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Southeast Data, Assessment, and Review

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Catch curve analysis of age composition data for Spanish mackerel

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Introduction

The plot of catch (or abundance or proportion) at age is termed a catch curve. Catch curve analysis is a simple analysis applied to this age-specific data with the goal of estimating a total mortality rate (Z). Rarely is catch curve analysis alone used for management measures, but instead serves as a method to understand results from more complicated models. Since the method relies on age data, it can reveal any issues surrounding the observed age samples. The application of catch curve analysis in this report is for diagnostic purposes primarily.

Methods

Catch curve analysis involves a linear regression fit to the log-transformed numbers or proportions-at-age. The exponential of the estimated slope from this regression analysis gives an estimate of Z . Ideally, the age data used to create the catch curve follows a cohort through time. This requires multiple years of sampling, which is not always possible. If only one or a few years of data are collected than catch curve analysis may be applied to a single year of data, often called a “synthetic cohort.”

In both true and synthetic cohort catch curve analysis, an important assumption is that mortality and catchability must be constant with age. An additional assumption of constant recruitment is necessary when catch curve analysis is applied to a synthetic cohort. It should be noted that both of these assumptions are rarely met with fish populations.

Because of sampling/fishing gear selectivity and/or population availability, it is common for younger ages to be excluded from the age data. This necessitates the need to know the age at which all fish are susceptible to capture. Since this is often unknown *a priori*, examination of the data can be used to select an appropriate starting age for the analysis. A common practice is to take the modal age or the modal age + 1.

Another issue that comes up with limited sampling data is the presence of zeros. Since the catch curve analysis involves log-transformed data, zeros must either be dropped or treated with some additive constant.

For this analysis, using the R statistical software package, catch curve analysis was applied to both true and synthetic cohorts. Also the age at full susceptibility was chosen as the modal age and the modal age + 1. Further, we allowed for two treatments of zero values; by dropping them from the analysis and adding half of the minimum value for that cohort to the all the cohort data. Therefore, for each set of age composition data eight sets of estimates of Z were computed. Because of the dropping of zeros and the number of years of available data is not always continuous, some age vectors have few values for the regression analysis. We only used age vectors with a minimum of three values for computing the slope. Also, annual age sample sizes can be small, therefore any years with less than 50 were dropped from the analysis.

Results

For Spanish mackerel in the U.S. South Atlantic there are three primary fisheries with sufficient age data for catch curve analysis. These include commercial gillnet, commercial handline, commercial castnet, commercial poundnet, commercial other, and general recreational (MRFSS) fisheries. The modal age from the age composition data from these sources was age-1. The Z estimates using both true and synthetic cohorts from each of these fisheries are shown in Figures 1-11. A lack of consecutive years of age data prevents any catch curve analysis of true cohorts for the commercial poundnet fishery.

Results suggest total mortality rates ranging from $Z = 0.15$ up to $Z = 1.0$. The bulk of the estimates seem to be between $Z = 0.3$ and $Z = 0.6$. If we use a constant natural mortality (M) estimate of 0.35, which corresponds to the Hoenig estimate, it suggests fully selected fishing mortality rates are on the order of $F = 0$ and $F = 0.25$. The number of estimates of Z which fall below the perceived natural mortality estimate of 0.35 suggests that exploitation on this species may be small or there are some issues with the aging and/or natural mortality estimates.

Figure 1. Total mortality estimates from catch curve analysis for Spanish mackerel age data collected from the commercial gillnet fishery. Analysis was conducted by year (i.e. using synthetic cohorts). Legend indicates the age at which full selection was assumed (Age1 or Age2) and the treatment of zero values; either dropped (NoZero) or using an additive constant corresponding to half of the minimum value (MinZero).

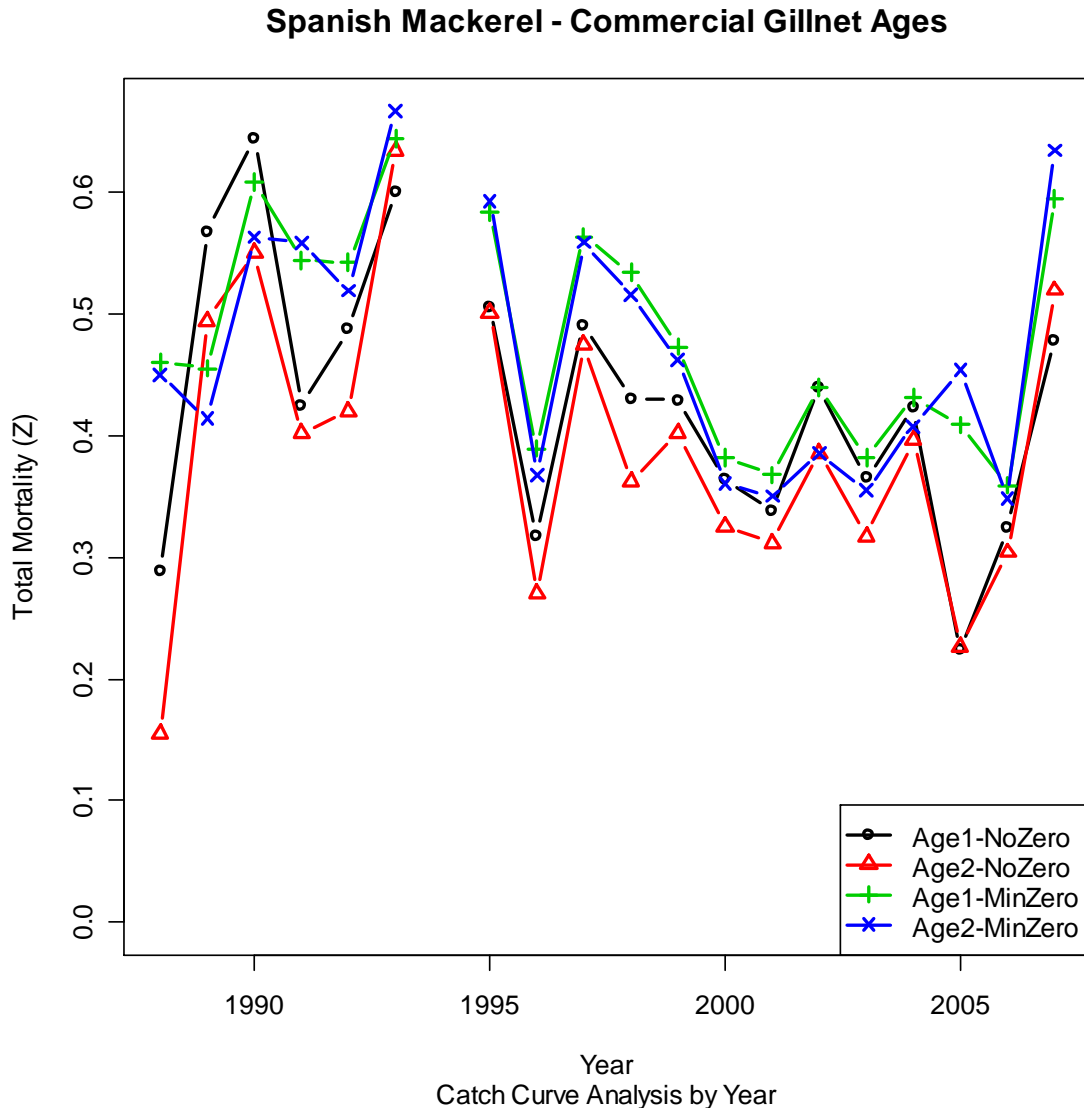


Figure 2. Total mortality estimates from catch curve analysis for Spanish mackerel age data collected from the commercial gillnet fishery. Analysis was conducted by true cohort. Legend indicates the age at which full selection was assumed (Age1 or Age2) and the treatment of zero values; either dropped (NoZero) or using an additive constant corresponding to half of the minimum value (MinZero).

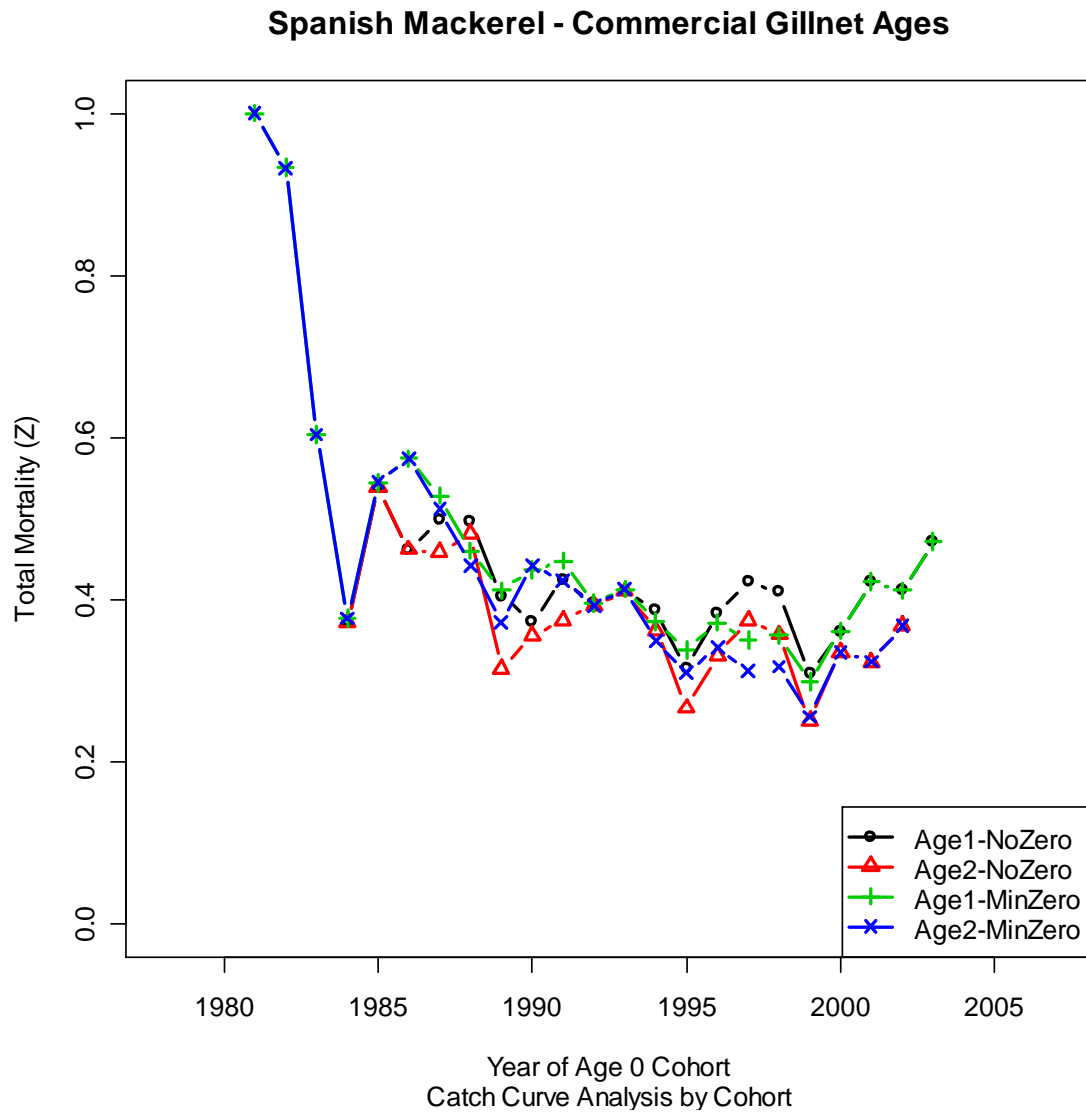


Figure 3. Total mortality estimates from catch curve analysis for Spanish mackerel age data collected from the general recreational (MRFSS) fishery. Analysis was conducted by year (i.e. using synthetic cohorts). Legend indicates the age at which full selection was assumed (Age1 or Age2) and the treatment of zero values; either dropped (NoZero) or using an additive constant corresponding to half of the minimum value (MinZero).

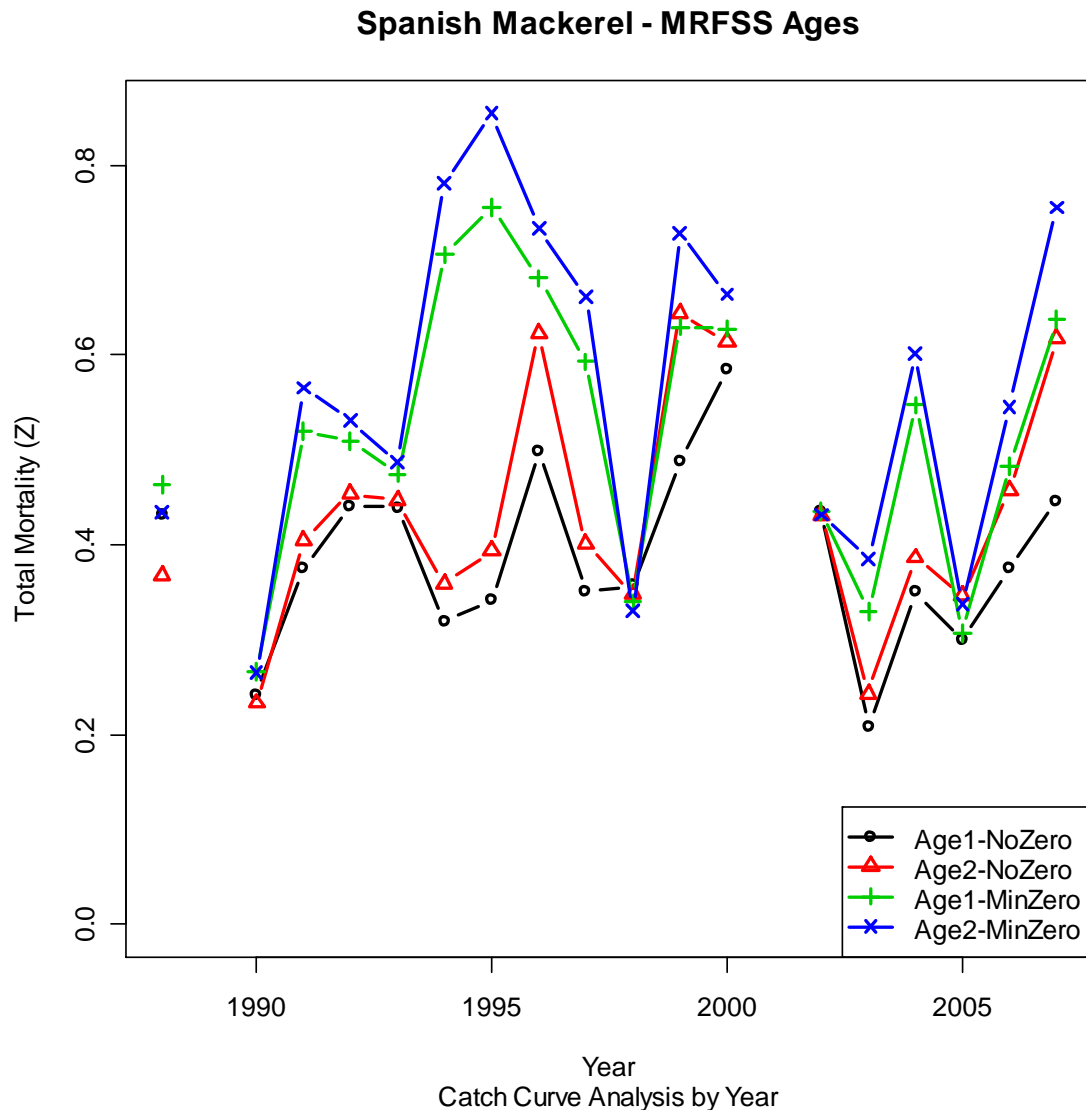


Figure 4. Total mortality estimates from catch curve analysis for Spanish mackerel age data collected from the general recreational (MRFSS) fishery. Analysis was conducted by true cohort. Legend indicates the age at which full selection was assumed (Age1 or Age2) and the treatment of zero values; either dropped (NoZero) or using an additive constant corresponding to half of the minimum value (MinZero).

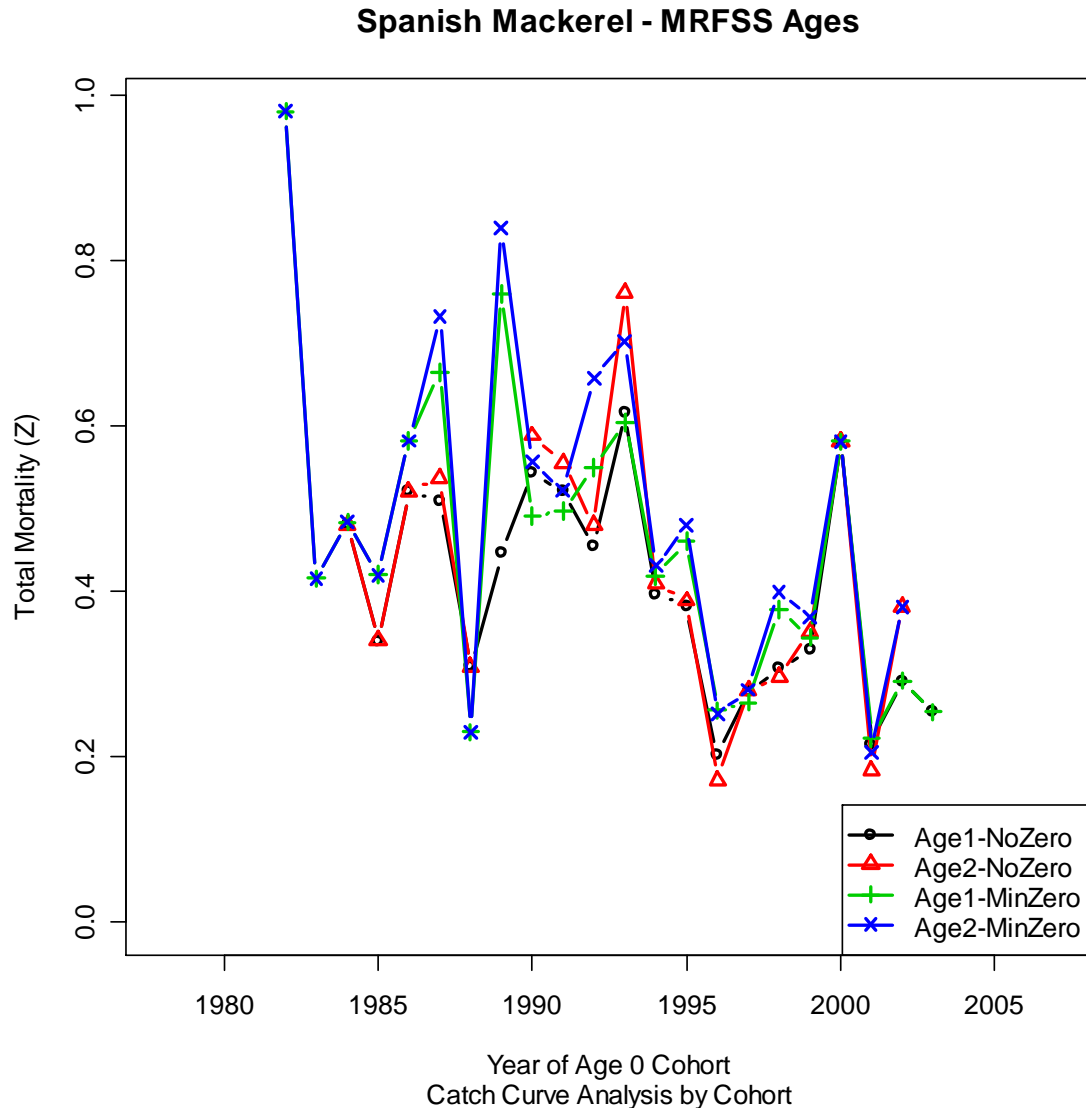


Figure 5. Total mortality estimates from catch curve analysis for Spanish mackerel age data collected from the commercial handline fishery. Analysis was conducted by year (i.e. using synthetic cohorts). Legend indicates the age at which full selection was assumed (Age1 or Age2) and the treatment of zero values; either dropped (NoZero) or using an additive constant corresponding to half of the minimum value (MinZero).

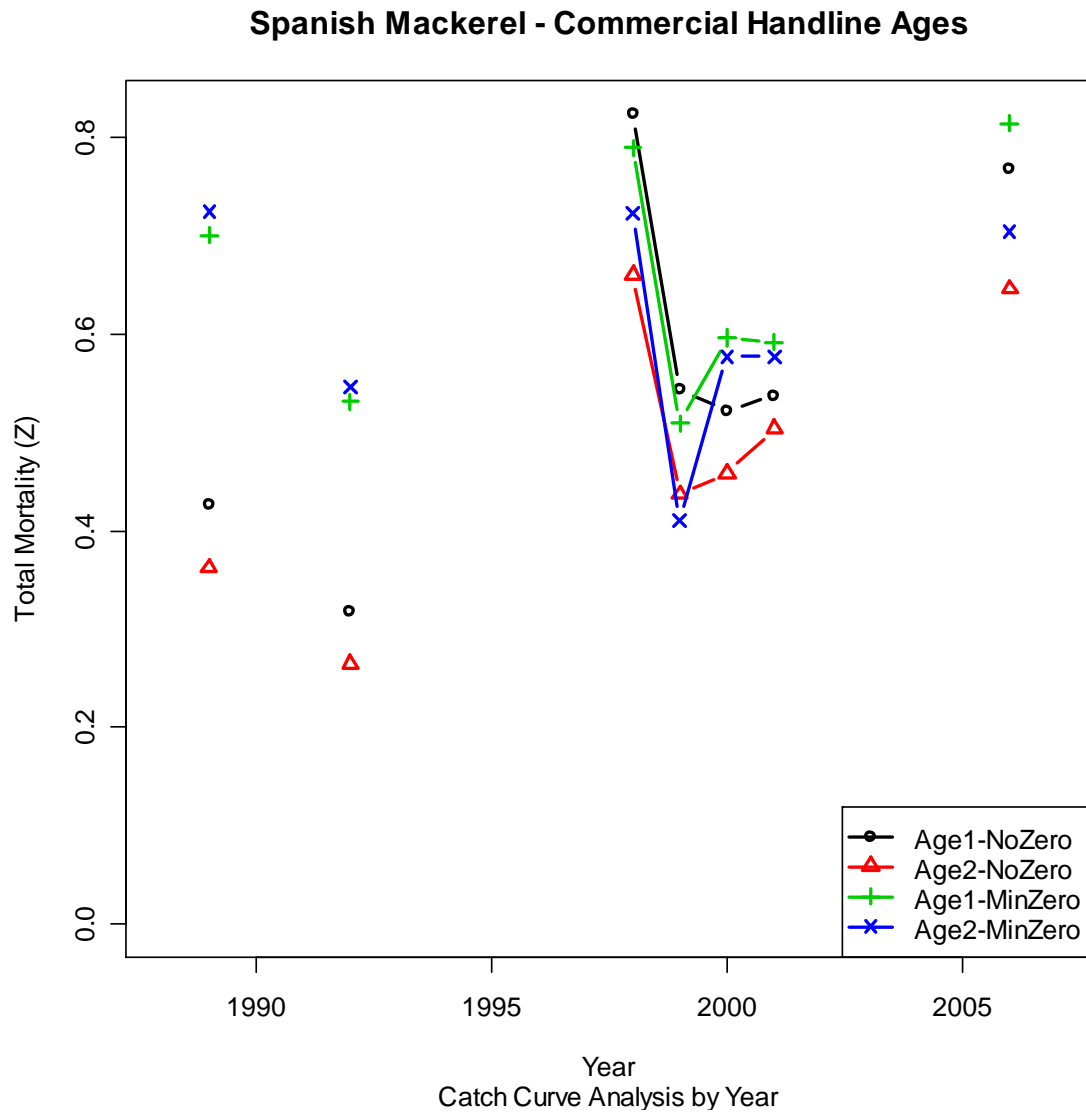


Figure 6. Total mortality estimates from catch curve analysis for Spanish mackerel age data collected from the commercial handline fishery. Analysis was conducted by true cohort. Legend indicates the age at which full selection was assumed (Age1 or Age2) and the treatment of zero values; either dropped (NoZero) or using an additive constant corresponding to half of the minimum value (MinZero).

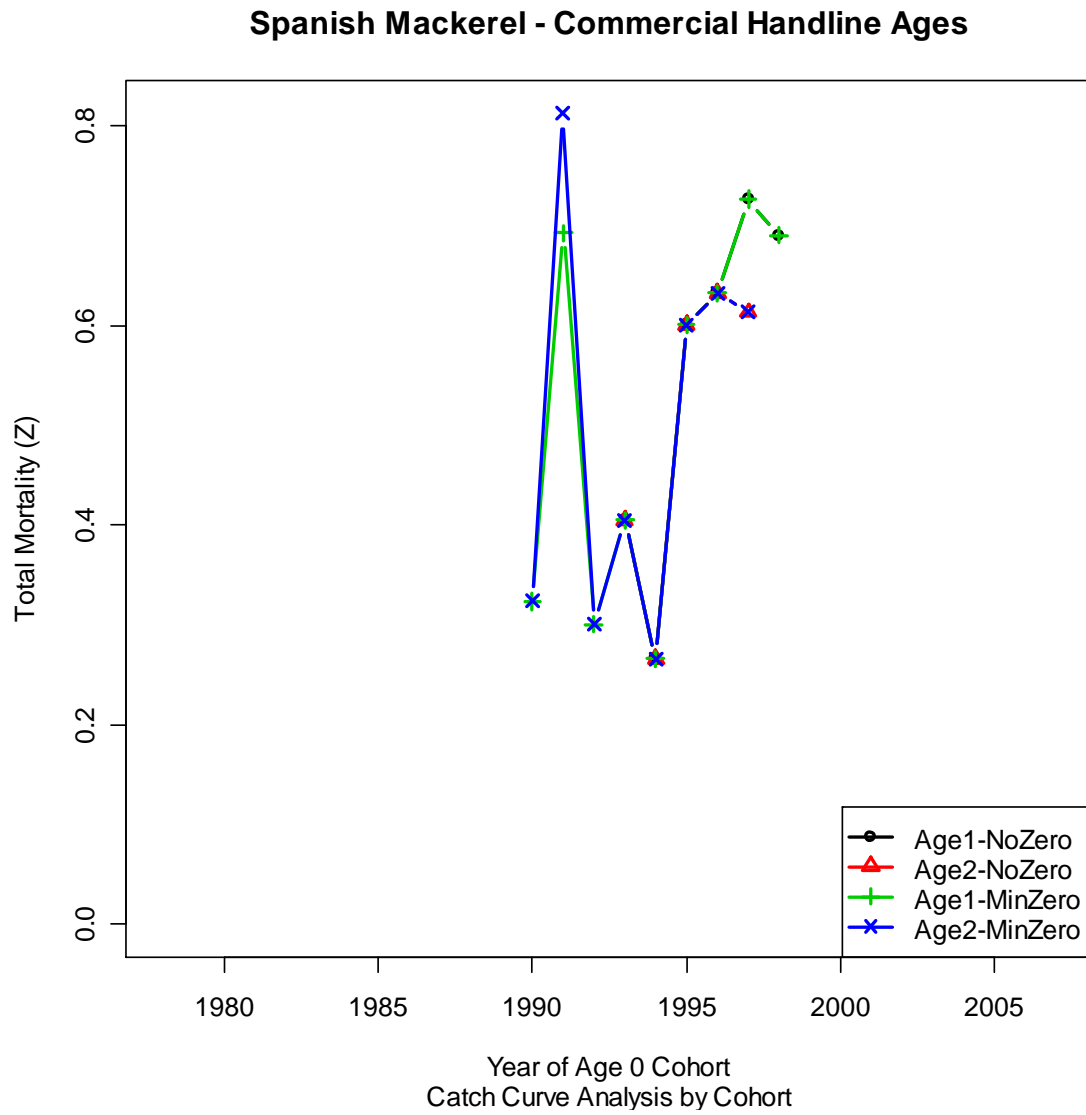


Figure 7. Total mortality estimates from catch curve analysis for Spanish mackerel age data collected from the commercial castnet fishery. Analysis was conducted by year (i.e. using synthetic cohorts). Legend indicates the age at which full selection was assumed (Age1 or Age2) and the treatment of zero values; either dropped (NoZero) or using an additive constant corresponding to half of the minimum value (MinZero).

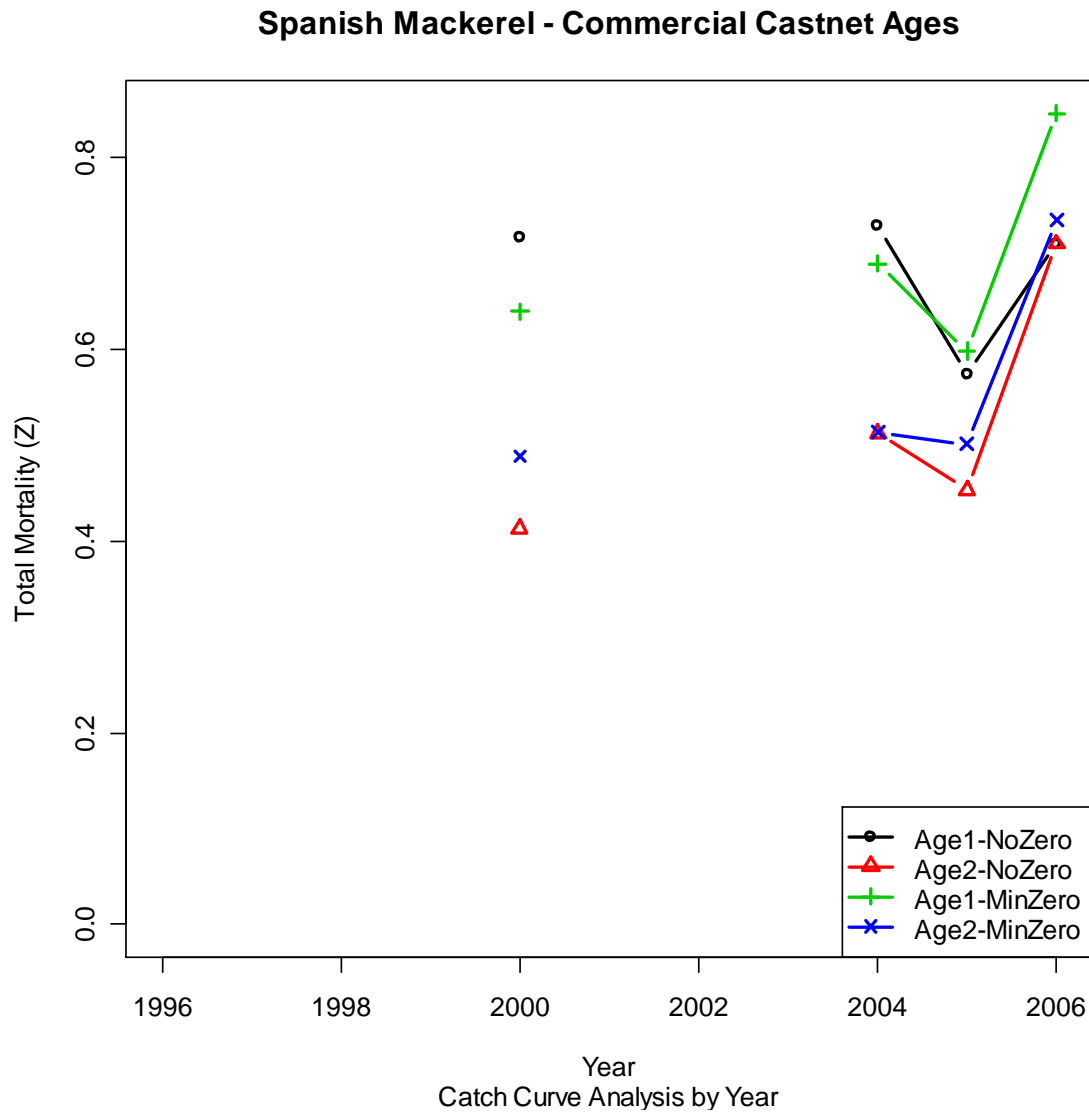


Figure 8. Total mortality estimates from catch curve analysis for Spanish mackerel age data collected from the commercial castnet fishery. Analysis was conducted by true cohort. Legend indicates the age at which full selection was assumed (Age1 or Age2) and the treatment of zero values; either dropped (NoZero) or using an additive constant corresponding to half of the minimum value (MinZero).

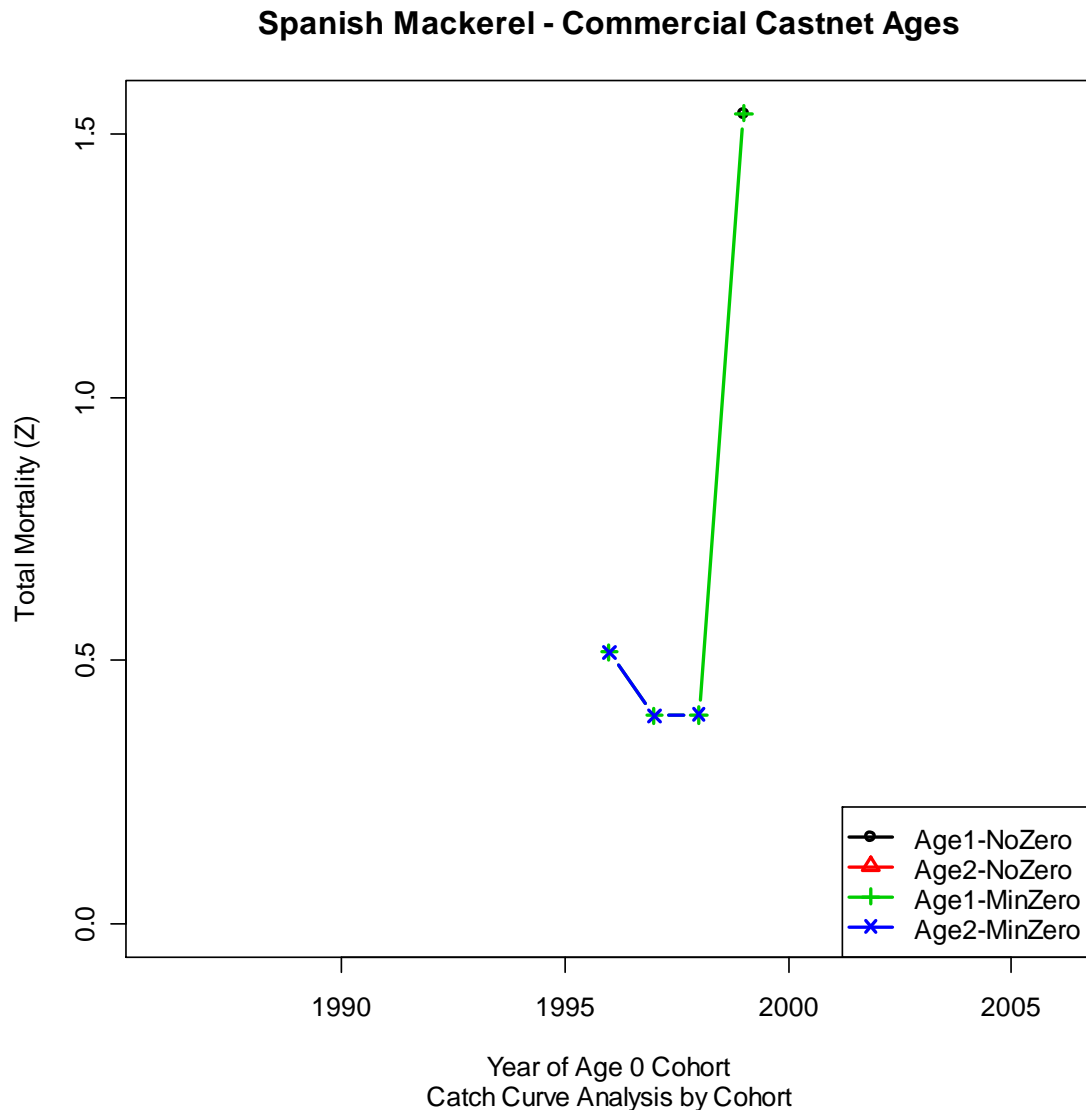


Figure 9. Total mortality estimates from catch curve analysis for Spanish mackerel age data collected from the commercial ‘other’ fishery. Analysis was conducted by year (i.e. using synthetic cohorts). Legend indicates the age at which full selection was assumed (Age1 or Age2) and the treatment of zero values; either dropped (NoZero) or using an additive constant corresponding to half of the minimum value (MinZero).

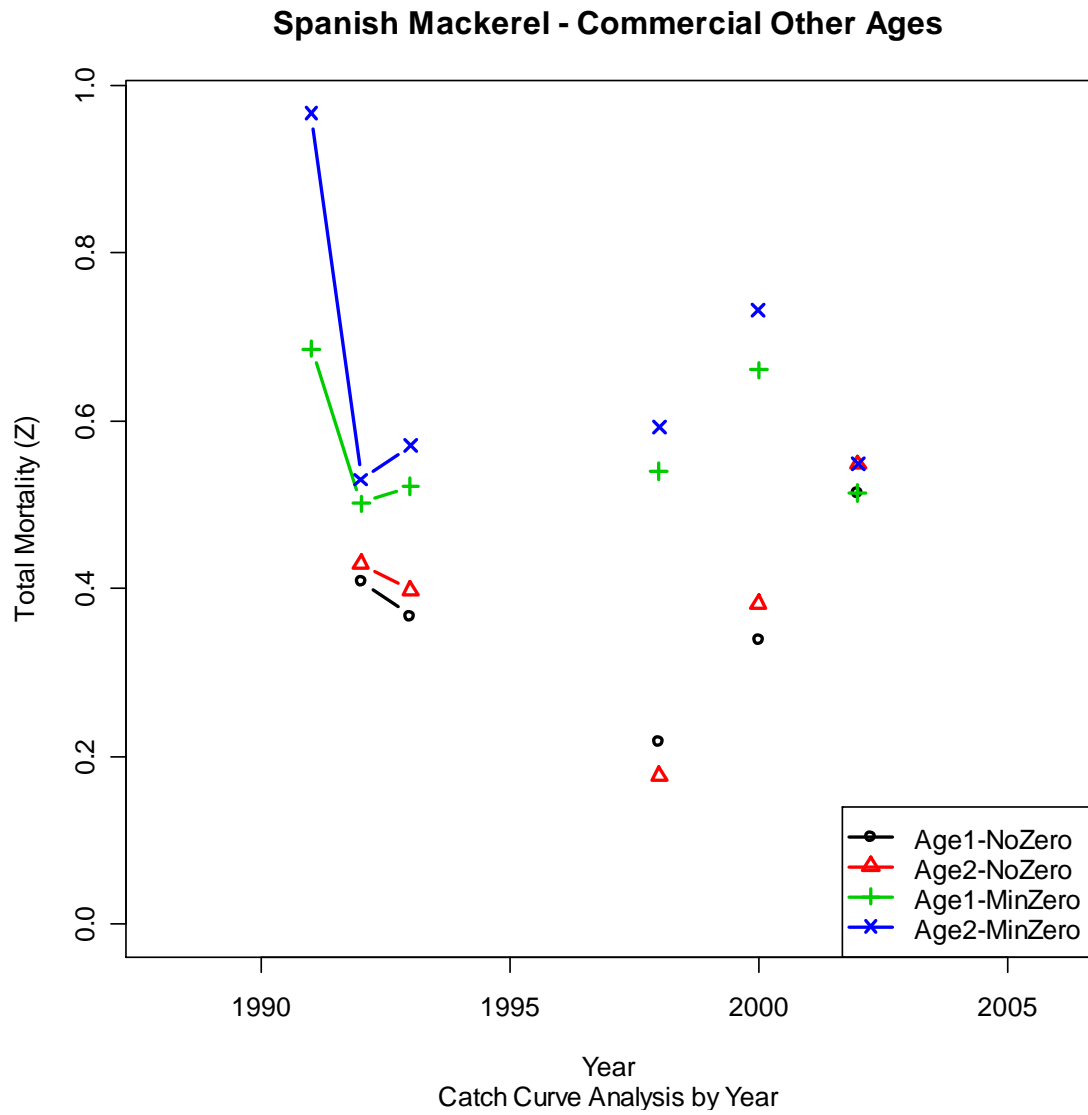


Figure 10. Total mortality estimates from catch curve analysis for Spanish mackerel age data collected from the commercial ‘other’ fishery. Analysis was conducted by true cohort. Legend indicates the age at which full selection was assumed (Age1 or Age2) and the treatment of zero values; either dropped (NoZero) or using an additive constant corresponding to half of the minimum value (MinZero).

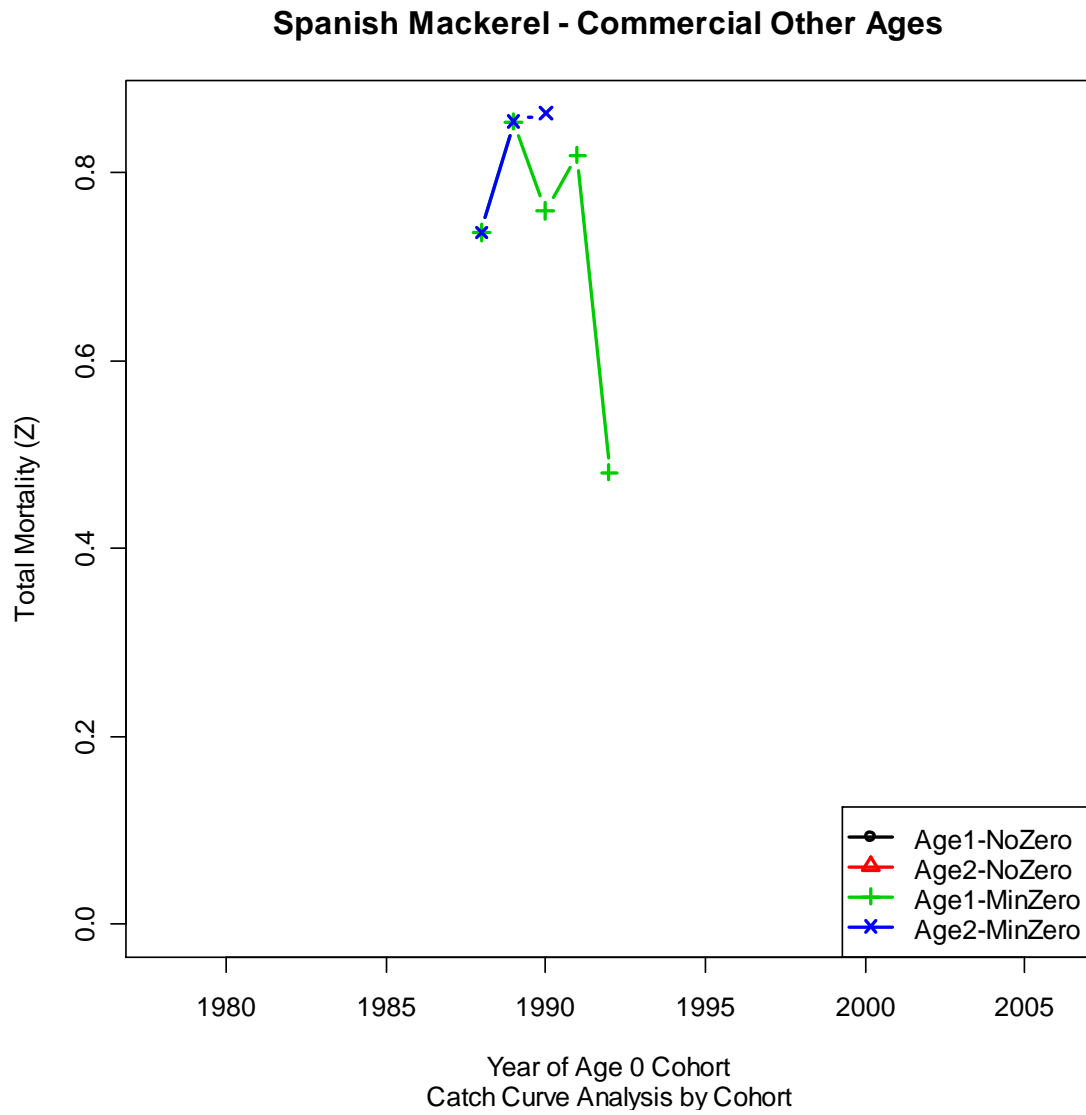


Figure 11. Total mortality estimates from catch curve analysis for Spanish mackerel age data collected from the commercial poundnet fishery. Analysis was conducted by year (i.e. using synthetic cohorts). Legend indicates the age at which full selection was assumed (Age1 or Age2) and the treatment of zero values; either dropped (NoZero) or using an additive constant corresponding to half of the minimum value (MinZero).

