. The L_∞ was 180.23 mm standard length and 248.22 mm standard length for 2012 and 2013 respectively. 23.5% of females were reproductively inactive at time of sampling, 60.5% females showed oocyte development and 2.7% were mature spawning. Males were either inactive or had active spermatides with none showing mature spawning. The results suggest that redfin perch in Lake Wainamu spawn at different time of the year than previously documented in New Zealand. This finding has a significant implication to the effectiveness of redfin perch eradication programme in New Zealand.

The Combined Effects of Low pH & Elevated Temperature on the Growth of Three Frondose, & Two Calcareous Rhodolith Seaweeds from New Zealand

Neill BARR // NIWA

Kate Neill, Sheryl Miller, Wendy Nelson, Graeme Moss // NIWA
Kristin Scheuer // University of Canterbury

We examined the effect of changes in pH and temperature predicted to occur around New Zealand coasts by 2100, on five seaweeds. Over the 12 day duration of the experiment *Ulva* showed increased growth rate in response to low (7.65) pH seawater, relative to ambient (8.05) pH, at all temperatures examined. The optimum temperature for growth in *Ulva* at ambient pH was between 15 and 18 °C, however at low pH the optimum temperature for growth was lower at 13 °C. *Gracilaria* had the highest growth rate at 22°C at ambient pH but had significantly lower growth in low pH seawater at this same temperature. At lower temperatures there was little evidence of a growth response in *Gracilaria* to pH level. Undaria had the highest growth rate at 11°C at both ambient and low pH seawater, and similarly to *Gracilaria*, growth showed little response to pH level. Compared with the growth patterns observed in these three frondose seaweeds, we found that two rhodolith species (*Sporolithon durum* and *Lithothamnion crispatum*), under similar experimental conditions, clearly demonstrated that the combined effects of elevated temperature and decreased pH, predicted for our future coasts, had a significant negative impact on growth.

Ancient Or Recent: When Did Freshwater Rotifers Invade Marine Habitats?

Clare BEET // The University of Waikato

Ian Duggan, Ian Hogg, Gemma Collins // The University of Waikato

We compared the species and genetic diversity of rotifers between marine and freshwater habitats. Rotifers are widespread and commonly found in marine, freshwater and terrestrial (soil) ecosystems. However, in marine habitats, rotifers are relatively species poor and are largely unstudied. We focused on the two main rotifer genera found in marine environments: *Trichocerca* and *Synchaeta*. There are over 20 *Synchaeta* species in marine environments, which are thus seemingly more diverse than their freshwater counterparts with around 12 species recognized globally. In contrast, there is only one marine *Trichocerca* species (*T. marina*), with considerably higher diversity found in freshwater habitats (>70 species). Here, we examined the genetic relationships among freshwater and marine *Trichocerca* and *Synchaeta* species using DNA sequencing of the mitochondrial COI region. Using divergence values within and among habitats, we test the hypothesis that marine taxa represent ancient invasions from freshwater habitats. Our preliminary data suggest that marine *Synchaeta* species are closely related to their freshwater counterparts, indicating a recent invasion of the marine environment followed by rapid diversification. In contrast, individuals of *Trichocerca marina* were deeply divergent relative to the freshwater taxa, indicating a potentially more ancient association with the marine environment.

Mitochondrial DNA Variability Among Closely-related Species Pairs of New Zealand Caddisflies (Trichoptera)

Kristi BENNETT // The University of Waikato

Ian Hogg // The University of Waikato
Brian Smith // NIWA
Jonathan Banks // Cawthron Institute
Paul Hebert // University of Guelph

We used mitochondrial DNA (COI) sequence variability to examine levels of genetic divergence among closely-related species pairs of New Zealand caddisflies (Insecta: Trichoptera). Based on an analysis of 509 individuals covering a putative 130 species, seven closely related species pairs were identified, consisting of morphologically distinct species, each restricted to either the North Island or South Island. Another five species showed similar or greater levels of "intraspecific" divergence, with genetically distinct populations on each island. Sequence divergences between these twelve "species pairs" ranged from 0.41% between *Confluens olingoides*/ *Confluens hamiltoni*, to 9.92% between the North and South Island populations of *Pycnocentria evecta*. Based on molecular clock estimates, divergences for these twelve species pairs has occurred within the last 5 million years, with most dating to the beginning of the Pleistocene (2 mya). We conclude that: 1) population fragmentation during the Pleistocene glaciations and the subsequent closing of the Cook Strait land bridge have played important roles in the isolation and speciation of New Zealand caddisflies; and 2) the diversity of New Zealand caddisflies, and other aquatic taxa, is underestimated and requires re-evaluation using a combined morphological and molecular approach.

Can Biological & Cultural Indicators be Used to Assess Impacts of Dairy Farming in Agriculturally Influenced Catchments?

Jennifer BLAIR // Kessels Ecology

Gerry Kessels // Kessels Ecology
Mahuru Robb // Kessels & Associates, University of Waikato
Sam Karaka // Ngati Tahinga

The effects of dairy farming on stream water quality and nutrient loads have been well studied in New Zealand, but the effects on stream fauna such as macroinvertebrates and fish are less well known. Assessing the effects on stream fauna is important for determining ecosystem function, and many aquatic species are also culturally important for Maori communities. Cultural indicators have recently been developed for assessing ecosystem health of New Zealand freshwaters, but have not yet been widely implemented for assessing the effects of dairy farming. We measured water quality, biodiversity and cultural indicators before dairy farm conversion, and will measure the effects of dairy farm conversion on these parameters over the next 3 years. In doing so, we aim to provide a case study for both scientific and farming communities detailing the effects of dairy farm conversion on key aquatic biodiversity and cultural indicators, as well as evaluating the efficacy of the initial farm/ stock management regimes and stream retirement and planting programmes for enhancing stream biodiversity. This study involves a partnership between farm managers, local Iwi and scientific advisors; this collaborative approach will provide a framework that others can use in similar situations.

Future Proofing Duck Creek

Tanya BLAKELY // Auckland Council

Vaughan Keesing, Stephen Fuller, Barbara Risi, Leigh Bull, Matiu Park

Duck Creek is a small lowland waterway in Whitby, Wellington Region, which flows into the nationally significant Pauatahanui Inlet. The creek had historically been constrained in an incised channel through a golf course. Despite this modification the creek still retained very high ecological values with a diverse macroinvertebrate and native fish fauna, including giant and banded kokopu, inanga, lamprey, and longfin and shortfin eels. As part of a consented development, 1.2 km of the creek were to be realigned to allow for the existing golf course to be developed into a residential subdivision. Boffa Miskell played an integral part in designing the new reach, including a meandering channel with diverse in-stream habitats and extensive riparian plantings. Ultimately, the aim was to create a fully functional waterway, to flow through the residential development within a Council Reserve. The design also aimed to provide equivalent or better freshwater habitat than the original channel, supporting the same diversity and abundance of freshwater species.

LakeSPI Reports Now Available Online

Tracey BURTON // NIWA

Mary de Winton, John Clayton // NIWA

Users of LakeSPI (Lake Submerged Plant Indicators) can now access information online, via NIWA's web-reporting portal lakespi.niwa.co.nz. Results for more than 200 lakes are now available in a standardised format that can be used for regional and national reporting. The LakeSPI monitoring method uses submerged aquatic plants as indicators of lake ecological condition. It is based on the principle that New Zealand lakes can be characterised by the composition of native and invasive plants growing in it, and the depths at which they grow. Submerged aquatic plants make good indicators of lake condition as they are easy to observe, reflect environmental conditions over an extended period and bring a focus to the shoreline margins, where greatest public interaction occurs. LakeSPI complements other physico-chemical methods of lake monitoring. NIWA's web-reporting portal allows lakes with LakeSPI data to be searched by name, their size, depth, type and condition, or through the use of advanced geospatial mapping software. Users can choose to view LakeSPI reports for single lakes or as groups of selected lakes, and previous LakeSPI data is available for indicating change in lake condition over time. Lake managers now have greater access to reliable and standardised information on the condition of the lakes they monitor.

Are Stream Food Webs More Stable in Forest Or Pasture?

Adam CANNING // Massey University

Russell Death // Massey University

- Aim: To determine if riparian cover (forest or pasture) influences the stability of six Taranaki streams crossing the boundary of the Egmont National Park.
- Both the un-weighted and invertebrate-weighted food webs were made for twelve sites on six Taranaki streams (one upstream forest, the other downstream in pasture) using abundance data collected between 1997 and 2003, and diet data from 31 published sources.
- Microsoft Network 3D, NEXCADE, and R with packages Foodweb and IGRAPH were used to calculate the network parameters for each food web and analyse their stability by calculating the robustness, conducting Sequential Perturbation Analysis, and an Algae removal ewvent.

No significant difference was found in robustness between closed and open canopy sites in both the un-weighted (closed canopy average: 37.26%, open canopy average: 37.77%, p=0.592) and weighted webs (closed canopy average: 42.29%, open canopy average: 40.65%, p=0.141). The SPA results indicate that on average open canopy sites collapsed to extinction with fewer sequential perturbations than closed canopy sites (closed canopy: 49.6% of all species, open canopy: 36.3% of all species, p=0.0297). After removing Algae from the webs, there was no significant difference in mean percentage node loss (closed canopy: 13.83%, open canopy: 17.84%, p=0.339), however weighted webs showed more nodes were lost in open canopy webs than closed canopy (closed canopy: 9.46%, open canopy: 25.27%, p=0.047).

Macroalgal Blooms Associated With Mangrove Removals

Kelly CARTER // NIWA

Carolyn Lundquist // NIWA
Steven Pratt // The University of Waikato

In recent years, mangrove removals have occurred in many estuaries in northern New Zealand as a response to rapid expansion of mangrove habitat. Removal methods have varied in the amount of biomass removed; most leave below-ground biomass (roots and pneumatophores) intact, while some also left above-ground biomass (stumps and branches) in situ, either intact or as mulchate. Observations between 2010–2012 documented macroalgal blooms in four estuaries in Tauranga Harbour (Waikaraka, Te Puna, Waikareao, Omokoroa) where mangrove removal had occurred, and mangrove mulchate was left in situ. Percent cover and species composition of macroalgae was determined using a 0.25 m^2 quadrat at 5 m intervals on transects through mangrove removal zones. Macroalgal blooms were observed on all mulch sites, and on some occasions, 100% cover in large (>1 ha) patches was observed. Seasonal and between-site variability in macroalgal abundance was apparent. However, most macroalgal bloom species were *Ulvaceae*, an algal family known to respond to increased nutrient concentrations with increasing growth rates. Macroalgal blooms consisted of *Ulva* sp. (tubular form) and filamentous species such as *Rhizoclonium* spp. and *Percursaria percursa* which were clearly attached to pneumatophores or remaining mulch material (and growing directly on site), as well as *Ulva* sp. (sheet form: sea lettuce) which was observed at the edge of many patches, and could potentially have washed in from outside the mulch zone. It is also of interest that *P. percursa* had previously not been documented on New Zealand's North Island.

Centimetre-scale Variation in Microphytobenthos on Tidal Flats

Katie CARTNER // NIWA

Drew Lohrer // NIWA

A study on the centimetre-scale variation in microphytobenthos of intertidal sediments was carried out at Whitford embayment to test how well data from a new in situ benthic fluorometer, the Benthotorch®, compared to data collected using the more standard extractive technique for measuring sediment pigment content (a proxy for microphyte abundance). An area of 12 m^2 was sampled with 48 sediment cores and 600 benthotorch measurements in a regularly spaced sampling grid, allowing us to map sediment chlorophyll a content and examine spatially paired data collected by each method. Sediment in the cores was freeze dried and homogenised, and chlorophyll a was extracted from a 5 g sub-sample by boiling the sediment in ethanol. Sediment chlorophyll a content (µg g^{-1}) was analysed by spectrophotometry using acidification to separate out degratory products (e.g., phaeophytin). The Benthotorch®, in contrast, is a non-destructive method that requires no sample preparation and takes less than 20 s to complete. It utilises the fluorometric characteristics of the different algal pigments present in surficial sediments, providing readings in µg cm^{-2} of chlorophytes, cyanophytes, and diatoms. Although the Benthotorch® is rapid and possesses many advantages over the traditional method, questions remain about how well it quantifies microphytobenthos abundance. In fact, both methods showed high variability at relatively small spatial scales, suggesting that perhaps only relatively large differences in chlorophyll a content (i.e., ± 2 µg g^{-1}) may be ecologically meaningful.

DNA Barcoding of the New Zealand Freshwater Rotifers

Gemma COLLINS // The University of Waikato

Ian Duggan, Ian Hogg, Clare Beet // The University of Waikato

Rotifers (Rotifera) are an integral component of freshwater ecosystems and often provide a key indicator of lake trophic status. We are currently assessing the molecular diversity of New Zealand rotifers using a sequence fragment of the mitochondrial cytochrome c oxidase subunit I (COI) gene. Rotifers were collected from a variety of freshwater habitats throughout New Zealand, and morphologically identified prior to DNA sequencing of the COI gene. All collection and sequencing data, as well as individual photographs have been entered onto the Barcode of Life Datasystems (BOLD) database and are now part of the publically available molecular identification platform (www.boldsystems.org). To date, we have assessed roughly 300 specimens covering >45 species, 20 genera, and 5 orders. Analysis of within-species variability has also revealed high levels of "intraspecific" genetic divergence for some taxa. For example, cryptic species have been confirmed for *Lecane bulla* and are in agreement with other international studies. Our developing sequence library will be used for the rapid, accurate, and routine identification of rotifer taxa as well as for the testing of phylogenetic hypotheses. We are currently using the library to develop and test a molecular version of the rotifer trophic lake index.

Temperate Mangroves as a Model Ecosystem to Study Plant Carbon & Water Relations

Jarrod CUSENS // Auckland University of Technology

Sebastian Leuzinger, Andrea Alfaro // Auckland University of Technology

Water and carbon relations of plants are tightly coupled via leaf pores (stomata) because they control both CO_2 uptake and water loss. Understanding water and carbon relations of trees is particularly important due to their key role in the global carbon and water cycle. For example, current global change induced broad-scale shifts in climate regimes will have a strong impact on water availability to trees, with important implications on the amount of carbon stored per unit forest area. Mangroves are an ideal model ecosystem because they represent a mature, yet highly accessible, monospecific forest stand undergoing periodic, predictable salt stress via tidal inundation. We will use state-of-the-art sensors to monitor continuous stem radius changes, leaf water potential and sap flow rates, combined with an eddy covariance flux tower. This, together with the assessment of daily and seasonal non-structural carbohydrate concentrations in various plant tissues will allow us to answer the following questions: (1) what factors limit mangrove growth at what times? Can these patterns be generalised to other forest stands? (2) How do mangroves transpire water against the strongly negative water potential of salt water? Are they taking up fresh water through stomates? These fundamental ecophysiological questions will be complemented by providing an accurate quantification of the carbon pools and fluxes of this ecosystem.

Extent of Burial of the Rena Oil Spills Within Bay of Plenty Coastal Sediments

Neeltje DE GROOT // The University of Waikato

Willem de Lange // The University of Waikato

Sediment cores were obtained from 12 coastal sites within the Bay of Plenty to determine the extent and characteristics of buried oil following the Rena oil spills between October 2011 and January 2012. Sites were selected based on local community preceptions of continuing oil presence. Cores were taken to a depth of ~1 m, which was sufficient to reach titanomagnetite placer deposits produced by coastal erosion in the 1970s and hence represent a maximum possible burial depth. Subsamples were elutriated with dichloromethane solvent to extract any organic material, and then analysed by gas chromotography mass spectrophotometry (GCMS) to identify the compounds present. The results were compared to a fingerprint library of Rena oil and known degradation products prepared using the same instrument. No traces of Rena oil were identified, indicating that the beach clean-up procedures and natural degradation were effective at removing the oil spills.

Effect of Temperature & Salinity on Early Development, & Adult Righting Time of *Evechinus chloroticus*

Natalí DELORME // The University of Auckland

Mary Sewel // The University of Auckland

Temperature and salinity are important environmental factors affecting the normal functioning of marine animals, particularly those living in shallow waters and tide pools, like the New Zealand sea urchin *Evechinus chloroticus*. The aim of this study was to evaluate the effect of different combinations of temperature and salinity levels on early embryos (fertilization and normal development within 24 hours post fertilization) and adult animals (through righting time) of *E. chloroticus*. Embryos were exposed to five salinity levels (29, 31, 34, 35 and 37 ppt) and two temperatures (18 and 21°C); whereas adult animals were exposed to five salinity levels (24, 29, 34, 39 and 44 ppt) and three temperatures (17, 20 and 23°C). Fertilization was high in all treatments, with the lowest fertilization (86%) at a salinity of 29 ppt and temperatures of 18 and 21°C. Normal development was also reduced at 29 ppt and temperatures of 18 and 21°C, with 40–50% of normal embryos at 24 hours post fertilization. In the case of adult animals, the righting time was higher at 24 ppt (>15 min) at 17 and 23°C. Overall, this study showed that embryos were more sensitive to lower salinities than adult animals. Therefore, adult animals may potentially be able to cope better than early embryos with short-term natural variations in salinity at naturally occurring temperatures.

Dynamics of Microbial Transport in Streams – a Multiple Tracer Stream Injection Experiment

Jennifer DRUMMOND // Northwestern University, NIWA

Rob Davies-Colley, Rebecca Stott, James Sukias, John Nagels // NIWA
Alice Sharp // NIWA, University of Waikato
Aaron Packman // Northwestern University

Water-borne diseases are a significant concern and a prevalent health issue. Currently we have limited ability to predict the downstream transport of contaminant microbes in waters, especially from diffuse sources of faecal pollution such as livestock manure in rural areas and sewage leaks in urban land. Micro-organisms can be viewed as fine organic particles (biocolloids) that migrate downstream through a series of deposition and resuspension events, which results in a wide range of microbial residence times. In-stream stores of microorganisms are mobilized during flood events, and contaminated storm waters are a major hazard to downstream water users such as water supplies, bathers and shellfish consumers. We are conducting studies to gain insights into contaminant micro-organism dynamics in streams with a campaign of experiments and modeling. These results can also be used to improve understanding of nutrient (C, N, P) spiraling and fine sediment movement in river systems. We present findings from a field injection study of multiple tracers into an agricultural stream that compared the transport and retention of *E. coli* and synthetic fluorescent fine particles that can be reliably measured to low concentrations. We found that the fluorescent particles and *E. coli* behaved similarly and contrasted with a solute tracer (rhodamine WT). Our results show the importance of the underlying sediment and in-stream vegetation as a reservoir for micro-organisms in streams.

Craspedacusta sowerbii Polyps in New Zealand: Medusae are Inadequate for Determining Distributions & Introduction Timing

Ian DUGGAN // The University of Waikato

Kevin Eastwood // The University of Waikato

The freshwater cnidarian *Craspedacusta sowerbii*, native to the Yangtze valley, has invaded lakes and ponds throughout the world, including New Zealand. Most distribution records globally have to date been based on observations of the jellyfish stage only, including numerous recent publications. We aimed to determine whether polyps are widespread in New Zealand lakes, and geographical areas, outside of where medusae have been observed, and whether constructed waters are more easily invaded than natural waters. Our results indicate that *C. sowerbii* is common and widespread in New Zealand, and far more so than is apparent from observations of medusae. We argue that observed occurrences of the jellyfish provide little useful information regarding the distribution of this species, and that published records of new jellyfish occurrences provide unreliable estimates of the timing of introduction or spread of *C. sowerbii* in new regions. We found no evidence that constructed waters were more readily invaded than natural waters. Overall, accurate determination of *Craspedacusta* occurrence and distribution requires systematic surveys of the polyp stages.

Developing a Drop Camera Methodology to Monitor the Spatial Extent of Subtidal Benthic Habitat Patches

Scott EDHOUSE // NIWA

Fraser Aidney, Judi Hewitt, Drew Lohrer, Simon Thrush // NIWA

The monitoring of subtidal benthic habitats using transects is suitable for determining species identities, densities and other information on habitat types. However, the use of transects provides little information on changes in the sizes, shapes and characteristics of habitat patches over time. To monitor long term changes in the spatial extent of benthic habitats, as well as gather data on density, size and composition, we trialled new methodologies using a drop camera system. We sought to accurately delineate the spatial extent of a specific benthic habitat type (in this case, patches of the structure-forming pinnid bivalve *Atrina zealandica*). We tested the repeatability of the method (as this is critical for temporal monitoring) and the cost-to-benefit ratio of post-processing of video data in the laboratory versus cheaper on-board processing only. Independent video data was also collected by divers to ground truth the drop-cam footage and assess its relative utility. The drop-cam patch survey method may be useful for monitoring patches of large conspicuous animals such as *Atrina*, but less so for other key species such as infaunal bioturbators. Accurate definition of patch boundaries and quantification of *Atrina* densities (individuals per m^2) is really only possible with laboratory post-processing of the video footage. The method is not well suited for finding patches, but with modification it may be suitable for monitoring existing patches that have been identified.

A Decision Making Toolbox for Constructed Wetland Design within Areas of Intensive Agricultural Land-use

Rebecca EIVERS // The University of Waikato

David Hamilton // The University of Waikato
John Quinn // NIWA

Elevated nutrient and sediment levels have been associated with agricultural expansion and intensification. Many peat lakes in the Waikato are within catchments used for dairy production and are particularly susceptible to eutrophication. Restorative management of selected lakes is being implemented through the construction of wetlands and sedimentation ponds to intercept runoff from dairy farms, however design guidelines are lacking. This study aimed to fill this knowledge gap using literature and a field study examining efficiencies of existing treatment systems. Inflows and outflows of up to twenty-six treatment systems were sampled over five seasons from 2010 to 2011. Seasonality and different catchment soil types significantly influenced suspended solids and nutrient loads primarily driven by variation in pH, flow rates and water temperature. Nutrient concentrations were significantly correlated with pH (ammonium r = -0.47; nitrate r = 0.45; organic nitrogen r = -0.42; and phosphate r = -0.50) suggesting different soil types within peat environments may strongly influence nutrient cycling and attenuation. Hydraulic residence time was a useful predictor of the extent of nutrient reduction of some treatment systems, while depth and the presence of macrophytes were more appropriate predictors for others. A framework has been developed for key design considerations (including physico-chemistry, morphology and hydrology) for wetland treatment systems; key elements are sufficient residence time to allow for biochemical processing and retention of suspended solids and particulate nutrients is presented.

A Web Based Directory of Decision Support Systems to Improve Their Understanding & Use

Tony FENTON // Alchemists Ltd

Marjan van den Belt // Massey University
Steve Markham // Tasman District Council
Beat Huser // Waikato Regional Council

A web based directory of decision support systems (DSS's) has been created through an Envirolink tools grant. The directory provides relevant information on a wide range of DSS's for use in environmental management and other local government decision-making. The range of DSS's within the directory includes computer models and assessment methods and frameworks. Provision and collation of this information in one directory aims to improve the understanding and capability of potential users to get the most out of the tools that are currently available. The Directory contains two types of information: (1) Basic information (metadata) on each of the included DSS's, such as; purpose, scope, state of development, input/output data required, key references and links to further information; (2) Case studies on some of the included DSS's. These provide practical examples of the application of a DSS. The case studies aim to provide an additional understanding of how suitable a DSS might be for supporting a particular decision process by illustrating how the DSS has been already applied to a situation. The examples have been chosen for their applicability to Regional Council management needs. Although primarily established for Regional Council and Unitary Authority users the Directory is open to the public and is also likely to be useful to other government agencies, researchers and consultants. The Directory has been designed to make the information held in its database highly accessible. A range of search options are available from the Home Page. Further development of the directory is planned to increase the number of DSS's and case studies. See the Directory at: www.tools.envirolink.govt.nz.

Sediment Dispersion in Estuaries from River Inflows Determined Using Compound Specific Stable Isotopes

Max GIBBS // NIWA

Sediment is a major contaminant of water, carrying nutrients and pathogens from land, smothering benthic habitat and affecting biodiversity in estuaries and coastal waters. Information on the source of the sediment is a key requirement for targeting sediment control measures. However, before you can manage something, you have to know what to manage. A forensic stable isotope technique (Gibbs, 2008) was developed to track sediment sources from land by land use and identifying land-use practice that exacerbate erosion. This enables mitigation of erosion by changing land-use practices at a landscape scale. This technique has been used to identify sources of sediment impacting on 19 estuaries in New Zealand and is being tested overseas in 15 countries around the world. It has also been used to track the movement of sediment through wetlands and harbours, such as the Kaipara Harbour (Gibbs *et al.*, 2012).

Spatial Variation in Functional Group Diversity in a Sandflat Benthic Community: Implications for System Resilience

Barry GREENFIELD // The University of Waikato

Conrad Pilditch // The University of Waikato
Casper Kraan, Simon Thrush, Judi Hewitt // NIWA

Community resilience to environmental stressors depends upon the vulnerability, adaptability and connectivity of living organisms. Recent studies suggest that the function(s) a species performs may be more influential in driving community response than the more traditional measures of abundance and occurrence. Where a number of species are performing similar functions, this gives rise to redundancy within the community, an important resilience attribute. To assess resilience, we focus on the functional diversity of a benthic community from a large intertidal area in the Kaipara Harbour, New Zealand. Based on intensive sampling of 400 macrofaunal and 360 sediment cores with an area of 300,000 m^2 we identified 115 taxa and 23,682 individuals. Linking species attributes (including, body type, body size, feeding mode, living depth etc.) we identified 26 functional groups that characterise important functional attributes of the macrobenthic community. Analyses were conducted to assess group redundancy considering both occurrence and abundance, as well as spatial patterns in their distributions, which in turn represent key characteristics of community resilience. Findings indicate various levels of redundancy for different functional attributes (ranging from 1 to 13 species per group). Moran's *I* spatial correlograms revealed distribution patterns ranging from small-scale homogeneity to large-scale heterogeneity with spatial arrangements including gradients and distinct patches. Abundance maps showed that some groups, such as tube worms and large free-moving suspension-feeding bivalves, show strong and opposing spatial distributions with clear boundaries separating them. These findings emphasise a joint role for spatial variation in functional diversity and species redundancy in structuring community resilience.

Effect of Nutrients on Growth & Potential Spread of Temperate Mangroves in New Zealand

Iana GRITCAN // Auckland University of Technology

Andrea Alfaro, Mark Duxbury, Sebastian Leuzinger // Auckland University of Technology

Mangroves are salt-tolerant plants that occupy intertidal areas of coastlines and estuaries throughout the tropics and in some temperate areas. In the tropics, mangroves have a great ecological value, including supporting high species diversity, providing breeding and nursery habitats and a variety of human services (e.g., fire wood, food, shelter). In temperate New Zealand, our one species (*Avicennia marina* subsp. *australasica*) is at the southernmost limit of the global mangrove distribution. Recent studies on New Zealand mangrove ecosystems have highlighted important differences from their tropical counterparts, such as much lower faunal biodiversity. One of the still under-investigated research areas is the role of nutrients on mangrove growth and productivity. In general, mangroves are highly productive in low-nutrient environments because they have strategies that allow them to use stored nutrients during periods of low nutrient availability. Previous studies have shown contrasting results from positive to negative effects of nutrient enrichment (e.g., due to human activity) on mangrove growth. Thus, more detailed studies on nutrient cycles are needed to clearly identify the role of nutrients on growth, productivity, and potential spread of mangroves in New Zealand. In this study, the uptake, storage and release of nutrients through these plants are quantified, and results will be used to model nutrient dynamics in the Mangawhai Harbour Estuary. The outcome will be crucial to future management and conservation efforts of mangroves in this country. In addition, the results of this project will be integrated within a larger mangrove program led by the Mangrove Research Group (AUT and UoA).

Tagging Experiments on Adult Inanga: Growth & Migration

Jessica HILL // University of Canterbury

Mike Hickford, David Schiel // University of Canterbury

The diadromous fish *Galaxias maculatus* (inanga) is one of the most widely distributed freshwater fishes in the world, occurring throughout the southern hemisphere. The post-larval juveniles of this species form the basis of New Zealand's whitebait fishery as they migrate back into freshwater. This essentially annual species spawns exclusively in tidally inundated riparian vegetation in upper estuaries. The success of spawning is closely linked to the availability and composition of suitable riparian vegetation. It has been widely assumed that after entering a river as whitebait, mature fish do not migrate to other waterways before spawning. Therefore, whitebait that enter a waterway are committed to finding critical spawning habitat in that river if they are to spawn successfully when they mature. If spawning habitat is absent or degraded, their ability to contribute to future generations is compromised. Consequently, degradation or reduction of spawning habitat in individual estuaries can lead to the formation of 'sink' populations. Here we present the results of a tagging study to track adult fish across waterways during the spawning season. This study will provide a measure of stream fidelity in adult fish along with basic population characteristics and dynamics. This knowledge will allow whitebait conservation and habitat rehabilitation to be targeted at productive waterways and estuaries.

Terrestrial Sediment Deposits Acidify the Pore Water of Intertidal Sandflats

Aysha HOHAIA // Auckland University of Technology

Kay Vopel // Auckland University of Technology

Conrad Pilditch // The University of Waikato

Coastal urbanization, rising sea level and extreme rainfall events increase the supply of terrestrial sediments to coastal habitats via waterways or from landslides. Eventually these fine sediments are deposited on the seafloor where they can alter the functioning of soft sediment ecosystems. Cummings *et al.* (2009) showed that terrestrial clays deposited on defaunated intertidal sediments affect the microbial decomposition of organic matter by increasing the diffusive distance between the source and sink of reactive solutes. This increase changed the sediment–seawater flux and the pore water distribution of hydrogen ions and dissolved oxygen. However, the importance of such changes remained questionable, because mixing and irrigation of the sediment by macrofauna was experimentally excluded. In a laboratory flume experiment we confirmed the results of Cummings *et al.* for bioturbated intertidal sediment (mainly tube-building polychaetes and juvenile bivalves): thin deposits (1.4 mm) of terrestrial clay acidify the pore water of the underlying intertidal sediment decreasing pH by ~0.1 units after 18 h. Such decrease may negatively affect benthic community recruitment because it can lead to dissolution mortality of "just-set" juvenile bivalves. Next, we will repeat our measurements under in situ conditions of a sheltered mid-intertidal sandflat.

A Wai Quality Assessment Model for North Waikato Streams & Lakes

Aareka HOPKINS // Ngaa Muka Development Trust

Whanau (families) and hapuu (tribes) affiliated to Ngaa Muka Development Trust (NMDT) are experiencing renewed optimism and enthusiasm for restoring the mauri (life force) of awa (rivers and streams), shallow lakes and flood plains in their tribal rohe (area). That optimism and enthusiasm is driven by the realisation that their kaitiakitanga (guardianship) obligations and responsibilities will be re-asserted. As kaitiaki (guardian) they will be able to restore elements in the landscape that are important to them, an opportunity afforded them by the Waikato River Authority Clean-up fund in North Waikato and elsewhere. Constructing a wai (water) quality assessment model is the focus of this project. A wai quality assessment model based on whakapapa (genealogy) to Papatuaanuku (earth mother) and Rangi-nui-aatea atua (sky father) was constructed to provide an alternative model to western science models that is simpler, cheaper and only uses western science to detect faecal coliforms in open wai bodies, a contaminant tapu (sacred) to whanau and hapuu across all of Aotearoa (NZ). Uptake of the wai model requires kaitiaki to gain an understanding of ecosystems as their tuupuna (ancestors) had. Google Earth technology provides kaitiaki with capability to do that by creating profiles of the catchment, awa, ngaahere (forests), tipu (plants), repo (wetlands), dwellings and dairy platforms. These profiles were required to create the model framework. We provide classifications to complement other classifications in the literature to enable both static and dynamic wai quality assessments for streams and lakes in North Waikato to be made by kaitiaki.

Before & After Integrated Catchment Management in Headwater Stream: Changes in Water Quality

Andrew HUGHES, John QUINN // NIWA

Improvements in land management practices, such as the establishment of riparian buffers and afforestation of degraded areas, are often implemented in an attempt to improve stream water quality. Despite the popularity of such approaches, there are few long-term studies that quantify their impact. This study analyses the water quality effects of the implementation of an integrated catchment management (ICM) plan, in 2001, within a sheep and beef grazed headwater catchment. Regular monthly water quality samples were obtained between 1995 and 2010.

Results show that since the ICM plan implementation, optical water quality (TSS, water clarity) has improved by 30–40%. The nutrient response to the land use changes has been more complex with no significant changes in concentrations of DRP, TP and NH4-N. The median concentration of total organic nitrogen has decreased by ~40%. In contrast, nitrate and TN concentrations have both steadily increased at 5%/y and 3%/y, respectively. Water clarity and sediment and nutrient concentrations at two control catchments have remained largely static.

Rapid improvements in the water clarity, TSS and TON are most likely a result of the removal of stock access to streams and riparian areas. Increases in nitrate (and TN) concentrations may be related to a number of factors:

- Lag in catchment response due to residence time of groundwater.
- Decreased instream nutrient uptake due to shade-induced reductions of instream biomass.
- Nitrate leaching from gorse which became widespread in the pine areas.

Modern Estuarine Habitats & Organism-Sediment Interactions at Mangawhai Estuary, North Island, New Zealand

Colleen HULBERT // The University of Auckland

Kathy Campbell, Paul Augustinus, Lorna Strachan // The University of Auckland
Andrea Alfaro // Auckland University of Technology

The Mangawhai Estuary, North Island, New Zealand, provides a unique look at organism-sediment interactions within a changing sediment environment. The estuary can be divided into three general divisions; the lower, middle, and upper estuary. The lower estuary is located closest to the estuary inlet and is composed primarily of rippled sands. The middle to upper portions of the estuary mark a gradual shift to a muddier environment along with an increase in mangrove (*Avicennia marina* var. *australasica*) populations. The identification of numerous different habitats throughout the divisions of the estuary show shifting ichnology and neoichnology across different sedimentological environments. These habitats are differentiated based on grain size, physical and chemical parameters, vegetation, and ecology. The different habitats have been depicted using ArcGIS computer based mapping software and show the zonation and boundaries of the individual habitats. Sediment infill history of the estuary is examined through the process of vibracoring. Vibracoring has allowed for the extraction of 2 to 6 meter long cores from various locations throughout the estuary. The stratigraphy within the vibracores represents a general shift to muddier sediments with the influence of mangrove populations. Mangrove expansion is promoting sedimetological and ecological shifts within the estuary. Results from this study show multiple differences to those of similar scientific studies concerning mangrove populations within tropical environments. Mangroves within New Zealand's temperate climate support a different type of ecosystem then their tropical counterparts. Both advantages and disadvantages of mangrove populations are observed within this study.

Prioritisation of Biodiversity Datasets in the Hauraki Gulf Marine Park

Susan JACKSON // The University of Auckland

Carolyn Lundquist // NIWA
Mark Costello // The University of Auckland

The Hauraki Gulf Marine Park, established in 2000, is recognised for its outstanding biological diversity, including marine mammals, seabirds, shorebirds, fish, invertebrates and plants. Currently, 5.4% of the Hauraki Gulf Marine Park is protected under existing Marine Reserves or Cable Protection Zones. Information about hotspots of biological and habitat diversity can be used to determine high priority locations for further protection or restoration of biodiversity, and inform placement of a network of representative marine protected areas. Here, we compile existing scientific datasets, including information to describe habitats such as depth, exposure, and substrate, and identify gaps in protection of particular habitats. We also identify existing biological datasets (e.g. demersal fish; rocky reef fish) that exist for the full Hauraki Gulf Marine Park. We use Zonation software to identify priority areas for protection in terms of both habitat and biological information, and compare priority areas based on each type of information. Future research will identify compatibilities between biodiversity protection and recreational opportunities.

Role of Scavenging in Basketwork Eel on Northeastern Chatham Rise, New Zealand

Matthew JONES, Barbara BREEN // The University of Auckland

Basketwork eels (*Diastobranchus capensis* Barnard, 1923) are common bycatch in deep-water fisheries of orange roughy (*Hoplostethus atlanticus* Collett 1889) in New Zealand waters. However, little is known about their ecology and feeding. This poster describes the food and feeding of 135 basketwork eels from northeastern Chatham Rise, New Zealand, from water depths of 1062–1196 metres. Basketwork eels from northeastern Chatham Rise were primarily piscivorous, with the diet supplemented by squid, natant decapod and mysid prawns. The weight of food increased with the size of the eel, but the numbers of food items did not, nor was there any major ontogenetic shift in the composition of the diet. The presence of fragmentary food items (fish heads and tails, beaks, and tentacle crowns of warty squid *Onkia ingens* (Smith, 1881), and seaweed), suggests that scavenging was important to basketwork eels. Scavenged material made up approximately 40% (by weight) of their diet, suggesting they perform an important role in the recycling of carrion at mid-slope depths on northeastern Chatham Rise. These eels could benefit from influxes of fisheries discards, which in turn, may alter the composition of deep-sea ecosystems.

Improved Confidence Intervals for Genetic Estimates of Effective Population Size

Andrew THOMAS JONES // University of Queensland

Estimates of effective population size are important tool in conservation genetics and have future potential as a means of monitoring commercially important fisheries species. The linkage disequilibrium method is current by far the most commonly method for estimating effective population size. Whether making point estimates of the current effective population size, or trying to detect on-going trends in the size of a population, producing accurate confidence intervals is important so as to properly quantify the uncertainty of the results. Depending on the size of the population, the data used, and a number of other potentially confounding factors, the techniques currently used to generate confidence intervals for estimates of effective population size using the linkage disequilibrium method do not always have accurate coverage probabilities. For example, this means that at a 0.05 significance level, the confidence intervals do not contain the true value being estimated 95% of the time. We examined a number of ways to improve the confidence intervals for linkage disequilibrium method based genetic estimates of effective population size. We present some numerical results based on a simulation study comparing the current most commonly used method to generate confidence intervals with the new ones. These results show that these new methods have better coverage performance than those currently in use. We also discuss some of the general issues surrounding the accuracy of genetic estimates of effective population size.

Effects on the Escapement of Juvenile Halibut from Shacking Codend Generating by Cap-like Canvas

Yonghae KIM // Gyeongsang National University

New method of increasing juvenile fish escapement from trawl codends is to encourage fish to approach the netting by generating an active shaking motion in the codend. The effects of actively stimulating devices (ASD) in the shaking codend on juvenile flatfish were studied to increase escape rates from the cod. Three kinds of model codend were used: a traditional codend, a fluttering flag-like net panel, and a double conical rope array as ASDs. Escape responses of juvenile bastard halibut (*Paralichthys olivaceus*), body length BL = 8.2 ± 0.7 cm) were observed in a circulating water channel. Three model codends (length 130 cm and diameter 40 cm) were made with 43 mm mesh generating shaking motion by unbiased cap-like canvas at the end of the codends. The shaking distance as an amplitude was 60% of the codend diameter and its period was 5 s around. The escape rate was significantly greater in the shaking model codends ranged 85–88% than in non-shaking state of the codends 55–63% respectively. The moving velocities of the fish for 2 s escaping were faster in the shaking cases 2 BL/s than in non-shaking cases 1 BL/s for three model codends respectively. There was no difference in escape rate between three model codends either in shaking or non-shaking cases. Therefore, the shaking codend as sieving effect operated actively driving fish to the net panel and weakening optomotor response of fish by variation of net position possibly to panic and then to try more escape resulted in reduction of juvenile by-catch.

Benthic Dinoflagellate Toxins in Flora & Fauna of Rangaunu & Parengarenga Harbours

Lincoln MACKENZIE // Cawthron Institute

Andrew Selwood, Paul McNabb, Lesley Rhodes // Cawthron Institute

A variety of environmental samples were analysed and passive solid phase adsorption toxin tracking (SPATT) devices were installed in Rangaunu and Parengarenga Harbours. These revealed the pervasive influence of a variety of bioactive polyether compounds secreted by benthic dinoflagellates within the mangrove and sea-grass habitats of these estuaries. Pinnatoxins (PnTxs) and okadaic acid (OA) and its esters were the most abundant, although traces of other polyether compounds (dinophysis toxins, pectenotoxins, spirolides) were also detected. The deposit feeding sea-hare *Bursatella leachii* contained relatively high levels of pinnatoxins and lesser amounts of OA esters in its tissues. Although there was abundant OA in these environments cultured oysters did not incorporate this toxin, presumably because they were not exposed to *Prorocentrum lima* cells in the water column or were unable to digest these cells. The low levels of pinnatoxins sequestered by oysters in these estuaries, despite persistent and very abundant populations of the causative dinoflagellate, is probably also due to the general inaccessibility of these cells to the shellfish and therefore there appears to be a low risk to human consumers.

It's a Buoy!!!

ANNA MADARASZ-SMITH // Hawke's Bay Regional Council

Oliver Wade // Hawke's Bay Regional Council

Paul Barter // Cawthron Institute

New Zealand nearshore coastal waters are the receiving environment for the freshwater drainage system and receive the impacts of land-based activities. Despite this, coastal waters have received less monitoring attention relative to their freshwater and terrestrial counterparts. At present, nearshore coastal water quality sampling in New Zealand is generally restricted in terms of spatial and temporal resolution, giving rise to 'point in time' data sets. If 'point in time' data are collected over a sufficiently long time period, it may be possible to determine water quality trends, however these intermittent samples are generally inadequate to detect the subtle changes in water quality that indicate the status of coastal waters. Recent developments in measurement technology have made real-time and continuous measurement practical and cost-effective. As a consequence, resource managers are now able to provide context to the 'point in time' data derived from routine monitoring programmes using real-time data collected at high frequency. In 2012 Hawke's Bay Regional Council (HBRC), with the assistance of the Cawthron Institute, deployed HAWQi (HAwke's Bay Water Quality information) water quality buoy, to collect continuous water quality information from three depths in the coastal water column (surface, 5 m and 14 m depth). Electrical conductivity, water temperature, turbidity and chlorophyll a, and meteorological parameters collected 1 m above sea level are transmitted from HAWQi to the HBRC's HydroTel telemetry system using inductive modem telemetry. HBRC plans to deploy an Acoustic Doppler Current Profiler (ADCP) during 2013.

Genetic Studies on Thermal Adaptation & Membrane Saturation in Antarctic Fish

Vanita MALEKAR // Lincoln University

Dr Victoria Metcalf // Lincoln University

The impacts of climate change are dictated by an organism's ability to alter its gene expression in response to environmental variation. However, understanding how organisms adapt to thermal change is lacking. Polar organisms like Antarctic fish may be especially affected their supposed narrow thermal tolerance may have limited adaptive potential to rising temperatures. Antarctic fish, such as the notothenioids, also favour unsaturated fatty acids for metabolism and within membranes, invoking a key role for the desaturase enzyme steraoyl-CoA-desaturase (SCD). Polyunsaturated fatty acid (PUFA) synthesis is catalyzed by SCD, allowing a mechanism for membrane properties to be altered depending on environmental temperature. This research aims to better understand linkages between lipid saturation and thermal adaptation. SCD will be cloned and characterized from two key Antarctic notothenioids and two non-Antarctic notothenioid relatives. Fatty acid composition and gene expression level changes of SCD and other gene targets in response to thermal acclimation will be examined. This project will contribute to understanding of thermal adaptive theory and climate change prognoses for biota, enhancing New Zealand's contribution to integrative research on life in extreme environments.

The Potential Use of Sugarcane Bagasse in Pelleted Fish Feed

Nawwar Zawani MAMAT // Universiti Teknologi MARA, Malaysia

Fatimah Tahira, M. Nasir // Universiti Teknologi MARA, Malaysia

An assessment of the potential use of sugarcane bagasse for wheat flour substitution in pelleted fish feed was carried out. Diets were formulated to include five inclusion levels of wheat flour being substituted by sugarcane bagasse (Control-0%, D1-25%, D2-50%, D3-75% and D4-100%). Results showed that protein content increased with the substitution levels of sugarcane bagasse between 50 and 100% (29.8%–31.3% protein). The differences in protein level of each treatment were relatively small, thus not giving any significant difference (P>0.05). The lipid content in pellets showed a fluctuating trend where it increased between 8.8 and 10.2% in control, D1 and D2 treatments. However, lipid levels decreased to 9.9% in D3 and it increased again to 10.4% in the D4 treatment. No significant differences were found in lipid levels of all formulated pellets. The highest carbohydrate content was observed in D1 (47.1%) and the lowest was exhibited by the D4 treatment (41.6%). No significant differences were observed in carbohydrate levels in all treatments (P>0.05). The results of ash content for each inclusion level ranged from 9.5 to 10.5%. Moisture content in pellets showed no significant differences among all treatments. It is suggested that the optimal level for replacing wheat flour with sugarcane bagasse in fish feeds is 50% since it exhibits the considerable amounts of protein which is 29.8%, 10.2% lipid, 9.9% moisture, 6.6% ash and 43.3% carbohydrate.

Catchment-scale Riparian Zone Optimisation Using the Mauri Model

Dr Kepa MORGAN // The University of Auckland

Dr Dan Hikuroa // Nga Pae O Te Maramatanga

Brian Peacock // Lafayette College, USA

Riparian zone restoration is one of the most ecologically sound solutions to water quality and runoff management issues. When planning a catchment scale restoration project, the choice of sites must be optimized to minimize financial, social, and cultural impacts whilst maximizing environmental benefits such as nutrient removal. The integration of the Mauri Model decision making framework with established approaches in pollution control and cost benefit analysis has developed an approach for prioritizing riparian zone restoration. Assessment uses a combination of two quantitative metrics: terrain-landuse analysis to identify areas of high areal pollutant flux and the Mauri Model decision-making framework to effectively integrate the social, cultural, environmental and economic factors. The result is a simple, flexible restoration site optimization tool that utilizes readily available GIS data and can easily be implemented by planners in a variety of catchments. The approach was applied as a case study to the Tarawera Catchment in the Bay of Plenty, New Zealand with the objective of decreasing nutrient pollution in the watershed. The metrics used in this tool proved effective in anticipating hydrological, environmental and anthropologic constraints that were used to pick sites for restoration. The final result was an ordinally ranked map of potential restoration sites. It is anticipated that this technique will prove useful in a variety of catchments despite variation in management goals and geographic location.

A Pressure-Response Framework for Evaluating Economic & Environmental Drivers in the Management of FreshwaterResources

Hannah MUELLER // The University of Waikato

David Hamilton // The University of Waikato
Graeme Dooler // The University of Waikato, University of Western Australia

Patterns of economic and environmental pressures, and policy responses to mitigate problems that arise can be discerned in the management of freshwater resources. Many factors, including environmental degradation and economic restraints, influence the way resources are managed. Extensive resource degradation, however, is often only recognised in policy responses when ecosystem health has been severely affected, and a large part of the population is affected by ensuing problems. Using New Zealand and the iconic Rotorua lakes as a case study, this research draws on international examples to trace developments in freshwater management over several decades. Based on a pressure-response framework, this research puts freshwater management regulations and developments both in New Zealand and overseas into a comparative perspective. It illustrates the interplay of pressure-response that led to outcomes of management of water quality in the Rotorua lakes. Due to dynamic responses of ecosystems, degradation often proceeds too far before new regulations take effect, making restoration more challenging. In freshwater ecosystems and lakes in particular, ecological and social lag times play an important role. The identification of common patterns of pressure and response can therefore help identify points for improvement of future regulations aimed at lake restoration.

POI: Open Science for a Healthy Pacific Ocean

Emma NEWCOMBE // Cawthron Institute

Chris Cornelisen, Rowan Strickland // Cawthron Institute

Pacific Ocean research and knowledge transfer is currently dispersed and is generally not adequately addressing critical ocean health issues. The Pacific Ocean Initiative (POI) is an exciting new way for science and communities to improve ocean health through a culture of collaboration and sharing of knowledge. POI provides a pathway for project development and communication between ocean users, knowledge providers and funders, and builds on the willingness of scientists to work together on projects that benefit ocean health. The concept of POI was first introduced at the 2012 NZMSS/AMSA conference and has continued to gain momentum, with progress in key areas, including; a commitment to supporting further development for two years by the Cawthron Institute, establishment of POI as an independent charitable trust, and the development of an on-line collaborative tool for project development. There are a number of exemplar projects currently in development, which in turn will provide a foundation from which to build further interest and participation of knowledge providers and end users. POI offers an environment that encourages collaboration and open science by facilitating diversification and expansion of funding opportunities for end-user-focussed ocean health solutions. Get involved, submit project proposals and contribute to project development by visiting POI at www.pacificoceaninitiative.org.

Pheromones as a Biosecurity Tool: Does a Common Attractant Exist Between Portunid Crabs?

Samantha PARKES // NIWA

Cindy Baker, Kristel van Houte-Howes, Wayne Smith // NIWA

Portunid crab species have established themselves as marine pest species in many parts of the world (e.g. *Carcinus maenas* and *Charybdis helleri* in the USA; *Carcinus mediterraneus* in Japan, and *Carcinus maenas* in Australia). In New Zealand the Asian paddle crab *Charybdis japonica* has established populations in the Whangarei and Waitemata harbours, and in the wider Hauraki Gulf. At present the impact on native species is still unclear, although there are concerns that the presence of this large predator may influence populations of the native paddle crab *Ovalipes catharus*. In light of these concerns, the development of new methods for surveying and / or controlling *C. japonica* numbers could be hugely beneficial to biosecurity managers in New Zealand. Recently, uridine diphosphate (UDP), a nucleotide released during chitin biosynthesis, has been identified as a sex pheromone in *C. maenas*. Pre-moult female crabs release UDP, which attracts males for guarding and mating during the moult cycle. As UDP is a physiological by-product and released by many crustacean species, it could potentially function as a sex pheromone in multiple species. As such, we investigated whether UDP operates as an attractant in the invasive *C. japonica*, which poses a biosecurity risk, and the native portunid crab, *Ovalipes catharus*, where an attractant has potential applicability to New Zealand's commercial crab fishery. This poster presents the study results which found interspecific activity of UDP within portunid crabs.

Fishing the Hills – Results of an Extensive Fish Survey in the Ruahine & Tararua Ranges

Michael PATTERSON // Horizons Regional Council

Logan Brown // Horizons Regional Council

In early 2011, Horizons Regional Council, in conjunction with the Department of Conservation, conducted a fish survey of 61 sites in the southern Ruahine and northern Tararua Ranges. The purpose of this was to locate new fish populations and to establish baseline data. Of the 61 sites surveyed 25 had either never previously been monitored, or had one or more species found which had not previously been recorded at that site. The survey found 14 fish species including a single lamprey, the first dwarf galaxias populations found in the Manawatu River catchment on the north-western side of the Ruahine Ranges (Pohangina catchment), and several large populations of the at risk shortjaw kokopu. Comparison of these results against the Leathwick Freshwater Fish Predictive model (2005) showed the model underestimated the presence of several large galaxiid species, relative to what we observed. As the model was based on data from the New Zealand Freshwater Fish database, this discrepancy may be a result of a deficiency in freshwater fish monitoring and reporting in similar hill country habitat in our region.

Boring Through Marine History: Shipworms, Pillbugs & Gribbles, & Their Current New Zealand Status

Courtney RAYES // The University of Waikato

Ian Duggan, James Beattie, Ian Hogg // The University of Waikato

Marine wood borers have been, and continue to be, a major concern for wooden ships and marine infrastructure worldwide. Three families of marine wood borer from two phyla occur in New Zealand; Teredinidae (Mollusca), and Sphaeromatidae and Limnoriidae (Arthropoda), otherwise known as shipworms, pillbugs and gribbles, respectively. Of the known species in New Zealand, most are considered non-indigenous or are of uncertain origin. Although assumed to have invaded New Zealand via wooden ships, introductions are historic, and it is possible that some were present in New Zealand prior to human colonization. Two key components contribute to this research. Firstly, a historical review seeks to address our understanding of the historic impacts and responses to borers. Secondly, field sampling for wood borers is being undertaken at historically important ports for analysis of the COI gene locus to examine genetic diversity and geographical structuring of wood borer taxa. Historical results illustrate the profound impacts of marine wood borers globally, particularly in the period after 1800, coinciding with significant growths in shipping, migration and global interaction. New Zealand reports of wood borer damage and management attempts began in the mid nineteenth century. Timber coatings and chemical impregnation were first utilized, but from 1860 their management shifted to the use of imported and native tree timbers, thought naturally resistant, and by the twentieth century chromium copper arsenic preservation was introduced. Despite relentless efforts worldwide, no infallible method for marine borer resistance exists.

Effects of Sample Processing on the Concentration of Microcystins Detected in Cyanobacteria

Shelley ROGERS // University of Waikato

Michèle Prinsep, David Hamilton // The University of Waikato
Susie Wood, Jonathan Puddick // Cawthron Institute
Daniel Dietrich // University of Konstanz

Cyanobacteria are capable of producing toxic compounds of which microcystins are the most notorious. Microcystins pose serious health risks to animals and humans by irreversibly inhibiting protein phosphatase enzymes, causing liver failure and neurological impairment. Several decades of research have been dedicated to determining the environmental factors regulating microcystin production and its ecophysiological role. Culture-based studies that manipulate environmental factors typically associated with a bloom have shown contradictory results and only yielded small changes in microcystin quotas (microcystins per cell). These findings might be due to the use of different methods for preserving, extracting and quantifying microcystins. A recent *in situ* study showed that an increase in cell density resulted in eighteen-fold increases in microcystin quotas. This highlighted the need to further investigate the methods used and the length of time between the concentration and preservation steps when assessing microcystin concentration. The microcystin concentration of two different *Microcystis* strains (CYN06 and CYN11) and one *Planktothrix* strain (CYN60) were quantified using high performance liquid chromatography coupled to mass spectrometry after processing via; (1) direct freezing (no prior cell concentration) and extraction by freeze-thaw cycles, (2) cell concentration by centrifugation and extraction in methanol and (3) cell concentration by filtration and extraction in methanol. Results show comparable microcystin concentrations for all the methods and suggest that cell concentration prior to preservation does not affect microcystin concentration. The results from this study have recently been applied to an in-lake mesocosm experiment performed at Lake Rotorua, Kaikoura.

Fisheries Research in Eastern Australia – at the Interface...or About to Go Under?

Kevin ROWLING // Retrenched (NSW Fisheries)

In recent years all eastern Australian states have seen a significant reduction in the funding and resources available for assessing the status of exploited fish stocks. In New South Wales, March 2013 saw the closure by the NSW Government of the iconic Cronulla Fisheries Research Centre, which for more than 100 years has been one of the pre-eminent marine research sites in the southern hemisphere. Its closure led to the retrenchment of about half of the fishery assessment scientists based at Cronulla, and the transfer of the remainder to disparate, inappropriate locations. An inquiry by a NSW Parliamentary Select Committee found there was no reasonable justification for the closure – the decision lacked an appropriate business case or any cost/benefit analysis. This 'expedient' approach has typified the restructuring of fisheries agencies in the other eastern Australian states, where reductions in research staff numbers may have serious implications for the future sustainability of commercial and recreational fisheries, as well as reducing the employment prospects for fisheries scientists in Australia. One significant factor contributing to this situation appears to have been the placement of Fisheries (which has a natural resource management function) under agriculture-dominated Department of Primary Industries portfolios.

The Importance of *Austrovenus stutchburyi* for Biodiversity-Ecosystem Functioning in an Intertidal Sandflat

Candida SAVAGE // University of Otago

Agnes Karlson // Stockholm University, Sweden
Keith Probert // University of Otago
Daniel Leduc // NIWA
Conrad Pilditch // The University of Waikato

Biodiversity loss in coastal ecosystems worldwide has prompted an urgent need to understand the importance of key functional groups for ecosystem functioning. We investigated the effects of the loss of a key species, the cockle, *Austrovenus stutchburyi*, on critical ecosystem processes, notably nutrient cycling and uptake of detritus in intertidal sandflats. Cockles are harvested commercially and recreationally, yet they are the main suspension-feeding bivalve in New Zealand estuaries. Removal of this key species thus results in the loss of an entire functional group, which is likely to have direct consequences for ecosystem functioning in marine sediments. Using a block design, we manipulated cockle densities (no cockles; 300 m^{-2}) and added ^{13}C and ^{15}N-labelled macroalgae to select high and low density cockle plots in Papanui Inlet, Otago. Nutrient and oxygen fluxes across the sediment-water interface were measured and the uptake of algal detritus by functionally different benthic communities was determined using isotope tracers. Oxygen uptake rates were greater in high density cockle plots and increased with the addition of macroalgal detritus. There was high interspecific variation in uptake of the algal detritus, with highest uptake by a tanaidacean and a nereidid polychaete. This multi-functional and mechanistic approach enabled us to assess the relative performance of species within and among treatments and quantify the feeding niche of the different communities.

How Much Nitrogen is too Flipping Much? Predicting the N Loading Threshold for Seagrass Collapse

Lena SCHALLENBERG // Hydrosphere Research Ltd

Marc Schallenberg

Seagrasses play an important role in lakes and lagoons by stabilising sediment and competing with nuisance macroalgae and phytoplankton for nutrients. Eutrophication can cause a sudden disappearance of seagrasses resulting in shifts to macroalgal and/or phytoplankton dominant systems. This regime shifting or 'flipping' is one of the most important ecosystem dynamics to predict in aquatic systems, given the complete reversal of species dominance and modified nutrient cycling that can result. Such a shift occurred in Lake Ellesmere/Te Waihora (Canterbury) and it is feared that intensification of dairying will also drive Waituna Lagoon (Southland) to a similar regime shift. This study sought information on nitrogen (N) loading rates which have caused collapses of seagrass communities in coastal lakes/lagoons/embayments around the world. Based on an extensive literature review, we found that N loading thresholds causing seagrass community collapse occurred between 20 and 100 kg N per year per hectare of water body area. The current best estimate of the N loading rate for Waituna Lagoon is 180 kg N/ha/y, which is above the maximum threshold for seagrass collapse based on overseas studies. Thus, our study indicates that to safeguard the seagrass community in Waituna Lagoon, the rate of N loading from the catchment should be reduced by at least 44%. Our finding is supported by an ecological model of Waituna Lagoon and by a nitrogen loading threshold for the lagoon independently determined by an expert in the health of coastal lakes/lagoons.

Marine Invertebrates of New Zealand: Diversity, Tools & Opportunities

Kareen SCHNABEL // NIWA

Sadie Mills, Anne-Nina Loerz, David Bowden, Dennis Gordon, Daniel Leduc // NIWA

A recent inventory of the New Zealand Animalia (including vertebrates) by D.P. Gordon listed a total of ~35,000 terrestrial and aquatic species. Notably, only about a third of these (just over 13,000) are marine, despite the fact that the New Zealand marine realm is 15 times larger than its land mass. This difference becomes even more striking when one considers the deep-sea environment: not even 800 invertebrate species are known from depths >1500m, meanwhile, these deep waters cover more than 65% of the New Zealand Exclusive Economic Zone. The first deep-sea samples in this region were taken by the HMS *Challenger* in 1874 with intermittent extensive regional sampling since then. More recently, new technologies including camera systems is adding exciting new resources and opening up new opportunities. We will summarise the ongoing research efforts in the New Zealand deep sea (beyond the continental shelf), highlighting some of the technological advancements that are adding a wealth of information and data that in turn allow insights into deep-sea biodiversity and ecosystem functioning. While it is not surprising that the recognition of new taxa happens at a rate much faster than they can be described, some encouraging progress has been made over the last years. Nevertheless, the possibilities for discovery remain endless.

To Study the Immuno-stimulant Activity of Watse Paua Blood & Guts

Ashish SHARMA // Auckland University of Technology

Noemi Gutierrez-Maddox, Andrea Alfaro, Jun Lu, Yan Li // Auckland University of Technology

The black-footed abalone *Haliotis iris* is the main commercial species of abalone in New Zealand, and is known as "paua". It is grown for its flesh and for its shells, which are polished and used as ornaments. OceaNZ Blue Ltd. Situated in Ruakaka mostly conducts cultivation of abalone in New Zealand, where they produce cocktail-size abalone for local and international markets. One of the big threats for this industry is the risk of diseases and mortality. In order to address the health of the stock, a good understanding is needed on the immune system of this under-studied species. Hemocyanin (Hc) is a high molecular weight respiratory protein, which carries oxygen using two copper ions found in the hemolymph of most crustaceans and molluscs. Oxygen binds with the copper ions that impart a blue colour to Hc when it is oxidized. Due to their large size, Hc exerts an immunostimulant activity in mollusks, but the mechanism of the stimulant effects on paua is unknown. A detailed study of *H. iris* blood and gut fluids will provide valuable information regarding the mechanisms that control its immune system and may provide a tool for early disease assessment.

Integrated Geophysical Study of Depth-to-basement & Sediment Thickness in Otago Harbour, New Zealand

Amy SHEARS // Horizons Regional Council

ABIGAIL SMITH, ANDREW GORMAN // University of Otago

Understanding how a harbour has filled (or emptied) in the past is critical to understanding the current sedimentary processes. Integrated geophysical research can be used to uncover such information on the past environment and changes over time. The aim of this research was to determine the depth-to-basement, sediment thickness and ancient sedimentation in Otago Harbour using lithological records alongside two complementary methods: land-based gravity anomaly profiling and marine single-channel seismic reflection.
The gravity surveys around Otago Harbour modelled a maximum depth-to-basement at ~100 m deep near the current entrance and >70 m at the South Dunedin paleo-entrance. The seismic reflection survey observed the greatest basement depth (~76 m) just 1km from the current entrance. Appearing like two elongated valleys, the basement surface was shallowest at Goat and Quarantine Islands and the rocky harbour margins and deepest towards the paleo-river mouths. The "V"-shaped bedrock valley and thick sediment fill at the current entrance was indicative of a steep river-incised and/or fault-incised valley. The total sediment volume in Otago Harbour was estimated at 1.62 billion m^3. This sediment package accumulated at a varied rate, predominantly depositing sediment during the last post-glacial sea-level transgression. The volume equates to an ancient sedimentation rate of ~90,000 m^3/y since the last glacial maximum (~2 mm/y). Investigating the sub-surface of Otago Harbour has provided information on basement geometry, pre-human sedimentation and geomorphological evolution, thus providing further knowledge to inform management of Otago Harbour. The same combination of methods could be useful for other shallow coastal sub-surface surveys.

Managing the Effects of Gravel Extraction in the Manawatu-Whanganui Region

Amy SHEARS // Horizons Regional Council

Harold Barnett, Jon Bell, Peter Blackwood // Horizons Regional Council

The removal of gravel from river channels and banks has a long history in the Manawatu-Whanganui Region. The demand for gravel use and flood control works to protect various land uses has led to significant modification of physical characteristics, ecology and natural character in some rivers. Horizons Regional Council is responsible for managing these effects whilst simultaneously providing for flood protection and allowing the extraction of gravel which benefits the local economy. Horizons has a number of tools to manage this balance, such as, a code of practice for river works, policies on total allocation limits and protection of significant habitats and a long-term monitoring programme of the gravel resource through cross-sectional river surveys. We will use a number of case studies to illustrate how these policy, science and monitoring tools feed back to inform policy reviews and consenting of gravel extractions. As a result of these management tools, the consenting process is better informed to avoid adverse effects of gravel extraction.

Regional Estuary Monitoring Programme: a Decade of Trends

Nathan SINGLETON // Waikato Regional Council

Hazel Needham, Hilke Giles // Waikato Regional Council

Sediment dwelling organisms (macrofauna) perform many important ecological processes that regulate ecosystem function. Estuarine habitats and their associated biological communities have been identified as being highly vulnerable to the pressures and disturbances associated with increasing human activities, highlighting the need for regular monitoring of these unique habitats. =In April 2001 Waikato Regional Council initiated the Regional Estuary Monitoring Programme (REMP) at five permanent monitoring sites in two key estuaries; the southern Firth of Thames and Whaingaroa (Raglan) Harbour. The objective of this long-term monitoring program is to assess both the current status and temporal changes in intertidal sediment characteristics and associated macrofaunal communities. Macrofauna have been widely used as indicators of estuary health in environmental monitoring programmes globally, as certain species respond predictably to many kinds of natural and man-made stressors.Sites are monitored either quarterly or twice a year. On each sampling occasion 12 replicate macrofaunal cores are collected in each monitoring plot. Sediment samples are collected for analysis of physical and chemical characteristics. Continual monitoring over many years enables the natural variability and cycles in organism abundances to be differentiated from those attributed to changes to environmental conditions. The Firth of Thames and Whaingaroa (Raglan) Harbour maintained distinct macrofaunal communities over the 10 year period. Sediment and community structure have not changed dramatically at an estuary wide scale. However within each estuary site specific changes concurrent with environmental change were observed. These trends in organism abundance and sediment properties will be presented.

www.waikatoregion.govt.nz/Environment / Natural-resources/coast/Regional-Estuary -Monitoring-Programme/

Tairua Harbour – Environmental Monitoring in Paradise

Nathan SINGLETON // Waikato Regional Council

Wilma Blom // Auckland War Memorial Museum

Waikato Regional Council (WRC) conducts the long-term Regional Estuary Monitoring Programme (REMP) in the southern Firth of Thames and Whaingaroa (Raglan) Harbour. REMP focuses on intertidal benthic macrofauna and sediment characteristics as "indicators" of the health of the region's estuaries. WRC wants to expand its REMP into Tairua Harbour, Coromandel Peninsula, and in November 2012 a pilot survey was undertaken. The Coromandel east coast is a popular holiday and retirement destination, but it is also seeing increased intensities in farming, forestry and horticulture. Despite this, little is known about it the coastal ecology in this area. The aims of the Tairua REMP are to collect baseline and longitudinal data to help WRC assess the state of the estuary, detect environmental change, determine the effectiveness of current as well as plan future work programmes. Initial results of the pilot survey show the macrobenthic community in Tairua Harbour may be quite different from that found in the southern Firth of Thames and Whaingaroa (Raglan) Harbour. An amphipod found in the upper reaches of the estuary may be a new species more characteristic of phreatic systems. We also found an isopod which, though probably not a new species, belongs to a genus which does not fit into any known isopod family. Based on records in the literature it has been previously recorded only from Stewart Island and the Chathams.

This poster describes the findings of the pilot survey and outlines the aims and design of the Tairua REMP, which commences in July 2013.

Observations of Giant Kokopu Spawning Habitat in an Urban Hamilton Stream

Josh SMITH // NIWA

Paul Franklin, Cindy Baker, Brenda Bartels // NIWA

Little is known of the spawning habits of giant kokopu (*Galaxias argenteus*). It is generally thought that the adults migrate to a common spawning site, but spawning has never been observed or any eggs discovered until now. Giant kokopu nests have been discovered in an urban park in the middle of Hamilton. Adult giant kokopu (43) ranging in size from132–303 mm were PIT tagged using 12 mm tags in a 500 m long section of a small Hamilton urban stream that flows into the Waikato River. Fish movements were monitored regularly by spotlighting and the use of a handheld PIT detector. A fixed PIT aerial was positioned in the lower section of the stream to detect fish leaving the stream. Ripe fish, both male and female, were found in early June. Shortly after this three separate giant kokopu nests were found. It appears that the majority fish in this particular stream spawn in-situ and don't undertake significant migrations for spawning. Spawning occurred during high flow events on at least two occasions, as development was less advanced in one nest compared to the other two. Eggs were laid in dense wandering jew (*Tradescantia fluminensis*) at two sites and dense yorkshire fog (*Holcus lanatus*) at the other. This new knowledge will support conservation and restoration of this iconic New Zealand species.

Predicting Climate Change Effects on Life at the Land–Freshwater Interface

Richard STOREY // NIWA

Paul Lambert // Richard Storey
Adam Uytendaal // Hawke's Bay Regional Council

Located at the interface of land and water, intermittent streams are extremely sensitive to changes in annual rainfall and temperature with respect to the length of their dry period. Climate models predict longer and more frequent droughts in eastern parts of New Zealand where intermittent streams are common. What will be the impact of such climate change on aquatic communities of intermittent streams in these areas? Will the impacts be greater in streams that lack protective riparian forest? Several intermittent streams in central Hawke's Bay were monitored for five years to determine the effects of dry vs. wet years on aquatic invertebrate communities. During the driest years, intermittent streams ceased flow for up to 6 months, whereas during the wettest year, streams did not dry at all. Intermittent streams in native forest showed a slight decline in total invertebrate richness, and a clear decline in EPT richness, EPT abundance and %EPT abundance with increase in dry season length. In nearby perennial streams, EPT richness and abundance showed a much smaller decline with dry period length. Correlations between invertebrate metrics and dry period length were not stronger in pasture than forested intermittent streams. These results indicate that invertebrate communities respond to short-term (year-to-year) variability in dry period; they may show stronger responses to long-term increases in dry period length associated with climate change.

Can Fisher Knowledge Provide Accurate Estimates of the Past?

Ruth THURSTAN // University of Queensland

Sarah Buckley, John Pandolfi // University of Queensland

Fisher knowledge is increasingly accepted as a valuable tool to help derive past trends in species abundance or environmental conditions. Yet inferring trends from fisher knowledge is fraught with uncertainty, and little is known about the accuracy of such data in comparison to records of catch and effort. We interviewed Queensland fishers from the trawl, line and net industries about their memories of past catches, catch rates, seasonal trends and general perceptions of change over time for their target species. Each fisher's response was compared to their individual records of catch and effort, either sourced from personal logbooks or from records collected by Queensland Fisheries, for which individual catch and effort has been recorded since 1988. We report upon the accuracy of fishers' recollections compared to their individual catch rate data and discuss the value – and the limitations – of such data for management.

Allometry, Biomass & Litter Decomposition of the New Zealand Mangrove *Avicennia marina* Subp. *Australasica*

Phan TRAN // Auckland University of Technology

Sebastian Leuzinger, Andrea Alfaro // Auckland University of Technology

Mangrove ecosystems are considered to be of high ecological and economic importance throughout the tropics and subtropics. Globally, these ecosystems are under threat due to land use conversion as a result from high population pressure in coastal areas. Conversely, temperate mangroves in New Zealand are expanding, but their biodiversity and ecological role differs from their tropical counterparts. There is limited available information and diverging views of how mangrove expansion may affect the various stakeholders' interests, which have led to conflicted management initiatives. Recent studies on New Zealand mangroves have mainly focused on faunal aspects and are generally lacking basic ecology and biology of our local mangroves. This study investigates the allometry, biomass, and litter production and decomposition of the New Zealand mangrove, *Avicennia marina* subsp. *australasica*, conducted at Mangawhai Harbour Estuary. Quantitative analyses of tree biomass, soil samples, litter production and decomposition are used to estimate carbon pools and fluxes. Preliminary results indicate that root biomass is relatively similar among replicate cores, and that fine roots are more densely concentrated in the top 20–40 cm. These data are fundamental for a better understanding and quantification of temperate productivity and carbon storage in mangrove-dominated estuaries. In addition, they provide basic information for research on nutrient, water, and carbon cycling that are underway as part of the Mangrove Research Group (AUT and UoA).

Catchment-derived Contaminants in Hamilton City Urban & Peri-urban Streams

Tammy VALLER // The University of Waikato

Susan Clearwater // NIWA
Nicholas Ling, Dudley Bell // The University of Waikato
Kevin Collier // The University of Waikato, Waikato Regional Council

Awareness of the consistently degraded state of urban streams with lower biodiversity has heightened worldwide, increasing restoration initiatives to ameliorate adverse effects. This study examined anthropogenically-derived contaminants (metals, metalloids, PAHs) in water and sediments, and bioaccumulation in shortfin eels (*Anguilla australis*) in Hamilton City urban and peri-urban streams to identify areas where biota may be affected and therefore, restoration initiatives constrained. Smaller streams with fully urbanised catchments and greater imperviousness had generally higher concentrations of Zn, Cu and Pb in the dissolved phase and/or sediments. Dissolved Zn and Cu were of concern in a number of stream sites with concentrations exceeding water quality guidelines during rain events. Seasonal mean concentrations of Zn and Pb exceeded sediment guidelines in some streams with fully urbanised catchments, while arsenic concentrations in sediments of Hamilton Lake and some tributaries of the Kirikiriroa catchment were of concern to aquatic life. Hamilton Lake sediment caused significant mortality to burrowing amphipods (*Paracorophium lucasi*) in 10-day toxicity tests. Peri-urban stream sediments showed elevated concentrations of Zn and Cd due to agricultural use. Sediment Hg concentrations exceeded guidelines in a number of urban and peri-urban streams. Non-physiologically regulated metals and metalloids in livers of eels reflected sediment concentrations, with elevated Pb, Hg and As in eels from urban sites and elevated Cd in those from peri-urban sites. Although sediment PAH concentrations did not exceed ANZECC guidelines, the PAH metabolite pyrene-1-glucuronide was significantly elevated in the bile of urban eels compared with rural controls.

Auckland Marine Habitat Mapping

Melanie VAUGHAN // Auckland Council

Jarrod Walker, Marcus Cameron, Megan Carbines // Auckland Council
Boyd Taylor // EcoGIS

Accurate mapping of the marine environment is a challenging and expensive task. Auckland Council has used satellite and aerial imagery, data points and expert knowledge to map intertidal habitats across the Auckland Region. We use worldview two multispectral satellite imagery which was designed for greater water penetration and has a 1.8m resolution. The analysis identified spectral signatures for marine habitats at a 5–8 m resolution for 2,000 km² of Auckland's east coast, including the majority of offshore islands. The analysis involved splitting the bands and running classifications over single habitats. Each classification was then compiled to generate final habitat assignments and boundaries. There is a vast expanse of data collected through Council monitoring and research programmes. These datasets have been collated to present amalgamated data layers detailing sediment and intertidal vegetation types in Auckland. These maps will be useful in the marine spatial planning process. The identification of marine habitats will allow for calculations of habitat area, coverage, rarity, biomass and productivity on a regional scale, which will be a first for some marine habitats in Auckland.

Testing the Effects of Technological Modifications to an Inshore Trawl in Hawke's Bay, New Zealand

Oliver WADE

Rick Burch
Laws Lawson // Te Ohu Kaimoana
Adele Whyte // Ngati Kahungunu Incorporated

Over the past three years we have tested three modifications to an inshore demersal trawl using a catch comparison method. The focus of these trials has been testing the efficacy of the modifications in releasing unwanted by-catch and discards. These modifications utilise varying sizes and orientations of mesh in different locations within the trawl. All fish caught were identified and measured and an existing glmmPQL model was used to analyse the catch data. Findings indicate that all three modifications had some impact on the catch composition. The test shows a reduction in numbers of fish caught that depends primarily on the morphology of the species. The fish species that was encountered in highest numbers during the trials was Gurnard (*Chelidonichthys kumu*), with 42 species encountered all together. Gurnard was also the species that saw the largest and most consistent reductions in numbers of smaller fish using the trawl modifications.

Implications of Gain Functions in Fisheries Management

You-Gan WANG // University of Queensland

Na Wang // University of Queensland

The fundamental aim in fisheries management is to determine an optimal fishing effort for sustainably harvesting from a replenishable resource. The Northern Prawn Fishery (NPF), one of Australia's most valuable fisheries in terms of gross production value, has been managed under the MEY objective since 2006. The recent average catches of tiger prawn species are about 1,250 tonnes only while the maximum sustainable catch stated from different studies are around 3,000–4,700 tonnes. How to make more efficient use of a fishery for society rather than fishing operators depends critically on the MEY functions applied. It may be more appropriate to use a MEY which is based on the value chain of the overall fishing sector, to benefit more groups rather than the fishing fleet only. We illustrate cases where broad MEY is larger than traditional MEY at different values of price elasticity of demand and multiplier effect. We also evaluated the net profit assuming there were no buyback scheme (which was undertaken to achieve traditional MEY) in 2005 and the fishing fleet was kept at 89 vessels since 2005, and concluded that 40% more catch on average (2006–2009) and an additional total profit of A$17 million (excluding crew cost) could have been gained in addition to the many million dollars of savings in the buyback scheme. These findings have great implications for future management in Australia and elsewhere as there is a grave concern of overfishing worldwide.

Assessing Next Generation Sequencing of Rotifer Communities to Measure Lake Water Quality

NATHAN WATSON // The University of Waikato

Jonathan Banks // Cawthron Institute
Clare Beet, Gemma Collins, Ian Duggan, Steve Woods, Ian Hogg // The University of Waikato

Lake water quality is typically assessed from physical and chemical variables (e.g., dissolved nutrients, water clarity). However these variables can fluctuate markedly over short periods and thus accurate measurements of the water quality require frequent monitoring which can be problematic if access to the lake is difficult and/or funding limited. Bioindicator organisms integrate biological, chemical and physical factors over time producing a measure of water quality from less frequent monitoring. Rotifers are commonly used in the rotifer trophic level index (rotifer TLI) to assess lake water quality as they are numerous and species rich, and community composition integrates environmental conditions over time. Identification of rotifers requires specialist taxonomic knowledge and is time-consuming. Next generation sequencing (NGS) enables the characterisation of communities from their DNA and we are testing the feasibility of using NGS to characterise rotifer communities. Before an NGS-based rotifer TLI can be widely implemented, the performance of the NGS platforms under different community structure has to be evaluated. Here, we will present preliminary data on artificial rotifer communities that range from homogenous species abundances to communities that are dominated by a single species with low abundances of other species. We will also compare an NGS based rotifer TLI to the traditional morphology based TLI.

Acute Toxicity of MV Rena Pollutants

Ashley WEBBY // The University of Waikato

Christopher Battershill, Nicholas Ling // The University of Waikato

The wreck of the container ship MV Rena on Astrolabe Reef in the Bay of Plenty in October 2011 discharged 350 tonnes of heavy fuel oil (HFO), large quantities of general cargo, and other goods classified as environmentally hazardous, in particular sodium hexafluoroaluminate or cryolite. Given the almost total absence of toxicity data on New Zealand marine species, this project sought to assess the acute sublethal toxicity of cryolite, HFO, and oil dispersant to a range of culturally and commercially important species. Exposure to 1:10000 cryolite or 1:10000 HFO for up to 96 h caused no lethality or measurable acute sublethal effects to sub-adult snapper (*Pagrus auratus*), spotted wrasse (*Notolabrus celidotus*) or rock lobster (*Jasus edwardsii*), although bile polyaromatic hydrocarbons (PAH) reached levels several orders of magnitude higher than controls. The dispersant Corexit 9500 did not apparently increase PAH body burden when combined with oil. Continuing studies will evaluate further conditions of exposure and longer term measures of sublethal effects following acute exposures, and evaluate effects in other fish and shellfish species from rocky and soft shore habitats.

Nutrition & Reproduction of New Zealand Scallops

Ka Lai Clara WONG // Auckland University of Technology

Andrea Alfaro, Barbara Breen // Auckland University of Technology

The New Zealand native scallop, *Pecten novaezelandiae*, has undergone extensive harvesting pressure by commercial and recreational fishing, and has experienced significant population declines. Scallop growth and recruitment are highly variable in time and space. This variability leads to an unpredictable and unsustainable fishery. In order to maintain and maximise the potential of the scallop fisheries in New Zealand, culturing scallops under controlled optimal conditions may prove to be a successful practice for re-seeding wild populations. In addition to which are likely to alleviate alleviating the current fishing pressures on this species, cultivation of this species may result in new aquaculture markets for New Zealand. Scallops have gained much attention worldwide because of their high economic value. However, nutritional requirements vary among species, depending on growth rates, longevity and maximum size of each species. In general, temperature and nutrition (food quality and quantity) have been found to be important factors that affect scallop production. The key to success in scallop aquaculture will rely on the understanding of feeding, growth, development and behaviour in its natural environment to recreate optimal growth conditions in land-based culturing operations. Hence, the investigation of environmental and biological parameters that affect scallop nutrition and reproductive condition form an integral part of the rationale for this research. Information gathered from this research can be applied to culturing techniques in laboratory and commercial settings.

Rapid Assessment of Zooplankton Diversity Using Next Generation Sequencing

Steve WOODS // The University of Waikato

Jonathan Banks // The University of Waikato, Cawthron Institute
Ian Hogg, Ian Duggan, Gemma Collins, Clare Beet // The University of Waikato

Traditional methods of determining zooplankton community composition for ecological studies or environmental assessments require time to process samples, a high level of expertise in identification and may miss rare and/or cryptic species. We are developing a molecular genetic technique to speed up and standardize the routine monitoring of zooplankton communities. We are currently testing different gene regions (e.g. COI, 28S, 12s) to find a suitably short and universal fragment that could identify species using current next generation sequencing platforms. Individual species will be sequenced and added to the Barcode of Life Datasystems (BOLD) database for reference. Following preliminary evaluation, next-generation sequencing approaches (e.g. Ion Torrent, 454, Illumina) will be used with DNA extracted directly from environmental samples. The focus thus far has been on rotifer taxa. However, this will be extended to cover the cladocerans and copepods as well. This approach will be used to rapidly assess zooplankton diversity in lakes, as well as to monitor zooplankton community changes in the ecosystem (e.g. Rotifer Trophic Lake Index).