Estimation of seabird captures in fisheries

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Abstract

The methods used to estimate total non-fish captures for fisheries in New Zealand and in CCAMLR fisheries are described. Varying methods are used, depending on the level of observer coverage, and the representativeness of that coverage. The advantages and disadvantages of three methods are discussed.

Introduction

Estimation of seabird and marine mammal captures in New Zealand fisheries is undertaken annually, to examine the effects of fishing mortality on protected species populations.

Data used for estimation are from observer set-by-set records, with estimation provided at the level of discreet fishery areas and target species. Up until 2007, fisher self-reporting has not been considered sufficiently reliable to allow other data sources to be used for these purposes. New reporting regimes to be introduced by 2008 will improve the quality and reliability of fisher reporting.

Observer coverage varies between fisheries, between less than 2% of effort observed (e.g. gillnet fisheries, snapper demersal longline fisheries) to over 90 % of effort observed (Joint Venture tuna longline fisheries). Trawl fisheries for middle-depths and deepwater target species are typically observed at the level of 10 – 30% of tows. Higher levels of observer coverage provide a more robust basis for management decision making, as there is more certainty about how fisheries are performing in reducing their protected species catches if observer coverage is over 20%. Figure 1 shows how variance measures (cooefficient of variation for ratio estimator, or confidence interval for random effects model) change with increasing observer coverage for 71 fishery areas over four fishing years, reducing dramatically up until 20 - 40% coverage is achieved.

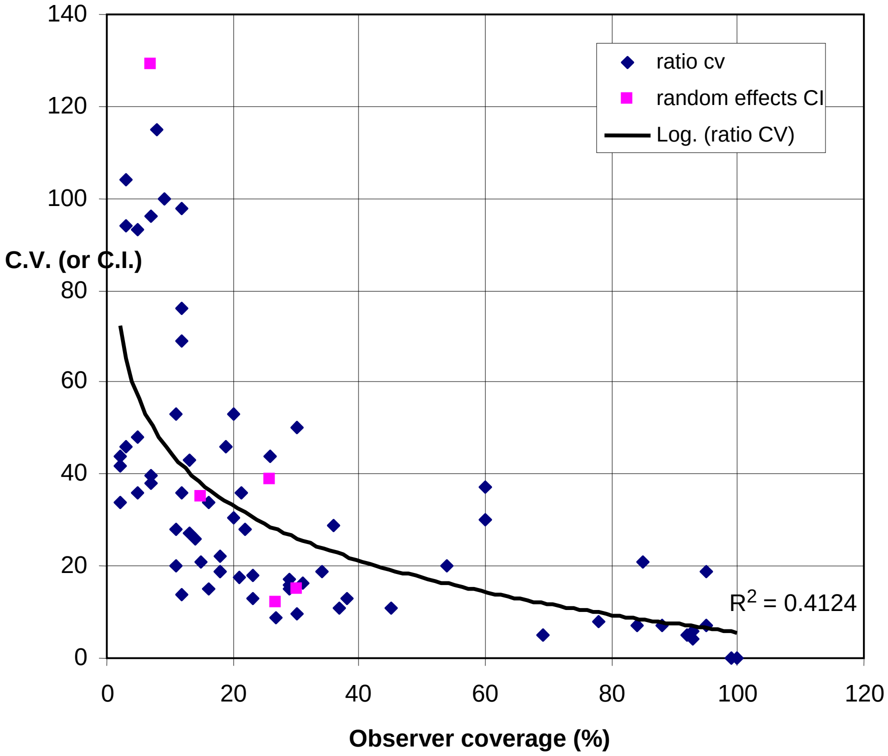

Figure 1: Observer coverage and variation indicated by the coefficient of variation (C.V.) or the confidence interval (C.I.) from all estimations of total seabird estimation by fishery/area combination from 2000-01 to 2004-05 (data from Baird 2004a, 2004b, 2005 and Baird & Smith 2007).

Researchers in New Zealand have developed a range of procedures for estimating captures of non-fish species. The main methods used are:

a) Ratio estimator and boot-strapped coefficient of variation

Baird and Smith (2007:4) state:

> *"The estimated total number of captures is obtained by multiplying the rate estimator by the total commercial effort (tows or hooks) in the fishery…The ratio method is very dependent on the assumption that the observed data are representative of the whole fishery and failure of the assumption produces a biased estimate. It has also been customary to use the theory of survey sampling from a finite population to calculate the coefficient of variation of the total captures, with the variability of the estimate of the mean capture rate determined by a bootstrap method (Bradford 2002)."*

This method is typically used where observer coverage is over 10% of effort, and the coverage representatively sampled the areas, seasons and vessel types in the target fishery. Coefficients of variation for these fisheries range from 12 to over 100% (Baird and Smith 2007). This high variance is not helpful for management of interactions between seabirds and marine mammals, and is largely generated by the low observer coverage and patchy nature of capture events in the fishery.

b) Random effects predictive model

For particular fisheries with relatively high observer coverage, and relative homogeneity in the fishing fleet, random effects models have been developed to estimate seabird and marine mammal captures. These models are useful to explore factors within the fishery (e.g. vessel type, fishing practice, capture location, mitigation efficacy) that may be affecting the probability of non-fish captures. Several researchers have used models of this type. Researchers from the National Institute of Water and Atmosphere (NIWA), Baird and Smith (2007:5) describe the random effects predictive model they built for seabird and sea lion captures:

> *"Separate models are fitted for each fishery, defined by area, target species, and fishing method, using additional covariates that model, at least partially, differences between capture rates for observed and unobserved tows (the method is only applied to selected trawl fisheries in this work). The approach also incorporates vessel random effects for modelling the correlation between tows by the same vessel of seabird capture rates. One advantage of using random effects is that it helps avoid the over-fitting that can occur when estimating a relatively large number of fixed effect parameters. Finally the error model used to model the extra-dispersion is the negative binomial model."*

This approach is recognised as highly computer intensive and requires a considerable amount of data for fitting the models. As a result it is only used for specific applications where the datasets are adequate.

Comparison of the results for the two methods (a) and b) above) is shown in Figure 2, comparing rates of capture and variance estimates for the two methods for the same fishery strata. For 5 fishery areas where ratio estimators and random effects models were used over two fishing years, there were differences in the estimates and coefficients of variation for each area. For areas with low bycatch estimates, the random effects model tended to produce lower estimates of total bycatch with lower coefficients of variation than the predictive modelling approach. For the two areas with highest bycatch totals, the random effects model tended to predict fewer captures with lower coefficients of variation than the ratio estimator.

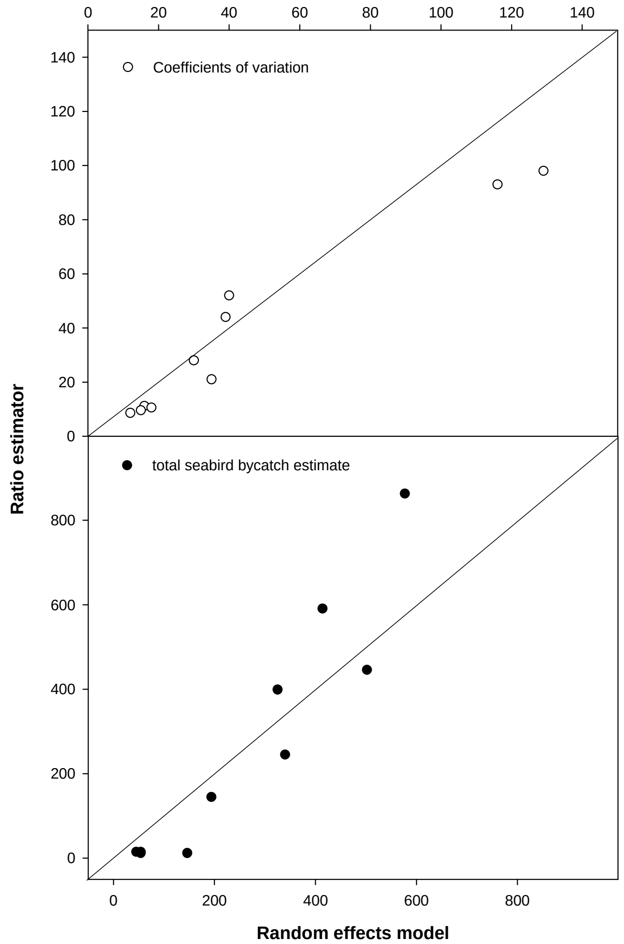

Figure 2: Comparison of results for two modelling techniques used to estimate total seabird captures and their variance in 5 fishery areas and two fishing years in New Zealand commercial fisheries.

c) Extrapolation to fleet level on the basis of high sampling percentages

In CCAMLR longline fisheries, high levels of observer coverage (100% of vessels, and over 20 - 100% of hooks sampled per vessel) have enabled a simpler extrapolation procedure to be adopted. CCAMLR working groups do not attempt to account for error in the calculations and the procedure is as follows (SC-CCAMLR-XXIV 2005: 454):

> *"The total observed seabird catch rate was calculated using the total number of hooks observed and the total seabird mortality observed…The estimated total catch of seabirds by vessel was calculated using each vessel's observed catch rate multiplied by the total number of hooks set."*

This process is very data intensive, but the simplicity of the approach leads to greater transparency of results than other methods which require a more detailed level of analysis.

Summary

Three methods of estimation of total seabird captures used in New Zealand and CCAMLR fisheries are described. Each has advantages and disadvantages. The type of model used depends primarily on the quality and availability of data. More intensive accurate methods can be applied where data are representative, high observer coverage has been achieved, and where specific questions about fishery performance are being analysed.

References

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