
Identifiability in Integrated Population Models

Frederic Barraquand^{*1}, Matthieu Paquet², Chloé Nater³, Choquet Rémi⁴, Elise Zipkin⁵,
Jonas Knape⁶, and Diana Cole⁷

¹Institut de Mathématiques de Bordeaux – Université de Bordeaux, Centre National de la Recherche Scientifique, Centre National de la Recherche Scientifique : UMR5251 – France

²Station d'Ecologie Théorique et Expérimentale – Centre National de la Recherche Scientifique, Fédération de Recherche Agrobiosciences, Interactions et Biodiversité – France

³Norwegian Institute for Nature Research (NINA) – Norway

⁴Centre d'Ecologie Fonctionnelle et Evolutive – Université Paul-Valéry - Montpellier 3, Ecole Pratique des Hautes Etudes, Centre National de la Recherche Scientifique, Institut de Recherche pour le Développement, Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement, Institut Agro Montpellier, Université de Montpellier, Université Paul-Valéry - Montpellier 3 : UMR5175, Ecole Pratique des Hautes Etudes : UMR5175, Centre National de la Recherche Scientifique : UMR5175, Institut de Recherche pour le Développement : UMR5175, Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement : UMR5175, Université de Montpellier : UMR5175 – France

⁵Michigan State University [East Lansing] – United States

⁶Swedish University of Agricultural Sciences (SLU) – Sweden

⁷University of Kent – United Kingdom

Abstract

Integrated Population Models are an increasingly popular class of demographic models fitted to multiple data sources at once. The combination of multiple data types (counts, capture-recapture, fecundity data, ...) is meant to increase our ability to extract demographic parameters from sparse and noisy ecological datasets. However, a statistical model has identifiable parameters when a unique optimal set of parameters can be obtained from data, and not all data combinations necessarily lead to identifiable IPMs. Although the very aim of IPMs is to improve parameter estimation, surprisingly little is known about the increase in identifiability provided by the combination of multiple data sources. We clarify how IPM identifiability can be evaluated in theory and practice, using several examples of data combinations with real and simulated data. We focus on two methods that have been previously used to evaluate the identifiability of ecological models and IPMs in particular: exhaustive summaries and prior-posterior overlap, in a Bayesian setup. Even though these methods are grounded in rather different theoretical frameworks, we show that these often provide similar answers in practice, though where they differ provides critical information on the limitations of each approach. We conclude with practical recommendations for checking the identifiability of IPMs and for handling unidentifiability issues when they arise.

*Speaker

Keywords: Integrated Population Models, State Space Models, data fusion, identifiability, estimability, demography