

A BALANCED MODEL OF THE FOOD WEB OF THE ROSS SEA, ANTARCTICA

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Abstract

A quantitative food web of the Ross Sea is presented here as a step towards investigating ecosystem effects of the fishery for Antarctic toothfish (*Dissostichus mawsoni*). The model consolidates quantitative information on trophic links across all the major biota of the Ross Sea and tests for data consistency. The model has 38 trophic groups and is balanced in terms of annual flows of organic carbon in an average recent year (1990–2000). The focus of the model is on the role of Antarctic toothfish in the food web which means that the model has greater taxonomic resolution towards the top of the food web than the base. A survey of the available literature and both published and unpublished data provided an initial set of parameters describing the annual average abundance, imports, exports, energetics (growth, reproduction, consumption) and trophic linkages (diets, key predators) for each model group. The relative level of uncertainty on these parameters was also estimated. This set of parameters was not self consistent, and a method is described to adjust the initial parameter set to give a balanced model, taking into account the estimates of parameter uncertainty and the large range of magnitude (>6 orders of magnitude) in trophic flows between groups. Parameters for biomass, production rate, growth efficiency, diet fractions and other transfers of biomass between groups were adjusted simultaneously. It was found that changes to the initial set of parameters needed to obtain balance were reasonably small for most groups and most parameters. The mean absolute change for all key parameters (biomass, production rate, growth efficiency) and all groups together was 1.7%, and for diet fractions was 0.6%. Large but not implausible changes in biomass, production/biomass and production/consumption parameters were needed to balance the microzooplankton (34–47%), ice bacteria (61–72%), and ice protozoa (24–54%), components of the model. Trophic levels are in close agreement with those derived from isotope and other ecosystems. In the balanced model, there is only enough large (>100 cm) toothfish production to satisfy 6.5% of the diet of Weddell seals, 5.6% of the diet of orca and 2.6% of the diet of sperm whales. The model does not support the hypothesis that depletion of Antarctic toothfish by fishing would change the diet of predators of toothfish (Weddell seals, orca, sperm whales) by large amounts throughout the Ross Sea, though the importance of toothfish as prey items to these predators is not tested and requires further investigation. The model shows that large toothfish consume 61% of the annual production of medium-sized demersal fishes and 14% of the annual production of small demersal fishes, implying a potential for the fishery to affect these prey through trophic cascades. There is a need to establish monitoring of medium and small demersal fishes in the Ross Sea, and to model potential changes to these groups due to the fishery.

Keywords: Ross Sea, trophic model, food web, Antarctic toothfish, CCAMLR, mass balance, inverse modelling, ecosystem model

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Includes 11 supporting documents:

- Pinkerton, M.H.; M.J.M. Williams (2010). Trophic modelling of the Ross Sea 1: Oceanography. Supporting documentation, CCAMLR Science. Pp 5.
- Pinkerton, M.H.; J.M. Bradford-Grieve; P. Wilson; D. Thompson (2010). Trophic modelling of the Ross Sea 2: Birds. Supporting documentation, CCAMLR Science. Pp 26.
- Pinkerton, M.H.; J.M. Bradford-Grieve (2010) Trophic modelling of the Ross Sea 3: Seals. Supporting documentation, CCAMLR Science. Pp 14.
- Pinkerton, M.H.; J.M. Bradford-Grieve (2010) Trophic modelling of the Ross Sea 4: Whales (revision 1, April 2010). Supporting documentation, CCAMLR Science. Pp 28.
- Pinkerton, M.H.; S.M. Hanchet; J.M. Bradford-Grieve (2010) Trophic modelling of the Ross Sea 5: Fishes. Supporting documentation, CCAMLR Science. Pp 39.
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