

Exploring fish community stability in time and space using Taylor's Law.

Matthew R. D. Cobain, Markus Brede, Clive Trueman

The variability or stability of a community's composition is a key emergent property of ecological communities, and differences in community stability across time and space may provide valuable information regarding ecosystem function in response to exploitation and climate change. Taylor's Law, which states that the variance in abundance of a population, in time or space, relates to the mean abundance of that population, has been applied to many systems, but the mechanism underpinning Taylor's Law scaling and its utility in ecology is still heavily debated. Here we explore the potential information contained in Taylor's Law exponents applied to fisheries survey data. We use ICES IBTS North Sea data to explore patterns in spatial and temporal variance in the North Sea demersal fish community. We estimated spatial variance in abundance across 40 years of survey data. We divided the fish community according to species and body size, and split the North Sea into shallow and deep habitats. When considered according to body size, deeper, more environmentally stable habitats showed consistently reduced Taylor's Law exponents, implying that populations are less spatially variable in deeper habitats. Temporal variance in abundance differed systematically between ICES statistical rectangles when communities are defined both by species and size. We argue that Taylor Law exponents may provide a powerful measure of community stability and ecosystem function that is well suited to fisheries survey data. Throughout, attention is particularly given to the statistical analysis of exponent estimation, which is often overlooked.

Keywords: Fluctuation scaling, mean-variance scaling, power law, community stability, aggregation, ecosystem metric

Contact Author: Matthew R. D. Cobain, Ocean and Earth Science, University of Southampton, Waterfront Campus, European Way, Southampton, SO14 3ZH, UK, mrdc1g10@soton.ac.uk