Peer Community In
Ecology

Marks lost in action, biased estimations

Sylvain Billiard 🆔 *based on peer reviews by **Devin Johnson**, **Olivier Gimenez** and 1 anonymous reviewer*

Capture-Mark-Recapture (CMR) data are commonly used to estimate ecological variables such as abundance, survival probability, or transition rates from one state to another (e.g. from juvenile to adult, or migration from one site to another). Many studies have shown how estimations can be affected by neglecting one aspect of the population under study (e.g. the heterogeneity in survival between individuals) or one limit of the methodology itself (e.g. the fact that observers might not detect an individual although it is still alive). Strikingly, very few studies have yet assessed the robustness of one fundamental assumption of all CMR-based inferences: marks are supposed definitive and immutable. If they are not, how are estimations affected? Addressing this issue is the main goal of the paper by Touzalin et al. (2023), and they did a very nice work. But, because the answer is not that simple, it also calls for further investigations.

When and why would mark loss bias estimation? In at least two situations. First, when estimating survival rates: if an individual loses its mark, it will be considered as dead, hence death rates will be overestimated. Second, more subtly, when estimating transition rates: if one individual loses its mark at the specific moment where its state changes, then a transition will be missed in data. The history of the marked individual would then be split into two independent CMR sequences as if there were two different individuals, including one which died.

Touzalin et al. (2023) thoroughly studied these two situations by estimating ecological parameters on 1) well-thought simulated datasets, that cover a large range of possible situations inspired from a nice compilation of hundreds of estimations from fish and bats studies, and 2) on their own bats dataset, for which they had various sources of information about mark losses, i.e. different mark types on the same individuals, including mark based on genotypes, and marks found on the soil in the place where bats lived. Their main findings from the simulated datasets are that there is a general trend for underestimation of survival and transition rates if mark loss is not accounting for in the model, as it would be intuitively expected. However, they also showed

from the bats dataset that biases do not show any obvious general trend, suggesting complex interactions between different ecological processes and/or with the estimation procedure itself.

The results by Touzalin et al. (2023) strongly suggest that mark loss should systematically be included in models estimating parameters from CMR data. In addition to adapt the inferential models, the authors also recommend considering either a double marking, or even a single but 'permanent' mark such as one based on the genotypes. However, the potential gain of a double marking or of the use of genotypes is still to be evaluated both in theory and practice, and it seems to be not that obvious at first sight. First because double marking can be costly for experimenters but also for the marked animals, especially as several studies showed that marks can significantly affect survival or recapture rates. Second because multiple sources of errors can affect genotyping, which would result in wrong individual assignations especially in populations with low genetic diversity or high inbreeding, or no individual assignation at all, which would increase the occurrence of missing data in CMR datasets. Touzalin et al. (2023) supposed in their paper that there were no genotyping errors, but one can doubt it to be true in most situations. They have now important and interesting other issues to address.

References:

Frédéric Touzalin, Eric J. Petit, Emmanuelle Cam, Claire Stagier, Emma C. Teeling, Sébastien J. Puechmaille (2023) Mark loss can strongly bias demographic rates in multi-state models: a case study with simulated and empirical datasets. BioRxiv, ver. 3 peer-reviewed and recommended by Peer Community in Ecology. https://doi.org/10.1101/2022.03.25.485763

Reviews

Evaluation round #2

DOI or URL of the preprint: https://doi.org/10.1101/2022.03.25.485763
Version of the preprint: 2

Authors' reply, 12 October 2023

Dear referees, thank you for your review. This latest version takes your comments into account, in particular those of Dr. Sylvain Billard, and an effort has been made on the writing to make reading more pleasant without changing the content.
All the best,
on behalf or the authors,
Fred Touzalin

Decision by Sylvain Billiard ⬤, posted 24 August 2023, validated 28 August 2023

Recommendation after minor revisions

Dear authors,
a reviewer and myself have thoroughly evaluated the revised version of your manuscript. We both agree that you did a very nice job and I will be happy to recommend it.

You will find attached a pdf file with many annotations, comments and other minor corrections I would like you to consider as they would further improve the quality of your paper. The large majority of these corrections and suggestions are languages, typos, consistencies in the redaction or notation, etc. Even though I am not a native english speaker myself, I found that the english could be susbtantially improved. If by any chance you could find some help for that, I think it would help the diffusion of your paper.

You will also find a couple more substantial comments but that do not need much work.
As soon as the new revised version is submitted, I will publish my recommendation.
Best regards,
Sylvain Billiard **Download recommender's annotations**

Reviewed by **Olivier Gimenez**, 22 August 2023

I have read the revised manuscript and the answers of the authors to my comments, and I'm happy with this new manuscript. Congrats to the authors on a cool paper.

Evaluation round #1

Authors' reply, 12 August 2023

Download author's reply

Decision by **Sylvain Billiard** ⓘ, posted 27 May 2022

Recommendation pending revisions

Dear authors,

based on the reports of three external reviewers, my own reading of your paper, and the help of Camille Jolivel for an extra careful reading of your manuscript, I would be happy to recommend your paper for PCI Ecology, pending some modifications and corrections.

The three reviewers, myself and Camille Jolivel have appreciated a lot your paper. The topic discussed is very interesting because CMR-based methods consider heavy assumptions, which could have large consequences on the final results. It is therefore interesting to see to what extent these assumptions are justifiable. The particular impact of mark-loss on estimation biases is scarce in the literature and is worth being studied further as you show here, especially because mark losses can have counter-intuitive effects.

Please find in the companion file a complete and detailed list of comments and suggestions.

Dr. Sylvain Billiard for PCI Ecology

Download recommender's annotations

Reviewed by **Devin Johnson**, 24 May 2022

The authors created an extensive simulation experiment to study the effect of mark-loss on bias of parameter estimates in multistate capture-recapture models. Overall the author did a good job illustrating the fact that mark-loss can induce substantial parameter bias in multistate models. Moreover, this bias can present itself in an unintuitive fashion due to the complexity of the model and the interactions of the parameters in the likelihood.

Although it is strictly a personal preference, the article might appeal to the ecological community that uses these models if the authors illustrated some of these bias effects on the real scale of the parameters in the main protion of the paper (not in an appendix). I.e., for perhaps with just the bat analysis, the authors could create a figure with, say survival or transistion probabailies under each model. That way users can see the effects in real terms, rather than EMD oir ROPE metrics that don't have a meaningful interpretation in real parameter space.

In addition to my overall comments, I have attached an annotated pdf with more specific comments and questions.

–Devin Johnson

Download the review

Reviewed by **Olivier Gimenez**, 03 May 2022

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Reviewed by anonymous reviewer 1, 17 May 2022

The manuscript presents a simulation and analysis of real data, assessing the bias due to tag loss in parameter estimates from multi-state CMR models. This is a timely contribution, as the effects of tag loss in CMR models have received some attention in the literature, but not in the case of multi-state models. I do not have the technical expertise to evaluate the correctness of the code presented (I trust other reviewers will do that), but I found the text clear and generally easy to understand what was done. The introduction is possibly the part of the manuscript that could do with a bit more work. Some sections, such as between lines 62-67 could use more references. The results and figures in the manuscript are clear, although I found that the supporting information is quite extensive and difficult to follow. I agree with the interpretation of the results, that tag loss is relevant and should be taken into account in CMR studies. To me it was also surprising that it biased the transition probabilities more strongly than survival estimates. The need for double marking is also an important message that the authors properly emphasize.