# Modelling catchment indicators in the coastal domain

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# The ICM programme

## ICM – Integrated Catchment Management

*"a 9 year programme which commenced in July 2000, and whose goal is to conduct multi-disciplinary, multi-stakeholder research to provide information and knowledge that will improve the management of land, freshwater, and near-coastal environments in catchments with multiple, interacting, and potentially conflicting land uses."*[1]

[1] from http://icm.landcareresearch.co.nz/

# ICM Stakeholder concerns for the coast

- Commercial (Aquaculture, Tourism)
- Recreation/Cultural (Scallops, fishing, safe swimming, marine mammals, birds)

-> requires broad-scale indicators that can be modelled to address a number of issues (e.g. Water quality – sediment, nutrients and bacteria)

# Model linkages

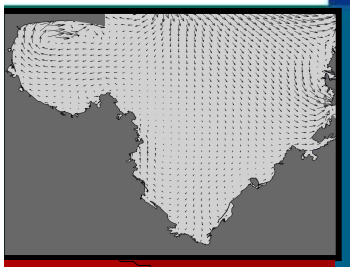
Catchment Model

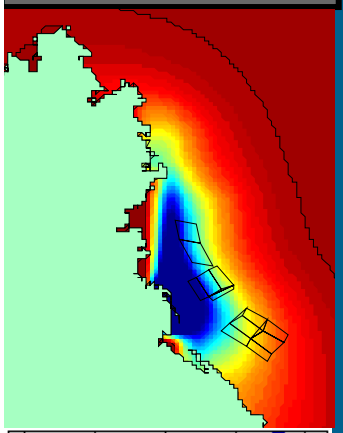
River Transport Model

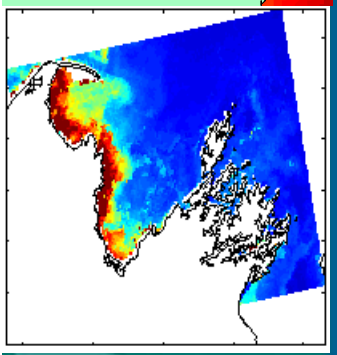
Water Quality & Flows

Coastal Models

# Coastal models used in ICM



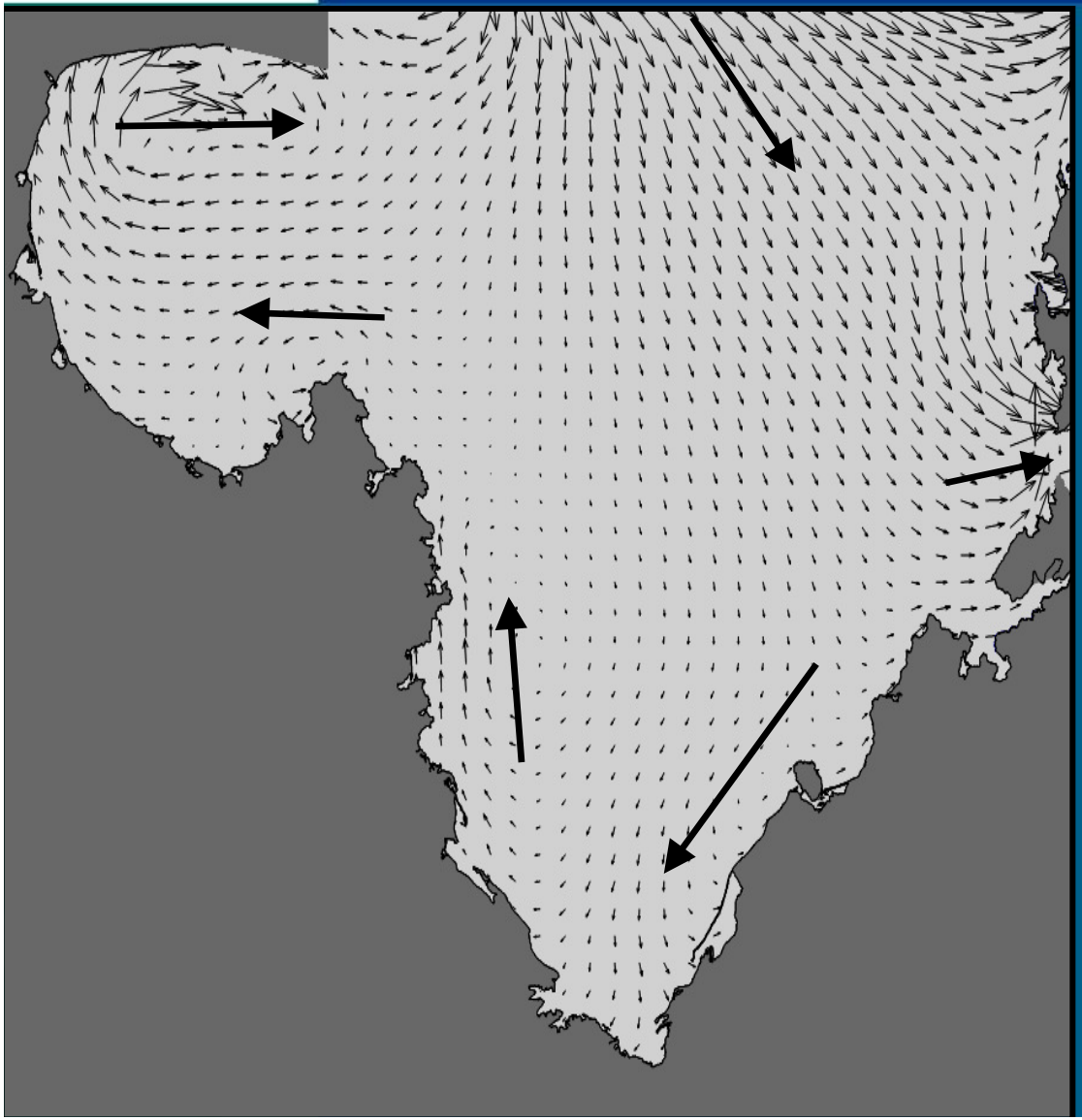




1. Hydrodynamic Model (Currents/Transport)
2. Water Quality Model (e.g. Sediment, Pathogens, Nutrients)
3. Phytoplankton Modelling
4. Foodweb Model (Fishing, Larvae, Aquaculture…)

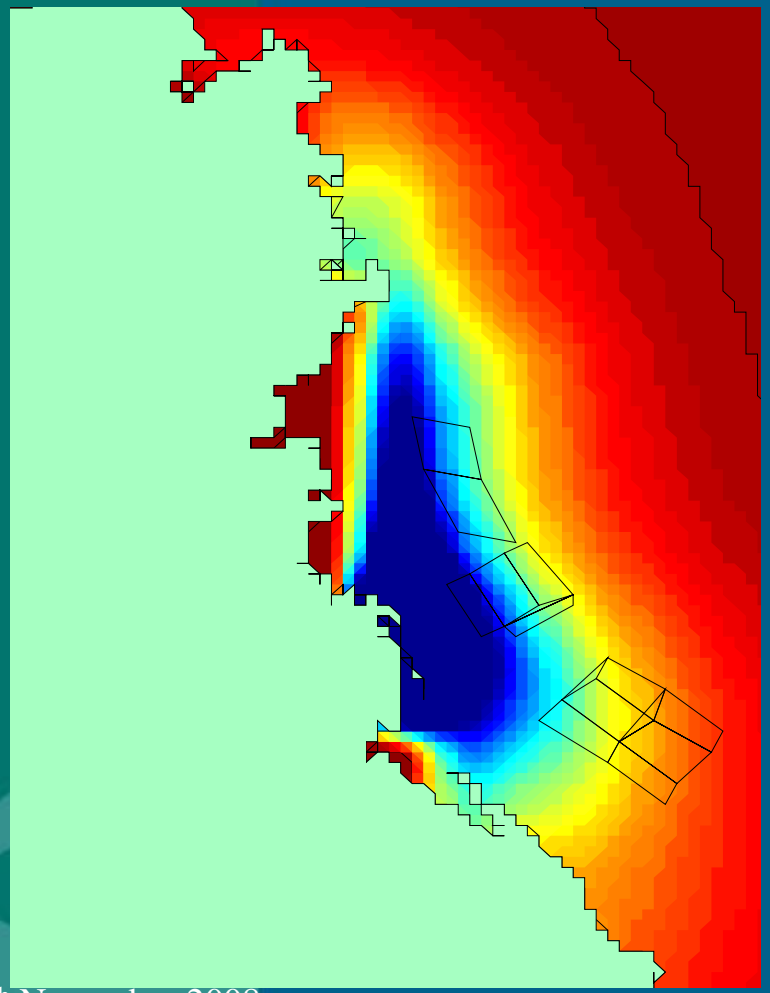

19 October 2007
Catchment footprint on
the coast can be large.

# Hydrodynamic Modelling



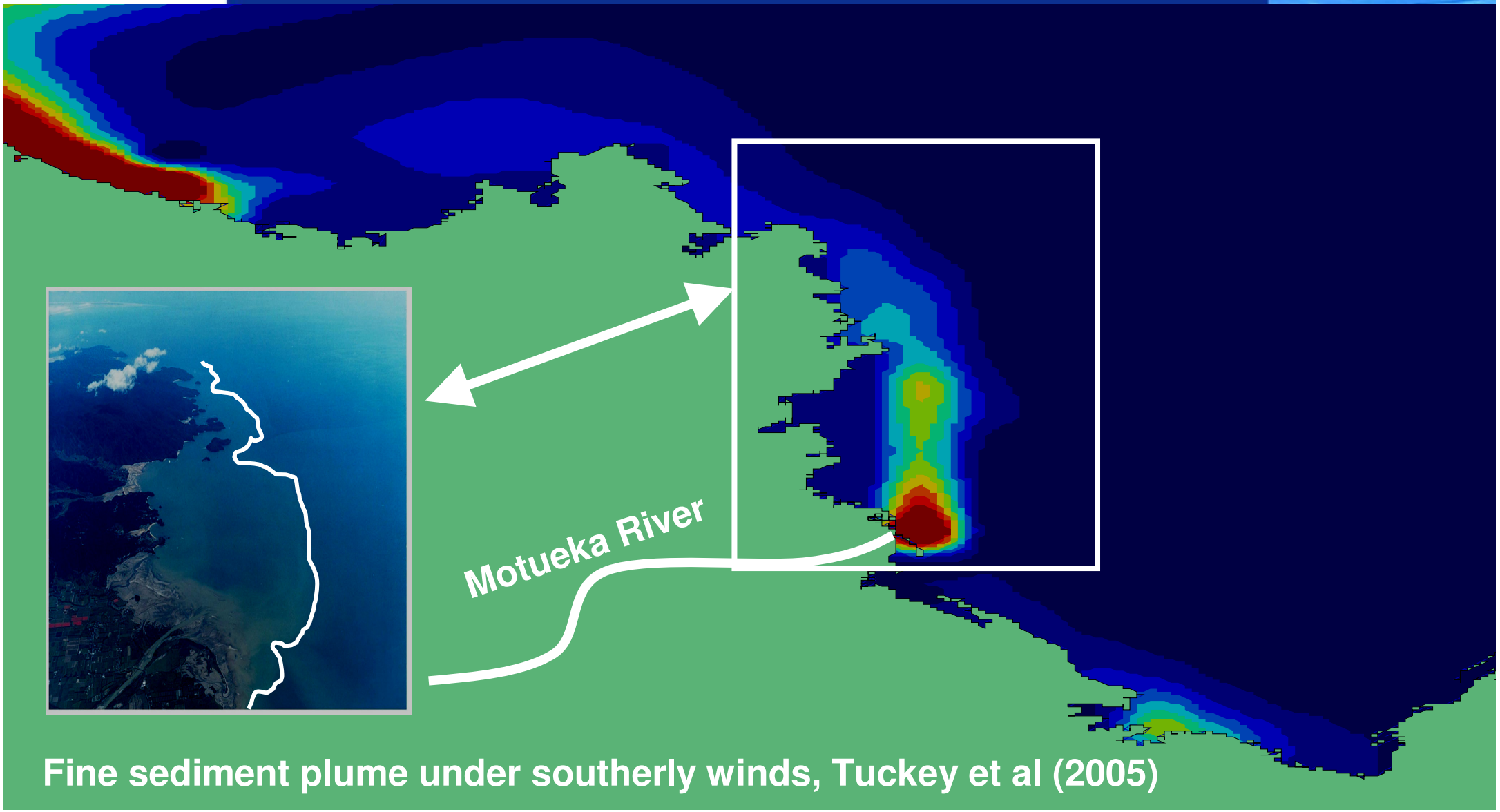
- Needed for determining spatial transport.
- Calculates currents and physical parameters.
- Tidal residuals show net northward transport from Motueka.

# Water Quality Modelling



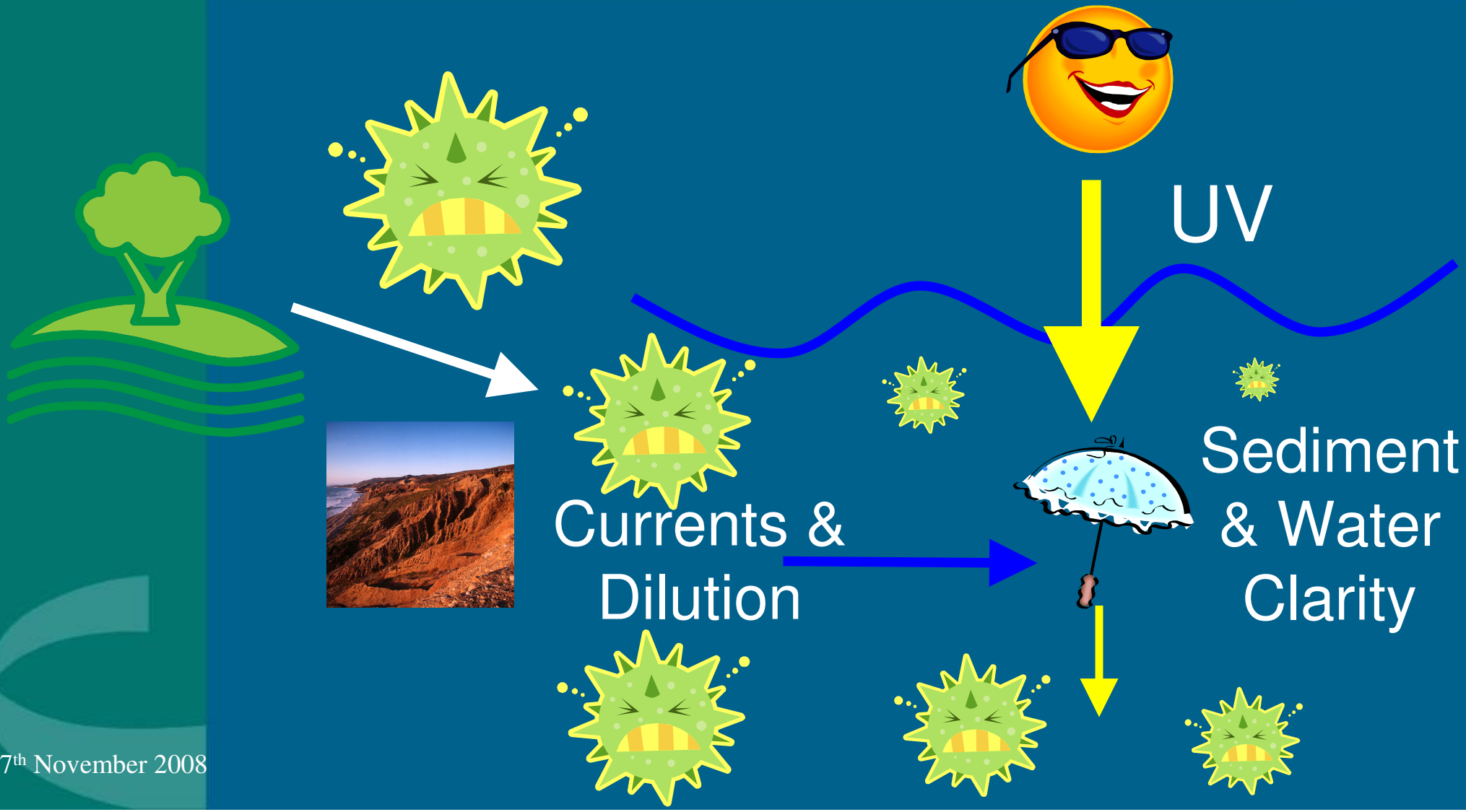
- Utilises transport information from hydrodynamic model.
- Can estimate transport of suspended particles (e.g. sediment, nutrients, pathogens).
- Can use to predict catchment footprints on the coast to address stakeholder concerns.

# Example: Sediment Modelling




Fine sediment plume under southerly winds, Tuckey et al (2005)

# Bacterial modelling

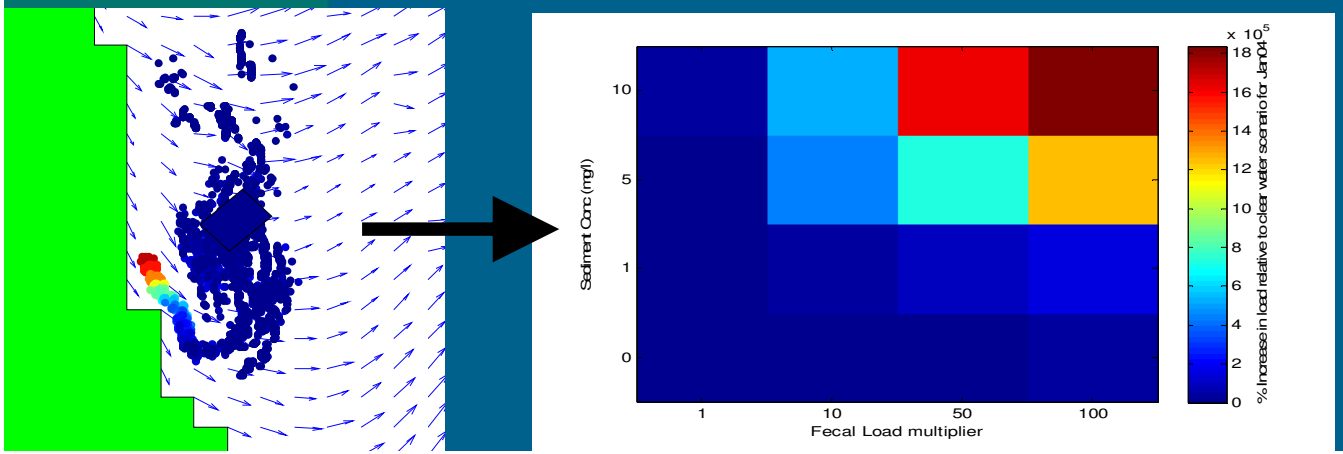


# Example: Application of bacterial model

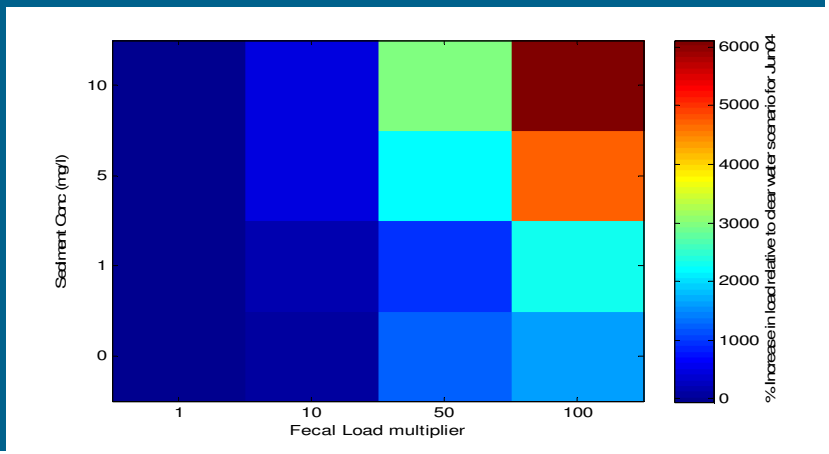
Does increased sediment or bacterial loads have a greater influence on numbers of bacteria reaching aquaculture site?

- In summer contribute equally to bacterial numbers.
- In winter bacterial load makes a greater difference.

Summer




Winter



# Phytoplankton Modelling

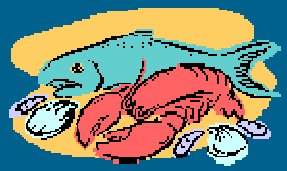
Solar Energy

N Nitrogen
Atomic Number: 7
Atomic Mass: 14.01

Phytoplankton (Organic Energy & Toxins?)

Currents

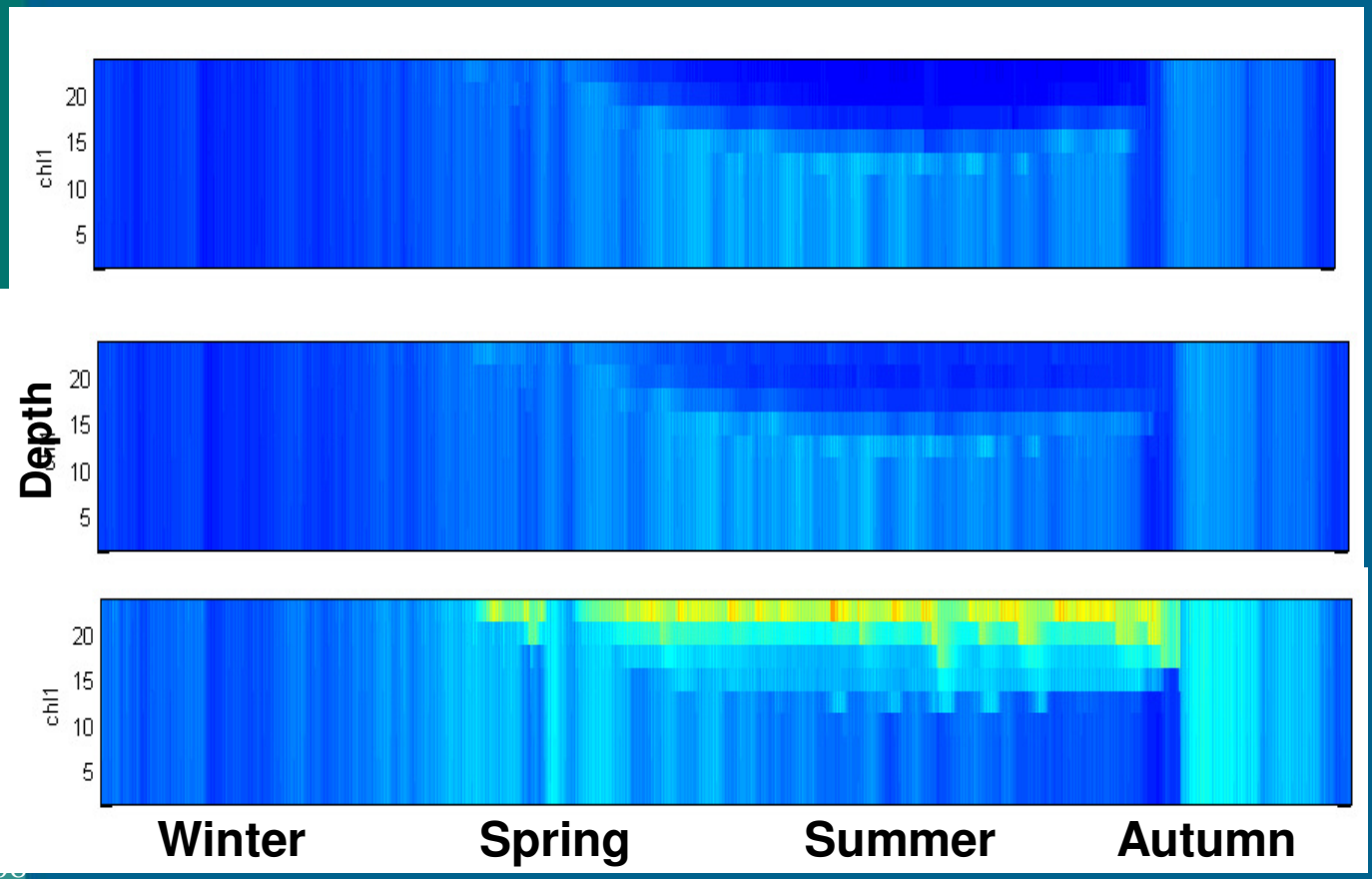
Food web



# Example: Application of Biophysical Model

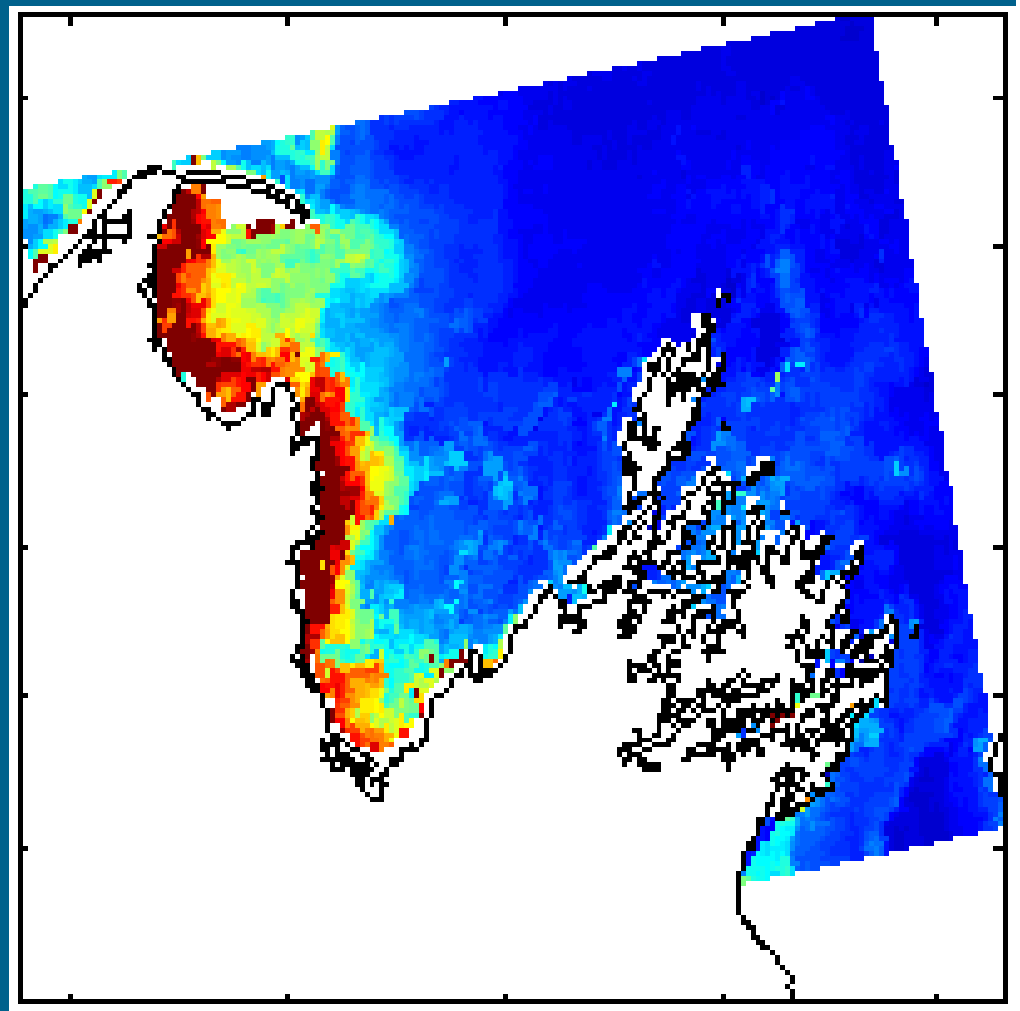
## What is the impact on algal growth from different land uses?

| | Nitrogen Load |
|---|---|
| Historical | 234,932 kg/yr |
| Current | 521,353 kg/yr |
| Intensive | 3,806,154 kg/yr |



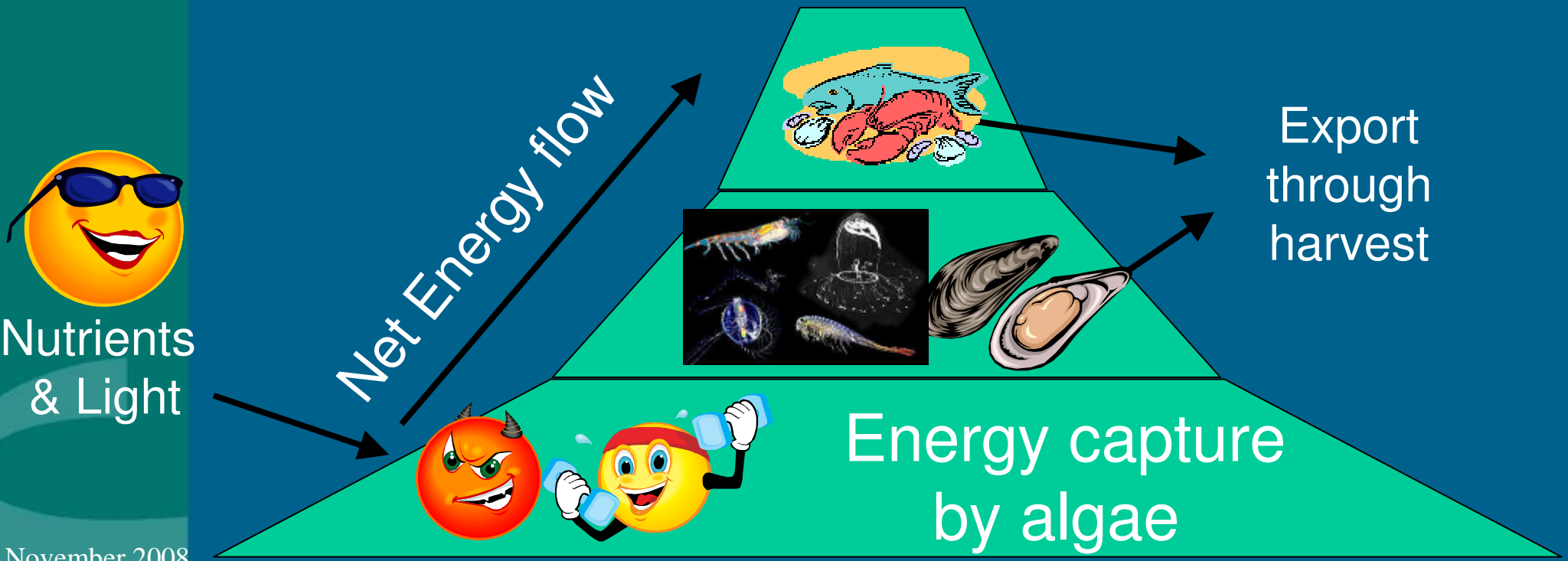
# Spatial Analysis

- Can predict spatial trends.
- Determine high risk areas for monitoring.
- Useful for resource management (e.g. matching new N inputs to N removal)



# Food web Modelling

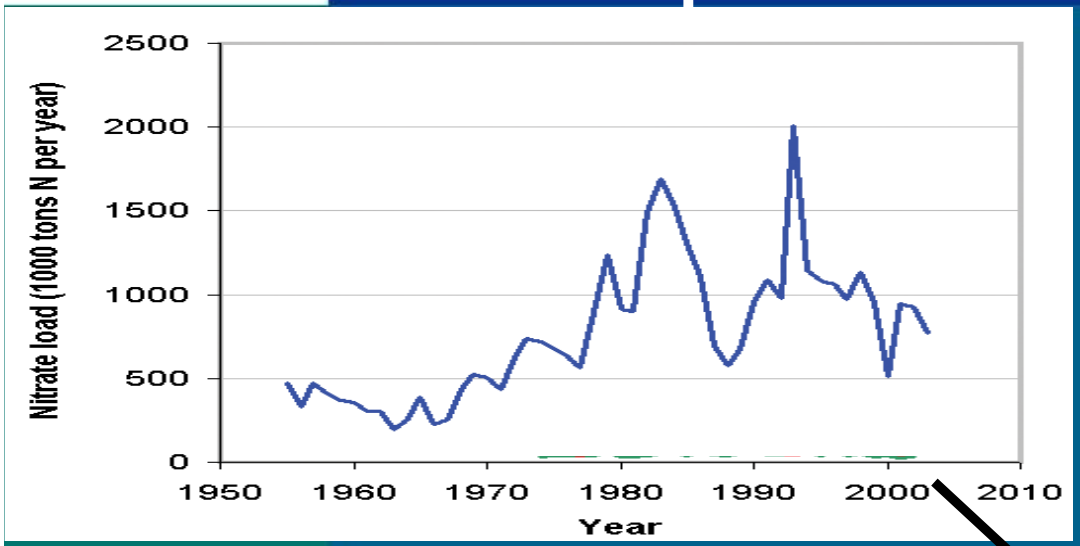
We can answer questions about how energetic changes may affect high trophic species to address stakeholder concerns.



# Example: Application of Food web Model

- Jiang and Gibbs (2005) used food web model to see what level of shellfish culture would start to affect structure of energy flows to ecosystem.
- Model suggests level of culture could be very high in Tasman/Golden Bay (~65 tons/km$^2$) before large changes in food web occur.
- Increased algal production in this model suggests more resources available for aquaculture and wider foodweb, BUT….

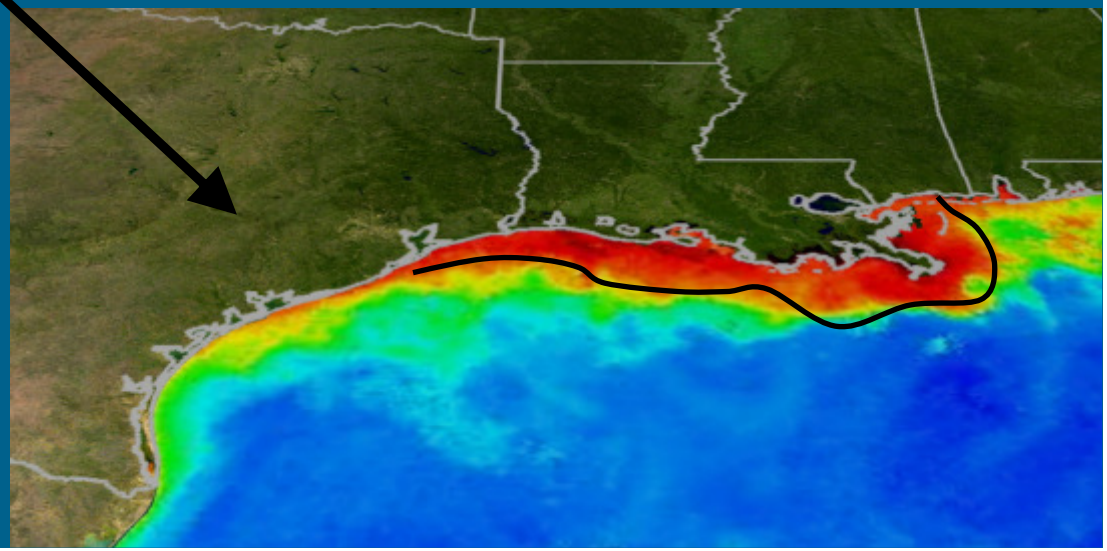
# An extreme nutrient loading example: Mississippi River




Large areas of coastline affected by hypoxic events during summer.

Increasing Nitrogen loads observed in the Mississippi since 1970.

Note: 1000 times higher than loads for Motueka River.



# Model Applications & Considerations

**Applications:**

- Predictive
- Use to isolate effects on indicators (e.g. anthropogenic vs. climate)
- Can fill in spatial or temporal gaps (e.g. compliance)

**Considerations:**

- Only as good as knowledge of system and data
- Data requirements for validation (High setup costs?)
- Potential to over fit -> loss of predictive utility.

# In Summary

- Application of modelled indicators to aquaculture suggest positive and negative impacts from land intensification.
- Impact assessment will be subject to the questions asked of it, need for collaborations between stakeholders, planners and researchers to find acceptable solutions to present and future issues.
- Coastal modelling tools offer an environment for testing ideas to achieve desired indicator outcomes.

# References

Jiang W, Gibbs MT, 2005. ”Predicting the carrying capacity of bivalve shellfish culture using a steady, linear food web model.” *Aquaculture* **244:** 171-185.

Tuckey BJ, Gibbs MT, Knight BR, Gillespie PA, 2006. “Tidal circulation in Tasman and Golden Bays: Implications for river plume behaviour.“ *New Zealand Journal of Marine & Freshwater Research*. **40**: 305–324.

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