"from ridge tops to the sea" Integrated Catchment Management

Introduction

Paul Gillespie - Cawthron

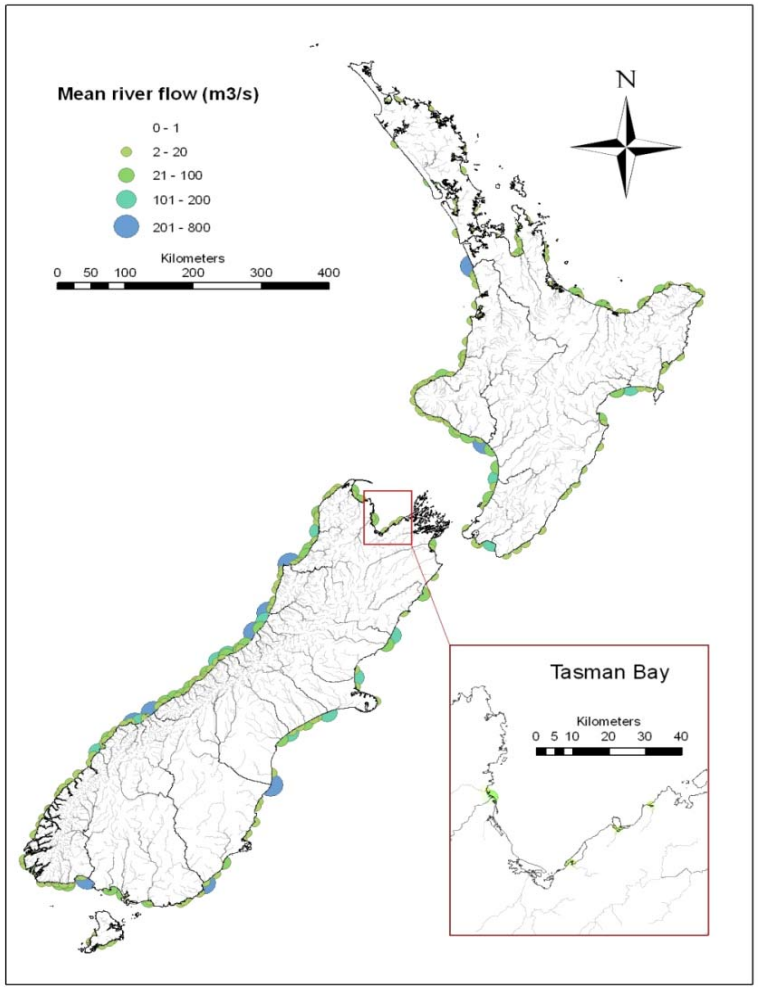
Goal of the marine component:

To develop a "river plume ecosystem" (RPE) basis for evaluating and managing catchment-sea linkages

In order to:

Facilitate coastal stakeholder input to catchment management as a step towards Integrated Coastal Management

Are river plumes important?



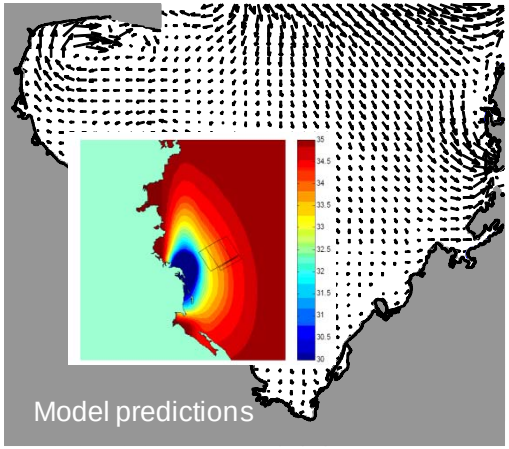
Major areas of investigation

- Nelson Bays Hydrodynamic Model - plume dynamics
- Synoptic surveys of temperature, salinity, nutrients, chl *a*, suspended sediments, contaminants.
- Mass transport of nutrients (N, P, Si) from the catchment into Tasman Bay.
- Mapping of intertidal and subtidal habitats created and nourished by the river outflow.
- Spatial patterns of seabed characteristics generated by the river plume .
- Suspended sediments in near-bottom waters.

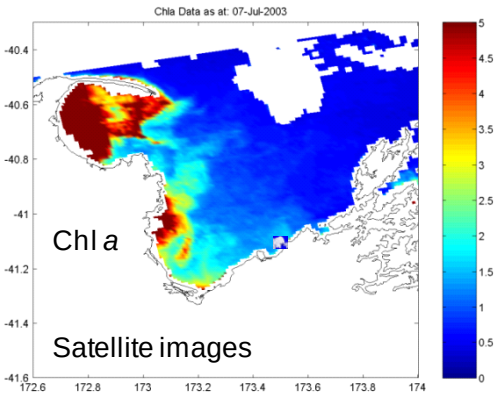
How big is the plume?

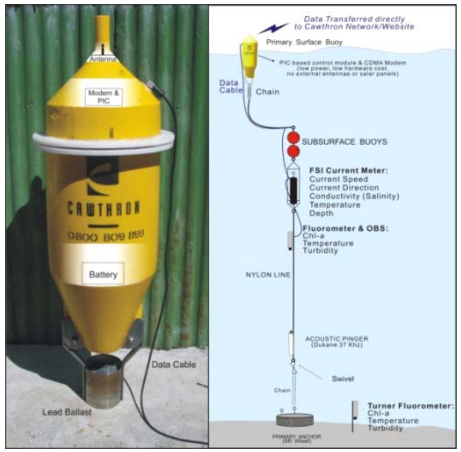
Water column: variable in size & shape and moves around

- <20 to >1500 km^2

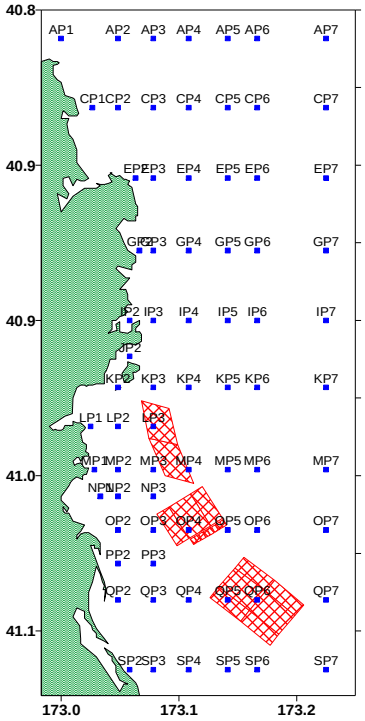


~300-400 km^2 after a moderate rainfall event





Buoy-mounted sensors



Seawater sampling

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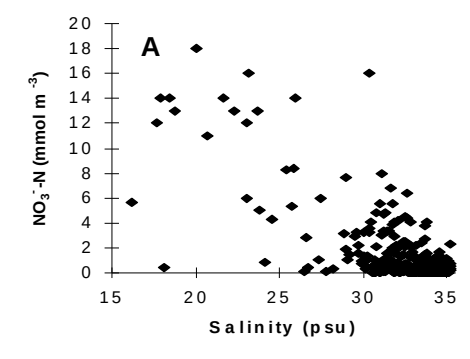
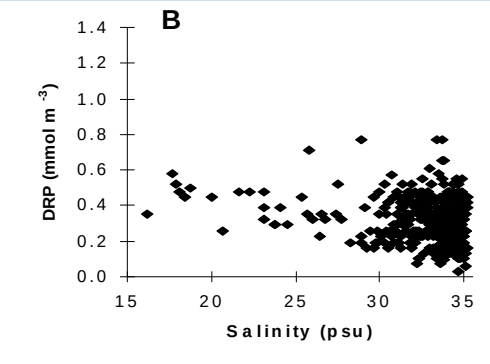
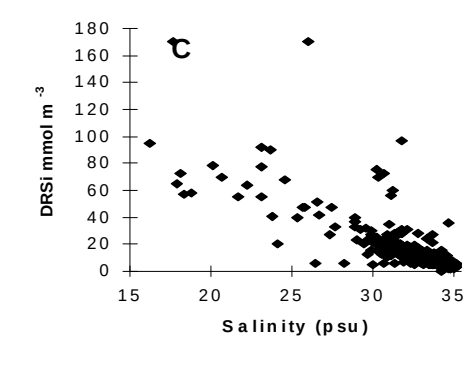
The Nutrient Story

Paul Gillespie, Lincoln MacKenzie, Richard Nottage, Kim Clark, Reid Forrest - Cawthron



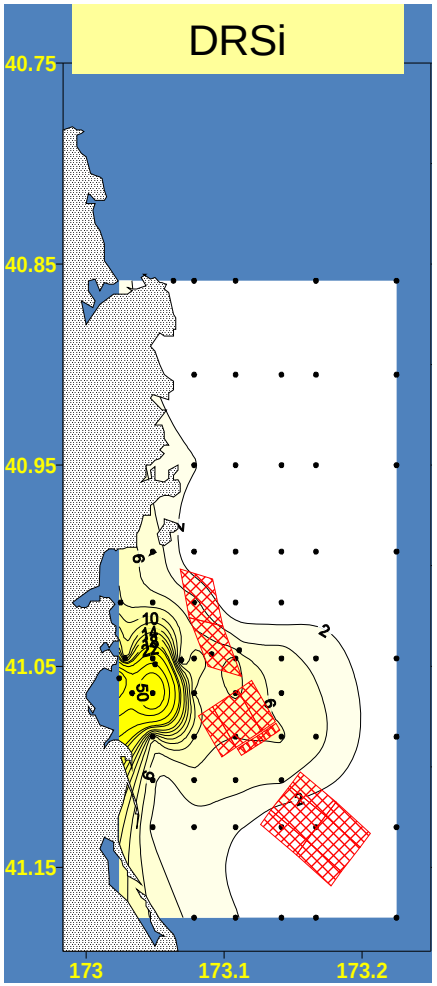


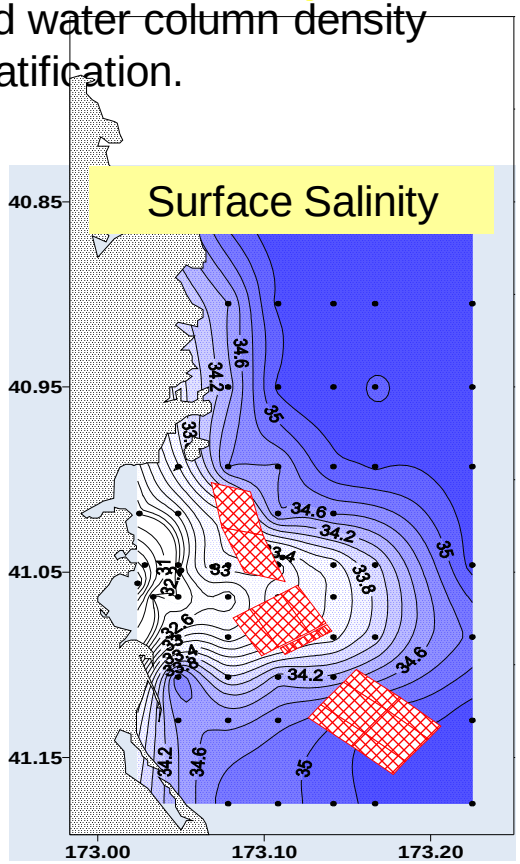


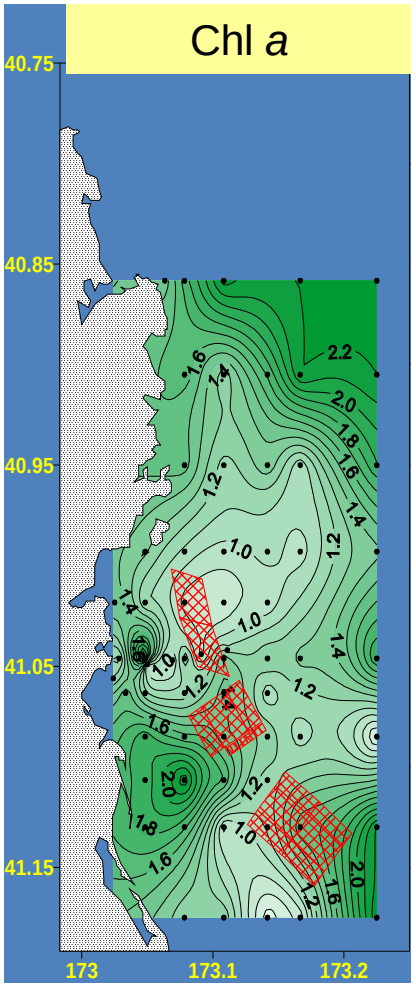
Highest dissolved nutrient concentrations associated with low salinities

Plume-affected phytoplankton production

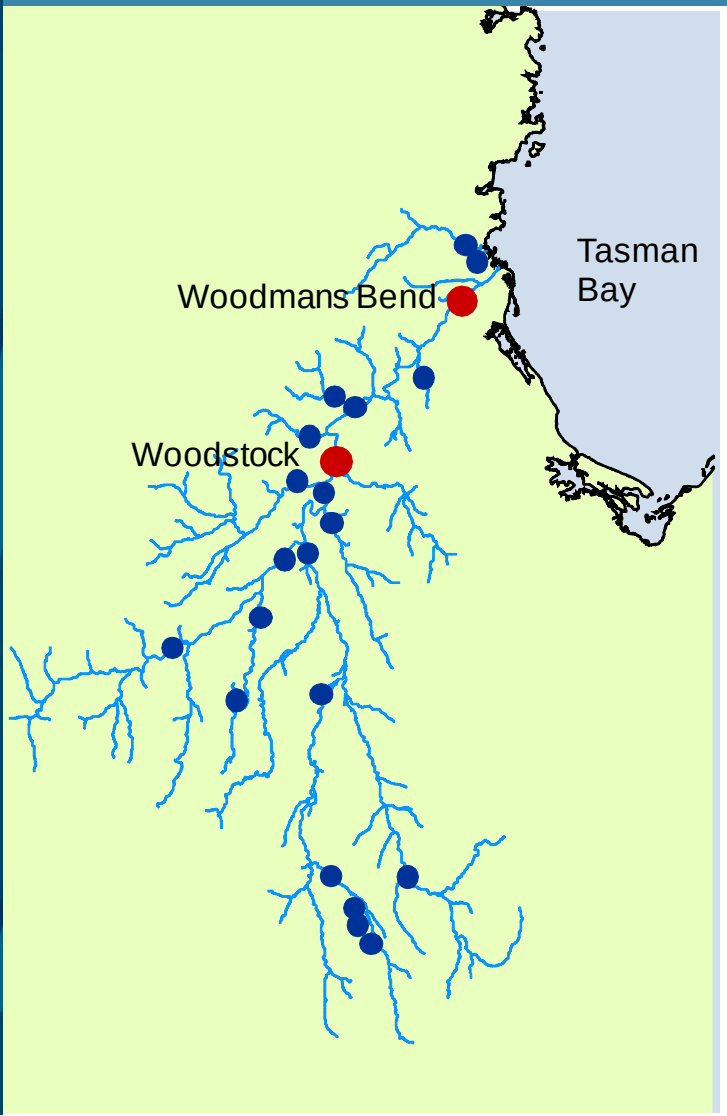
Periodic development of east to west gradients of nutrients and chl *a* dictated by river flow and water column density stratification.





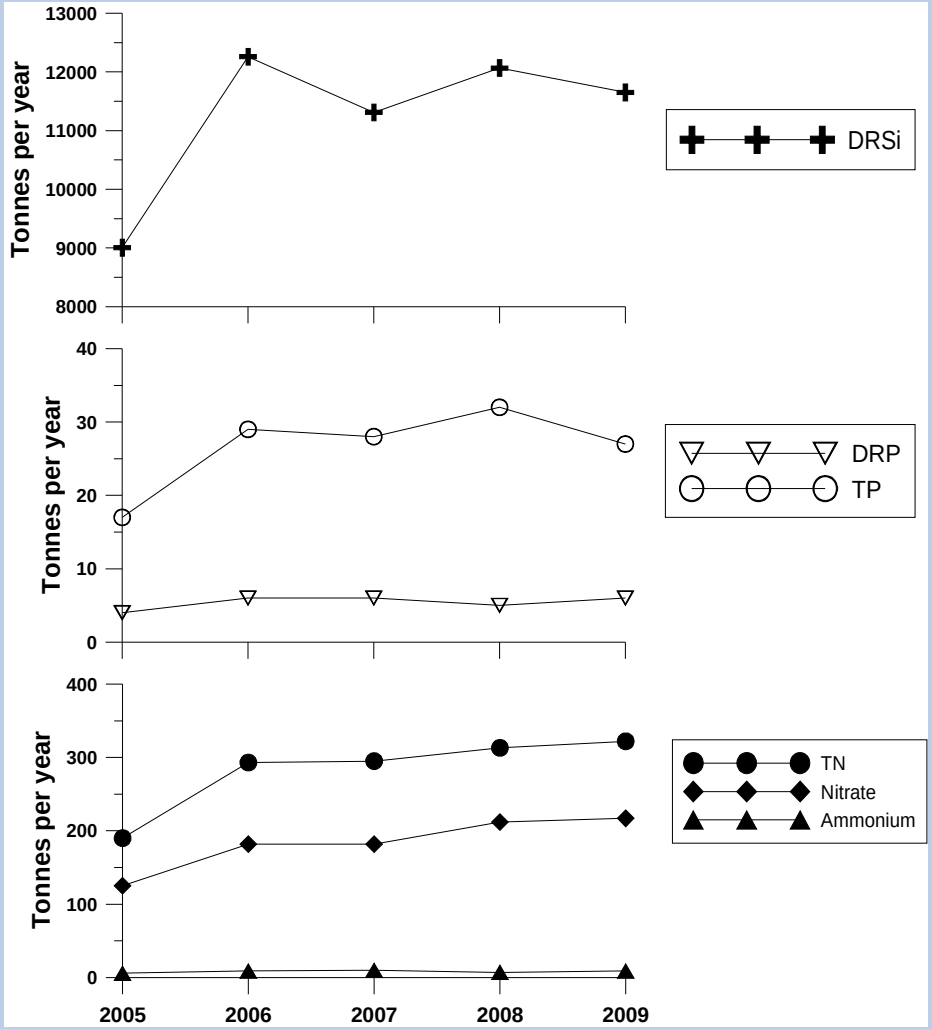


Water Quality Monitoring Sites

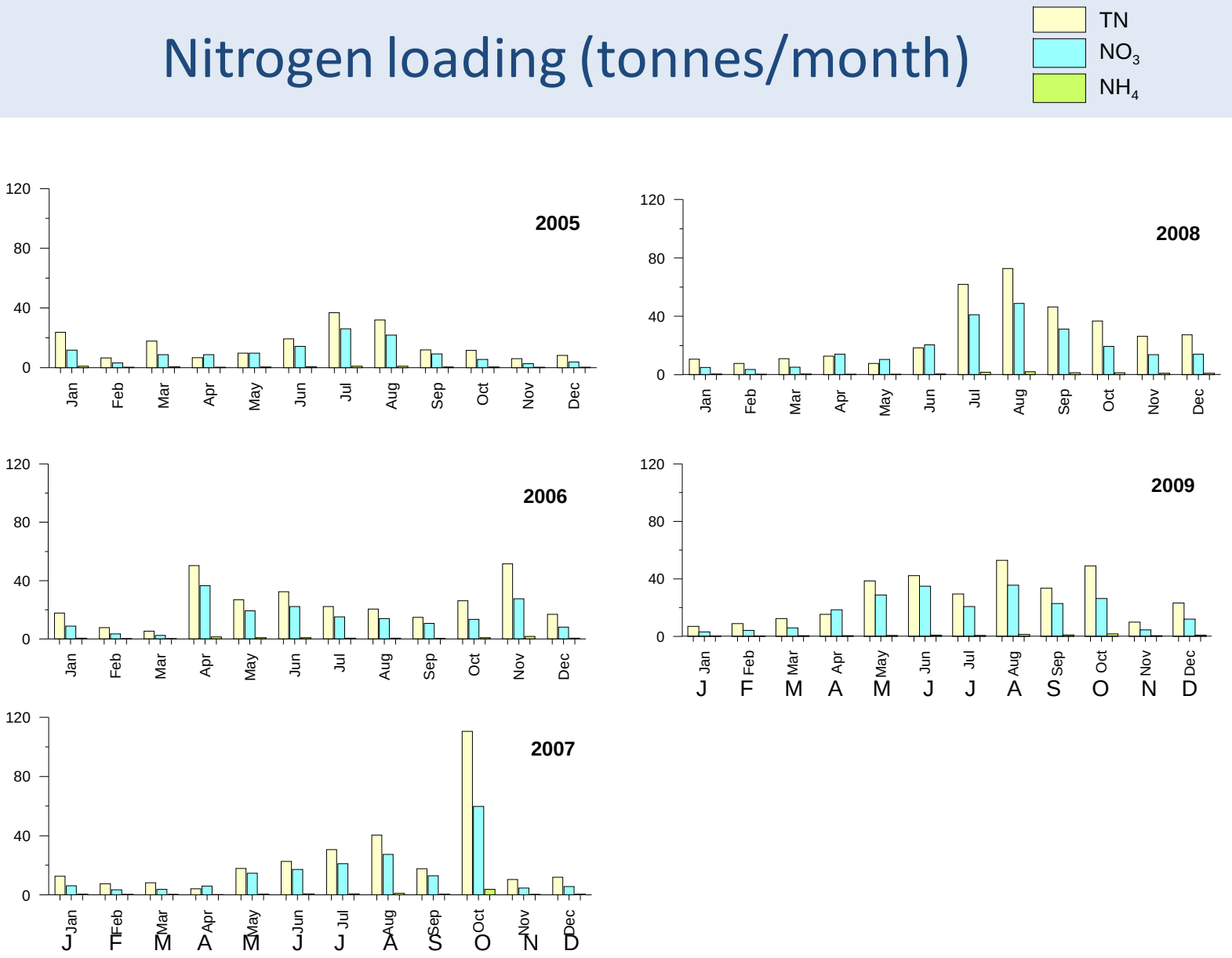


Flow : concentration relationships used to estimate nutrient loadings to Tasman Bay.

Nutrient Loading to Tasman Bay (tonnes/yr)



Nitrogen loading (tonnes/month)



Good or bad for Tasman Bay?

- Motueka TN discharge (average 2005-2009) = **~283 t**
- Total freshwater TN discharge (including point source discharges) = **~900 t/ year**
- N loss via denitrification = **~1800 t/year**
- N Inputs ~50% of assimilation capacity
- Problems associated with eutrophication unlikely
- Nutrients probably having beneficial effects on productivity
- But there still could be some effect on HAB incidence???

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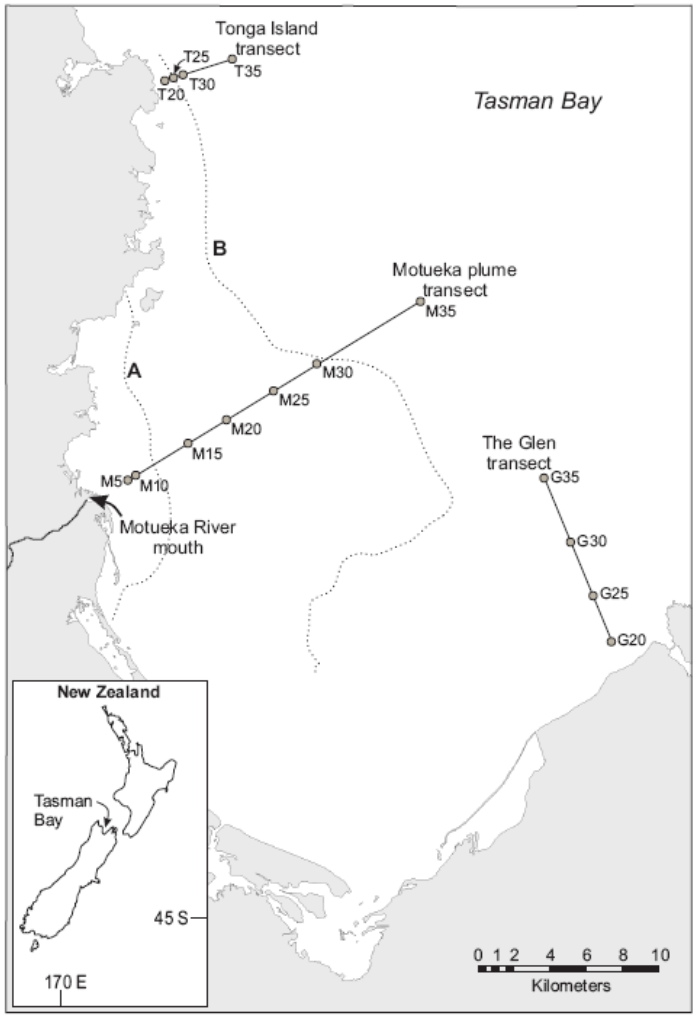
Delineation of the depositional footprint of the river plume

Deanna Clement, Reid Forrest, Chris Cornelisen, Barrie Forrest,
Paul Gillespie – Cawthron
Barrie Peake – University of Otago

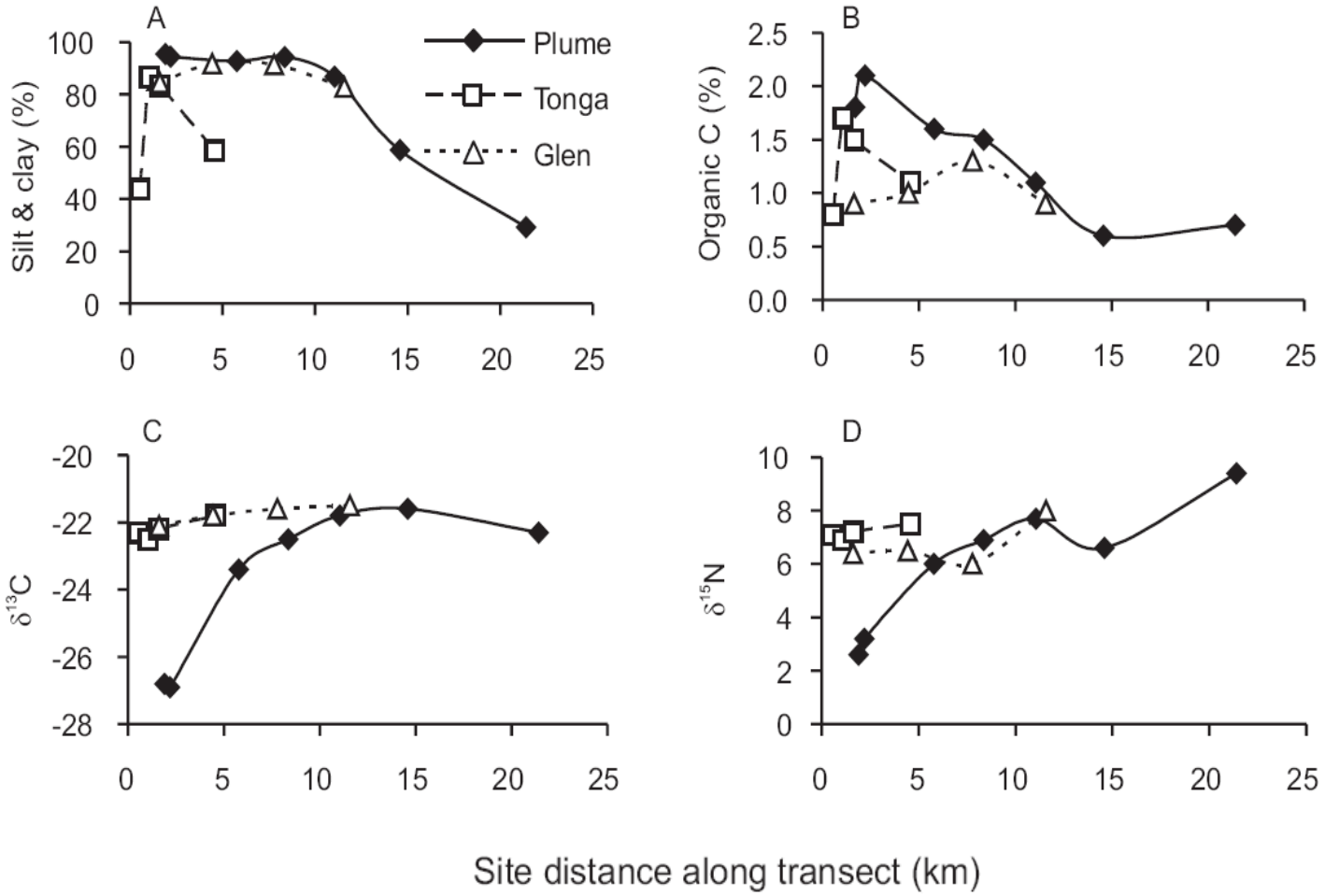
Multiple indicators reveal river plume influence in a New Zealand coastal embayment

Barrie Forrest, Paul Gillespie, Chris Cornelisen-Cawthron,
Karyne Rogers-GNS

Pilot study



Various indicators (chemical, geological, biological) were used to delineate the spatial extent of river plume influence



Natural catchment source of elevated sediment trace metals

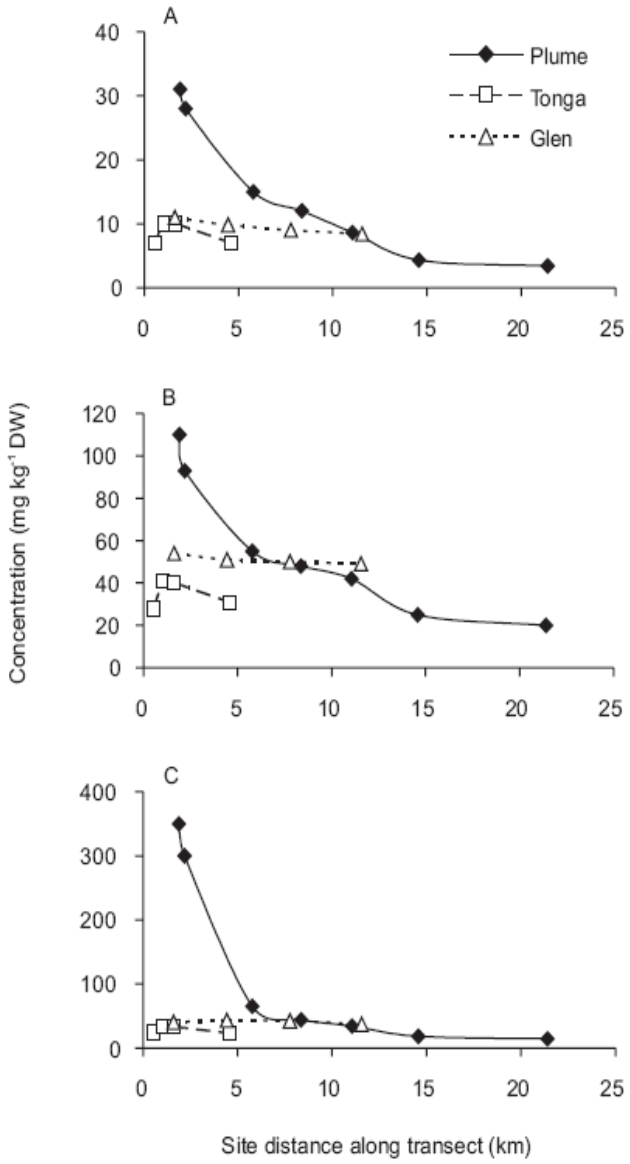
Unexpected result:

Contaminated levels of Ni & Cr in plume sediments

Copper

Chromium

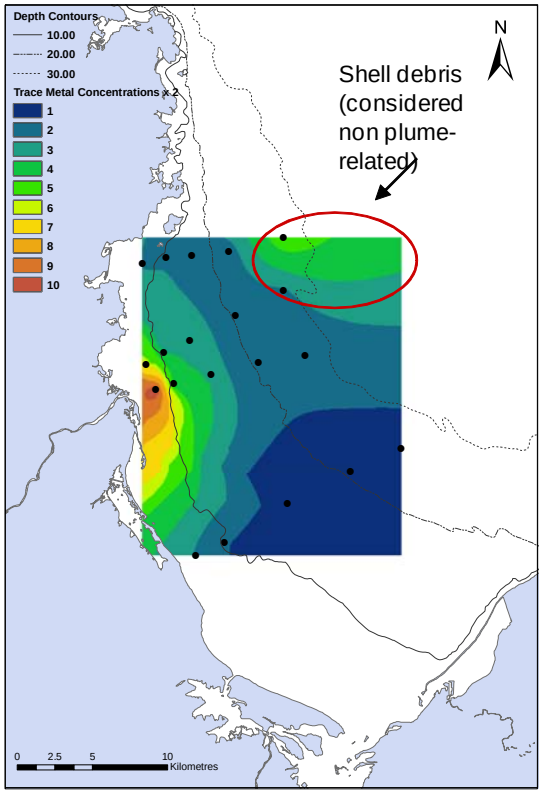
Nickel



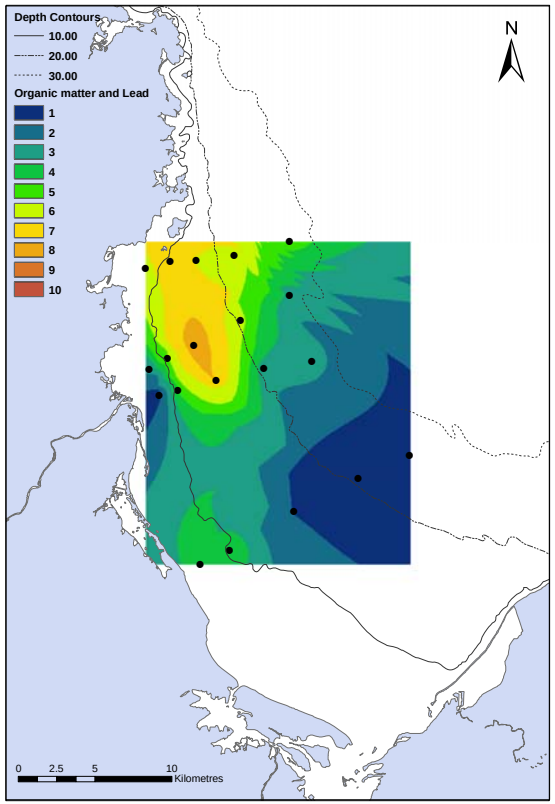
Benthic characteristics considered for delineation of catchment influences

- Trace metal concentrations (Al, Ba, Cr, Cu, Ni, Pb, Sr, V, Cd)
- Organic content (ash free dry weight)
- Grain size - % gravel, sand, silt/clay
- Infauna abundance & diversity

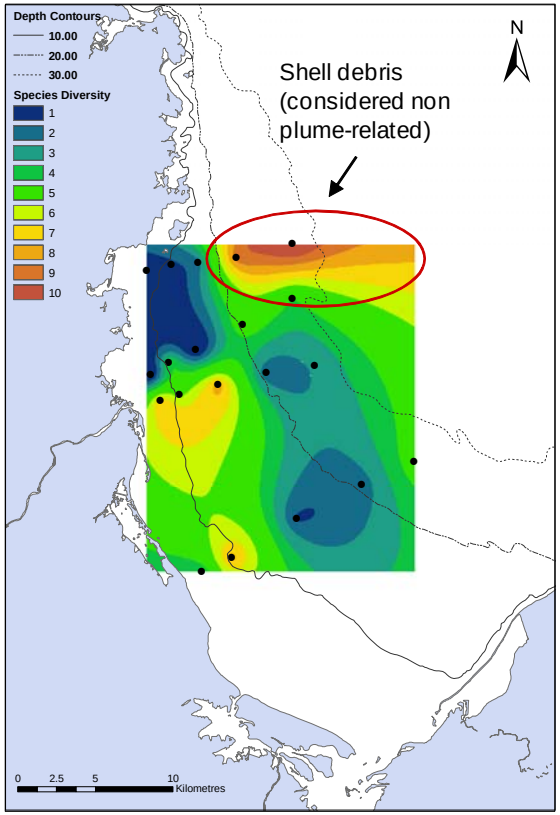
KEY SEDIMENT INDICATORS OF RIVER PLUME INFLUENCE



Trace metals



Organic matter & lead

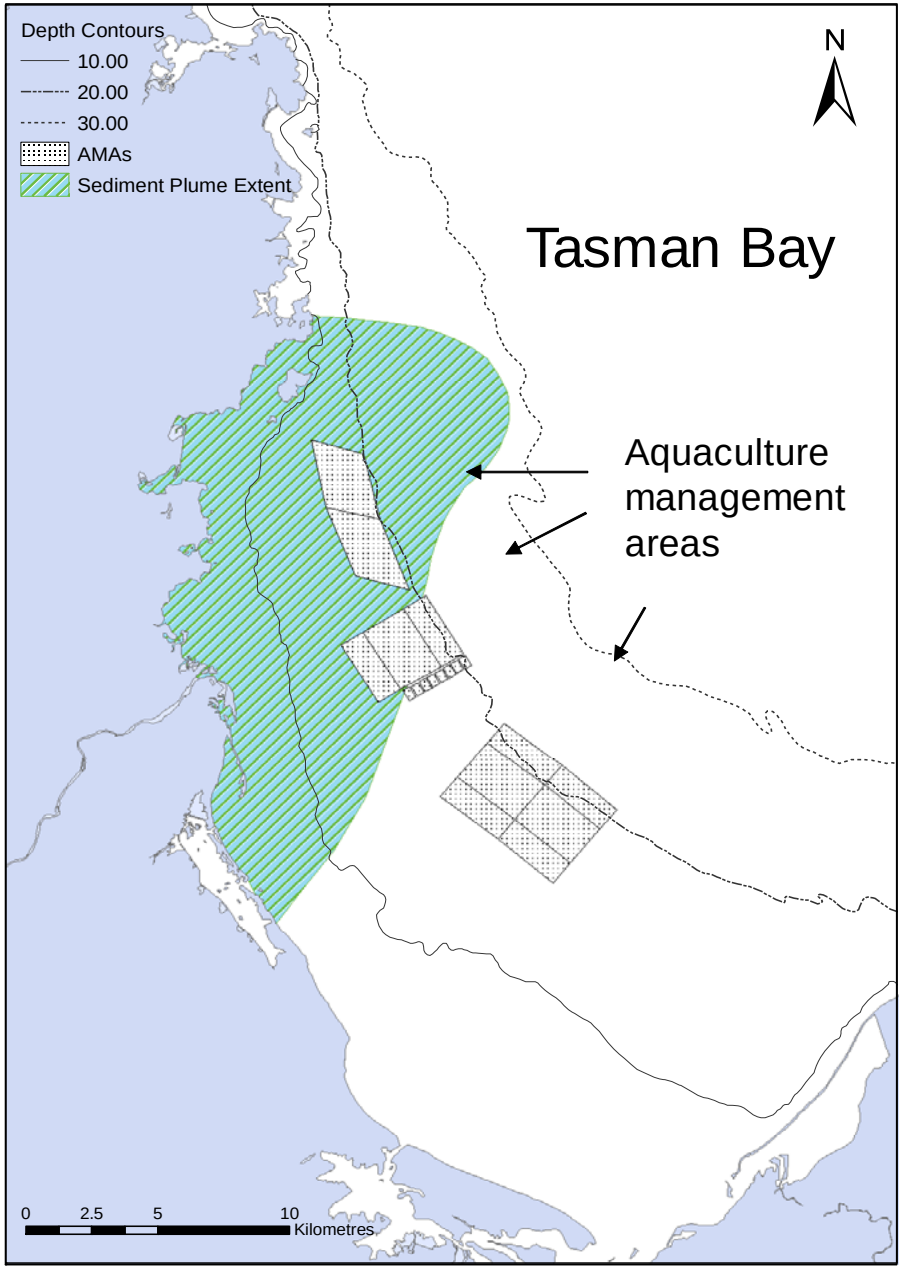


Infauna diversity (SW)

180 km² river plume depositional area

based on

composites of multiple benthic indicators



"from ridge tops to the sea"

Integrated Catchment Management

Suspended sediment effects on shellfish

Paul Gillespie - Cawthron

Fish & shellfish resources/activities potentially influenced by the river plume

- Enhanced scallop fishery
- Dredge oyster fishery
- Trawl fishery (*flounder and sole)*
- Recreational fisheries
- Mussel farming

Annual Suspended Sediment Contributions to Tasman Bay

70,000-800,000 tonnes (mean~370,000)

Loading data provided by Les Basher - Landcare

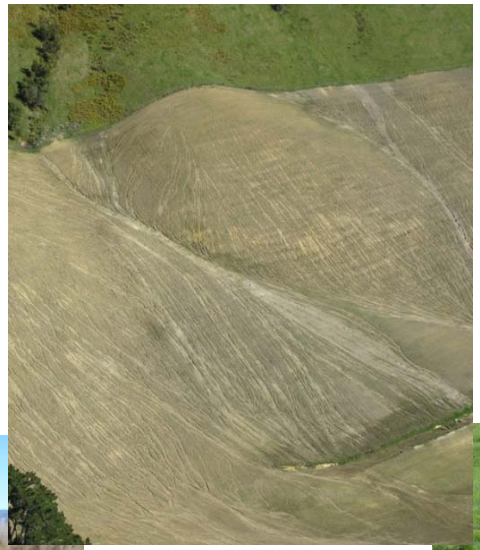
Frequent SS plumes occur in Tasman Bay under a variety of weather conditions.

Motueka R. SS Plume - the day after a moderate flood event

SS mobilisation and export from nearby estuaries - strong winds during spring high tides, no rain

Sediment Mobilisation

Cumulative impacts?



SS Effects on Benthic Suspension Feeders

- SS inhibition of scallop feeding
  - Near-bottom (**50 mm above the seabed**) SS concentrations of **11-25 g/m^3 (89-96% inorganic)** were seen to interrupt the feeding activity of scallops on the seabed
  - Scallops in baskets 0.5 or 1.0 m above the seabed continued feeding normally

Potential effects on shellfish resources in Tasman Bay

Physical disturbance due to dredging & trawling

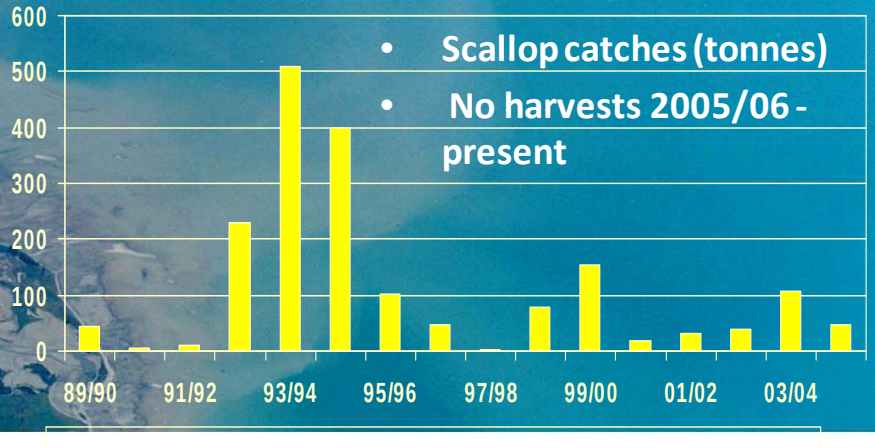
?

- **Chronic condition of high near-bottom turbidity**

Deposition/ Resuspension

Interference of scallop feeding

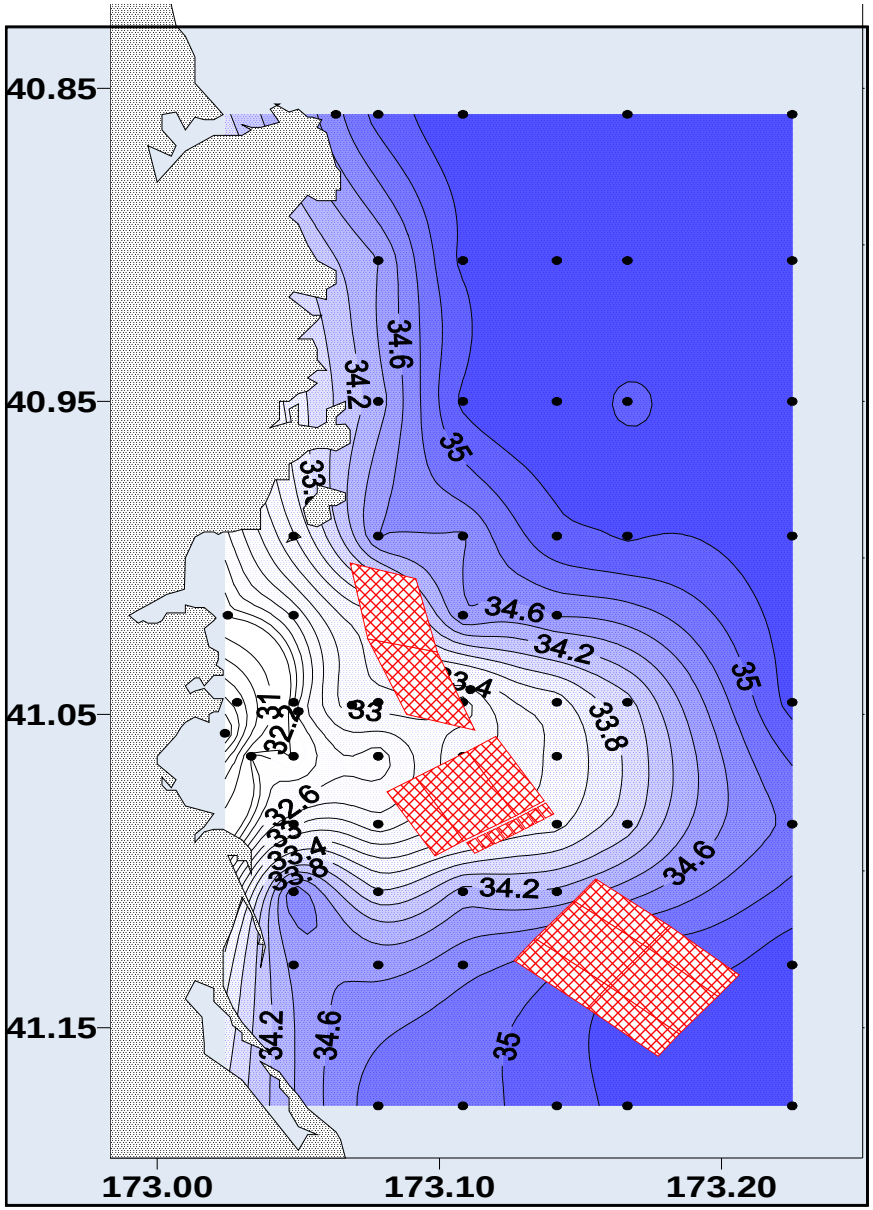
Catchment susp. sed. loads



Tracking faecal contaminants in the Motueka River plume

Chris Cornelisen

- Sedimentation
- Contaminants (faecal, nutrients, metals, hydrocarbons, etc)




Woodmans bend
Sherry
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2009 DigitalGlobe
Image © 2009 TerraMetrics
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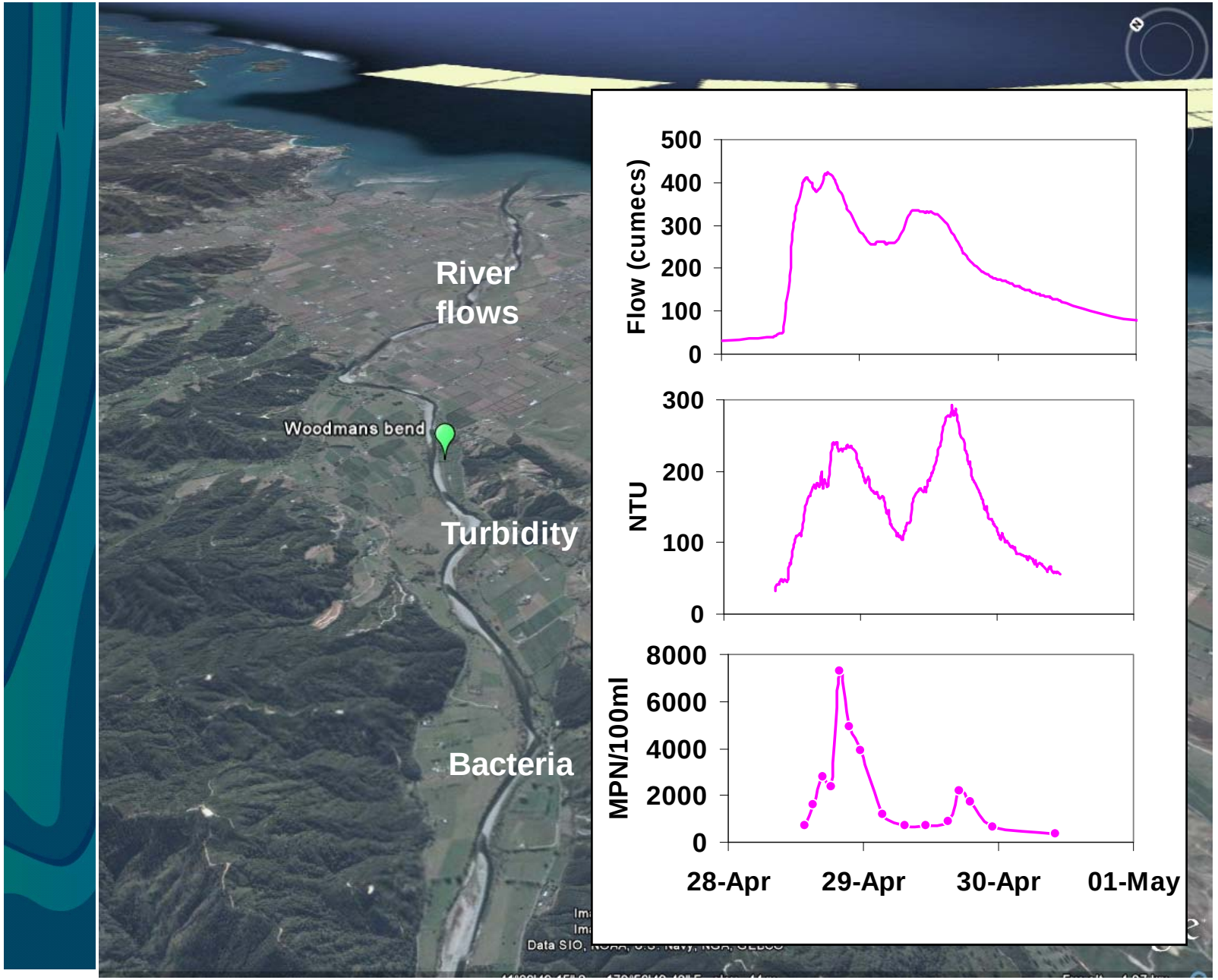

River flows
Woodmans bend
Turbidity
Bacteria
Flow (cumecs)
500
400
300
200
100
0
NTU
300
200
100
0
MPN/100ml
8000
6000
4000
2000
0
28-Apr
29-Apr
30-Apr
01-May

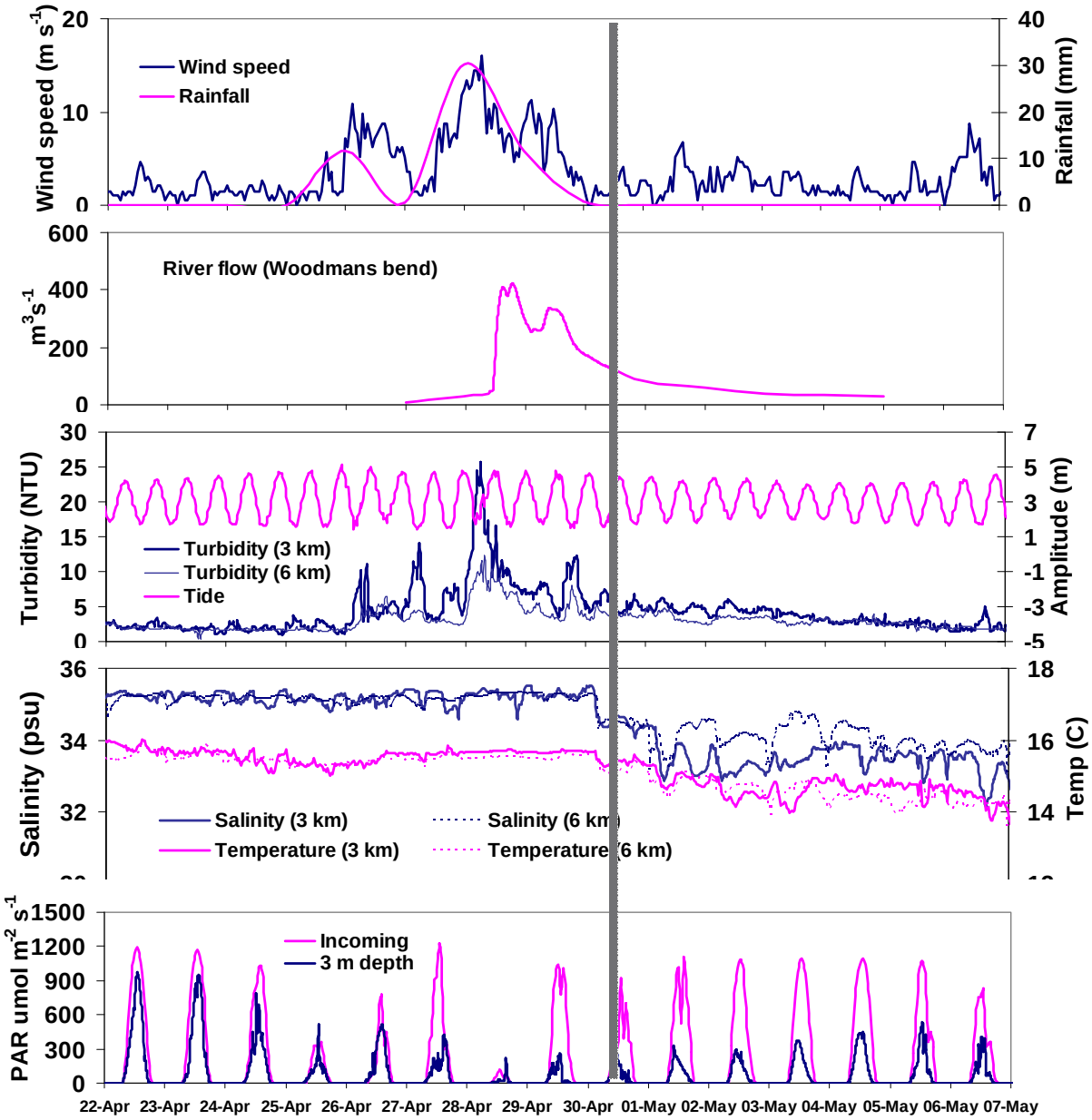
Bad weather

High river Discharge

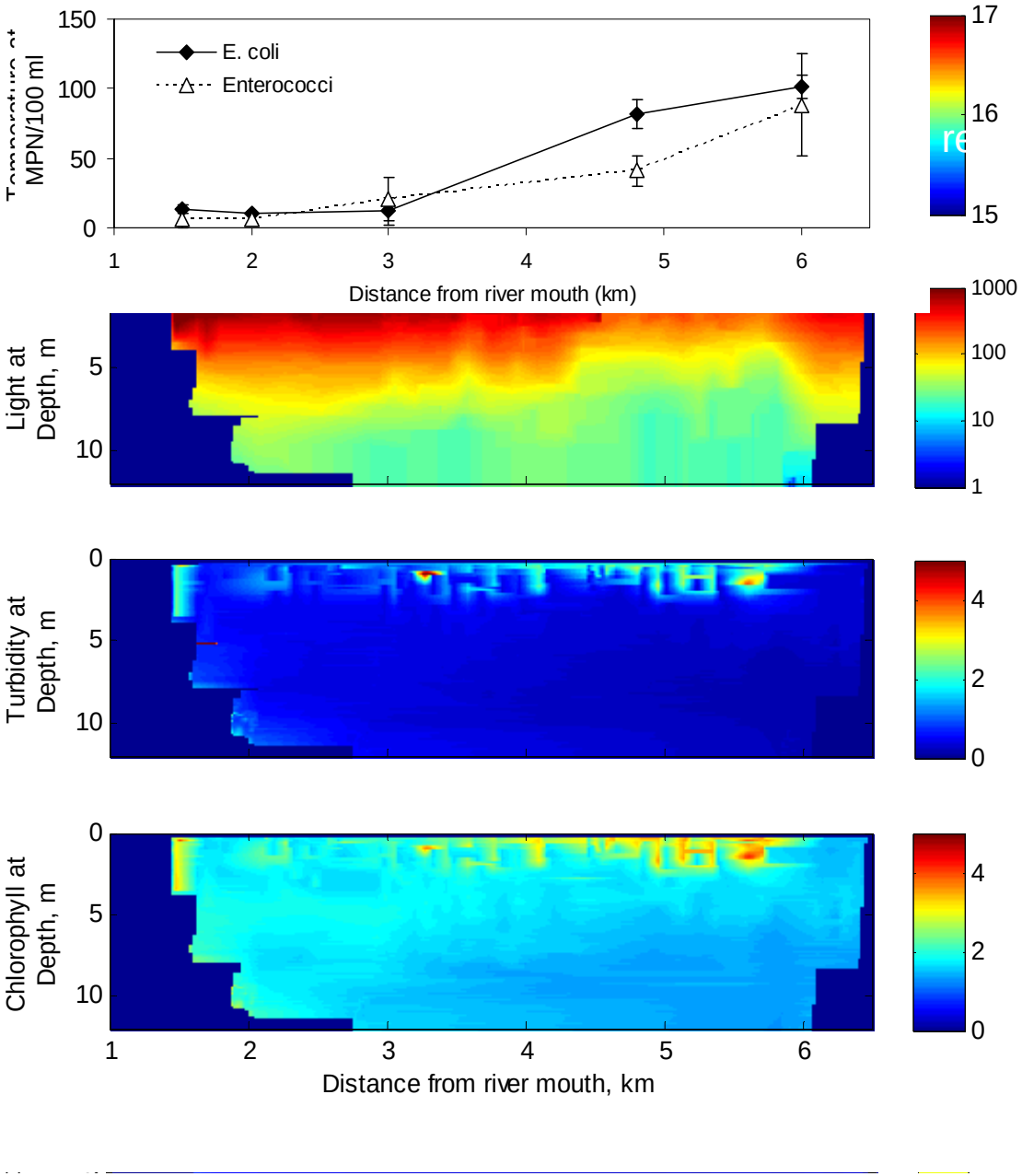
Increase in turbidity coinciding with winds

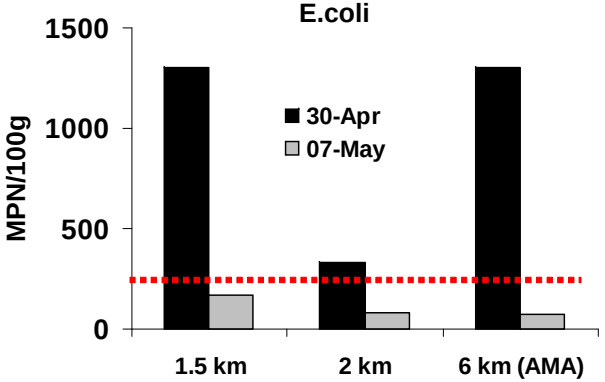
Mixing and persistence of shallow low salinity plume

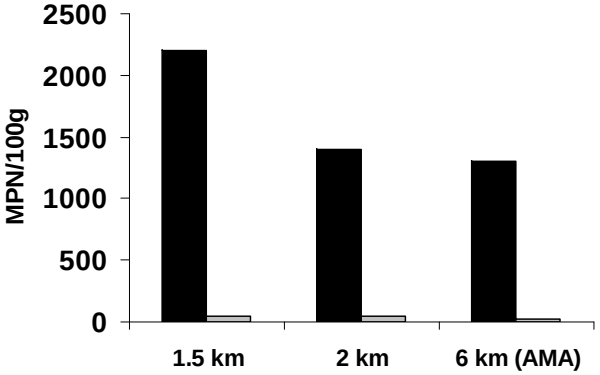
Shading by thin surface layer of fine sediment

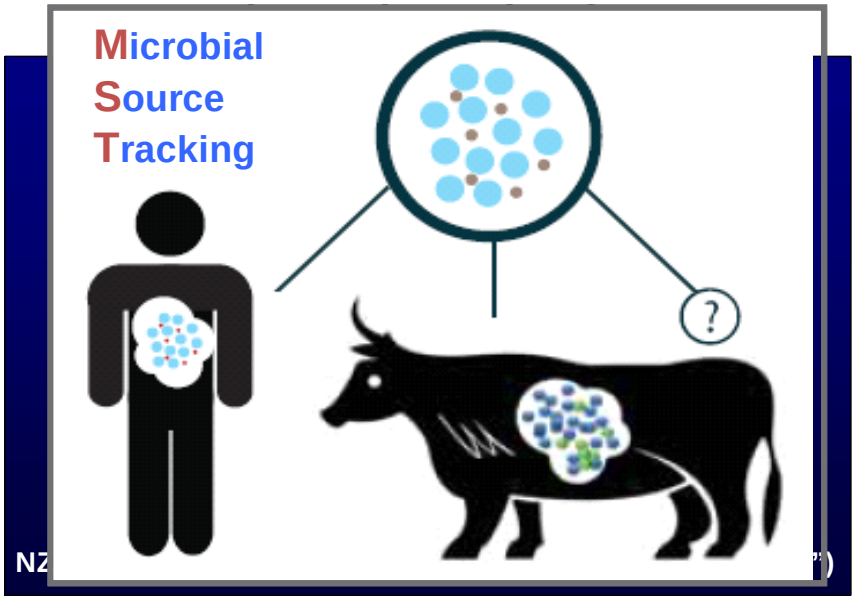



Woodmans bend
Google


150
100
50
0
MPN/100 ml
E. coli
Enterococci
1
2
3
4
5
6
Distance from river mouth (km)
17
16
15
Light at Depth, m
5
10
1000
100
10
1
Turbidity at Depth, m
0
5
10
4
2
0
Chlorophyll at Depth, m
0
5
10
4
2
0
1
2
3
4
5
6
Distance from river mouth, km







3 human markers not detected

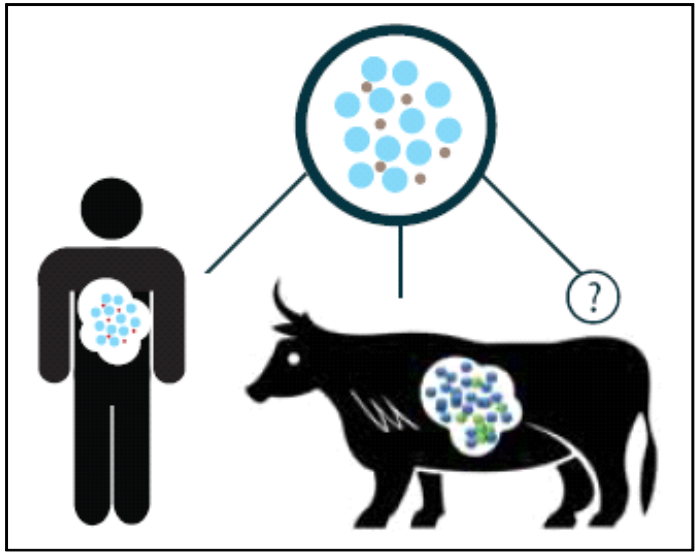
Human *Bacteroides* (Bac183)

Human *Methanobrevibacter*

Human Polyomavirus (HPyV)

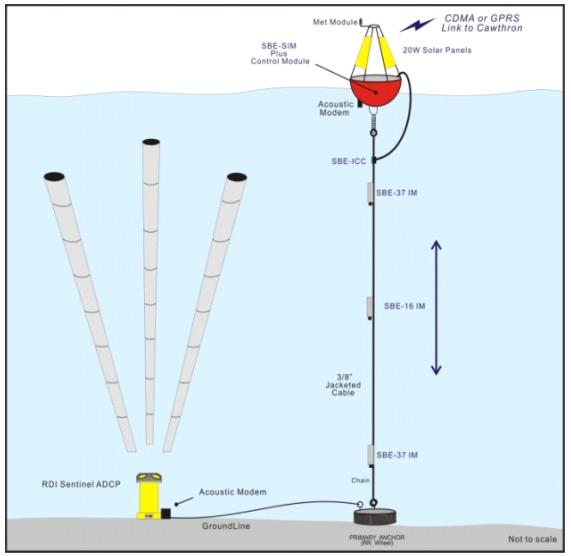
Continuing efforts

Molecular tools



- MST tools for water quality monitoring
- MST tools for ensuring shellfish quality
- Quantitative PCR
- DNA probe arrays

Real-time monitoring



- Telemetry-data accessibility
- Real-time Environmental Sample Processing (ESP)

Acknowledgements

Cawthron: Paul Gillespie, Marek Kirs, Roger Young, Reid Forrest, Paul Barter, Aaron Quarterman, Eric Goodwin, Ben Knight, Ron Fyfe, Mark Englefield

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