# Structural stability of ADBM predicted food webs

**Abstract**

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## 1 Introduction

### 1.1 Background on anthoropogenic changes and its impact on food web

Anthropogenic changes such as climate change and habitat destruction is a threat to biodiversity and can lead to food web collapse. Climate change can lead to the collapse of a food web (Ullah et al. 2018). Primary extinctions in a food web can give rise to further secondary extinctions in a food web resulting in collapse of the food web. Depending upon the food web, removal of few species from a food web can result in the food web collapse.

A loss of species in an ecosystem can lead to secondary extinction of species that feed on the species. The effect of these losses would depend upon the complexity of the food web.

### 1.2 Briefly explain papers by Jennifer Dunne

Simulation study has been used to understand the robustness of food webs predicted using food web models (J. A. Dunne and Williams 2009a). As food web models can be used to predicting interactions to understanding the mechanism behind interactions in a food web, it is important to know how robust these predicted food webs are.

### 1.3 ADBM predicted food webs

The allometric diet breadth model (ADBM) was the first model able to predict food web connectance (i.e. the number of realised links divided by total number of possible links) and structure (i.e. the arrangement of those links). ADBM uses foraging theory specifically the contingency model (MacArthur and Pianka 1966) to predict the diet of each potential consumer and thereby the food web structure.

In Gupta et al. (2021), the connectance (number of realised links divided by the total number of possible links) was overestimated by the allometric diet breadth model (ADBM) when compared with observed food webs. The study used approximate Bayesian computation to parameterise the ADBM and true skill statistics as the goodness of fit. It is crucial to understand the robustness of these food webs predicted using the ADBM.

- Canonical experiments not possible
- Community viability analysis
- How diversity and complexity influence the susceptibility of communities to secondary extinctions

### 1.4 Robustness of ADBM predicted food webs

Theoretical studies have simulated primary extinctions to check the robustness of food webs (J. A. Dunne and Williams 2009a). J. A. Dunne, Williams, and Martinez (n.d.) had shown that the robustness of a food web increases with connectance.

## 2 Materials and methods

### 2.1 Allometric Diet Breadth Model (ADBM)

The allometric diet breadth model (ADBM) is based on optimal foraging theory, specifically the contingency foraging model (**macarthurOptimalUsePatchy1966?**). The ADBM predicts the set of prey species a consumer should feed upon to maximise its rate of energy intake (**petcheySizeForagingFood2008?**). The foraging variables in the model: energy content of the resources, handling times of the prey, space clearance rate and prey densities are allometrically scaled to the body sizes of the species.

### 2.2 Food web data

The observed food webs that we fit the ADBM to belong to marine, freshwater and terrestrial ecosystems (Table **??**). The observed connectance of these food webs is from 0.03 to 0.24 and there are 29 to 239 species. The food webs contain primary producers, herbivores, carnivores, parasites, and parasitoids. They also contain various types of feeding interactions, including predation, herbivory, bacterivory, parasitism, pathogenic, and parasitoid.

### 2.3 Species removal

We used the primary species removal method used in J. A. Dunne and Williams (2009a) by sequentially removing species using one of three criteria: removal of (i) the most-connected species, (ii) the least-connected species and (iii) randomly chosen species. The most-connected and least-connected criteria are based on the degree (i.e. total number of links to resource and links from consumer for each species) of species. Given a primary removal if any remaining species lost all of their resource species, or any cannibalistic species lost all of their resource species except the cannibalistic links, they are dropped from the web and were recorded as a secondary extinction. Then the next appropriate species are removed determining the most- and least-connected species based on the web remaining after all prior primary removals and secondary extinctions had occurred. This process was carried out until all species were extinct from the web.

Robustness (R) of food web was quantified as the proportion of species subjected to primary removals that resulted in a total loss (i.e. primary removals plus secondary extinctions) of some specified proportion of the species. In our study, we use $R_{50}$, primary extinctions that result in at least 50 per cent of total species loss (J. A. Dunne, Williams, and Martinez 2002; J. Dunne, Williams, and Martinez 2004; J. A. Dunne and Williams 2009b). Therefore, there is no secondary extinction in a maximally robust community ($R_{50} = 0.50$), whereas in a minimally robust community ($R_{50} = 1/S$) there is extensive secondary extinctions (i.e. at least $S/2 - 1$)

# 3 Results

# 4 Discussion

# References

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