TRAINING WORKSHOP ON THE BYCATCH ESTIMATOR TOOLKIT

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SUMMARY

The R package BycatchEstimator uses model-based and design-based procedures in a semi-automated process of estimating total annual bycatch by expanding the data from an observer program to the total effort from logbooks or landings records. The authors of the tool conducted a training workshop in Madrid on 15-17 July, 2024. The goal of this training was to provide scientists responsible for bycatch and discard reporting with the tools and skills they need to expand observer data to the total fishery and provide discard estimates. The participants discussed possible improvements to the tool and also applied the tools to their own data sets.

KEYWORDS
Bycatch estimation, catch statistics

1. Introduction

Babcock (2022) has developed a toolkit that uses model-based and design-based procedures to estimate total annual bycatch by expanding the data from an observer program to the total effort from logbooks or landings records. This toolkit has previously been tested using simulated and actual data to evaluate its utility for bycatch estimation in ICCAT CPC fisheries (Babcock and Goodyear 2021; Babcock et al. 2022; Babcock et al. 2023, Babcock et al. 2024).

The author of this tool (Babcock) and an expert in bycatch estimation (Adao) conducted a training workshop in Madrid on 15-17 July, 2024, at the ICCAT offices. The goal of this training was to provide CPC scientists responsible for bycatch and discard reporting with the tools and skills they need to expand observer data to the total fishery and provide discard estimates. The participants discussed possible improvements to the tool and also presented preliminary results from their own data sets. This report summarizes the set of recommendations provided by participants as it relates to training and user guide materials, and technical improvements to the toolkit. Outputs of a discussion on what information should be contained in a SCRS document presenting bycatch estimation results are also included in this report.

2. Methods

2.1 Bycatch estimator toolkit

The bycatch estimator toolkit is a statistical framework for bycatch estimation that has been developed as a freely available R package under the title BycatchEstimator (Babcock 2022). Model-based bycatch estimation uses generalized linear models (GLM) based on the user's choice of observation error models (e.g., delta-lognormal, negative binomial) and predictor variables (e.g., year, season, depth). Information criteria (AICc, AIC or BIC) can be used to find the best set of predictor variables, and cross-validation can be used to compare observation error models. The selected GLMs are used to predict total bycatch in all logbook trips and total bycatch is estimated by summing across trips. The design-based methods include a stratified ratio estimator, and the delta-lognormal estimator of Pennington (1983), and the user may specify the stratification variables for these estimators (e.g., seasons, spatial areas). For the design-based estimators, if any strata have less than a user-

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specified number of observations (e.g., sets), estimates for those strata are made by pooling across the user's choice of stratification variables. The tool can also be used to estimate an annual CPUE index calculated only from the observer data using the model-based methods.

2.2 Workshop structure and training materials

A set of presentations and R tutorials have been developed for a three-day training workshop, which was presented for the first time in 2023 (Babcock et al. 2024). The current workshop took place over three days (15-17 July, 2024), in which the first day and part of the morning of the second day involved presentations of the training materials, and the rest of the workshop involved the participants working with the BycatchEstimator tool with their own data. The final session on day three involved the participants presenting the results from their analyses to the group and sharing their challenges when conducting the analyses.

3. Results

3.1 Group discussions

There were twelve participants, who brought data on either bycatch or discards from longline and purse seine fisheries. Most of the participants were able to produce data checking plots and preliminary bycatch or discard estimates with either design-based methods, model-based methods or both. One-to-one support from the facilitators was provided throughout the workshop, and extra code was made available to participants that had particular requirements with their data sets (e.g. code to run the tool using only 1 year of data; code for creating simulated observer data). Participants gave positive feedback on the usefulness of the BycatchEstimator tool. Much of the discussion throughout the meeting centered on the kinds of data issues that come up when calculating discards to report to ICCAT.

Discards generally need to be reported in weight rather than numbers. If size data are available, numbers can be converted to weight in the original observer database and the calculations can all be done in weight in the BycatchEstimator. The tool does not provide number to weight conversions. If the numbers are converted to weight using a single number for average size, then the conversion can be done either before or after using the tool to estimate total bycatch.

If it is possible to match sets or trips between observer and logbook data (i.e. to identify which logbook effort has been observed and which has not), then it is possible to get more precise estimates of bycatch in the model-based methods by including the observed bycatch as a known constant and only estimating bycatch for the unobserved effort. This method is not necessary but may be desirable for some datasets, particularly with high observer coverage where the alternative of estimating bycatch across the whole fishery would overestimate the variance of the total bycatch estimate because a substantial fraction of the bycatch is actually known without error from the observer data. Some participants were able to do this with their data. However, observed trips that do not correspond to trips in the logbook data cause problems because it is not clear which logbook trips have bycatch records in the observer data, and which are unobserved and need estimates of bycatch based on predictions from the model. When users attempt to include observed catch as a known constant in the model-based total bycatch estimates (includeObsCatch = TRUE), the tool should provide useful error messages if there are unmatched trips or the effort is inconsistent between observer and logbook data. Trips in the observer data that are not present in the logbook data may indicate data quality problems, such as fishers not turning in logbooks.

The group discussed whether variance estimates are needed in discard estimates, since these don't necessarily need to be reported in Task I (reporting of all nominal catches). Variances are useful as a diagnostic of the quality of the bycatch estimates, so they should be reported in SCRS documents reporting bycatch or discards. Also, variances can potentially be used in some stock assessment models, even if they are not included in the Task I data.

Although the BycatchEstimator tool can produce CPUE estimates from the observer data, the best model for deriving a CPUE index may not be the same as the best model for bycatch estimation. The tool focuses on finding the model that best predicts bycatch, which can be found with information criteria and cross-validation. Methods such as stepwise variable selection using deviance explained, which are commonly used in CPUE standardization, are not included in the tool. The difference between CPUE standardization and bycatch

estimation is clear when there has been a change in fishing practice (e.g. fishing deeper, change of hook type, use of bycatch mitigation gear, changes in regulations) that changes catchability. These catchability variables must be modeled to remove their effect in CPUE standardization, but they should be included for bycatch estimation because they improve the quality of the bycatch estimates in the unsampled component of the fishery. If such variables are not available in the logbook data, bycatch estimates can be biased. Another potential source of bias is when fishers' decisions to discard are variable, for example if they sometimes discard large amounts due to technical difficulties, and this is not documented in the logbook data.

3.2 Improvements to the tool and training materials

A new function called "dataCheck" has recently been added to the tool, to allow users to verify that all the predictor variables are consistent between the observer and logbook data, identify strata in the experimental design with no observations of the species of interest, and check for outliers in the CPUE (e.g. **Figure 1**). The group found this useful, and recommended adding more plots and automated data checks. Suggested improvements to the data checking function include:

- Add explanatory warning messages if, for example, any factor levels are different between the observer and logbook data.
- Add a catch outlier plot, not just CPUE.
- Add effort time series by factor.

Additional suggestions to improve useability of the tool:

- Use clear and consistent column labels in the output files (e.g. ratioMean is the mean bycatch calculated by the ratio estimator not the mean of the ratio).
- Make sure pooling works if the pooling variables are different from the stratification variables, and provide more user-friendly summaries of how the pooling worked (e.g. which strata, if any, were still below the cutoff after all pooling), rather than just the current .csv file.
- Clarify which variables are needed for running multiple species. Verify that this works if there are NA values in the catch for some species.
- Make it easier to run the tool with only one year of data, or with a time variable other than Year.
- Provide error message if the observer data includes sets or trips that are not in the logbook data, when matching the datasets to include observed catch as a constant.
- Add the ability to calculate design-based estimators for specified subsets of the data (e.g. ICCAT areas for each species or gears) and make sure variances are calculated correctly.
- Provide useful guidance if no models are able to converge (This is usually caused by a data format problem).

Additional information to the training materials:

- Add a slide on how offsets work in negative binomial models.
- Add guidance on how the quantile (DHARMa) residuals work and how they should be interpreted.
- Provide more explanation of how to match trips or sets between observer and logbook data.
- Improve labels and axis titles of graphs in R tutorials.

3.3 SCRS document describing bycatch estimation

The group discussed what kinds of information should be provided in SCRS documents providing bycatch or discard estimates made using the BycatchEstimator tool. The following outputs were discussed.

- Explanation of how observers are allocated to vessels.
- Separate or classify catches into live or dead discards, and retained catch.
- Data checking figures, including information on sample sizes and the amount of effort observed and unobserved by levels of variables.
- For design-based methods, an explanation of if any pooling was done.
- For model-based methods, model selection tables and residuals for the selected model.
- Figures showing the estimated total catches with confidence intervals, perhaps for multiple methods.
- A table providing the estimated bycatch, standard error, and confidence interval for the authors' preferred estimation method. If presenting discards of an assessed species, this should be in the areas designated by ICCAT for the species. This would be the potential input to a stock assessment model.

4. Discussion

The group made many useful suggestions for improving the BycatchEstimator tool and the training materials, which the authors are interested in applying. The remaining improvements discussed in the 2023 workshop should also be implemented, such as improving the workflow of the tool, so that data checking and design-based estimation can be done without having to specify any settings for model-based estimation.

There was some discussion of developing a web-based version of the tool, perhaps using R Shiny, so that people who are not familiar with R could use the tool. This could focus on data checking and design-based estimators, as many users would not need the model-based methods.

There is a need to formalize guidance for presenting SCRS documents on bycatch and discards. The discussion from this workshop could serve as a starting point for a discussion at the working group on Stock Assessment Methods (WGSAM). Although CPCs must report live and dead discard estimates along with other fisheries statistics through the established ICCAT data reporting process, it is also important to document the methods clearly using an SCRS document, especially when the CPC first begins reporting bycatch or discards using the method. Furthermore, ICCAT requires (Rec. 2019-05, paragraph 16) that CPCs present the statistical methodology used to estimate dead and live discards to the SCRS. Such documents can be presented in either the WGSAM, the Sub-Committee on Statistics, or the appropriate species working group.

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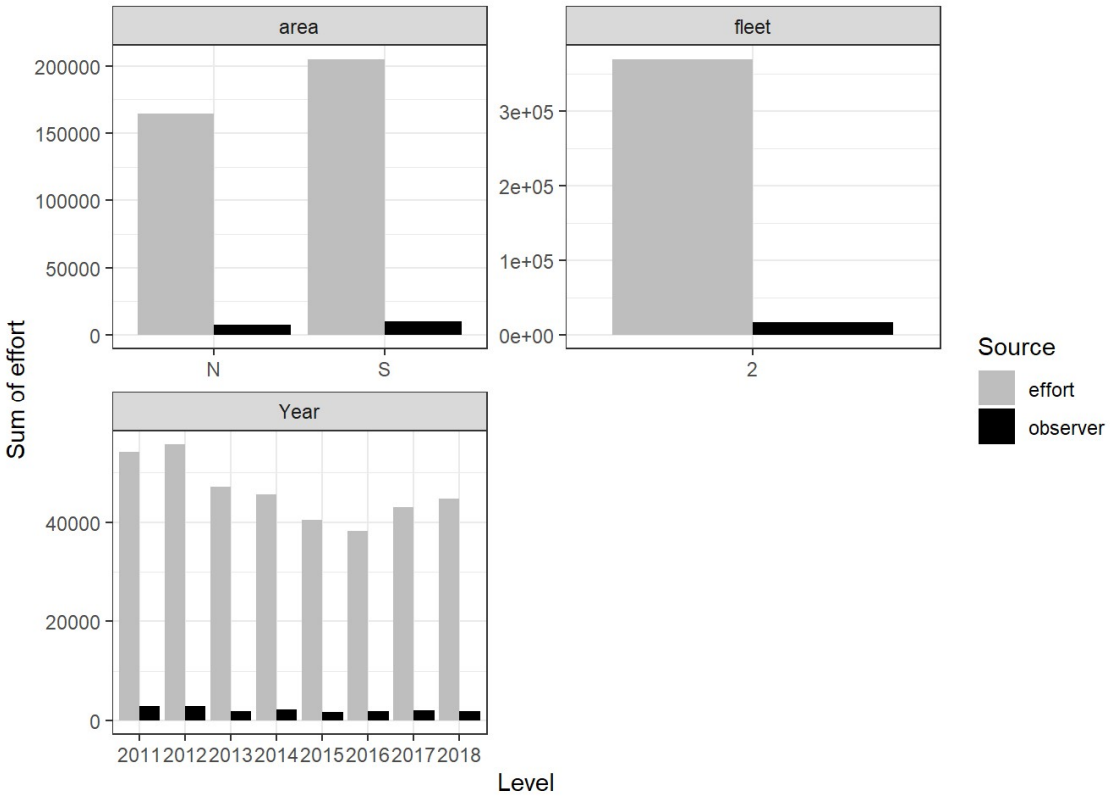

Figure 1. Example data checking plots from simulated data, showing the total effort in the observer and logbook (effort) datasets across several factor variables (area, fleet and year).