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Inference using plankton models forced by spline interpolations: a study of algal loss processes in Lake Geneva

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Data interpolations (e.g. splines) are useful to provide forcings for dynamical models in aquatic ecology, and may facilitate inference using smaller, better constrained models with fewer ecological assumptions. However, we show by simulation that a standard approach of neglecting interpolation error when making inference on the dynamical model can invalidate tests and confidence intervals based on asymptotic theory. Inference is improved using the parametric bootstrap to simulate the effects of forcing error, but a more effective solution is to fit the forcings jointly with the dynamical model (ideally, in combination with the bootstrap). We apply these methods to investigate algal loss processes in the surface 10 m of Lake Geneva, during 1990, using a dynamical phytoplankton model forced by spline data interpolations for primary production and zooplankton abundance. The model passes a goodness-of-fit test, and hypotheses of no grazing, no grazing saturation, and no "other" loss processes (assuming 40% losses to respiration) are rejected under the model. Inferred grazing fluxes vary seasonally between roughly 3 and 100 mg C m-3 day-1, and the annual grazing efficiency (total grazing flux as a % of gross primary production) is estimated as 31% with a 90% confidence interval of 19 – 47%.