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A framework for improving accuracy in fisheries data used in stock assessments

Michael Pennington[1], Jöel Vigneau[2], Kristin Helle[1] and Jon Helge Vølstad[1]

1) Institute of Marine Research, P.O.Box 1870 Nordnes, N-5817 Bergen, Norway
2) IFREMER Port-en-Bessin Station, P.O.Box 32, F-14520 Port-en-Bessin, France

Introduction

There are basically two ways that fishery data are collected: by conducting a complete census or by using (it is hoped) a sound statistical sampling program. It is clear how a census can produce biased results. For example, fishers not reporting honestly the amount of fish caught during a trip. By contrast, bias inherent in non-census data collection program will be difficult or impossible to detect if the sampling programs is not based on a sound survey design, for example, if it employs an ad hoc sampling scheme.

Definition of bias

Bias is the difference between the true (unknown) value and the average value generated by the estimation or census procedure:

$$\boldsymbol{Bias} = \bar{\theta}_{average} - \theta_{true}$$

An avoidable source of estimation bias

Fish are collected from clusters, e.g. from a trawl haul. The consistent estimator of the mean is:

$$\hat{\mu}_1 = \frac{\sum_{i=1}^{n} M_i \tilde{x}_i}{\sum_{i=1}^{n} M_i}$$

where M_i is the number of fish in the cluster.

If the usually inappropriate estimator is used, i.e the unweighted estimator:

$$\hat{\mu}_2 = \frac{\sum_{i=1}^{n} \tilde{x}_i}{n}$$

Then the probable bias is given by:

$$Bias(\hat{\mu}_2) = -\frac{Cov(M_i, \tilde{x}_i)}{\overline{M}}$$

In words: if the measurement for a cluster is correlated with the cluster size, which is often the case, then the unweighted estimator will be biased.

*ICES WKACCU report 2008

Developing a scorecard for detecting possible bias

Bias in fisheries data used for stock assessments is difficult to quantify. The WKACCU* approach was to develop simple indicators of bias in key parameters that could be summarized in a table with a scorecard of green (minimal or no risk of bias), yellow (some risk of bias), and red (established sources of bias). The scorecards can be used to evaluate the quality of data sources used for stock assessments, and to reduce bias in future data collections by identifying steps in the data collection process that must be improved.

Sources of possible bias for stock assessments:

A) Species Identification
B) Landings Weight
C) Discard Weight
D) Effort
E) Length Structure
F) Age Structure
G) Mean Weight
H) Sex-ratio
I) Maturity Stages

Example of a scorecard for assessing the quality of landings weight data:

B - LANDINGS WEIGHT	NO BIAS	RISK OF BIAS	CONFIRMED BIAS
Recall of bias indicator on species identification	All green	List of potential bias	List of confirmed bias
1 - Missing part	Checked and Ratio = 1 OR checked and	Any other situation	Confirmed missing but not corrected
2 - Area misreporting	corrected	Any other situation	Checked and problem not corrected
3 - Quantity misreporting:	Checked and no problem OR checked and corrected	Any other situation	Checked and problem not corrected
4 - Population of vessels	Checked and no problem OR checked and corrected	-	Partially covered
5 - Source of information:	All covered	Only one source used	
6 - Conversion factor:	Several sources considered	Any other situation	CF Wrong OR Not whole and CF not used
7 - Percentage of mixed in the landings;	Whole fish OR appropriate conversion factor	Any other situation	Checked and problem not corrected
8 - Damaged fish landed:	None OR Checked and corrected	Any other situation	problem not corrected
Final indicator	No partial fish	List of potential bias	List of confirmed bias

See WKACCU report for scorecards for the other quality factors

Conclusion

Whereas precision in fisheries statistics can be improved by increasing sample sizes in data collection programs, this is not the case for bias.

The scorecards can be used to evaluate the quality of data sources used for stock assessments and to reduce bias in future data collections by identifying steps in the data collection process that must be improved.

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