
MARIE AUGER-MÉTHÉ, Dalhousie University

Tackling the challenges of fitting movement models to marine data

Understanding animal behavior by applying statistical models to movement data is becoming increasingly common in ecology. While applying movement models can be challenging in terrestrial systems, fitting such models to marine data is hindered by many formidable challenges. First marine movement data are often associated with large amounts of error because accurate positioning systems (e.g., GPS) are not well suited to the marine environment. Models therefore often include additional parameters to account for the effect of measurement error. Second, environmental data are often spatiotemporally coarser than movement data, requiring models that accommodate for discrepancies between these scales. Third, unlike terrestrial systems, the marine habitat has 3 dimensions (latitude, longitude, and depth). Fourth, the ocean is not static. Factors, such as tides and winds, create advection and turbulence. Thus models need to disentangle ocean drift from the voluntary movement of animals, as well as incorporate how animals react to changes in the strength and direction of currents. While all of these aspects are essential for our understanding of the behavior of marine animals, they result in highly complex models that are difficult to fit to data. Fitting these models to large datasets often requires colossal amounts of computational power and may give inaccurate results. We discuss these challenges and potential solutions. In particular, we show how methods based on automatic differentiation and the Laplace approximation, like those implemented in Template Model Builder, reduce computational time and increase the robustness of both state and parameter estimates.