



Cumulative Discard Methodology Review Greater Atlantic Regional Office Summary and Response April 5, 2017

Introduction

During November 7-9, the Greater Atlantic Regional Fisheries Office (GARFO) hosted a review of the cumulative discard methodology (CDM) used to track discard catch for management purposes. When developed in 2010, the initial review of the methodology recommended another review when more data was available. This review is the fulfillment of that recommendation.

To maintain a reasonable project scope, two constraints were needed to regulate the method review. First, alternative statistical methods to the cumulative method were not evaluated. For Northeast Multispecies, alternatives for discard methods will be reviewed in upcoming Council actions. Second, it is assumed for this review that observer coverage is representative and unbiased. However, as noted by the reviewing panelists, this is an extremely important issue that merits careful review in its own right to ensure the overall performance of the monitoring system.

More information on the CDM review is posted online:

<https://www.greateratlantic.fisheries.noaa.gov/aps/discard/review/index.html>.

Acknowledgments

The CDM review material, programs, and analysis was developed and presented by staff of GARFO's Monitoring and Analysis Section. I would like to express my appreciation for each participant's contribution. I also wish to thank GARFO and other NOAA Fisheries staff who helped make this well-received event.

A special thanks to the two panelists provided by the Center for Independent Experts:

- Robin Cook, Ph.D., University of Strathclyde, Glasgow, Scotland
- Shijie Zhou, Ph.D., CSIRO Oceans & Atmosphere, Australia

Their feedback and recommendations were insightful and will be helpful in future work with the cumulative discard methodology.

Remarks

Recognizing that the principal thrust of the CDM analysis was to identify better stratification schemes and transition rates and stating that a thorough analysis using the best available science was applied within the Terms of Reference limits, the reviewers noted that, with the exception of the longfin squid fishery where trimester stratification was demonstrably better, analyses tended not to show, definitively, improved stratification schemes. The results did reveal possible further avenues of analysis, but it was not possible to firmly choose revised stratifications.

When highlighting several strengths and weaknesses of the CDM based on the separate ratio estimator identified as the preferred method at the 2010 review, the panelists noted that the use of a design-based ratio estimator limits the flexibility with which the discard rate can be estimated. For this reason, both reviewers advocated for exploring a model-based approach to rate estimation.

As a modeling tool, the reviewers agreed that the `discard` package provides a useful and convenient framework for calculating the in-season discard rate and cumulative discard for a given species or stock, while allowing for multiple options regarding the weighting of data over time (i.e., transition rates) and stratification scenarios. The bootstrapping exercises revealed the variety of trends that may have been observed and estimated in a given year under a particular approach, and had some value in identifying scenarios where in-season discard estimates may have falsely indicated exceedance of a catch quota.

A weakness noted by the reviewers in the bootstrapping assessment of stratification and transition rate approaches was its focus on precision and not accuracy. The latter can only be addressed by a simulation study where the underlying truth is known. Any comprehensive assessment of stratum definitions, data weighting schemes, or modeling structures would benefit from a well-developed simulation that compares estimates to a known truth regardless of whether a design-based or model-based approach is taken for estimating discards.

Model-based Approach

A model-based approach would allow for increased flexibility in how the observed data are used to quantify discards over strata, including temporal trends. Treating observed discards as a random variable with a probability distribution function opens the door to a myriad of model fitting and assessment procedures that can vary in complexity and adapt to the specific conditions of a given fishery.

In addition to the simplicity of the calculation and its explanation to a general audience, a primary benefit of the ratio estimator is the increased precision that results when the numerators (discards) and denominator (fishing effort) are highly correlated (related linearly). A simple linear model that uses fishing effort as a predicting variable can achieve similar precision while also providing a variety of potential model structures to accommodate nonrandom sampling and deviations from expected fishing behavior. A linear (or non-linear) model's complexity can also be chosen according to the quality of the model's fit using common tools for model selection, improving the ability to pool discard rates within appropriate strata.

More advanced techniques would also be possible with a model-based framework, including the use of latent variable models that could allow for estimating measurement error and/or incorporating time series structures that can capture complex within-season trends in the discard rate. The latter approach may be particularly useful in fisheries, where in-season temporal trends are highly variable across years, and possibly address problems related to the transition rate by allowing inclusion of seasonal effects and removing externally imposed time strata with hard boundaries.

R package: `discard`

To streamline the calculations used in the CDM analysis we built an R package called `discard` containing functions that can process fishery dependent data and calculate design-based estimates of discard rates under a variety of stratification and transition scenarios. Additional functions allowing for model-based estimation and simulation frameworks could be added to expand the capabilities of `discard` and allow greater flexibility in discard estimation across fisheries. Thus, the `discard` package represents a tool that can potentially be improved upon by expanding its capabilities and, with additional evaluation approaches, be used to refine the nature of CDM assessments.

The package can be downloaded from our website and will eventually be hosted on GitHub to enable interested users to contribute code or download updates as the package is further developed. The package is currently documented with help files for the various functions and includes an example dataset from the `vmstools` package consisting of ICES logbook records for two years in the North Sea, where all catch has been recorded.

While `discard` could be used in a simulation without a complete census of discards in the Greater Atlantic region, such a simulation would require specifying a probability model for the true population of discards. Alternatively, data from other sources (e.g., ICES) could provide an empirical census that could then be sampled to assess the accuracy and precision of various estimation schemes. The latter approach would be useful for identifying general patterns but not for examining specific stratum definitions in the Greater Atlantic region.