

# Sea Warming transforms tropical reef food web

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## **Abstract**

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# 1 Introduction

The objective of our study was to explore the potential future effects of sea warming on the pristine reef ecosystem of the Rocas Atoll, using a food web model reflecting the 2012 year situation. The model was fitted to the best obtainable biomass time series (2012-2018) for the modelled area and it was parameterized with thermal tolerances for the species. The impact of sea warming was tested using future rising temperature under IPCC Representative Concentration Pathways (RCPs) scenarios for the modelled area. Biomass' simulations outputs were presented for several reef fish species which are identified as ecosystem keystone species (reef sharks and generalist predators) and other important compartments from different trophic guild.

## 2 Results

The Rocas Atoll's food web (Fig. 1) shows different groups' trophic levels (TL): top predators are (in order): reef sharks, as *Negaprion brevirostris* (TL=3.56), *Ginglymostoma cirratum* (TL=3.47), sea birds (TL = 3.46) and generalist predator fish such as *Lutjanus jocu* (TL=3.27) and *Cephalopholis fulva* (TL=3.28). Other groups such as microinvertebrates and macroinvertebrates, polychaetes, amphipods, small crabs and even cryptobenthic reef fish occupied the first consumer level with trophic level between 2 and 2.2. Additionally, *Acanthurus chirurgus*, the most abundant herbivore fish at the ecosystem, has the lower trophic level (TL = 2.1). Algae (*Digenea simplex* and algae turf) accounted for the largest proportion of total living biomass in the system (93%). Fish biomass was composed mainly by herbivore-detritivore trophic guild (53%), followed by invertivore (20%), generalist predators (18.5%) and reef sharks (8.5%).

### 2.1 Simulated biomass changes

The best fitted model, without temperature as an ecosystem driver, was capable of reproducing historical trends in fish abundance for the period 2012-2018, with a total sum of square of 11.04 and the lowest Akaike Information Criterion (AIC) of -205.6 (Fig. 2SM/Table 3SM). The biomass accumulation rates for most fish species were positive, leading to increasing total fish biomass, a 0.7% increase from 2012 to 2100 (Fig. 2). Our simulations showed that in Rocas Atoll, the total fish biomass would be lower by the year 2100 than at the beginning of the time series under medium (RCP 4.5) and high (RCP 8.5) emissions scenarios (Fig. 2). In contrast, under RCP 2.6 scenario, simulated changes in total fish biomass reached 0.7% increase until 2100 relative to year 2012 (Fig. 2).

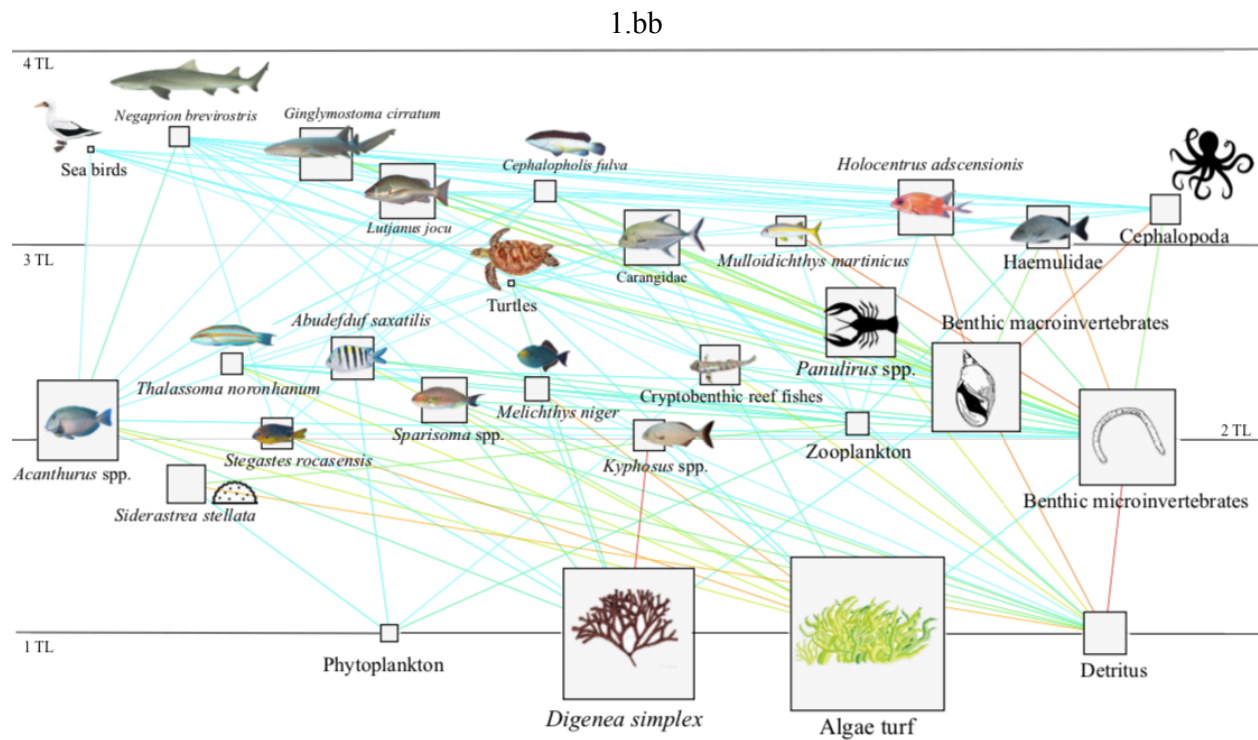


Figure 1: Diagram of the food web and trophic flows of the Rocas Atoll ecosystem (year 2012). Each functional group is shown as a square and its size is proportional to the log of its biomass. The functional groups are represented by their trophic levels (y-axis) and linked by predator-prey relationships showed as coloured lines representing the relative prey's contribution in the predator's diet (red: >85%, orange: >75%, yellow: >50%, green: >25%, light blue: >5%)

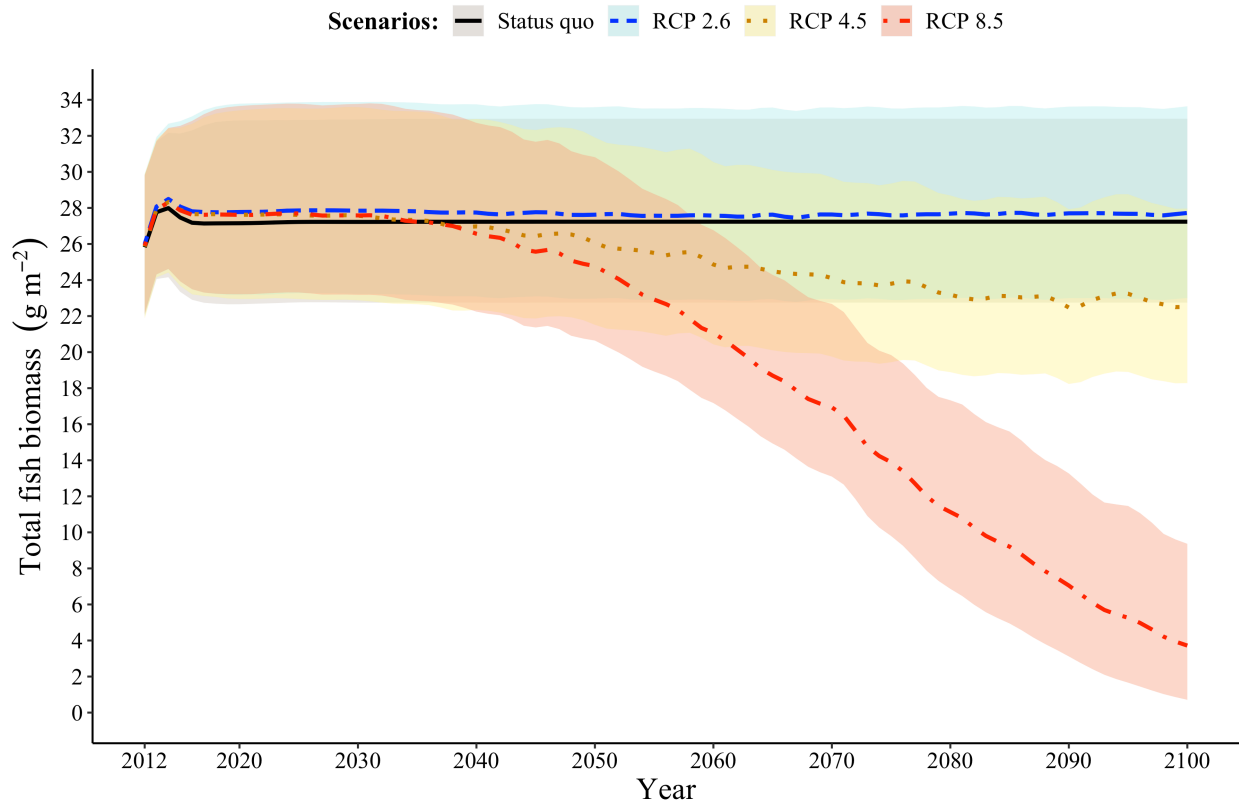


Figure 2: Means of projected historical and future total fish biomass under low climate change mitigation, medium and strong climate change (emissions scenarios: RCP4.5, RCP8.5) for 2012–2100