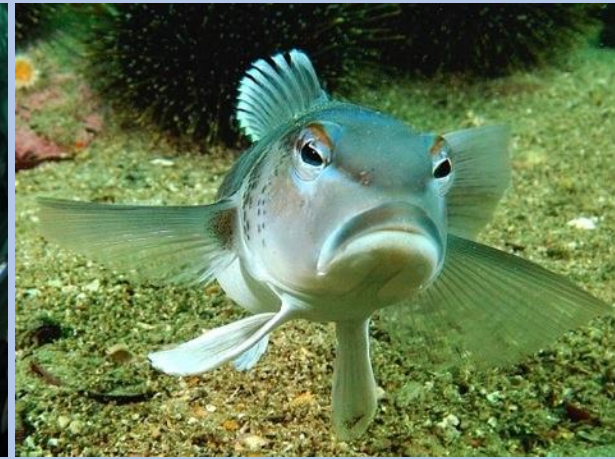


# 4.1.1- Ecosystem Connectivity

*How can resolving biochemical fluxes help inform sustainable development  
New Zealand's marine ecosystem?*



Biochemical fluxes in bivalve communities

Material Dynamics in Aquaculture Systems

Trophic dynamics of fish communities

Pelagic ecosystems



Wing, Schiel, Shima, Frew, Hageman, O'Connell-Milne, McMullin, Durante, Sabadel, Kolodzey, Connolly, Udy, Borra, Schlieman, Meyers, Salmond

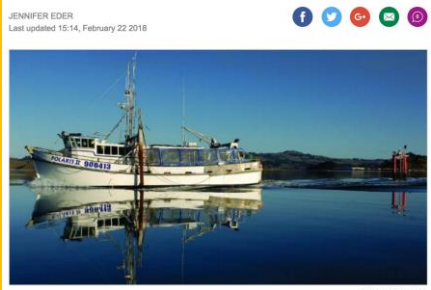
# Extreme Events – Critical tests of ecosystem resilience

## Marine Heat Wave 2017 Australia-New Zealand



### Kaikoura earthquake

#### 'Seaworthy' scientists outrun ex-Cyclone Gita as they flee Sounds

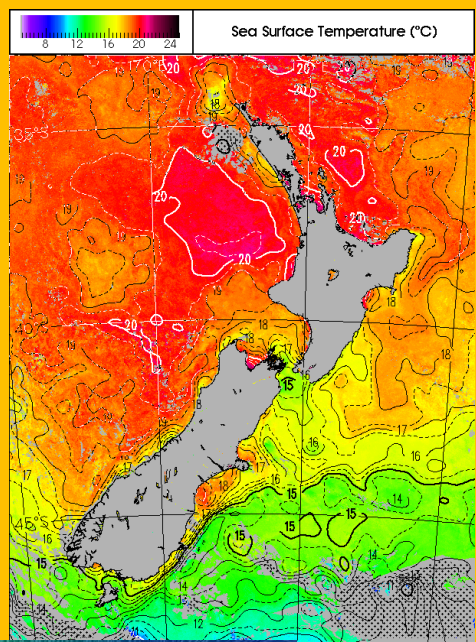


The University of Otago's research ship The Polaris II has been travelling around the South Island collecting samples for a project on ecosystem connectivity.

A team of marine scientists knew "something big was coming" as early as Sunday as strong winds buffeted their ship ahead of ex-cyclone Gita.

Project leader and professor of marine science Professor Steve Wing said they decided to make a "run for it" when it became clear the weather wasn't going to clear before hitting New Zealand.

"The initial model had it going north a bit, but as soon as they started tracking it south we started thinking about making a run for it. Well, I say making a run for it, but it's quite a slow boat."



### Kingfish in harbour climate 'sentinels'

**JOHN LEWIS**

A DECADE ago, catching kingfish in Otago Harbour was rare. This year, it appears they have become "almost prolific" along the coastline, and a University of Otago marine ecologist is calling them "sentinels of climate change".

Dunedin recreational fisherman Brent Russell caught a 72cm kingfish at the weekend near Quarantine Island. He was delighted with the rare catch, but put it back because it was less than the legal size.

"The last caught in the harbour that I'm aware of was a small one in 2015," he said.

Commercial fisherman Allan Anderson, of Karitane, said he and his son had been set-netting off the coast of Karitane for years, but in the past few years, kingfish had become much more common.

"We would catch maybe one or two in a summer season 10 years ago. We're catching one or two every day now, if not 10 sometimes."

"Twice is the most we've caught in a day."

"It's been something that's been turning up in our waters more regularly every year. They're becoming almost prolific."

He said they were set-netting more than 4 nautical miles off the coast, but kingfish preferred the waters closer to the coast.

He believed there was potentially even more of them closer to shore.

"We're only on the fringe of what's truly there."

Kingfish are most abundant in the northern half of the North Island, and can grow to more than 1.5m and weigh more than 5kg.

University of Otago marine ecologist Prof Steve Wing said the fish were becoming more prevalent in southern New Zealand because the water was getting warmer.

Coastal water temperatures were between 2degC and more than 2degC above average at the moment.

"One of the things we are seeing now are a lot of the species we associate with subtropic waters. They are showing up further south than we normally see."

He said kingfish were one of those species.

He had also heard reports of kahi being caught around southern parts of New Zealand and snapper being caught in Piccolini this year.

"These fish are real sentinels for what's going on."

"They show sub-tropical waters are here and they indicate a larger, physical change is going on."

"This is what we expected to happen in a warming ocean."

"This is one of the things we are expected to see under climate change."

A Niwa meteorologist said La Niña was causing much of the water heating this year.

It brought large ridges of high pressure to the atmosphere across the Tasman Sea and over New Zealand, resulting in sunny, warm weather and tranquil seas.

Without storms to mix up the sea, the surface layers of the ocean had warmed up quite dramatically.

Prof Wing said sea currents were causing sub-tropical water to move south.

"The waters are so warm because we've got this big injection of sub-tropical waters into the Tasman and it's coming up along the Southland Current."

He said it was difficult to know whether it was a one-off event or would continue into the foreseeable future.

"The ocean is quite variable from year to year. We have observed in the past, warm periods and cool periods."

"But the overall trend – the trend over 50 years – is that our winter-time temperatures are increasing."

"What that means is the sub-tropical water that's normally here in the summer is spending more time here in the winter, as well."

"Overall, the temperatures are increasing."

Prof Wing said there would be "winners and losers" during climate change, and it might not be "all bad" for everyone.

"Things will be different – it's the only definitive thing we can say. It's not necessarily all bad."

"There will be some changes that are quite dramatic in some places, and in some places it will be quite bad."

"For us, there may be some improvements. There will be some services that we didn't get before, like catching kingfish off our coast."

"However, Mr Anderson said it was an issue that was now costing commercial fishers thousands of dollars each season."

Each time a commercial fisher netted a kingfish, they were fined because there was no quota this far south to catch them, he said.

"The water temperatures are rising and kingfish are changing their habits when looking for food sources."

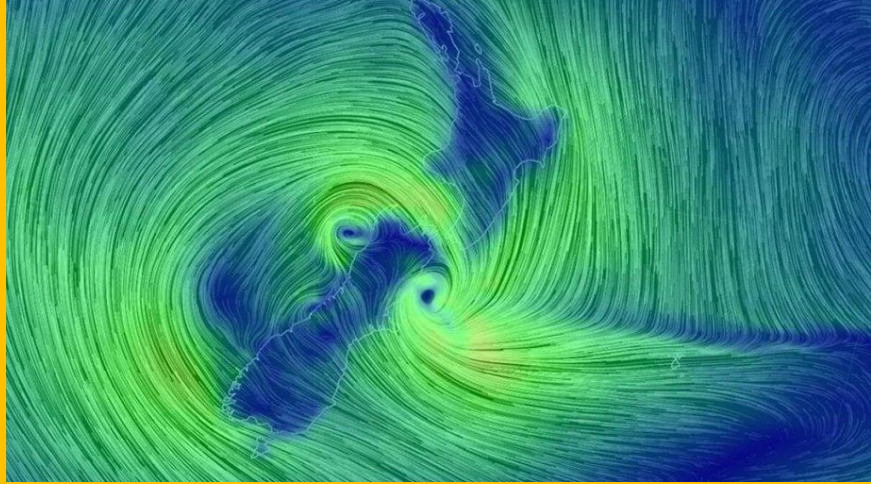
"The right sort of food is abundant here and the kingfish are changing it."

"There's no quota in the area for kingfish because there's been no previous history of catching these fish."

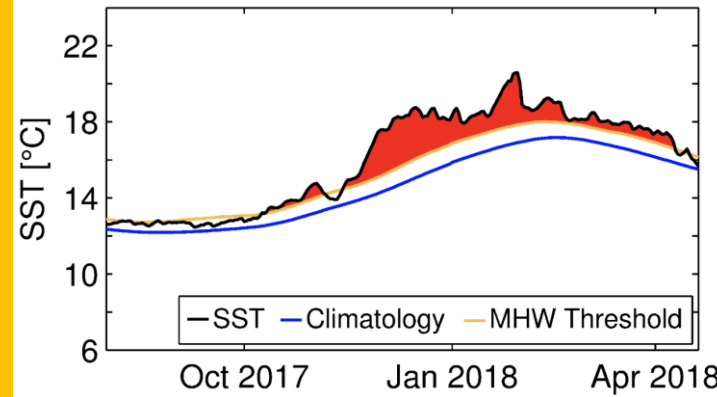
"Some of the boats are paying over tens of thousands of dollars per season in fines."

He hoped the Government would introduce a quota for kingfish in the area to ease the financial strain on commercial fishers.

John.lewis@odt.co.nz



### Tasman Sea [160–175°E, 36–48°S]



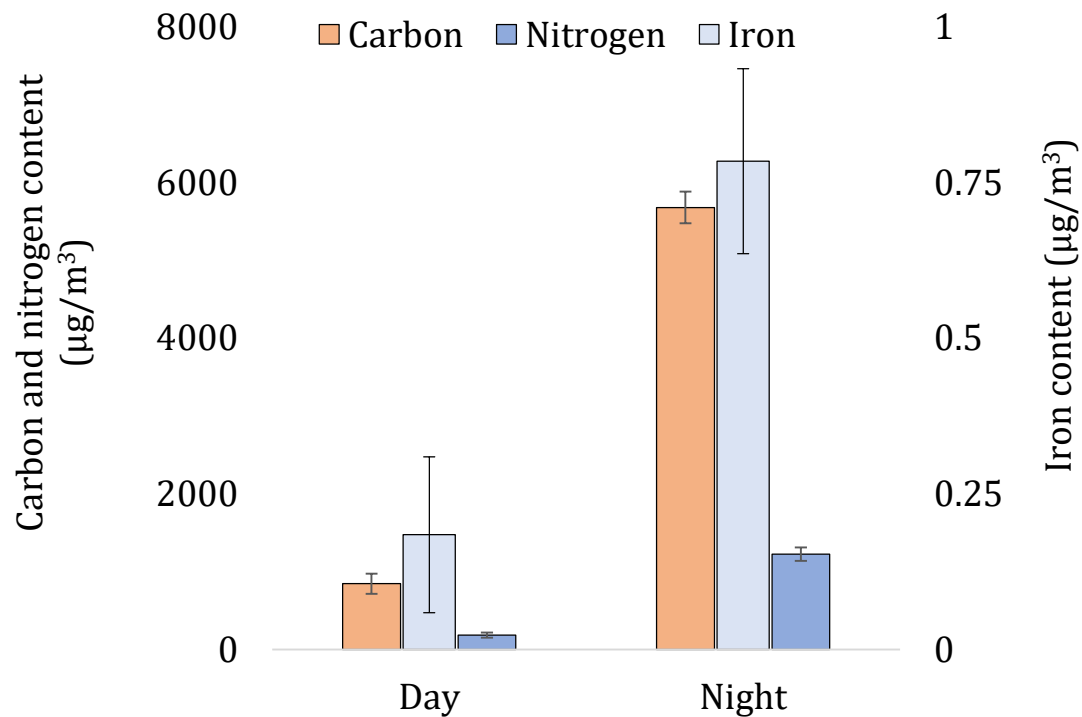
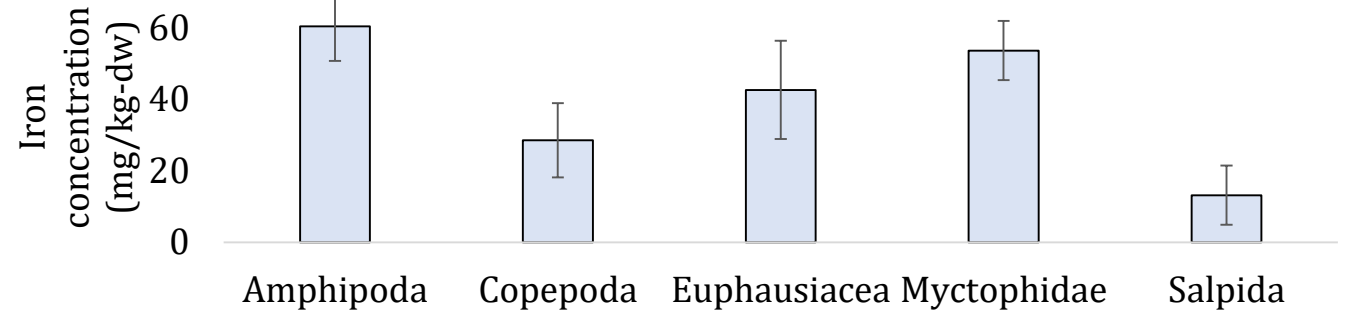
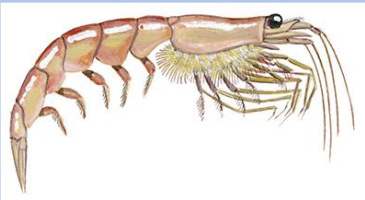
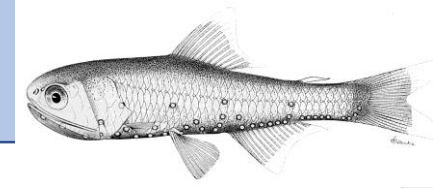
+3.5 - 6°C anomaly

(Salinger et al. in review)

### "bomb lows" and Cyclones

# Do migrating zooplankton and fish influence ocean productivity?

Charlotte Borra



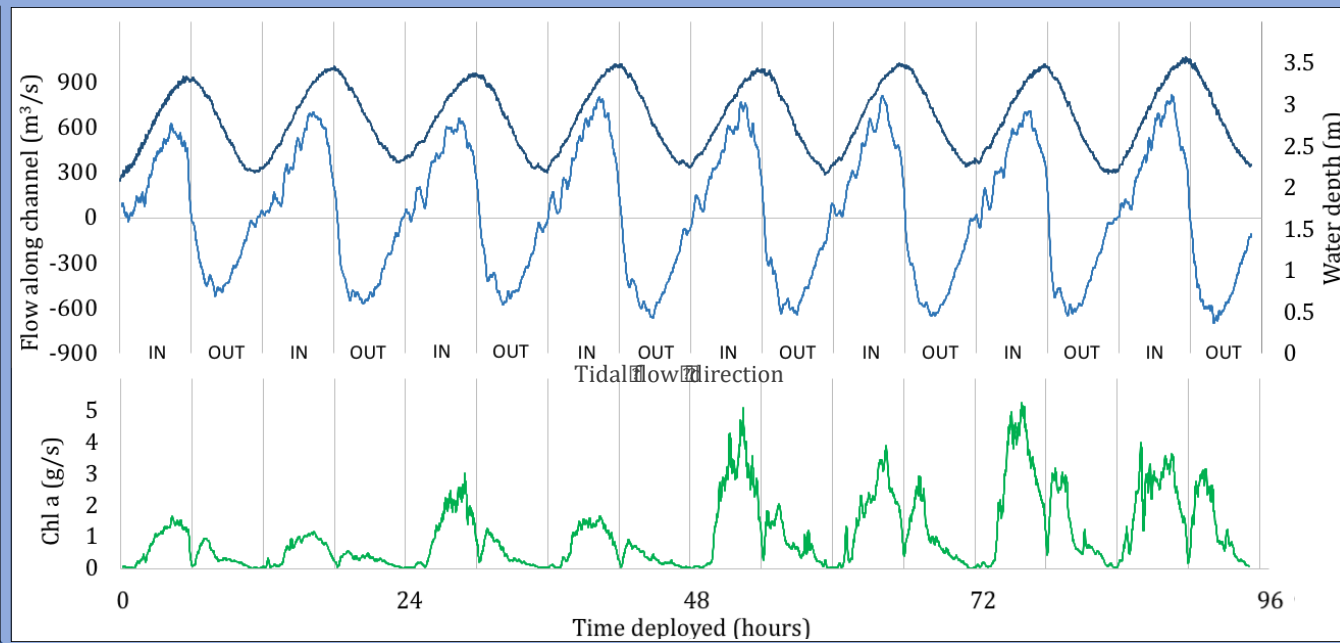
Zooplankton and mesopelagic fish bioaccumulate iron and concentrations differ among taxa.

Through the Diel Vertical Migration (DVM), zooplankton connect the deep recycled organic matter and nutrient pool with the surface layers, where elements can be utilized by phytoplankton.

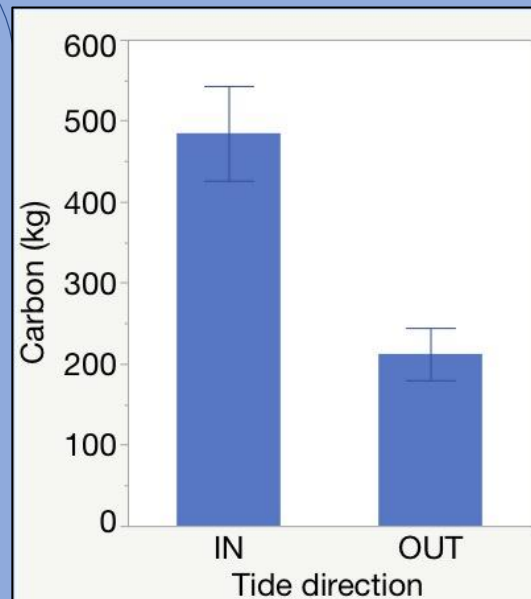
The fluxes resulting from the DVM are substantial, and even a small amount of iron transferred to surface layers would considerably increase primary production. >600% increase in surface iron inventory available to support primary production at 10% excretion rate.

# What causes estuaries to shift from net heterotrophic to net autotrophic?

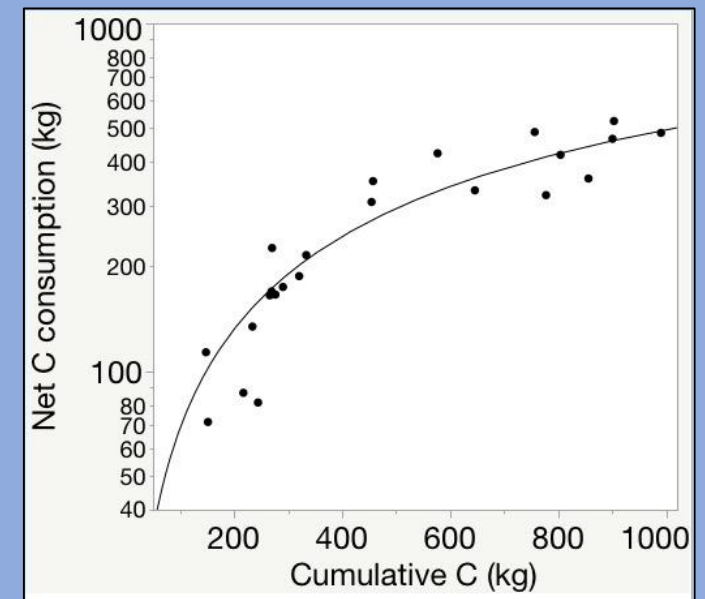
Sorrel O'Connell-Milne



## STUDY SITE:



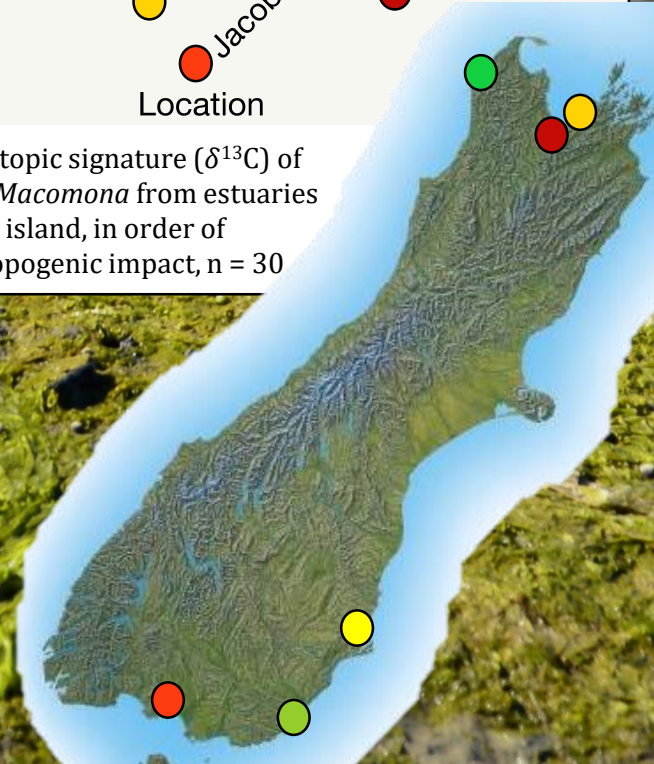
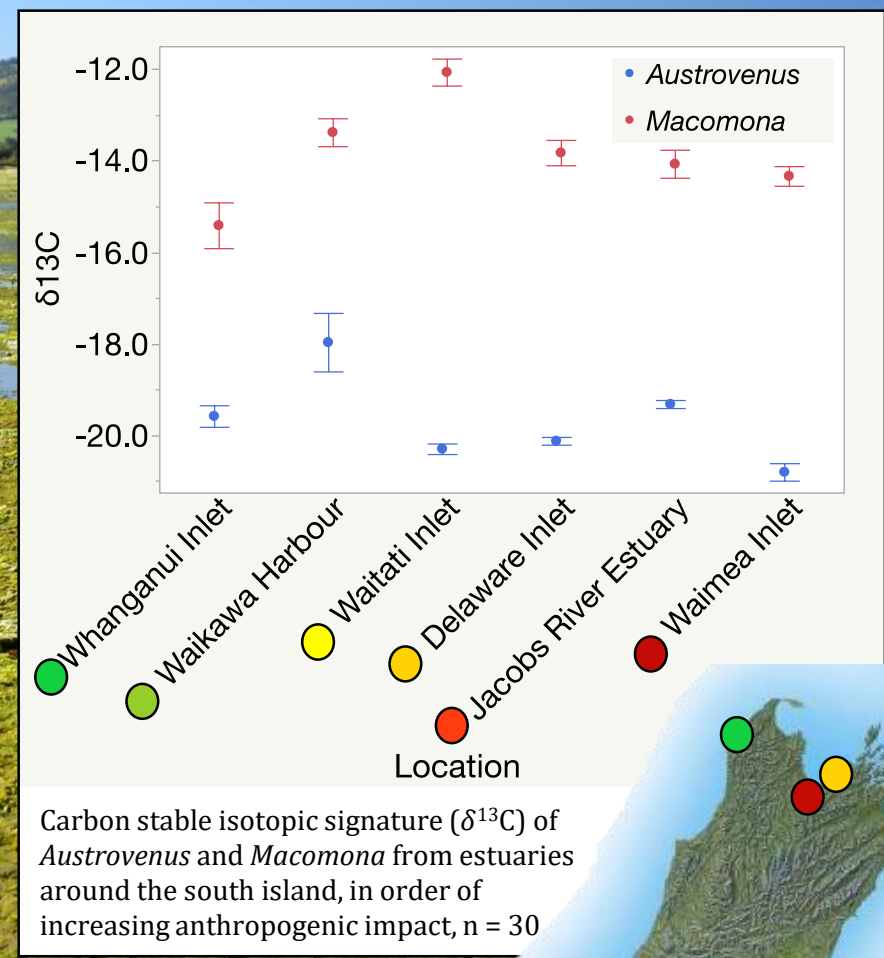
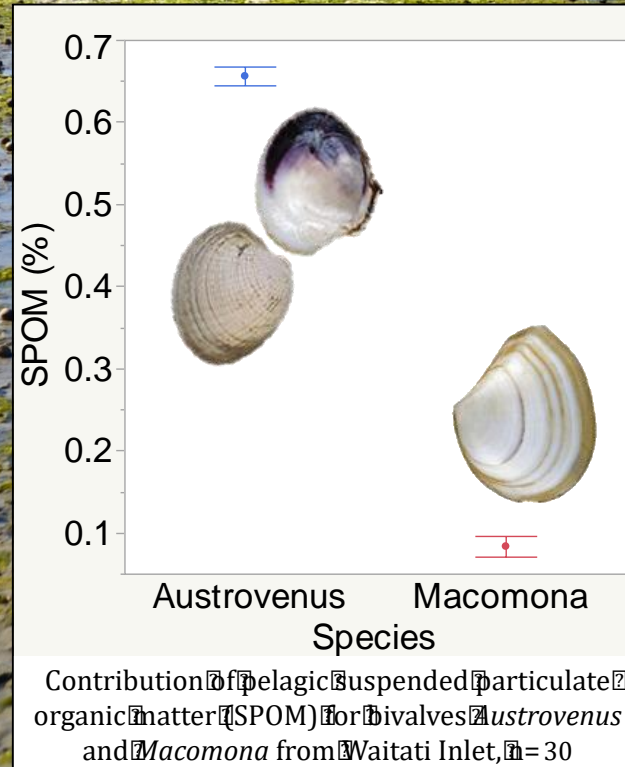
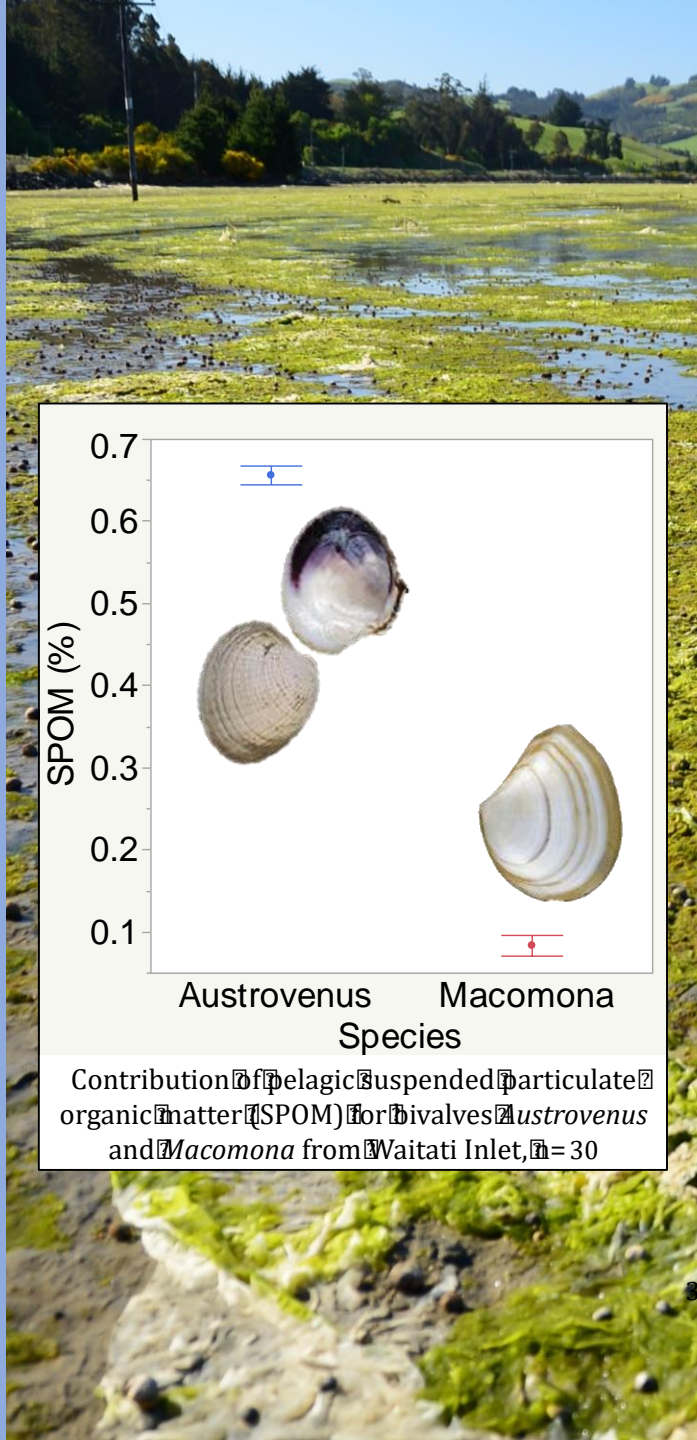
Carbon (kg) transported on flood vs ebb tide, bars represent mean value ± SE, n = 23



Cumulative flood tide organic C (kg) vs net consumption of carbon within the inlet (kg) per tidal cycle. Fitted with a type 2 functional response curve.

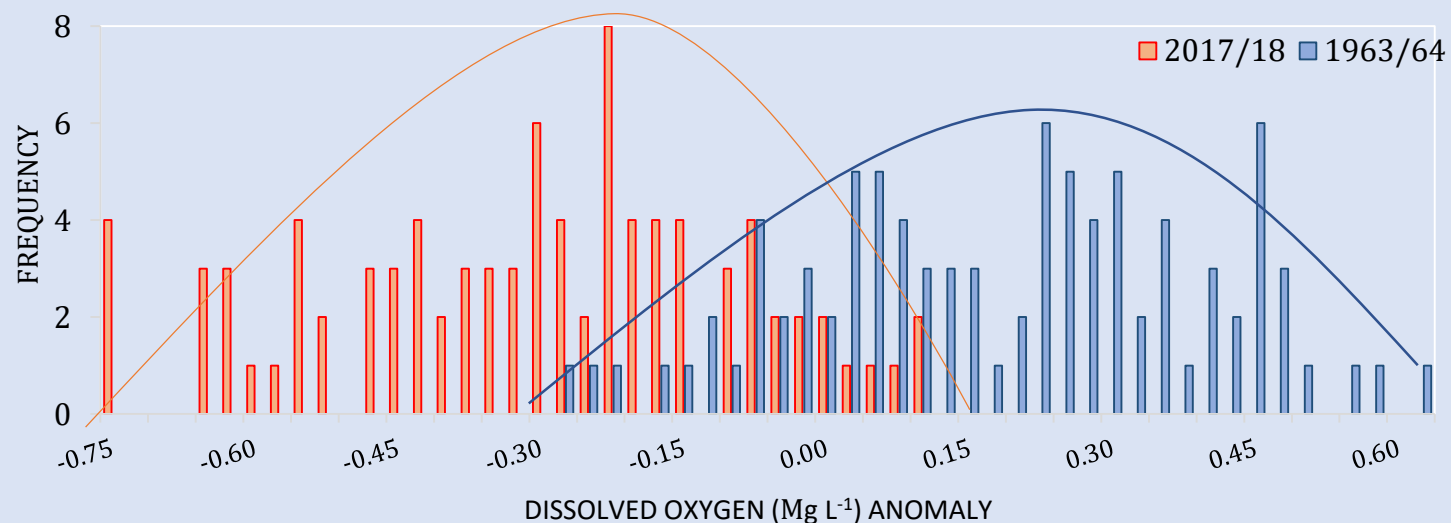
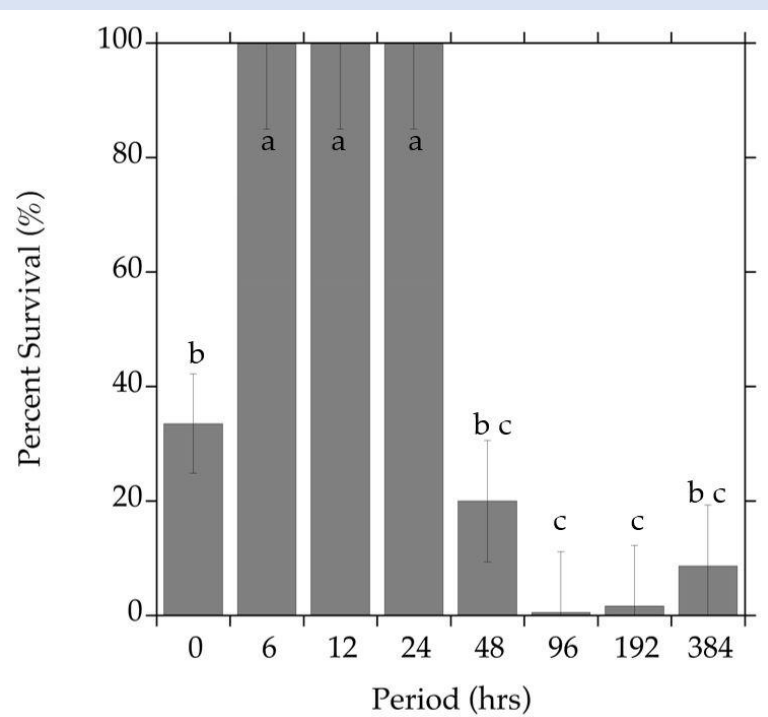
# Bivalves: maintaining heterotrophic estuaries

- Bivalves provide benthic-pelagic coupling and have an essential role facilitating estuarine and coastal ecosystem connectivity by mediating nutrient and sediment flow from land to sea.
- Current management of bivalves is based on growth of biomass rather than consideration of ecological importance or ecosystem services provided.



# How will changes in frequency of anoxic events drive tipping points in estuaries?

Nichola Salmond



- Impacts of multiple stressors including shifting SST baselines and elevated nutrient loading of coastal systems, increases the frequency of eutrophication-induced low oxygen events.
- Increasing the frequency of hypoxia and warming could cause a survivorship threshold for the estuarine bivalve (NZ cockle) to be reached.

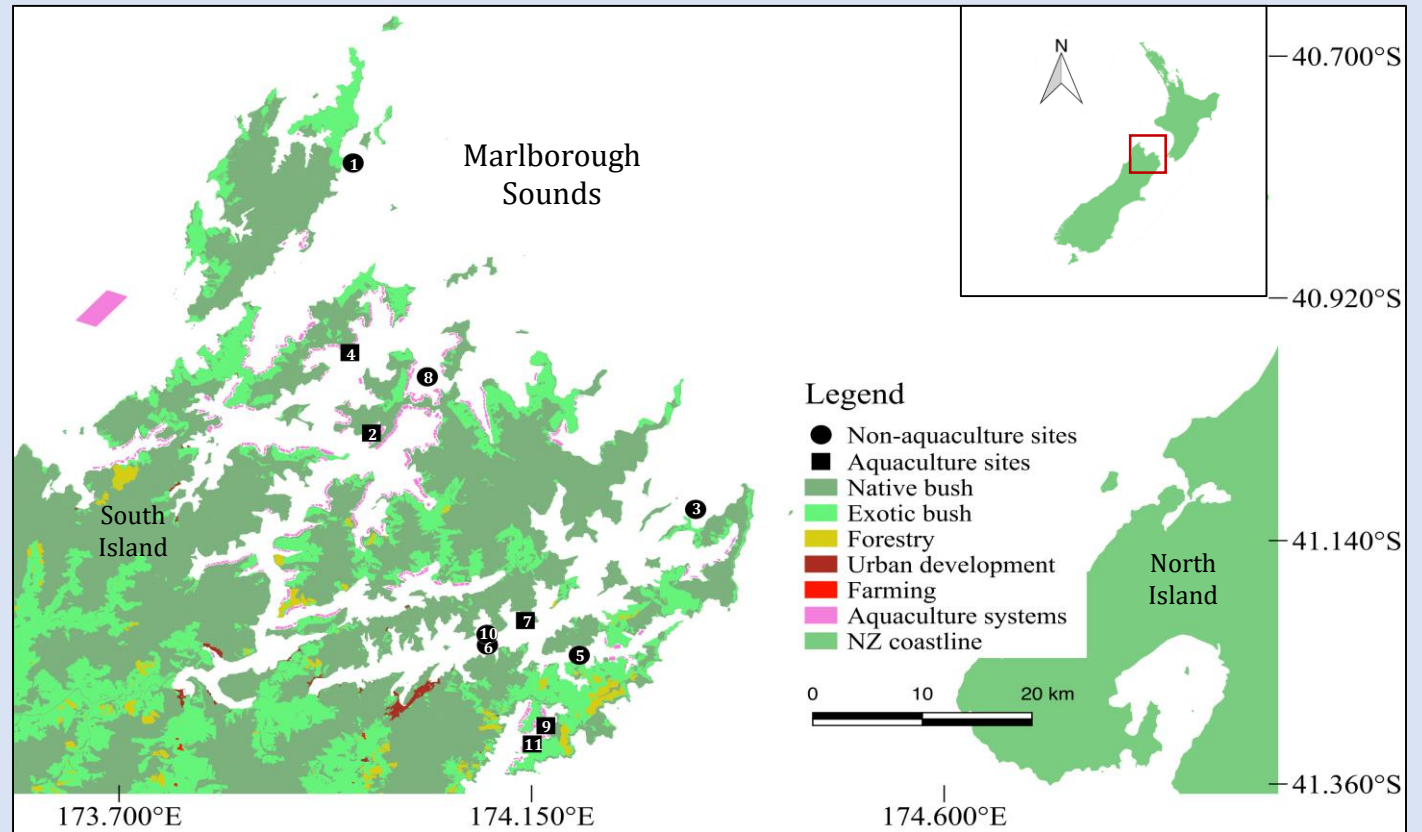
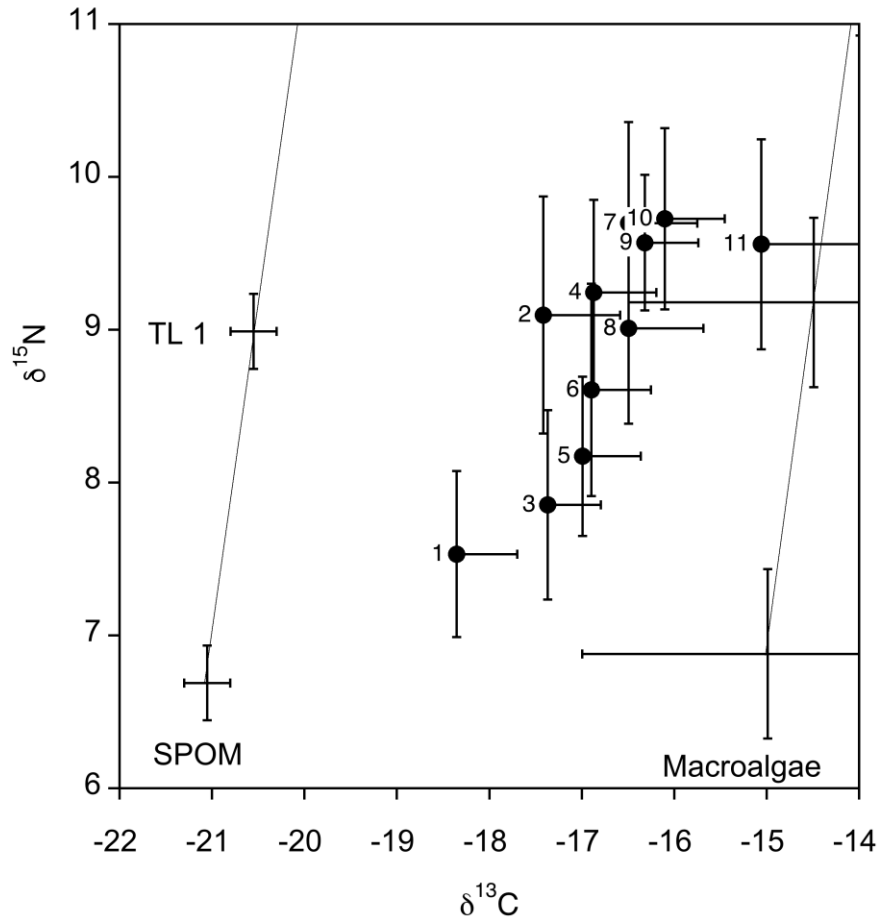
# How do land-based inputs influence the trophic position and contaminant load of bivalves?



Clara Schlieman



Testing links between organic matter sources and Cd, As, Hg, Pb



High plasticity in trophic position among scallop populations, with significant influences around marine farms

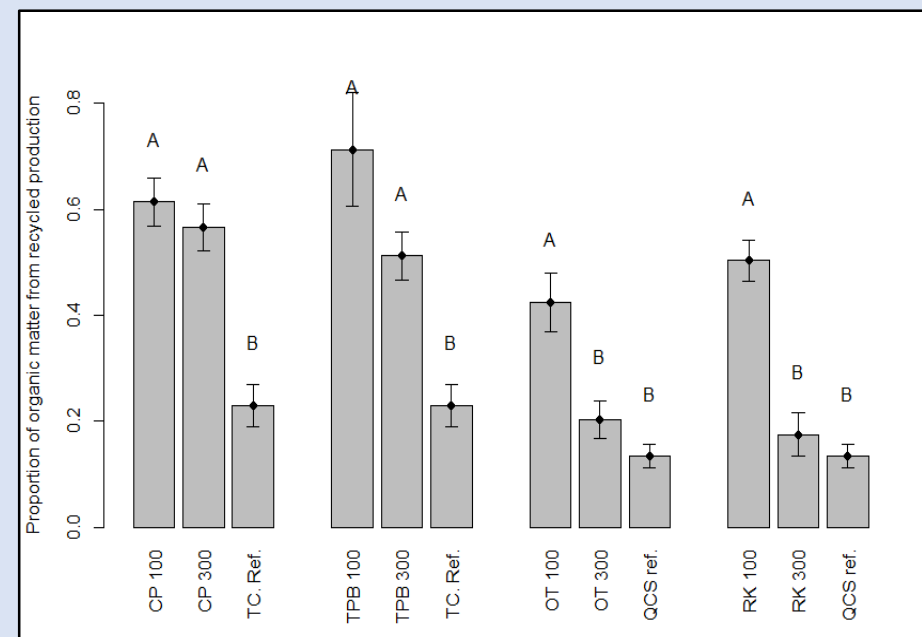
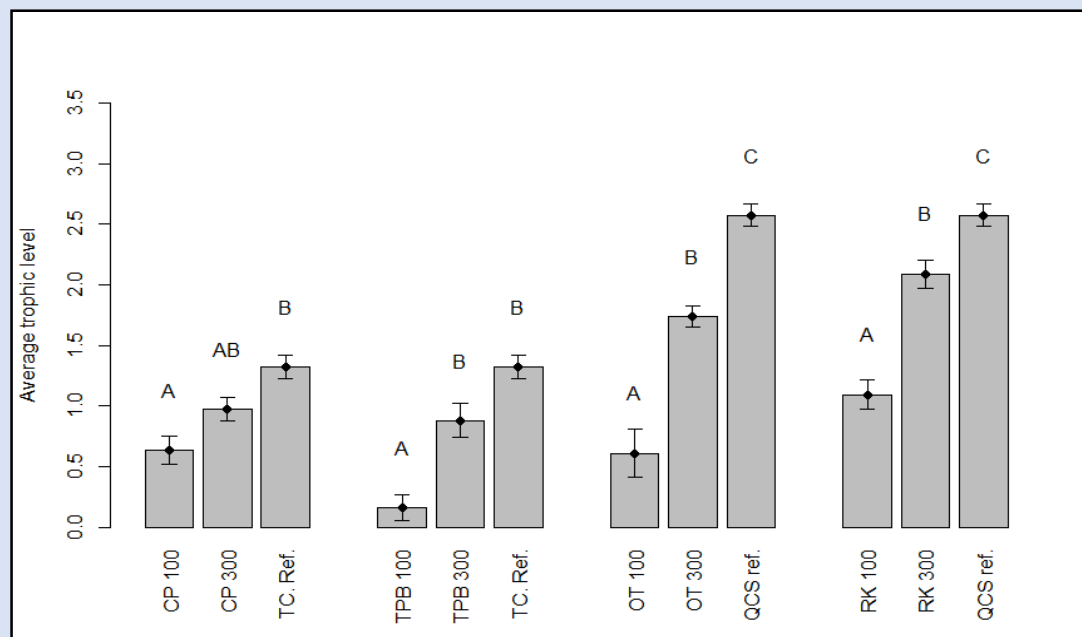


# How are organic wastes from fish farming incorporated into natural food webs?



Rebecca McMullin

- Salmon farming provides an additional source of organic matter to benthic communities which can be traced using stable isotope analysis, and quantified in terms of  $\text{kg m}^{-2}$
- Presence of salmon farms influence the trophic architecture and biomass of softbottom communities within the depositional footprint of farms

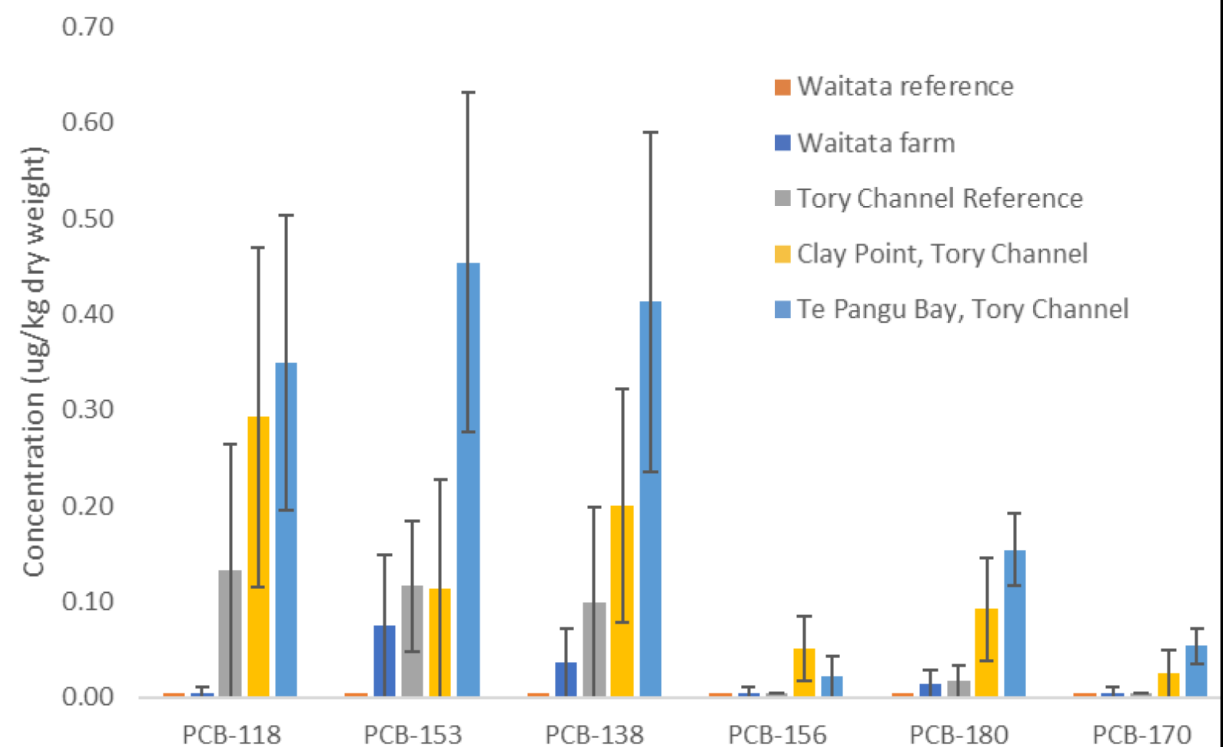
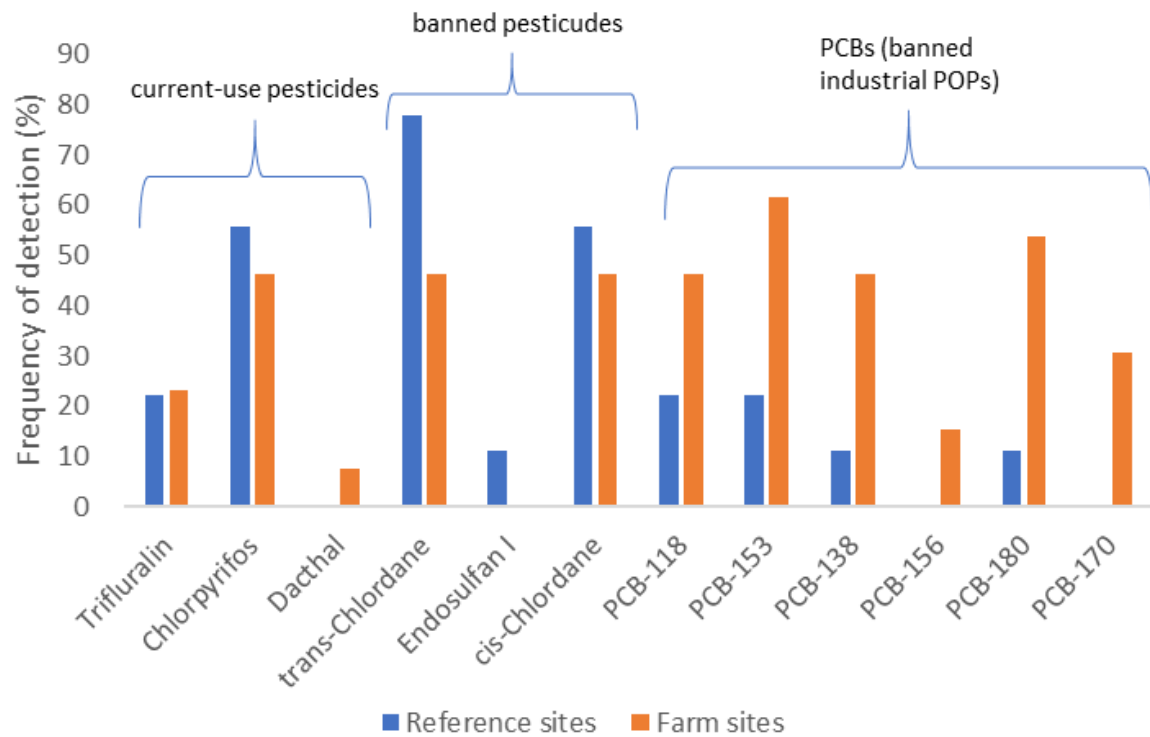






# Contaminants present in the system are bioaccumulated in blue cod

- Results suggest a different pathways of exposure exists for pesticides groups and PCBs
- Salmon feed, sourced from outside of New Zealand, may represent a pathway of exposure of PCBs to wild populations of fish and invertebrates around salmon farms



# How has food web structure of commercial species changed since the expansion of industrialised fishing?

Leo Durante

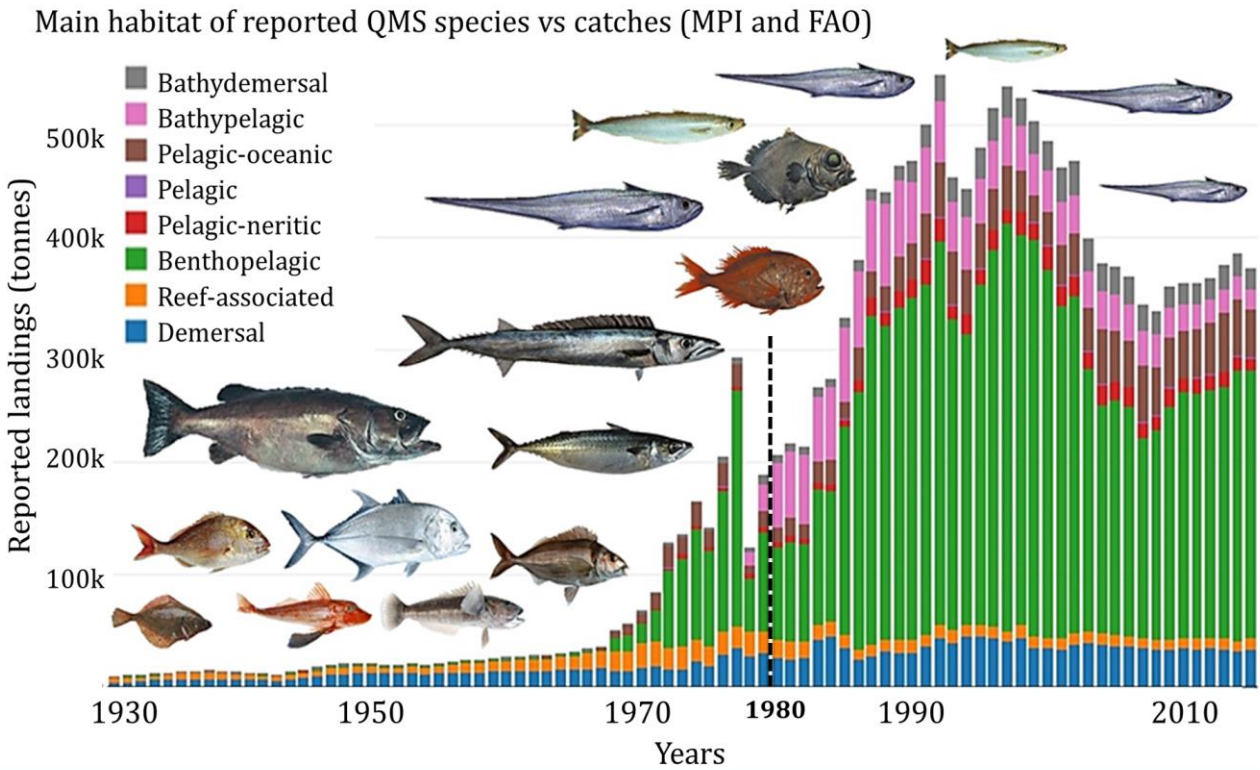


Figure 1: Reported landings of whole New Zealand commercial fisheries from the Food and Agriculture Organization of the United Nations (FAO) and Ministry of Primary Industries of New Zealand (MPI) since 1930

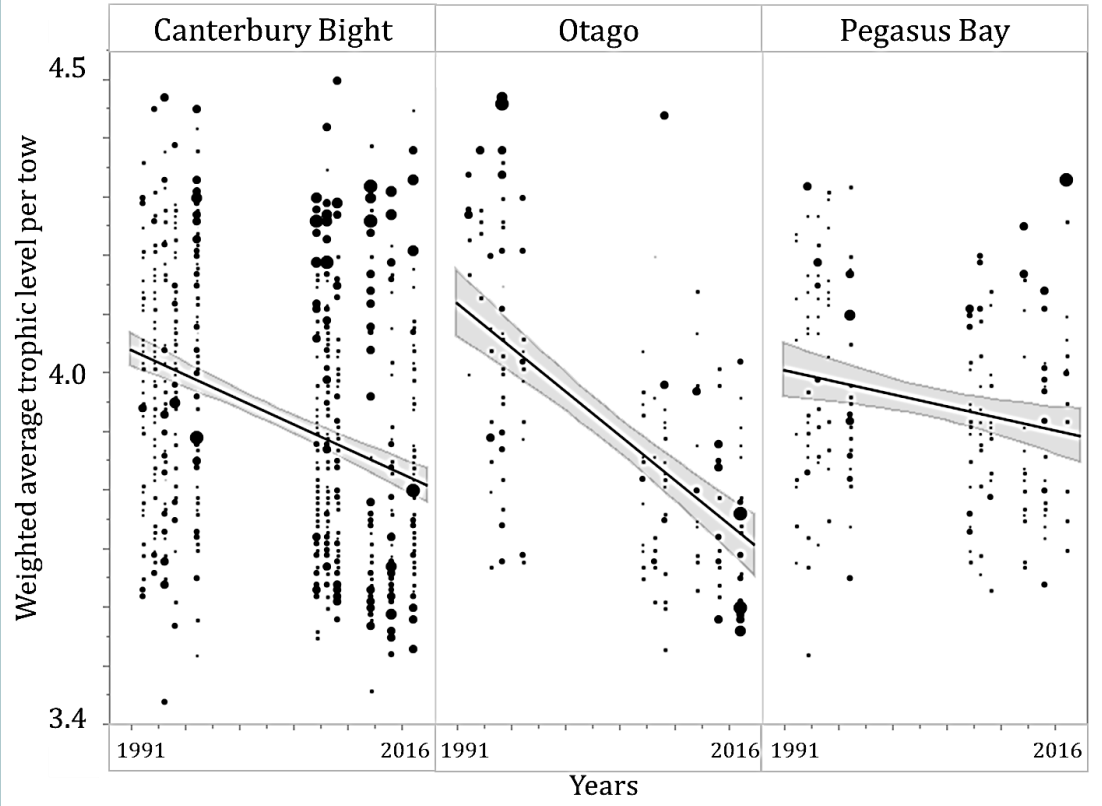


Figure 2: Weighted average trophic level of fish species by tow from the Winter East Coast of South Island NIWA trawl survey. Data is divided by years and regions within the East coast. Trophic level estimates from fishbase.org.

# Changes in community composition, food web structure and niche breadth – each aspects of critical fish habitat

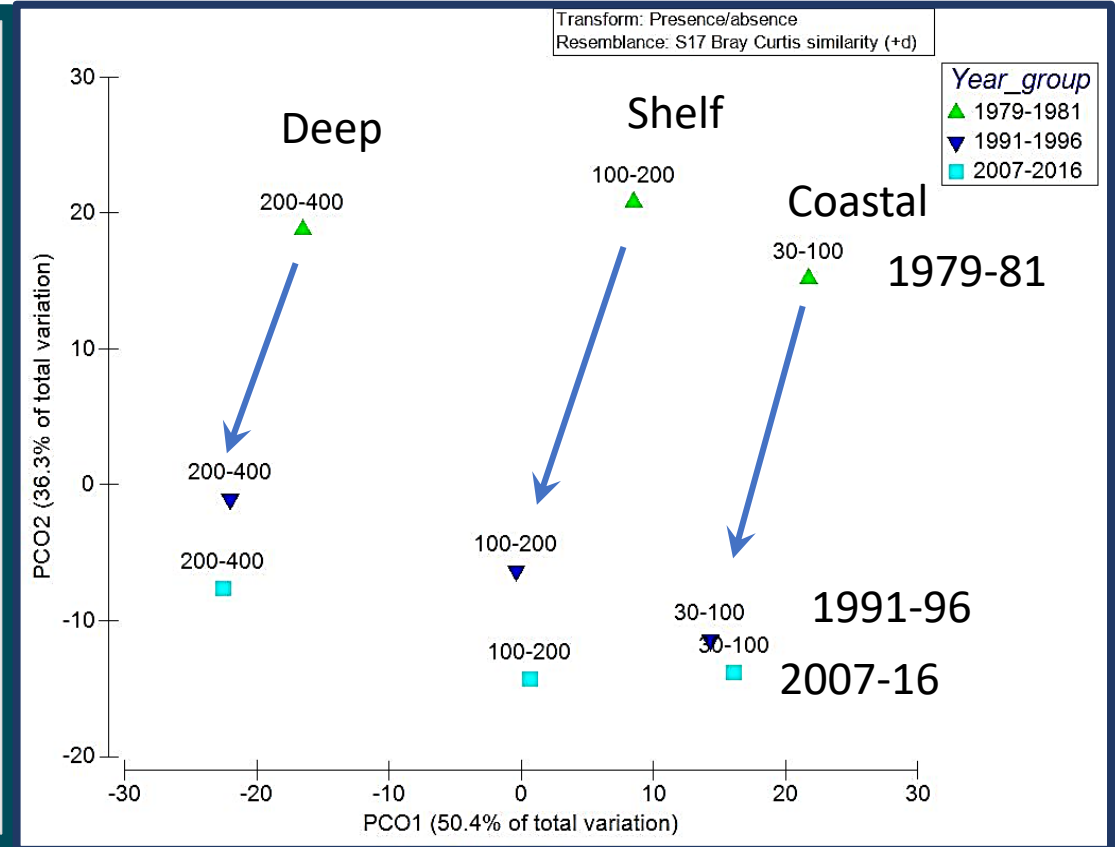
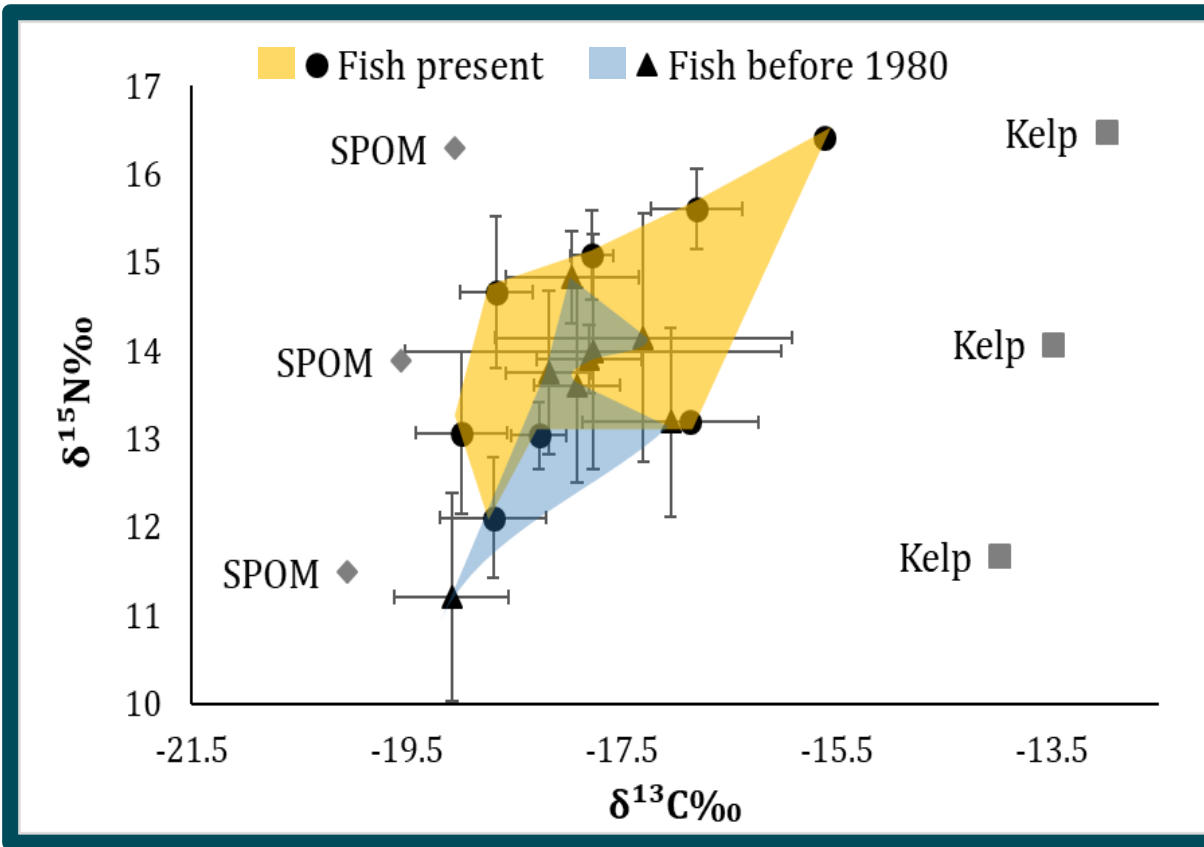


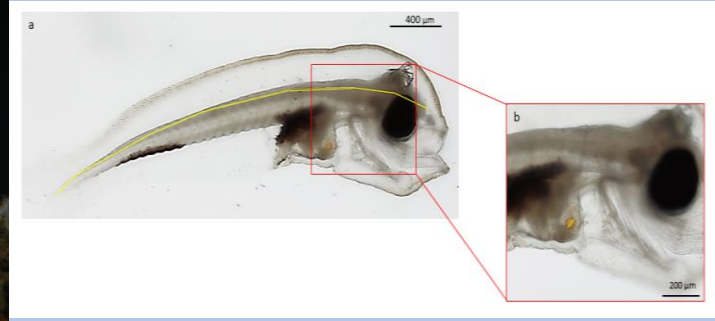
Figure 3: Representation of niche breadth using carbon and nitrogen signatures of commercial communities from Otago coast collected in the present and before 1980. Polygons represent the area occupied by the community's niche in each time period. Change of 450%.



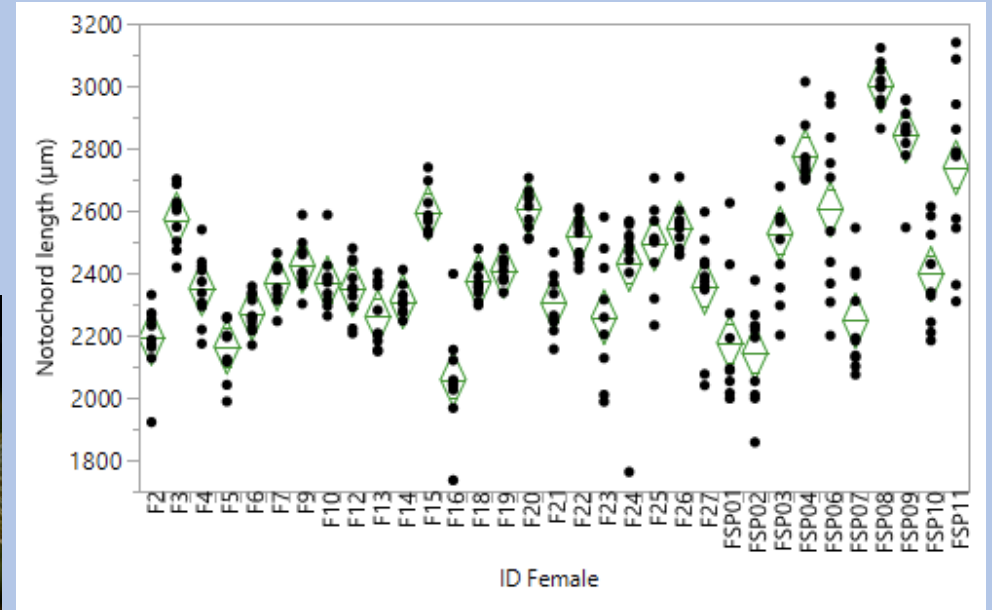
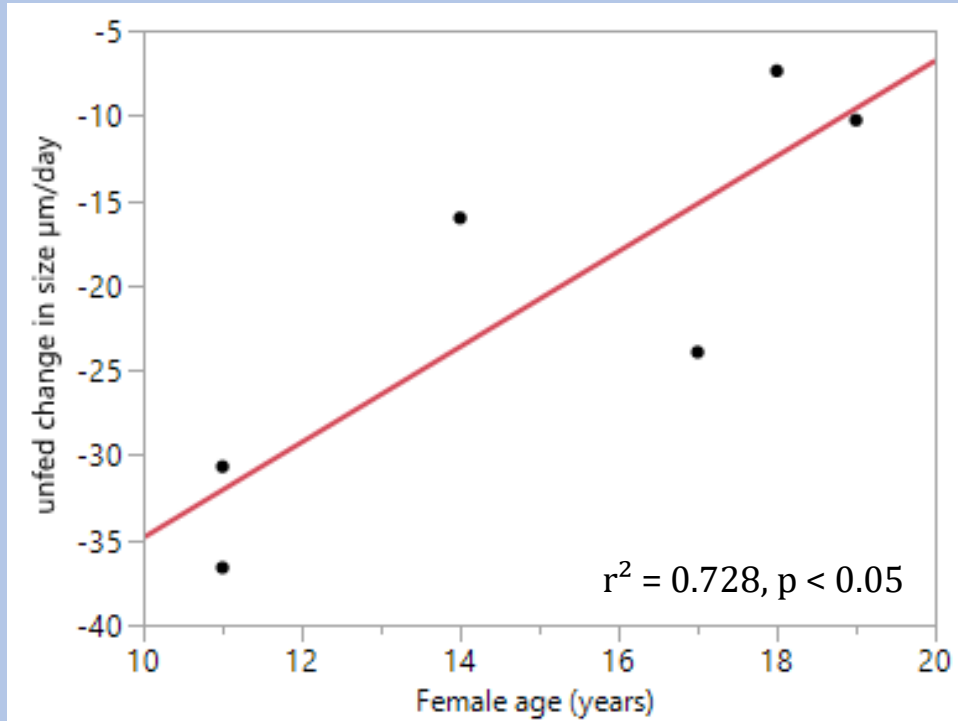
Figure 4: Principal coordinates analysis of a resemblance matrix calculated from presence-absence data collected during trawl surveys in the East Coast of the South Island. Surveys were divided in 3 time periods, oldest one being the W J Scott and the other two the Kaharoa survey. Only data collected during winter and with good net performance were analysed.

# How do changes in age structure influence reproduction in fishes?

Stina Kolodzey



Female age influences the notochord length of larval cohorts on the day of birth

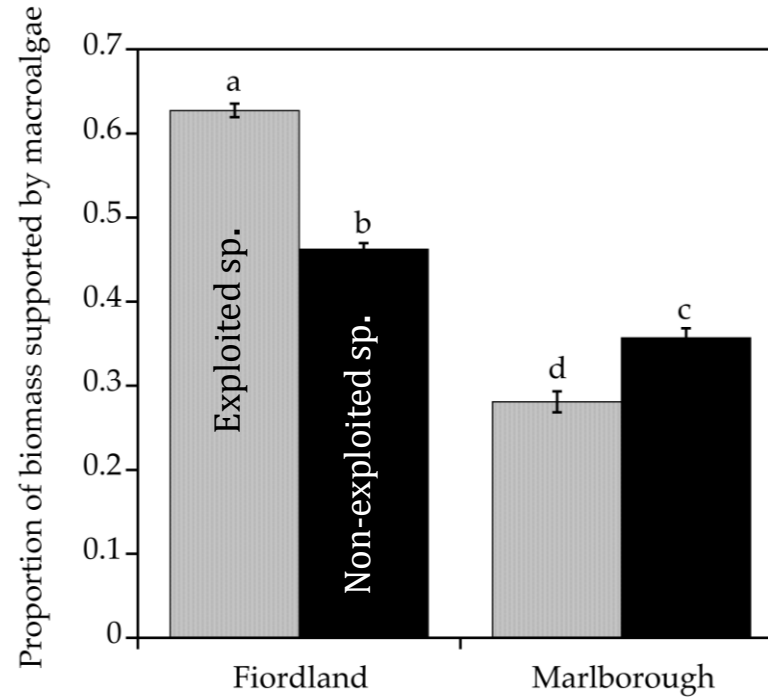
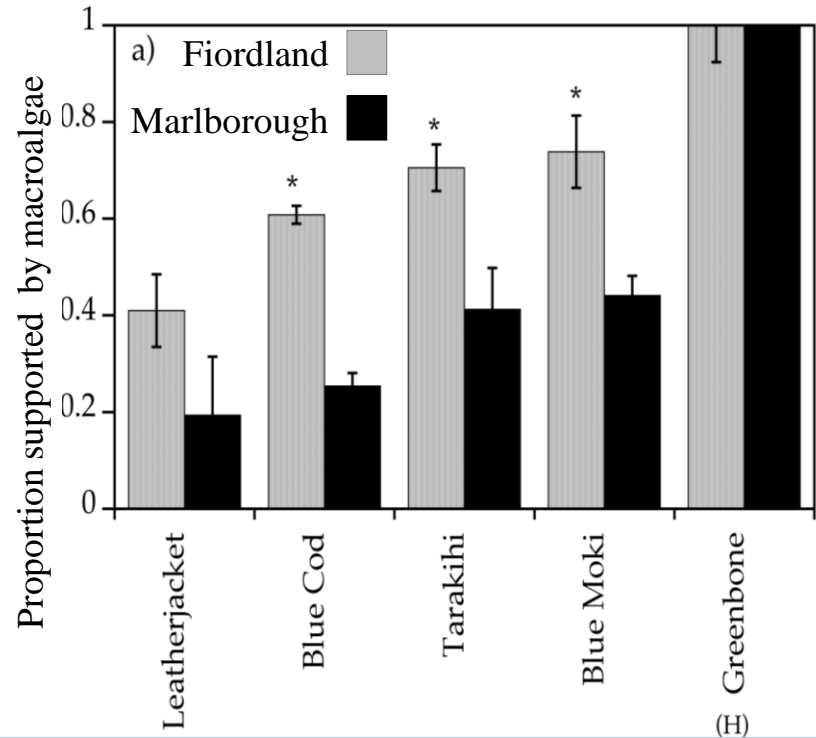


Correlation between female age and change in size of cohorts of larvae

Larvae of older females may resist starvation better than larvae of smaller females.

# How does organic matter from kelp forests support fish productivity?

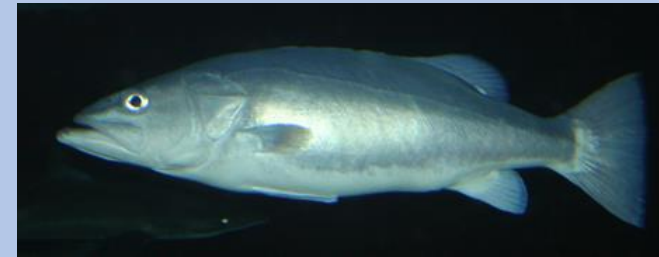
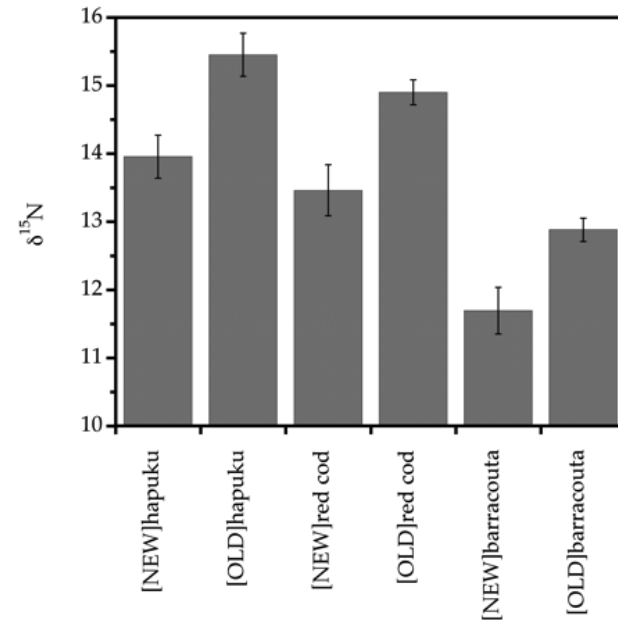
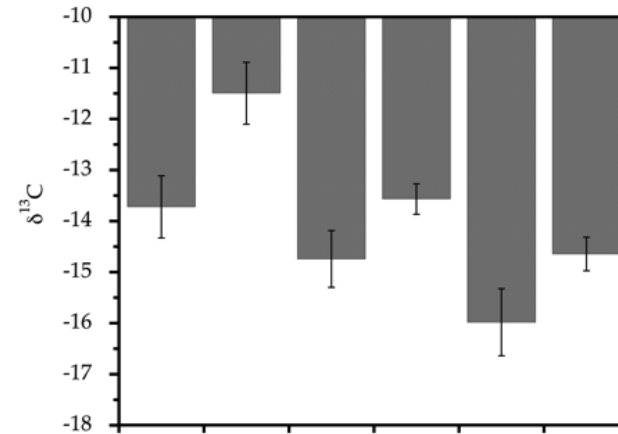
Jacquetta Udy



Density – Biomass – SIA --- inventory of organic matter sources

# Shifts in trophic structure of fishes ca. 700 ybp vs. modern

Alex Connolly, Lucy Wing, Ian Smith



How can knowledge of connectivity within ecological systems support effective management?

“One of the most basic requirements of intelligent resource conservation is to anticipate and prevent ecological collapses”

Quinn et al. 1993

Goal: Understand and maintain vital ecosystem connections to increase resilience of ecosystems in the face of an increasingly volatile environment