Land-sea interactions and consequences for marine food webs: a test of ECOTRAN in the sub-Antarctic

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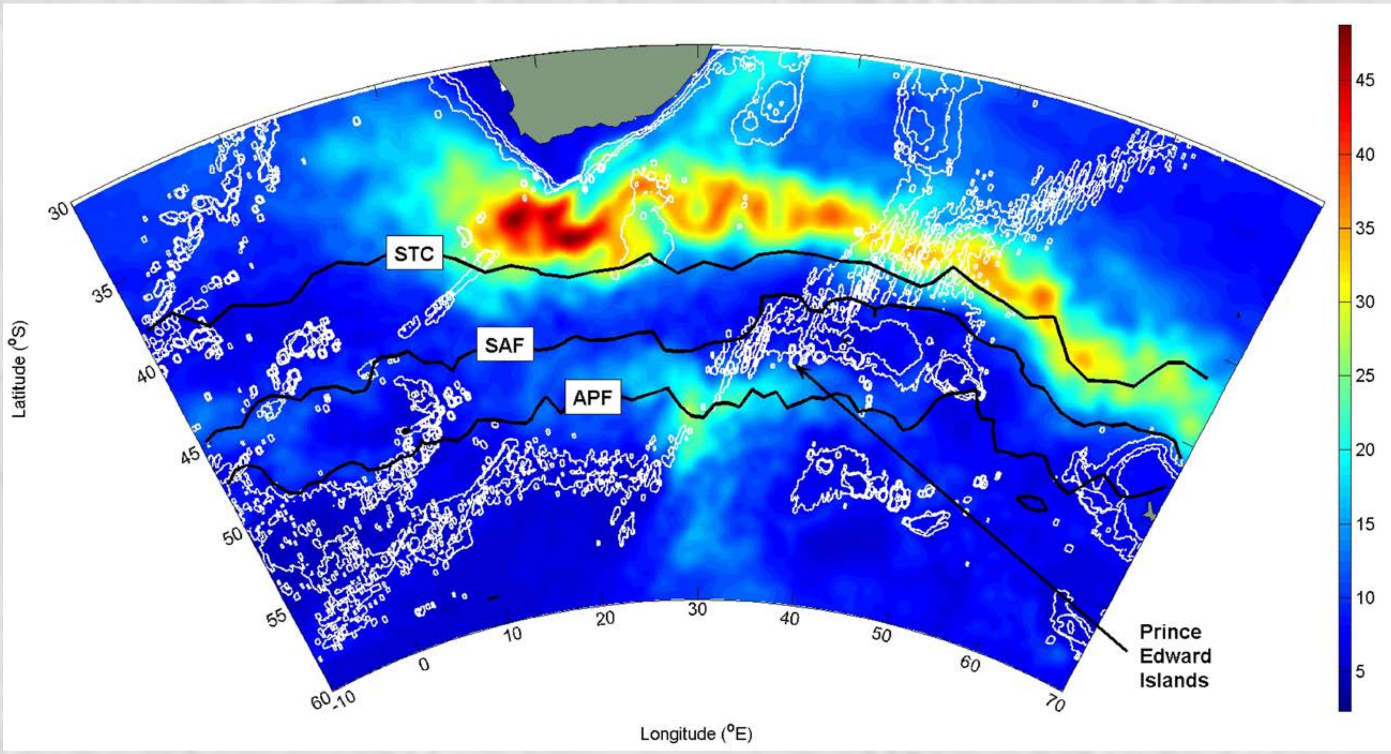

Figure 1: Location of the Prince Edward Island group. SAF = sub-Antarctic Front, APF = Antarctic Polar Front, STC = Subtropical Convergence (courtesy of Durgadoo et al. 2010)

Resource subsidies can influence the structure and dynamics of recipient food webs in a wide range of ecosystems through direct and indirect effects. On the sub-Antarctic Prince Edward Islands (PEIs) (Fig. 1), large populations of top predators import substantial amounts of nutrients and energy from the oceans to the islands, and guano runoff from the islands increases the availability of nutrients in the near shore marine environment, supporting periodic phytoplankton blooms. We apply mass-balanced and end-to-end food web models to the ocean ecosystem around the PEIs to investigate food web responses to variability in subsidy-driven primary production and community structure.

We use ECOTRAN to transform an ECOPATH model of the PEIs into a donor-driven map of energy flow up the food web, incorporating microbial processes driving nutrient recycling. We investigate: 1) the effects of resource subsidy driven island-associated blooms on the PEIs marine ecosystem and, 2) the consequences of variability in groups identified as having particular importance in energy transfer. In doing so, we also provide a test of ECOTRAN for the PEIs system and demonstrate its usefulness as a standardised model which can be used for different regions.

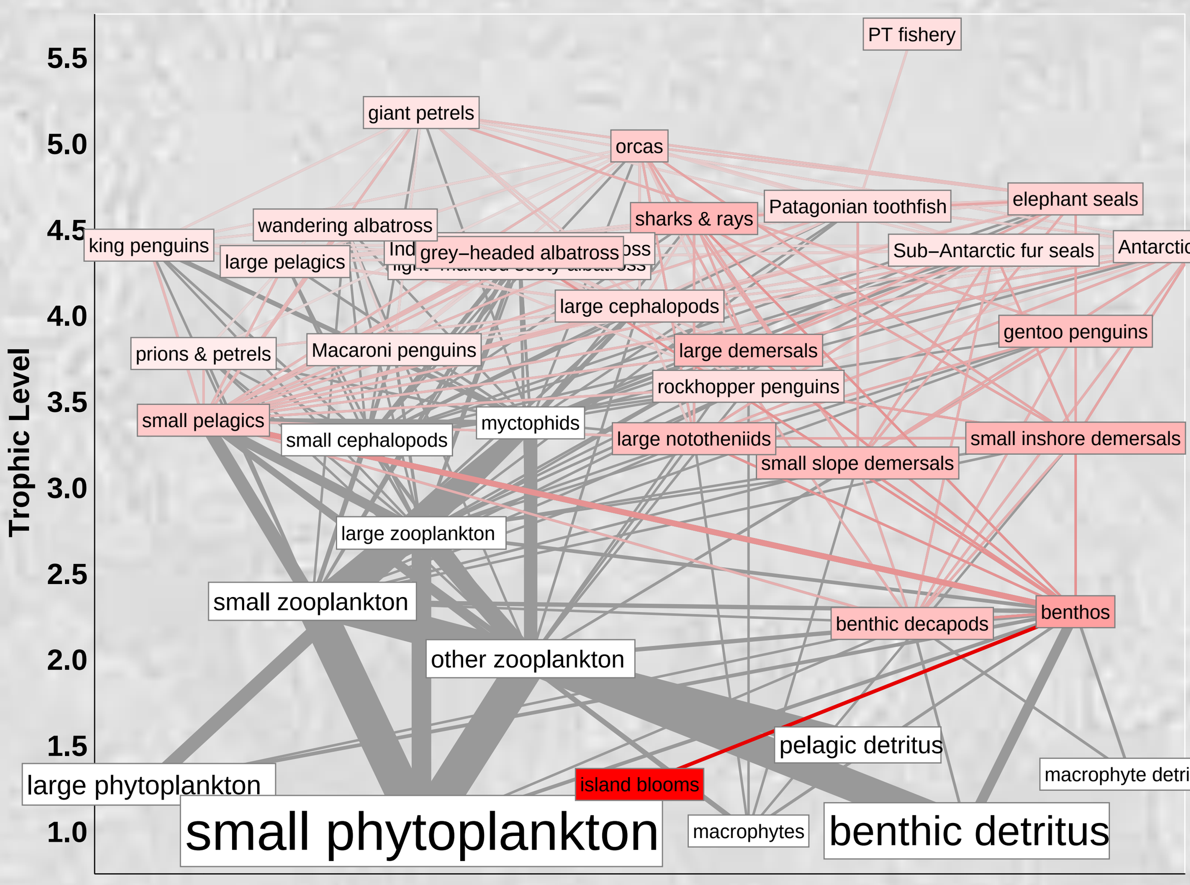

Figure 2: PEI food web diagram highlighting the role of island-associated blooms

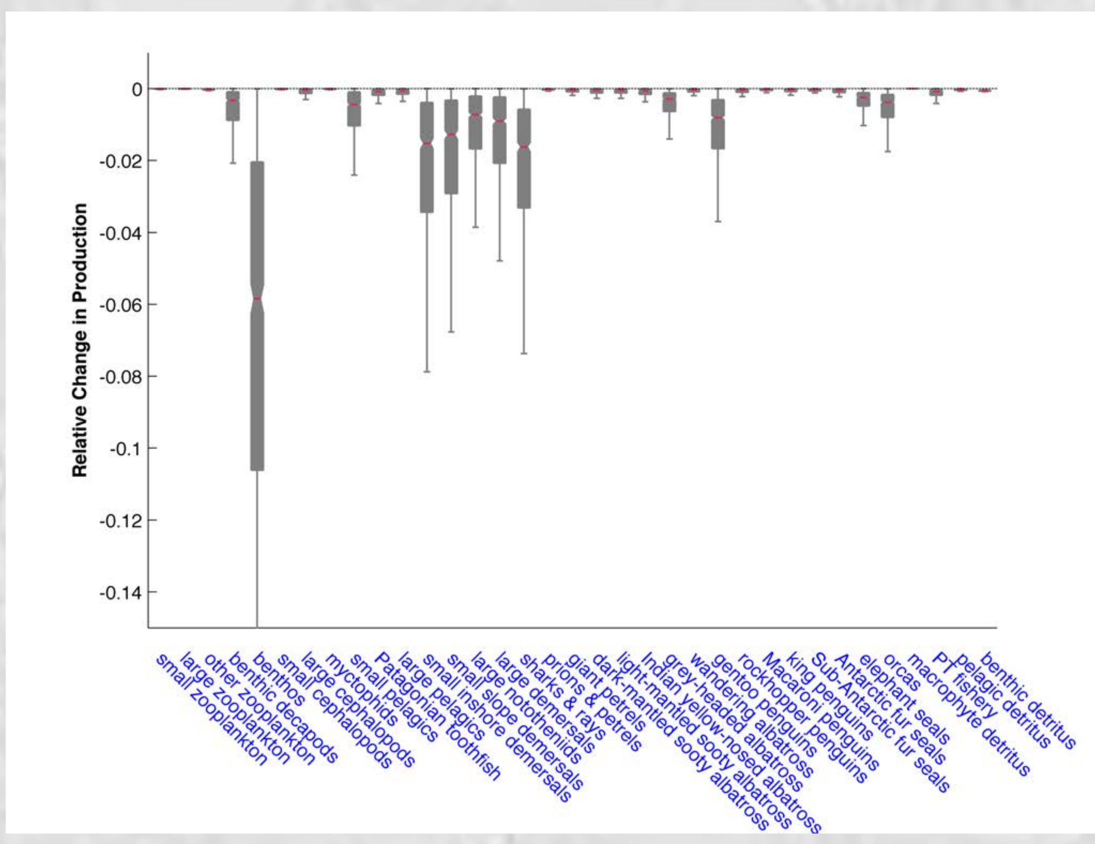

Figure 3: The relative change in productivity of all trophic groups in a scenario where island-associated blooms are switched off

Island-associated blooms are linked to the production of many groups in the PEIs food web (Fig. 2). Modelled bloom scenarios indicated small changes in productivity in the PEI ecosystem, particularly for benthic communities, highlighting the bentho-pelagic coupling in the system (Fig. 3). These effects are small when averaged over the full 200 nm EEZ model as shown here (Fig. 3), but increase in smaller model sizes.

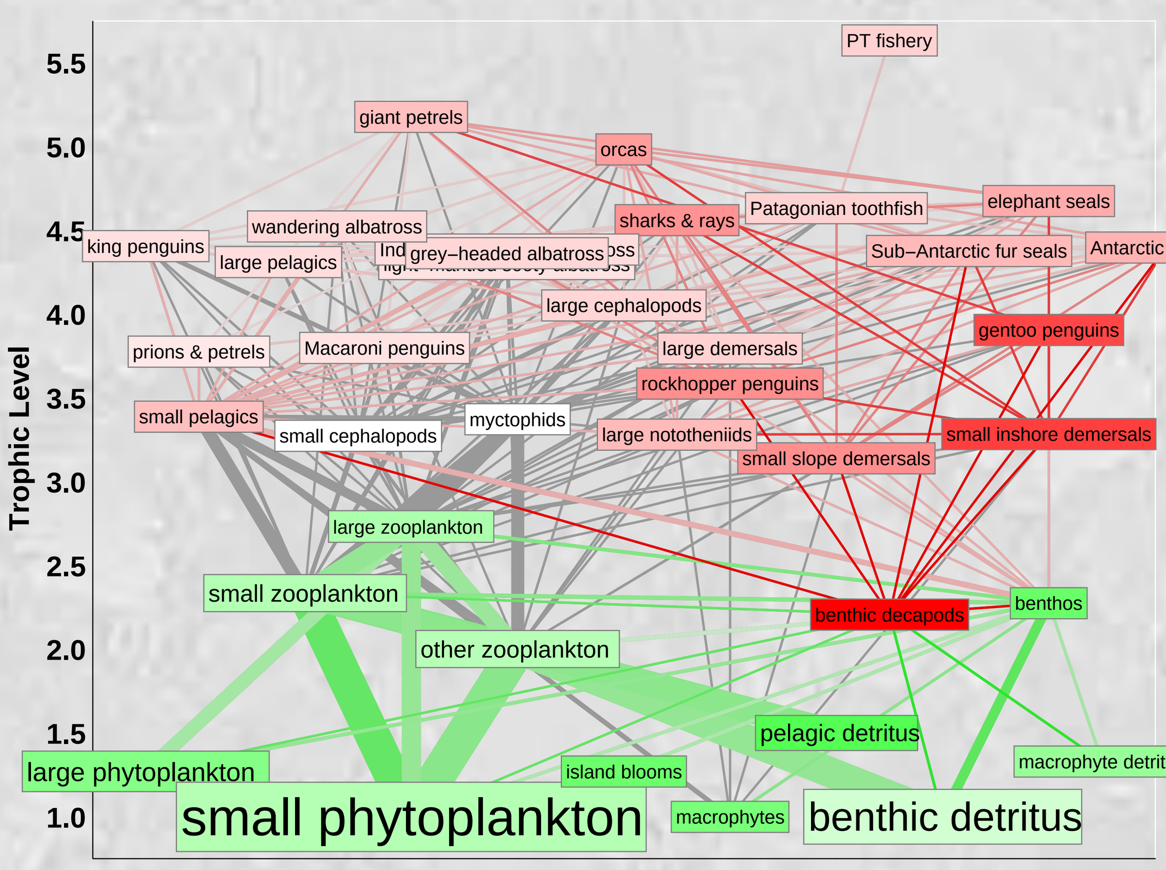

Figure 4: PEI food web diagram highlighting the role of benthic decapods (Green = relative proportion of trophic groups' production consumed by the decapods. Red = the relative proportion of consumers' production that is supported by the decapods via all direct and indirect pathways)

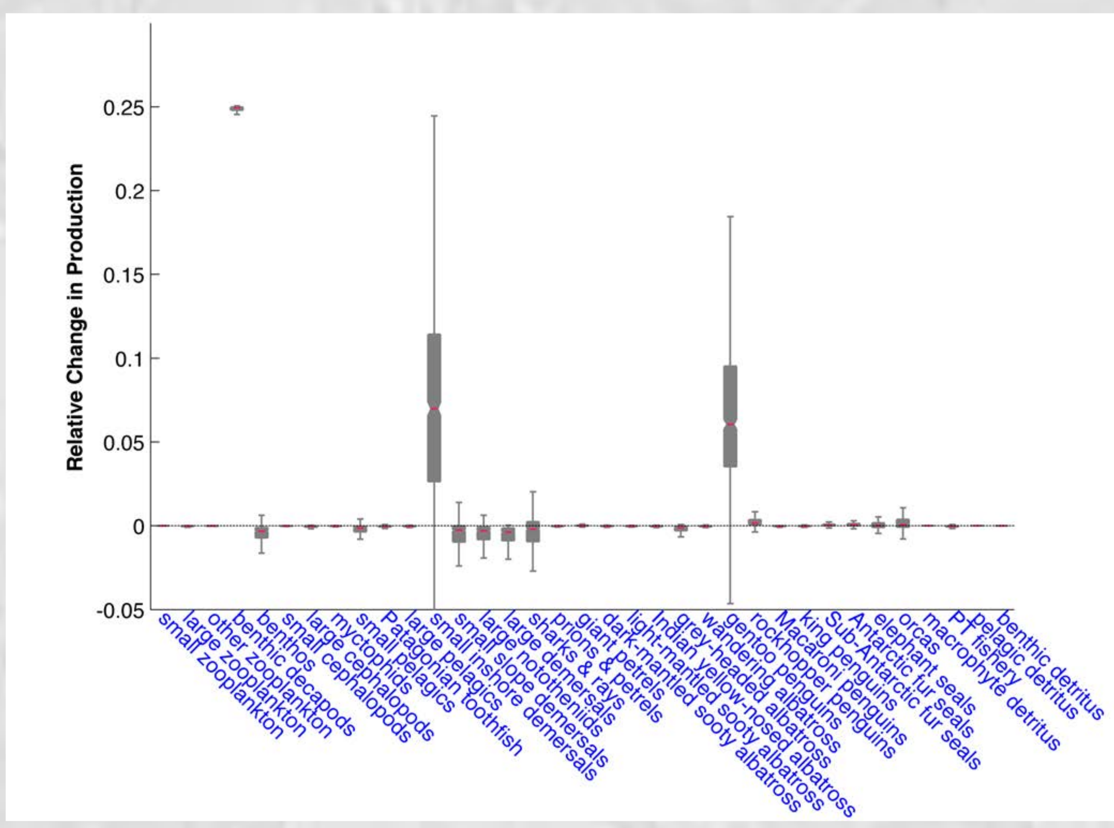

Figure 5: The relative change in productivity of all trophic groups with a 25% increase in the biomass and consumption of the benthic decapod shrimp (*Nauticaris marionis*)

Variability in groups of particular trophic importance indicated strong effects of species such as the caridean shrimp *Nauticaris marionis* (Figs 4 & 5). This decapod is an important benthic-pelagic link and provides an important food source for higher trophic groups (Fig. 4).

Changes in resource subsidies or bloom conditions could impact benthic-pelagic links in the system with effects on marine species (such as *N. marionis*) and communities.

Work in progress includes: 1) driving the bloom scenarios with model derived estimates of NH_4 contributions from top predators to the near shore ecosystem and, 2) estimating the effects of variability in the physical environment by coupling the model to physical oceanographic drivers.

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