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BOOTSTRAP BASED METHODS FOR ESTIMATING EDGE AND DISPERSION PARAMETERS AT MINIMUM LEVEL OF DISCARD SAMPLING STRATA

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INTRODUCTION

Fishing Discards have long been recognized as a harmful practice for fisheries, therefore, accurate and unbiased quantifications are of major concern to fisheries assessment purposes. Discard estimations in Spanish fisheries are based on stratified random sampling of trips (primary sampling unit) per *metier* and year, following the general ICES raising procedures (ICES, 2003). This sampling scheme yields analytical estimations of mean and variance with their bias and precision depending on several issues such as:

i) Method for selecting samples
ii) Variability in the data
iii) Estimator used

The high error values associated with discards sampling programs imply some levels of bias when analytical quantification is carried out . The main aim of this preliminary study is to apply bootstrap methods in order to provide robust estimations of discards. Further, we use the bootstrap to evaluate the errors associated with ordinary estimations and to explore the consequences in bias and precision under different simulated sampling scenarios. This methodology is applied here on megrim (*Lepidorhombus whiffiagonis*) discard data, which was recorded for the Spanish discard monitoring progam by observers on board the bottom trawl fleet operating in ICES Subareas VI-VII

METHOD

The Spanish Data Collection Sampling Program has placed observers onboard commercial vessel since 2003 to date. The sampling effort within fisheries is distributed into métiers (defined by gear, fishing ground and target species), and the primary sampling unit currently considered is the trip. Table 1 summarizes the equations commonly used to a by-métier quantification of discards. Alternatively, here we use the naive bootstrap (Efron, 1992) to approximate the distribution of our 2003-2008 discard statistics. Bootstrap methodology uses simulation (generation of artificial samples) as an alternative to the asymptotic theory to approximate the distribution of a given statistic and to assess its statistical accuracy.

Results from the bootstrap procedures are used to obtain Percentile- t-symmetrized and Percentile Confidence Intervals (P-ts and P). The earlier have better coverage index than both Percentile and Standard CI´s . The three proposed approaches are compared by the limit lengths performed in the present study.

The Error Coefficient of Variance Bootstrap (ECVB) from every simulation was also calculated. This statistic measures precision and bias of a given estimator. It is used, in a first step, to assess the quality of the standard mean discard estimations of megrim along the years sampled.

In addition, we used the ECVB in order to compare the quality of discard estimations under different sampling scenes. The first simulation investigates the effect of reducing sampled trips. The so called “leaving One-Trip-Out” simulation estimates yearly discards once one trip from each resampling has been removed. The ECVB yielded by this simulation is compared with the original results. The second simulation, called “Sampled hauls variation” investigates the effect at length class level of reducing sampling effort within trips (5%,10% and 15% reduction and increment of sampled hauls).This approach was carried out only for the 2008 data and resampling length classes instead of absolute values of discards.

Table 1

$$T_0 = \bar{d}_{hu} = \frac{1}{n_{hu}} \sum_{h=1}^{n_{hu}} d_{hu}$$

$$T_1 = A_u = \bar{d}_{hu} x N_{hu}$$

$$T_2 = \bar{A}_{uy} = \frac{1}{n_u} \sum_{u=1}^{n_u} A_u$$

$$T_3 = \hat{\sigma}_{uy}^{\ 2} = \frac{1}{n_u - 1} \sum_{u=1}^{n_u} (A_u - \bar{A}_{uy})^2$$

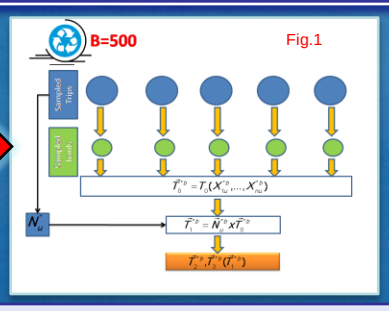


Fig.1

Table 1. Analytical formulae for calculations of discard summary statistics at metier level .
Fig.1. Simulation scheme for calculations of bootstrap discard statistics

CONCLUSIONS

1.- The bootstrap performed a non-parametric approach from our samples to the real population, allowing the construction of statistics with no asymptotic restrictions.

2.- P-ts C.I., the technique with better coverage index showed the largest length limits. This results suggest that the standard approach could generate unreliable Intervals.

3.-The removal of one sampled trip from yearly data series caused different effects on precision and bias of the estimators. Further studies is needed to clarify thie results of this simulation.

4.- Variations at sampling effort level yield strong changes in errors of discard estimations. Results suggest that low reductions in sampling effort induces dramatic quality reduction of estimations for lower discard abundances. The increment of sampled hauls produce limited improvement

5.- Intra-haul variability has not been explored in the present approach. Bootstrap schemes can be applied in further studies to explore the contribution of this source of variability to the total variability of discard programs.

STANDARD SAMPLING PROCEDURE

Fig.2

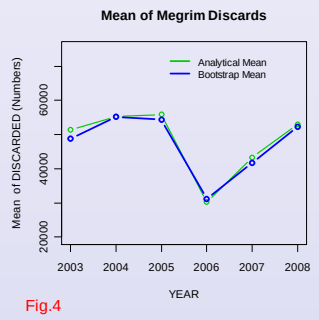


Fig.3

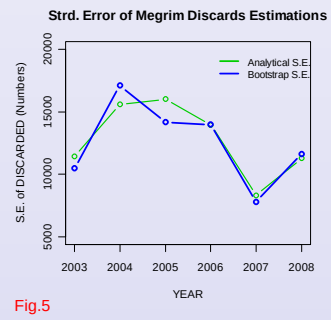


Fig.4

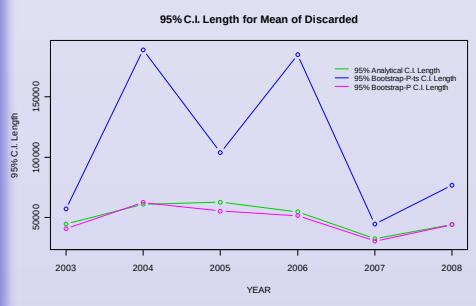
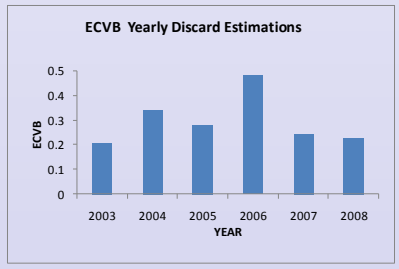


Fig.5



Mean and standard error analytical estimations of megrim discards are compared with the bootstrap approach in Figs. 2 and 3. Bootstrap performed a reliable simulation of the trip populations using the information from the sampling data. Pseudosamples allow the construction of the bootstrap C.I. drawn in Fig 4. Bootstrap-P-ts shows the larger distance between Confidence limits. Bootstrap-P and Standard yield similar width limits
Fig. 5. The Error Coefficient of Variance Bootstrap oscillate between ~ 0.2 to ~ 0.4 along the years sampled. No clear relation was found between ECVB and abundance of discarded.

LEAVING ONE-TRIP-OUT

Fig.6

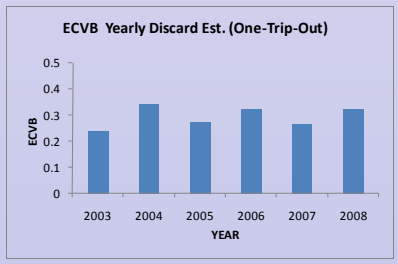
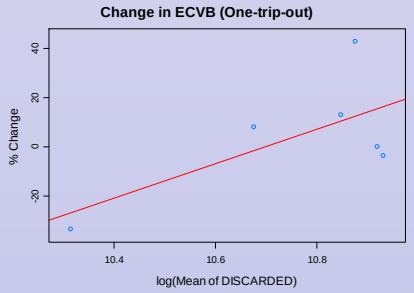


Fig.7



Figs. 6 and 7 show the effects on ECVB when one trip is dropt from yearly estimations. Left panel shows similar values of ECVB compared with the standard case. Right panel suggests that loss of precision in this simulation could be related to yearly mean abundance of discarded.

SAMPLED HAULS VARIATION

Fig.8

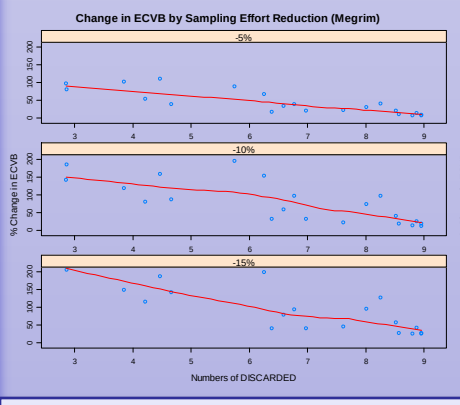


Fig.9

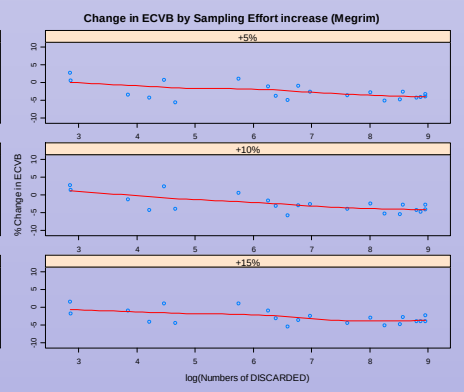


Fig. 8,9 Show the effect on ECVB of varying the sampling effort (number of sampled hauls within trip).Left panel summarizes the results from a sampling reduction scenario. The reduction of sampling hauls per trip (-5%, -10% and -15% sampled hauls) yields a clear loss of precision. This effect is negatively related with the abundance of discarded. As could be expected, the more the sampling effort is reduced, the more error increment is found. Right panel shows the results when sampled hauls are increased in every trips. The Increment of sampling effort (+5%, +10% and +15% sampled hauls) reduces the errors of the estimations slightly and this improvement reach ~ 5% for highly discarded length classes .

REFERENCES

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•Efron, B., Tibshirani, R.J., 1993.An introduction to the Bootstrap,Chapman and Hall, New York. 436pp.