

# INTRODUCTION TO THE USE OF QUOTIENT CURVES FOR CHARACTERIZING SPAWNING HABITAT OF SMALL, PELAGIC FISH

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## Introduction

Quotient curves provide an easy to implement tool to characterize the spawning habitat of small pelagic fishes in regard to physical and/or biological parameters. A quotient curve is a bi-variate curve, considered as an exploratory data analysis technique (Lluch-Belda *et al.*, 1991) that describes the “relation shape” between relative abundances of fish eggs and environmental variables such as temperature, salinity, depth, phytoplankton, *etc.* (e.g. van der Lingen *et al.*, 2001). This abstract describes how quotient curves are constructed, and illustrations of this are provided in the abstracts for the Workshop, published in this volume.

## Procedure

Quotient curves are computed on simple datasets. Datasets should provide egg abundance and other biological and physical measurements collected from field sampling for all the stations sampled (single station, integrated segment). The presence or absence of eggs is equally important. Egg abundance units can be measured in  $m^{-3}$ ,  $m^{-2}$ ,  $min^{-1}$ , but need to be constant for all the stations. These egg abundances must be associated with one or more environmental factor such as temperature ( $^{\circ}C$ ), salinity (psu or ‰), *etc.* Other information can be useful at latter stages of analysis (e.g., date, time, latitude, longitude...) but are not required for the quotient curves.

The units used in the dataset are of no special importance because the quotient curves are based on relative occurrences. The first step is to define a pertinent classification for the environmental variable (e.g. 0.5 or 1.0 $^{\circ}C$  classes for temperature), and the environmental variable is then assigned a number of categories (around 30) to ensure that maximum occurrence per category does not exceed 20% of all measurements and that it remains significant for each category. Stations are then assigned to a category, from which the relative “importance” or weight of each category is computed. Spreadsheet software is used.

The same procedure is applied to egg abundance data, with each environmental category being assigned a relative egg abundance value (egg abundance within the category divided by total abundance of eggs). The final step is to compute the quotient between the relative abundance of eggs and the percentage occurrence of the category. To prevent artefact from very high egg abundances, a smoothing function (running mean of 3-5 points) is applied to the quotient curve.

## Interpretation

The curves represent the relative abundances of eggs over the whole spectrum of environmental values. Since the sampling strategy is rarely balanced regarding the environmental variable, the quotient curve provides an efficient weighting procedure. Inferences are made from the curves, with quotient values greater than one ( $>1$ ) of particular interest, since they express significant selection for that range of the environmental variable (positive selection), whereas quotient values less than one ( $<1$ ) indicate avoidance of those environmental ranges for spawning (van der Lingen *et al.*, 2001). Examples of quotient curves are given in Twatwa *et al.* (2004), where the spawning habitats of anchovy (*Engraulis encrasicolus*) and sardine (*Sardinops sagax*) in the Southern Benguela upwelling ecosystem were characterized using CalVET net data collected during annual pelagic

spawner biomass surveys. Despite some overlap, the spawning habitats of these two species show significant differences.

It is important to emphasize that this approach is no substitute for in-depth statistical approaches of complex correlation which can be undertaken using GLM or GAM models. Quotient analysis provides a first step exploration of these relations using simple spreadsheet software and simple structured data. This step is a very relevant input for further elaborate approaches.

## References

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