

Graphical Presentations of the Striped Marlin *Kajikia audax* Size Composition Data to be used in the 2015 Stock Assessment Update

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Abstract

This working paper (WP) presents graphical presentations of striped marlin *Kajikia audax* size data in the form of time series from ISC, WCPFC, and cooperating nations, which will be used in the 2015 ISC Billfish Working Group stock assessment update. This WP explores the consistency of the historical length frequency distributions during 1975-2010 between the 2011 assessment and the 2015 update assessment. Seeming discrepancies were identified, tabulated, and investigated to the extent possible. This WP conforms to ISC guidelines concerning use of best available scientific information by presenting the size data by years and quarters, categorized by fleets and gears.

Introduction

The ISC Billfish Working Group (BILLWG) completed a stock assessment for striped marlin *Kajikia audax* in the Western and Central North Pacific Ocean (WCNPO) in 2011 (ISC, 2012). The 2011 assessment used data through 2010, and the results suggested that overfishing is currently occurring relative to MSY and that the WCNPO striped marlin stock is in an overfished state.

In response to these findings, the BILLWG proposed to conduct an updated stock assessment with four additional years of fishery data (2010 - 2013) to monitor stock status carefully. This work plan was approved at the 2014 ISC plenary meeting (ISC, 2014). The updated assessment of striped marlin in the WCNPO will be developed by using the newly available catch, CPUE, and size composition data (ISC, 2014), including available quarterly size composition data from 1975-2013.

Inconsistency of input data can cause the model misfit. The estimations of selectivity and recruitment can be biased by inconsistency in size composition data. The objectives of this WP are to illustrate the complete body of size composition information available for this stock assessment update; and to evaluate the consistency of the length frequency distributions used in the 2011 stock assessment and this stock assessment update.

Methods

The graphical output in this WP was produced using the R package **knitr** (Xie, 2013) using the markdown syntax. **knitr** calls the application **Pandoc** (MacFarlane, 2014) to write the WP in the PDF format. The **rmarkdown** (Allaire et al., 2015) R package was used to streamline the **knitr** workflow.

We were able to compare some current 2015 data submissions to those from the previous assessment. Seeming discrepancies were identified, tabulated, and investigated to the extent possible.

A public repository is currently in preparation. It is intended to facilitate use of the data and source code used in the WP, and to present documentation regarding preparation of size data for use in the stock assessment model.

Results

The size composition plots were examined to identify apparent differences between the 2015 and the 2011 stock assessment data submittals. The results are summarized in Table 1. The 2015 size composition data submittal for the Hawai'i-based pelagic longline fleet differed from the 2011 data in the second quarter of 2010. This discrepancy apparently resulted from use of length measurements that became available after the 2011 stock assessment, as indicated by different sample sizes (2011: $n = 63$; 2015: $n=110$ EFL measurements).

The entire WCPO size composition time series differed between the 2011 stock assessment and the 2015 update. Of the 21 reporting quarters, the sample size for the EFL measurements was greater on 18 occasions in the 2011 data than in the 2015 data.

The quarterly sample sizes throughout the Taiwan longline fishery size composition time series also differed between the 2011 stock assessment and the 2015 update. Except for the fourth quarter of 2008, the mean EFL for this fleet in the 2015 data submittal always exceeded the corresponding values for 2011 by more than 20 cm.

The differences between the mean sizes in the Japanese drift net fishery from 2011 and 2015 were attributable to greater numbers of measurements available for this study. In certain cases, the differences in numbers of measurements were very large. For example, 15 measurements were available for the second quarter of 2005 in 2011, but there were 6,304 measurements in 2015, a 420-fold difference. The remaining differences between the 2011 and 2015 size composition data from the Japanese longline fisheries 1-3, the Japanese coastal longline fishery, and the Japanese drift net fishery were also attributable to different sample sizes.

Most 2015 sample sizes were greater than in 2011, but this was not always the case. The 2006, Quarter 1 data from the Japanese longline fishery 1, and the 2009, Quarter 3 data from the Japanese longline fishery 3 included more measurements in 2011 than in 2015. In contrast to the fisheries with apparent disparities in their size composition time series, the data submittals from the Japanese "other" longline fleets (Early, Late) were identical in 2011 and 2015. The two series spanned the year in 1977, 1978, 1983, and 1985. The pooled results from these four years appeared similar to modal progression.

Fleet-specific size composition patterns

The catch of the Japanese longline 1 fleet, particularly in 1975-1983, was dominated by striped marlin in the smallest size bin. This size bin included the greatest proportion of the catch in 29 (of 69) reporting quarters for this fleet, with 20 of these quarters in 1975-1983. Striped marlin ranging from about 140 - 180 cm EFL were usually predominant thereafter, although large (215-220 cm EFL) fish comprised substantial proportions of the fourth quarter catch in 1999.

The catches of the Japanese longline fleets 2 and 3 exhibited similar patterns with respect to the presence of small fish. These fish comprised the largest proportions of the Fleet 2 catches from the fourth quarter of 1978 throughout 1979, the fourth quarter of 1980 and first quarter of 1981, the fourth quarter of 1983 and first quarter of 1984, and the fourth quarter of 1984 through the second quarter of 1985. Small fish never comprised the largest proportion in any quarter during the next five years, but were again during the second quarter eight times beginning in 1995. Fish from the smallest length bin comprised the largest proportion of the longline 3 fleet catches during 14 quarters of 1975-1980, and seven times during the second quarters of 1995-2003.

The size composition of the Japanese Coastal longline fleet catch was not obviously seasonal, although the largest fish were caught during Quarter 2 of most years. The catch was usually dominated by fish ca. 150 cm EFL.

The two periods in the Japan "other" Fleet exhibited differences in size composition. The distributions were usually centered at approximately 180 cm EFL in the early series, but were

shifted toward 140-160 cm EFL in the later data. During four years (1977, 1978, 1983, 1985), the two series covered all four quarters, and the quarterly patterns appeared to be modal progressions.

The Hawaii longline fleet data were characterized by predominance of fish in the smallest size bin during the first and fourth quarters. Small fish were always predominant in the first quarter catches during 1994-2009 and constituted the largest fraction of the fourth quarter catches 12 times during 1994-2008.

The systematic differences between the two WCPO time series raised questions about the central tendency of the size distributions. The 2015 data suggested that the size composition included more large fish than had previously been estimated, although the 2015 final WCPO data submittal (2009, Quarter 1) had the entire catch assigned to the smallest size bin, whereas the corresponding proportion was around 0.15 in the 2011 data.

Discussion

The size composition data, expressed as eye-fork lengths (EFLs), used in this stock assessment update for striped marlin of the Western and Central North Pacific stock exhibited several differences between the 2011 and 2015 data sets. Because differences in mean sizes were attributable to different sample sizes, it is requested and strongly recommended that ISC and other data-providing countries include sufficient metadata to elucidate fully any possible ambiguity regarding their submittals. (Brodziak and Dreyfus, 2011)

Differences in sample sizes may have had some effects on the stock assessment model results, but in practical terms any such effects were probably minor. On at least two occasions, the 2015 WCPO data submittals (1995, Quarter 4; 2009, Quarter 1) consisted of a single EFL measurement, as opposed to 40 and 14 EFL measurements for these quarters in 2011. Because any fishery with one (or zero) size measurements would be dropped from the assessment model, these reporting quarters would not have contributed to the final results.

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Table 1. Summary of apparent differences between striped marlin *Kajikia audax* size composition data submitted for the 2011 stock assessment and for the 2015 assessment update. Table entries include the fleet, year and quarter for data reporting, the apparent differences between data used in 2011 and the data available for the 2015 update, and pertinent comments.

| Fleet | Reference code | Year | Quarter | Apparent differences | Comments | Source |
|------------------------|--------------------------------|--|---------------------------------|--|--|--|
| Japan longline 1 | JPLL_1 | 2006 | 3 | 2015 data with smaller fish | This was the final reporting quarter | Yokawa et al. (2015) |
| Japan longline 2 | JPLL_2 | 2009 | 1 | 2015 data with larger fish | This was the final reporting quarter | Yokawa et al. (2015) |
| Japan longline 3 | JPLL_3 | 2004, 2005, 2009 | 1,1,1-4 | 2015 data for 2009 with smaller fish | 2009 was the final reporting year | Yokawa et al. (2015) |
| Japan coastal longline | JPcLL | 2009 | 3 | 2015 data with smaller fish | This was the final reporting quarter | Yokawa et al. (2015) |
| Japan drift net | JPdrift | 2005-2009 | 1-4 | 2015 data with smaller fish | Quarter 3 data in 2008 and 2009 were comparable | Yokawa et al. (2015) |
| Japan “other” longline | Jpothor_early; Jpothor_late | Early series: 1972-2000; Late series: 1977-1992 | 1, 2, or both; 3, 4, or both | None | The two series combined covered all quarters during 1978, 1979, 1983, and 1985 | Yokawa et al. (2015) |
| Hawaii longline | HW | 1999, 2010 | 3,2 | 2015 data for 2010 with smaller fish | Quarter 2 in 2010 was the final reporting quarter | Eric Fletcher, pers. comm., Jan 13, 2015 |
| Taiwan longline | TW | 2006-2009 | 1-4 | 2015 data with larger fish | The 2011 and 2015 data series appear to differ systematically | Su et al. (2015) |
| WCPO | WCPO | 2006-2009 | 1-4 | 2011 data with small ranges for several quarters | The 2011 data series may be systematically biased | Yau and Chang (2015) |

Explanation of Figures

The following section of this WP consists of time series plots of the size composition of striped marlin *Kajikia audax* catches for nine fleets operating in the North Pacific Ocean, and regional information provided by the Western and Central Pacific Fishery Management Commission. The x-axis is eye-fork length (EFL, cm) and the y-axis is the proportion of the catch within the 5-cm EFL bins. The plot headings identify the fleets, fishing years, and fishing (i.e. calendar) quarters. The fleets include seven from Japan and one each from Taiwan, Hawaii, and the WCPO.













































































