Summing the parts: Improving population estimates using a state-space multispecies production model

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# Introduction

# Methods

## Model formulation

Trends in fish populations have frequently been described using biomass dynamic models of the form

where and represents biomass and catch at annual intervals , and changes in biomass due to growth, recruitment, and natural mortality are captured via the production function ([1](#ref-polacheck1993)). An early and influential form for the production function was based on the logistic equation,

where is the maximum per-capita rate of change, and is the carrying capacity ([2](#ref-schaefer1954)). That is, a populations’ intrinsic ability to grow () is limited by the size of the current population relative to the maximum biomass the system can support ().

# Results

# Discussion

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# References

1. T. Polacheck, R. Hilborn, A. E. Punt, Fitting surplus production models: Comparing methods and measuring uncertainty. *Canadian Journal of Fisheries and Aquatic Sciences* **50**, 2597–2607 (1993).

2. M. B. Schaefer, Some aspects of the dynamics of populations important to the management of the commercial marine fisheries. *Inter-American Tropical Tuna Commission Bulletin* **1**, 23–56 (1954).

# Figures