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ESTIMATING INDICES OF RELATIVE ABUNDANCE FOR YELLOWFIN TUNA FROM CATCH-PER-UNIT-OF-EFFORT ON SCHOOLS ASSOCIATED WITH DOLPHINS

by

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1. ABSTRACT

An index of relative abundance for yellowfin tuna in the eastern Pacific Ocean was calculated by standardizing catch-per-day-fished data from purse-seine vessels that set mainly on yellowfin tuna schools associated with dolphins. The explanatory variables month, latitude, vessel, use of aircraft, and sonar had little effect on the estimated index of relative abundance. The estimated index of abundance was similar to the relative vulnerable biomass for the fisheries on schools associated with dolphins from the yellowfin tuna stock assessment.

2. INTRODUCTION

Indices of relative abundance estimated from catch per unit of effort (CPUE) data are among the most commonly-used data types in fishery stock assessments. However, there are many problems with using CPUE data to create indices of relative abundance (Hampton *et al.* 2005). Analyses that attempt to overcome these problems are widely applied in fisheries stock assessment (Maunder and Punt 2005). For example, general linear models (GLMs) are commonly used to standardize CPUE for factors such as month and area.

Purse-seine CPUE data are particularly problematic. It is difficult to identify the appropriate unit of effort for such data. In general, effort is defined as the amount of searching time required to find a school of fish on which to set the purse seine.

There are three types of purse-seine set in the eastern Pacific Ocean (EPO) tuna fisheries: 1) on tuna associated with dolphins; 2) on tuna associated with floating objects; and 3) on unassociated schools of tuna. These different types of set have different characteristics and catch different species compositions and sizes of tuna. Therefore, the types of purse-seine set are more or less applicable for standard CPUE analysis. Since about 1993, most sets on floating objects have been made on artificial floating objects, called fish-aggregating devices (FADs), which are planted by the fishermen and have locator beacons so that they can be found easily. Purse-seine sets on unassociated schools are often mixed with the other two types of sets within the same trip. Therefore, for yellowfin tuna, purse-seine sets on schools associated with dolphins are the most likely to produce a reliable index of relative abundance.

We present a method to estimate relative abundance of yellowfin tuna using purse-seine catch data from sets on tuna associated with dolphins. We restrict the analysis to vessels that mainly set on schools associated with dolphins, and use a delta-gamma GLM to standardize the index for explanatory variables.

3. METHODS

Catch and effort (days fished) data were summarized by 1x1-degree square for each day for each vessel (data provided by Robert Sarazen, IATTC). We included only data for vessels that made 80% or more of their sets on dolphin-associated tunas and 90% or more of their sets on either dolphin-associated or unassociated schools.

The data set was too large for the R software to analyze the set data. Therefore, two subsets were created by grouping the data for each characteristic (*i.e.* there was only a single summarized observation for each combination of the characteristics). The first subset included time (quarters of years), month, and latitude; the second included time (quarters of years), vessel, aircraft, and sonar. Each of these data sets was analyzed independently. The explanatory variables were all included as categorical variables.

A delta-gamma GLM, using R code supplied by E J Dick, was used, due to the large number of zeros in the raw data, but was less necessary when using the data subsets, which have been grouped across sets.

4. RESULTS

All of the explanatory variables in the models were significant for both data sets based on the AIC criteria. However, the explanatory variables had little influence on the estimated index of relative abundance (Figures 1 and 2). The estimated indices are similar to the raw catch and effort data included in the stock assessment model (Figure 3). The index of relative abundance was similar for the two data sets and corresponded well with the relative biomass vulnerable to the fisheries on schools associated with dolphins estimated in the yellowfin tuna stock assessment (Figure 4).

5. DISCUSSION

The current use of catch-per–day-fished data from the purse-seine fishery on schools associated with dolphins, as an index of relative abundance for yellowfin tuna vulnerable to that fishery, appears to be reasonable. The index of relative abundance estimated in this study was similar to the relative biomass vulnerable to the fisheries on schools associated with dolphins estimated in the yellowfin tuna stock assessment. This validation is somewhat circular because catch–per-day fished from the fisheries on tuna associated with dolphins is used in the stock assessment. However, the results of the stock assessment also depend on catch and effort data from other fisheries, length-frequency data, and assumptions about population dynamics.

Several issues still need to be investigated, including the use of unaggregated set data, inclusion of additional explanatory variables, and the influence of the abundance and spatial distribution of then dolphin populations.

Punsly (1987) found that catch-per-day-fished produced a biased estimate of relative abundance due to shifts in the purse-seine fishery away from and back to dolphin-associated sets in the late 1970s and 1984-1985, respectively. Our analysis should compensate for this by using only vessels that fished mainly on dolphin-associated schools. Punsly (1987) also used search time instead of days fished as the measure of effort by eliminating the time taken to conduct a set. Using search time or area searched may remove some of the nonlinearity in the relationship between catch rates and abundance, due to less search effort per day in high-abundance years because of increased time spent conducting sets.

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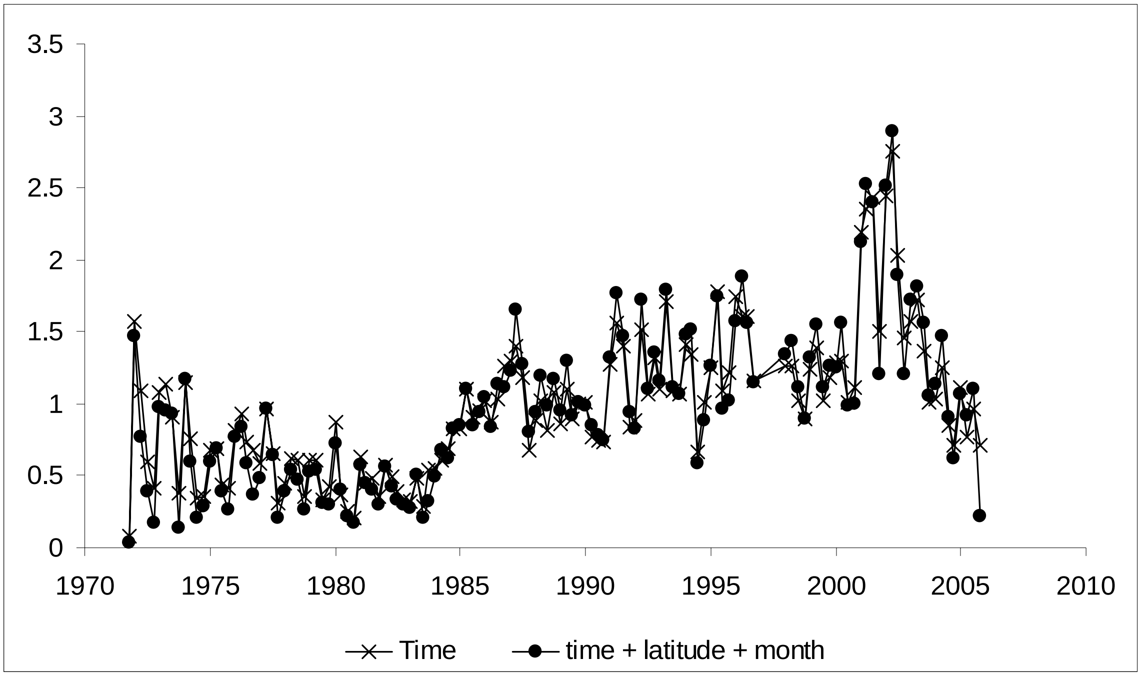

FIGURE 1. Comparisons of the index of relative abundance estimated from the first data set using only time as an explanatory variable and using time, latitude, and month.

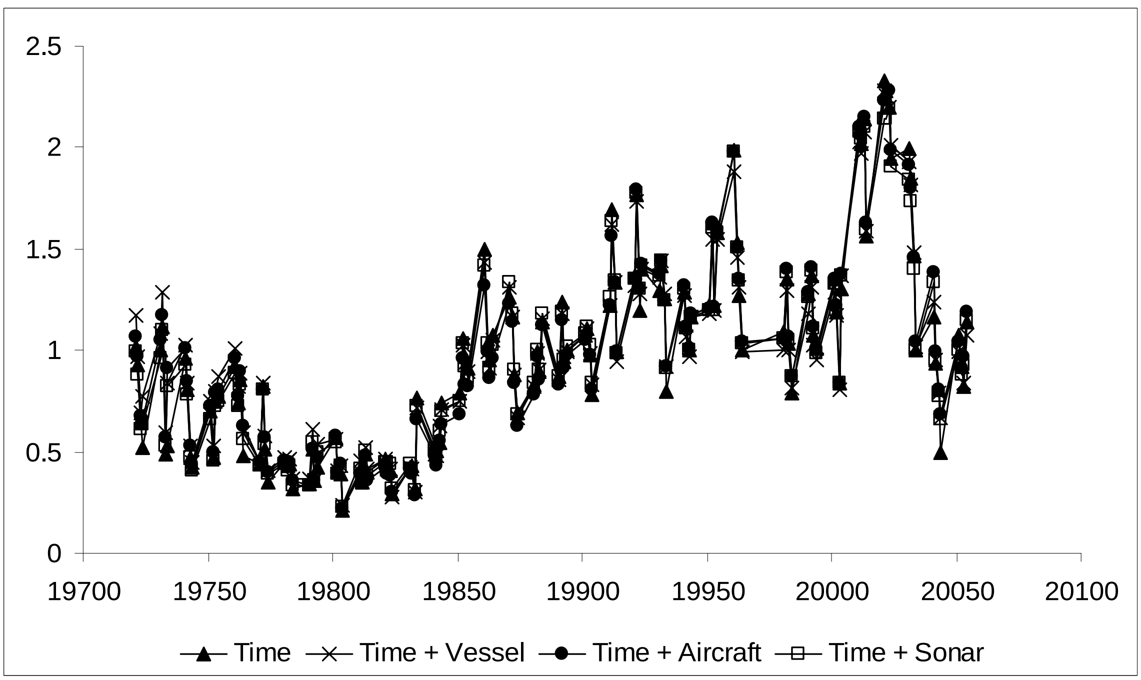

FIGURE 2. Comparisons of the index of relative abundance estimated from the second data set using only time as an explanatory variable and using time plus one of the other three explanatory variables (vessel, aircraft, or sonar).

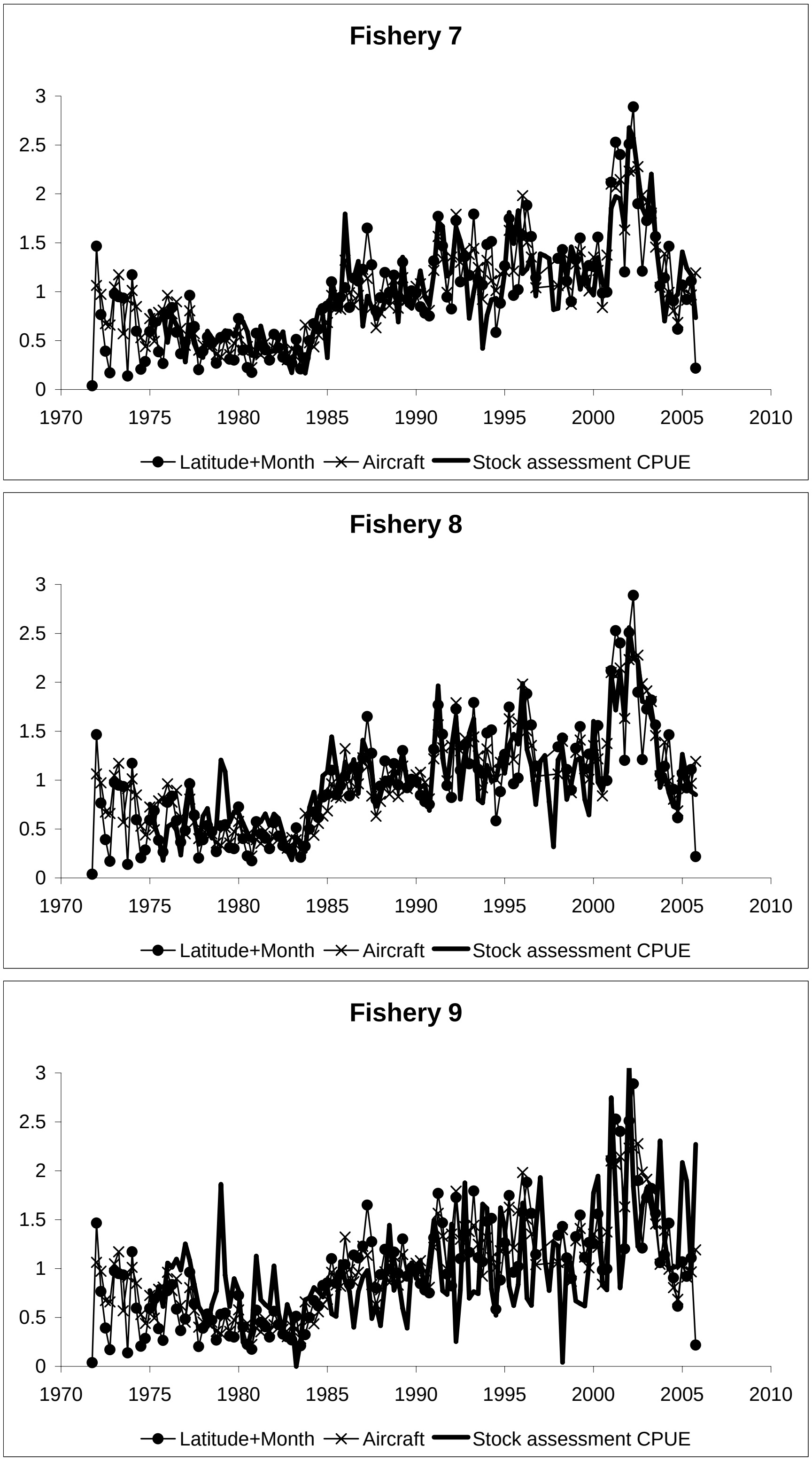

FIGURE 3. Comparison of the index of relative abundance estimated by the best model from each of the data sets with the catch divided by effort used in the stock assessment (Hoyle and Maunder, in prep.).

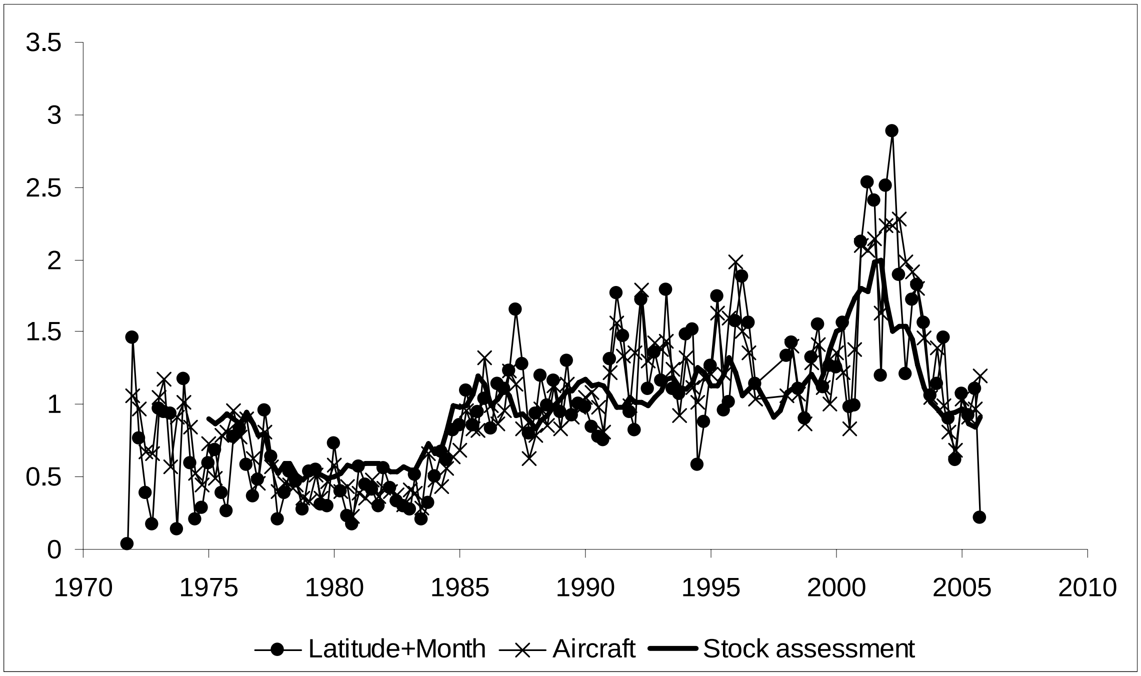

FIGURE 4. Comparison of the index of relative abundance estimated by the best model from each of the data sets with the relative biomass vulnerable to the purse-seine fisheries on schools associated with dolphins estimated by the stock assessment (Hoyle and Maunder, in prep.).