Analysis of Blue Marlin (Makaira nigricans) Catch Rates in the Hawaii-based Longline Fishery with a Generalized Additive Model and Commercial Sales Data

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ABSTRACT

Blue marlin, Makaira nigricans, catch rates (catch per set) in the Hawaii-based longline fishery from March 1994 through June 2002 were analyzed by development and application of a generalized additive model (GAM), and results were verified against commercial sales data. The study was conducted because the official statistics compiled from commercial logbooks include fishery observers stationed aboard commercial longline vessels (N = 8397 observed sets; 89.6% of all sets deployed between March 1994 and June 2002). It included significant predictors and explained 41.1% of the variance of observed blue marlin catch rates. The GAM coefficients were then applied to the same independent variables in the logbook report to generate corrected sets (N = 87277 sets; 90.8% of all non-observed sets deployed during the study period), for which the logbook catch rates were regressed (log-log) on the resulting predictions. The residuals were used to identify trips with possible systematic errors in species identification; the quantile forest data were checked against observed catches from the public fisheries observer database, which revealed that the logbook total for blue marlin was slightly underestimated approximately 29%, due primarily to misidentifications of striped marlin, Tetrapturus audax, as blue marlin. The 95% prediction limits for the GAM-generated estimate do not include the logbook total. Hence, the Hawaii-based longline fishery takes significantly less blue marlin than was officially reported from March 1994 through June 2002. This finding was reinvestigated comparing the GAM of logbook CPUE to the logbook data. The GAM-generated predictions were very highly correlated (r = 0.888; p < 0.001) with the logbook CPUEs, with the GAM CPUEs being 8% lower than those reported in the logbook data. The GAM catch rates were very highly correlated (r = 0.888; p < 0.001) with the logbook CPUEs.

RESULTS

GAM of Blue Marlin Catch Rates

The GAM (Fig. 1) included nine significant predictors and explained 41.1% of the variance of observed blue marlin catch rates. The first six entries yielded 95% of its explanatory power. A pronounced seasonal variation was observed in the GAM catch rates, with the highest rates in the summer months (June-August). As expected, the uncorrected logbook catch rates were generally lower than those with the corrected logbook data. The GAM catch rates were very highly correlated (r = 0.888; p < 0.001) with the logbook CPUEs, with the GAM CPUEs being 8% lower than those reported in the logbook data.

DISCUSSION

The observation that the GAM CPUEs did not include the uncorrected logbook total demonstrates that the Hawaiian longline fishery took significantly less blue marlin than was officially reported from March 1994 through June 2002. This finding was reinvestigated comparing the GAM of logbook CPUE to the logbook data. The GAM-generated predictions were very highly correlated (r = 0.888; p < 0.001) with the logbook CPUEs, with the GAM CPUEs being 8% lower than those reported in the logbook data. The GAM catch rates were very highly correlated (r = 0.888; p < 0.001) with the logbook CPUEs.