# Updated Recreational MRFSS and Headboat Abundance Indices for Cobia (*Rachycentron canadum*) in the Gulf of Mexico through 2017.

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# Recreational Indices of Abundance for Cobia in the Gulf of Mexico

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## Introduction

Two main sources of recreational angler fishing success data exist for cobia. The Marine Recreational Fishery Statistics Survey (MRFSS, https://www.fisheries.noaa.gov/insight/marine-recreational-fisheries-data) provides information on participation, effort, and species-specific catch. Information is collected to inform estimates of catch and effort by recreational fishing mode (shore fishing, private/rental boat, charterboat, or headboat/charterboat combined) and area of fishing (inshore, state Territorial Seas, U.S. Exclusive Economic Zone) in each state, except TX. The MRFSS Survey was conducted in TX through 1985; however, not all modes in all years were surveyed. Beginning in 1986, MRFSS excluded headboats in the Gulf of Mexico and South Atlantic. Catch estimates are made for strata sampled in the intercepts: fish landed whole and observed by the samplers ("Type A"), fish reported as killed by the fishers ("Type B1") and fish reported as released alive by the fishers ("Type B2"). Additional information on recreational fishing is obtained through the NOAA, NMFS, SEFSC, Headboat Survey. The Headboat Survey covers Gulf of Mexico headboats starting in 1986. Total catch per trip and fishing effort is reported in logbooks provided to all headboats in Texas (TX) through North Carolina (NC).

This document summarizes analyses of the catch and effort observations from the MRFSS and Headboat Survey used to develop standardized catch per unit effort (CPUE) indices of abundance for cobia (*Rachycentron canadum*) in the Gulf of Mexico through 2017. Additionally, the results summarized herein provide an update of the standardization of GOM cobia recreational indices as presented in SEDAR 22 (provide reference).

## Methods

The MRFSS and Headboat Survey data sets were explored across different strata to quantify the sample size of total fishing trips and positive trips (i.e., trips with successful catches of cobia) within each of the strata. Data from Texas, for years 1981 through 1985, were removed from the MRFSS data because the State of Texas conducts its own survey. In addition, data from the headboat mode in MRFSS, also present in the years 1981 through 1985, were removed as this information is covered by the Headboat Survey program. The shore fishing mode (e.g., trips where anglers were fishing from piers, bridges, and similar) was excluded from the data as less than 0.1% of the shore mode trips encountered a cobia and cobia are typically not caught via shore based fishing events. The Headboat and MRFSS datasets were partitioned according to consensus decisions made during SEDAR 22 Data Workshop Plenary sessions. The stock boundary separating the Gulf of Mexico from the South Atlantic stock was determined to be the state boarder between Florida and Georgia. With the Headboat Survey, the dataset was partitioned where fish surveyed in headboat reporting areas 1,2,3,4,5,6,9 and 10 were considered to be part of the South Atlantic Stock, while fish in all other areas were considered to be part of the Gulf of Mexico Stock. The MRFSS data were first partitioned into Gulf vs Atlantic using the state code designations at the Florida-Georgia state boarder. The Species Association Approach (Stephens and MacCall 2004) was explored to try and identify cobia-directed trips. This approach; however, was unsuccessful because it eliminated too many trips. As a result, individual indices were estimated using the traditionally applied delta lognormal model (Lo et al.1992), as applied in SEDAR 28. In addition, another CPUE index was developed using a subset of the trips from each dataset that only caught the study species (i.e., positive or successful trips only) using a generalized linear model assuming a lognormal error structure. A number of *ad hoc* approaches to subset directed trips for cobia from the MRFSS and Headboat Survey data were explored by the analysts. As a result, a guild approach was selected to subset the MRFSS data. This approach (i.e., the guild) was not used to subset the Headboat trips as routinely, headboat trips do not target offshore pelagics thus the analyses were performed using all headboat trips. Cobia are part of the pelagic species guild containing multiple species (list); therefore, only trips catching members of the pelagic species guild were selected. For the indices constructed using the guild approach, the delta lognormal model approach was also used. This method combines separate generalized linear model (GLM) analyses of the proportion of successful trips (trips that landed cobia or Spanish mackerel) and the catch rates on successful trips to construct a single standardized CPUE index.

Parameterization of each model was accomplished using a GLM procedure (GENMOD; Version 9.4 of the SAS System for Windows © 2000. SAS Institute Inc., Cary, NC, USA) applying the procedure in the same manner as for SEDAR 28. For each GLM evaluation of proportion positive trips, a type-3 model was fit, a binomial error distribution was assumed, and the logit link was selected. The response variable was the proportion successful trips. During the analysis of catch rates on successful trips, a type-3 model assuming lognormal error distribution was examined. The link function selected was “normal”, and the response variable was ln(CPUE). The response variable was calculated as the natural log of CPUE. For the MRFSS data, CPUE for each trip was equal to the number of fish caught on a given trip divided by the effort, where

effort was angler hours fished. Angler hours fished was calculated as the product of the number of anglers in the group that was interviewed and the total hours fished. For the Headboat Survey data, CPUE for each trip was equal to the number of fish caught on a given trip divided by the effort, where effort was calculated as the product of the number of people on the headboat and the hours fished.

A stepwise approach was used to quantify the relative importance of the explanatory factors. First a GLM model was fit on year. These results reflect the distribution of the nominal data. Next, each potential explanatory factor was added to the null model sequentially and the resulting reduction in deviance per degree of freedom was examined. The factor that caused the greatest reduction in deviance per degree of freedom was added to the base model if the factor was significant based upon a Chi-Square test ($p<0.05$), and the reduction in deviance per degree of freedom was $\geq 1\%$. This model then became the base model, and the process was repeated, adding factors and interactions individually until no factor or interaction met the criteria for incorporation into the final model. All 2-way interactions among significant main effects were examined; however, higher order interaction terms were not examined. The final delta-lognormal model was fit using a SAS macro, GLIMMIX (Russ Wolfinger, SAS Institute). All factors were modeled as fixed effects except two-way interaction terms containing year which were modeled as random effects. To facilitate visual comparison, a relative standardized index and relative nominal CPUE series were calculated by dividing each value in the series by the mean value of the entire time-series.

## Results

Data Subsetting

Efforts were made to apply the Species Association Approach (Stephens and MacCall 2004) to the datasets for each of these species; however, these efforts were met with limited success. Due to the inability to use this approach, an index was constructed using the Delta lognormal approach for the pelagic guild (MRFSS) or the entire database of all trips (Headboat), and an index was constructed using a subset of only positive trips using a lognormal model. The pelagic guild consisted of oceanic and coastal pelagic species including Tunas, Mackerels Dolphins and other similar species. Various factors were tested for significance using the stepwise approach and accordingly included or excluded from the model. From the Headboat Survey year, area, and month were considered as well as all first level interactions, where area represents the large fishing area blocks as defined in the Headboat Survey. As mentioned earlier analyses were conducted using all the headboat trips. From the MRFSS data, year, mode, month, and state were considered as well as all first level interactions, where mode represents the fishing mode, charter boat or a private boat/rental boat.

MRFSS

Results from the cobia MRFSS index standardization are variable without significant trending (Figures 1-2; Table 1), potentially driven by the proportion of positive observations from year to

year (Figure 1; Table 1). As in the 2012 analysis the nominal date of 1997 suggest an outlier in CPUE. Apparent differences are most likely due to differences in input data. The 2012 index used the entire dataset, whereas the 2018 analysis subset the data to trips catching the member of the pelagic guild. Use of the guild to subset the full data set was considered by the analysts to be more realistic and representative of a true cobia fishing trip.

Headboat

Results for the cobia Headboat index shows an apparent departure between the observed (nominal) and standardized CPUE in years 1993-1997 (Figures 3-4, Table 2). Departure from the nominal index in some years is likely due to the comparably strong effect of the significance of fishing mode on the model. In general, there was good agreement between the 2012 index (SEDAR 22) and the updated index using data through 2017) index.

**References**

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Stephens, A, MacCall, A. 2004. A multispecies approach to subsetting logbook data for purposes of estimating CPUE. Fisheries Research 70: 299-310.

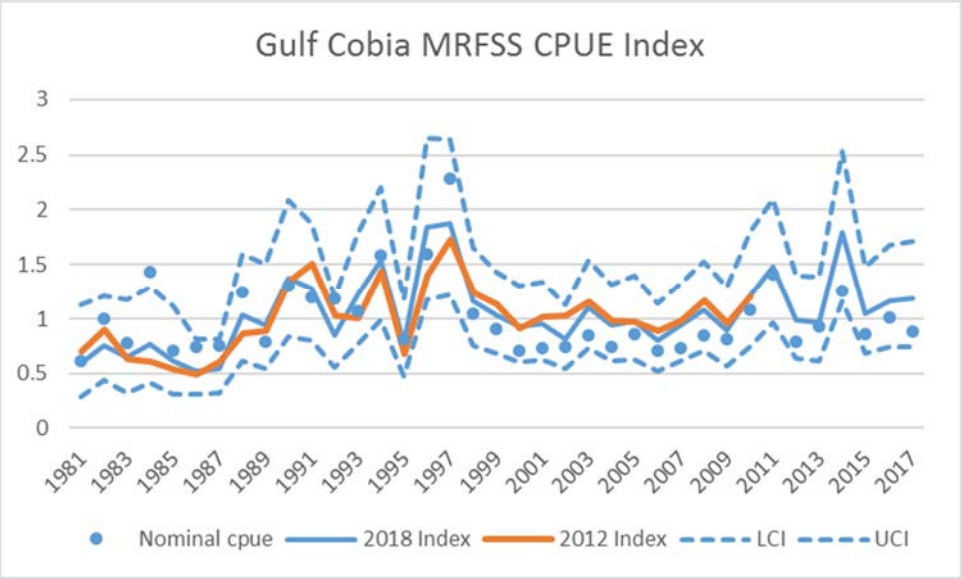


Figure 1.—MRFSS catch per unit effort index for Cobia in the Gulf of Mexico from 2012 SEDAR22 and 2018. SEDAR 22 values are based on the complete dataset. The 2018 values are based on using the Pelagic Guild subset of the full data.

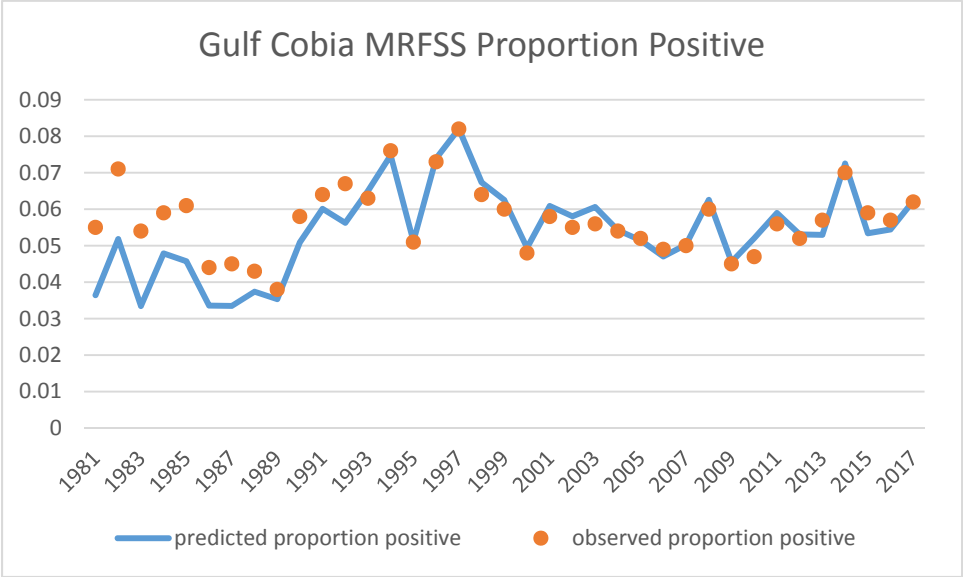


Figure 2.—MRFSS proportion of positive catches for Cobia in the Gulf of Mexico from 2012 SEDAR22 and 2018. SEDAR 22 values are based on the complete dataset. The 2018 values are based on using the Pelagic Guild subset of the full data.

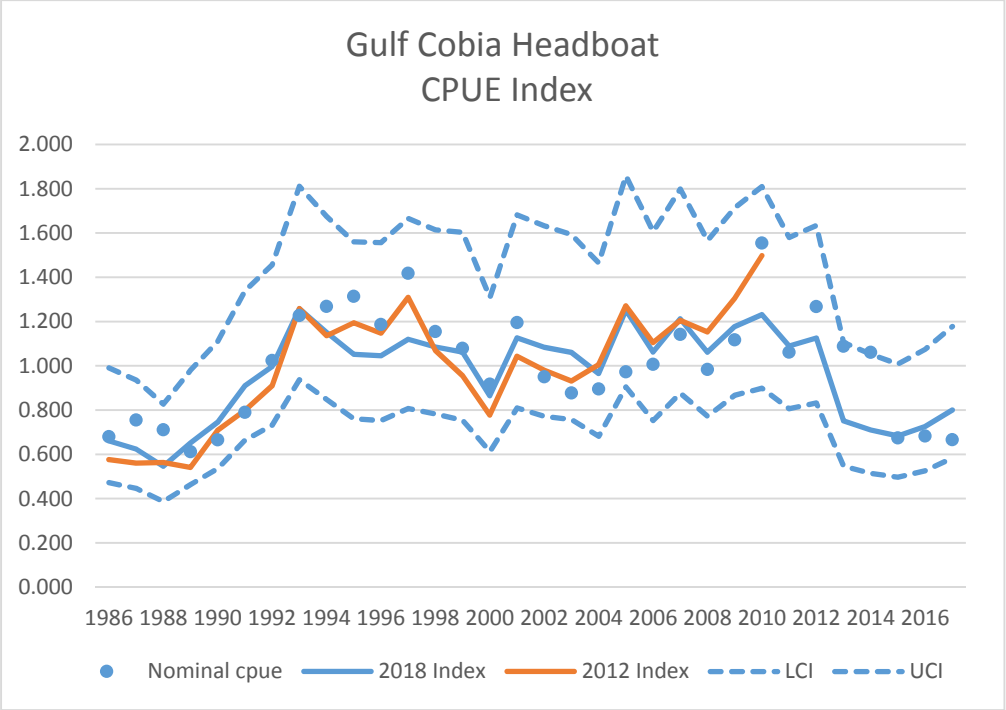


Figure 3. Headboat catch per unit effort index for Cobia in the Gulf of Mexico from 2012 SEDAR22 and 2018. SEDAR 22 values are based on the complete dataset.

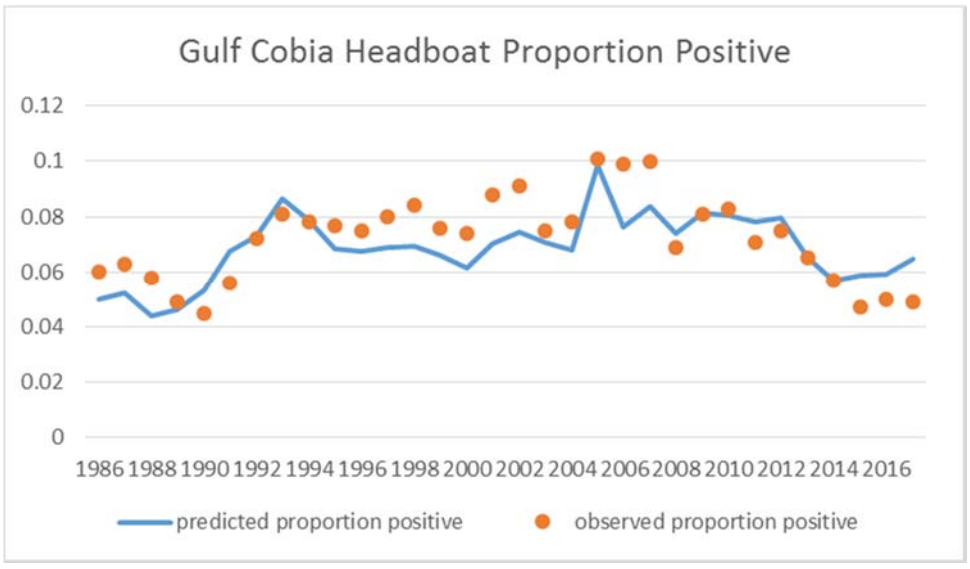


Figure 4.—Headboat proportion of positive catches for Cobia in the Gulf of Mexico from 2012 SEDAR22 and 2018. SEDAR 22 values are based on the complete dataset.

Table 1.—MRFSS cpue index and 95% confidence intervals for Cobia in the Gulf of Mexico from 2012 SEDAR22 and 2018. SEDAR 22 values are based on the complete dataset. The 2018 values are based on the Pelagic Guild subset of the data.

| Year | 2012 Index | Lower CI | Upper CI | Nominal cpue | 2018 Index | Lower CI | Upper CI |
|---|---|---|---|---|---|---|---|
| 1981 | 0.705 | 0.349 | 1.424 | 0.611 | 0.563 | 0.282 | 1.124 |
| 1982 | 0.898 | 0.546 | 1.476 | 0.995 | 0.724 | 0.433 | 1.209 |
| 1983 | 0.627 | 0.324 | 1.211 | 0.774 | 0.619 | 0.326 | 1.176 |
| 1984 | 0.605 | 0.335 | 1.092 | 1.433 | 0.729 | 0.412 | 1.291 |
| 1985 | 0.532 | 0.278 | 1.018 | 0.705 | 0.591 | 0.312 | 1.122 |
| 1986 | 0.495 | 0.316 | 0.775 | 0.744 | 0.500 | 0.309 | 0.811 |
| 1987 | 0.604 | 0.394 | 0.926 | 0.758 | 0.516 | 0.326 | 0.817 |
| 1988 | 0.860 | 0.554 | 1.336 | 1.251 | 0.988 | 0.613 | 1.594 |
| 1989 | 0.889 | 0.558 | 1.417 | 0.793 | 0.905 | 0.544 | 1.506 |
| 1990 | 1.350 | 0.885 | 2.059 | 1.306 | 1.321 | 0.836 | 2.086 |
| 1991 | 1.505 | 1.034 | 2.191 | 1.204 | 1.226 | 0.801 | 1.876 |
| 1992 | 1.032 | 0.747 | 1.425 | 1.181 | 0.816 | 0.555 | 1.200 |
| 1993 | 1.007 | 0.695 | 1.459 | 1.075 | 1.168 | 0.763 | 1.788 |
| 1994 | 1.440 | 1.021 | 2.030 | 1.582 | 1.473 | 0.986 | 2.201 |
| 1995 | 0.673 | 0.446 | 1.014 | 0.814 | 0.743 | 0.472 | 1.170 |
| 1996 | 1.406 | 1.004 | 1.970 | 1.595 | 1.767 | 1.178 | 2.651 |
| 1997 | 1.734 | 1.274 | 2.360 | 2.290 | 1.796 | 1.221 | 2.642 |
| 1998 | 1.241 | 0.914 | 1.686 | 1.041 | 1.119 | 0.757 | 1.653 |
| 1999 | 1.129 | 0.852 | 1.495 | 0.906 | 0.990 | 0.683 | 1.435 |
| 2000 | 0.915 | 0.679 | 1.233 | 0.707 | 0.888 | 0.606 | 1.300 |
| 2001 | 1.019 | 0.765 | 1.356 | 0.733 | 0.915 | 0.624 | 1.342 |
| 2002 | 1.030 | 0.777 | 1.365 | 0.743 | 0.780 | 0.539 | 1.128 |
| 2003 | 1.158 | 0.870 | 1.542 | 0.846 | 1.055 | 0.725 | 1.536 |
| 2004 | 0.978 | 0.729 | 1.312 | 0.741 | 0.897 | 0.613 | 1.311 |
| 2005 | 0.967 | 0.705 | 1.325 | 0.862 | 0.936 | 0.626 | 1.398 |
| 2006 | 0.889 | 0.650 | 1.216 | 0.710 | 0.771 | 0.521 | 1.139 |
| 2007 | 0.984 | 0.721 | 1.343 | 0.729 | 0.902 | 0.611 | 1.332 |
| 2008 | 1.164 | 0.864 | 1.569 | 0.842 | 1.037 | 0.703 | 1.531 |
| 2009 | 0.960 | 0.693 | 1.330 | 0.812 | 0.857 | 0.570 | 1.289 |
| 2010 | 1.205 | 0.871 | 1.666 | 1.077 | 1.158 | 0.748 | 1.793 |
| 2011 | | | | 1.408 | 1.418 | 0.960 | 2.095 |
| 2012 | | | | 0.791 | 0.943 | 0.636 | 1.396 |
| 2013 | | | | 0.930 | 0.919 | 0.610 | 1.386 |
| 2014 | | | | 1.259 | 1.718 | 1.165 | 2.533 |
| 2015 | | | | 0.865 | 1.003 | 0.679 | 1.483 |
| 2016 | | | | 1.005 | 1.117 | 0.747 | 1.672 |
| 2017 | | | | 0.882 | 1.133 | 0.747 | 1.717 |

Table 2.—Headboat catch per unit effort index and 95% confidence intervals for Cobia in the Gulf of Mexico from 2012 SEDAR22 and 2018. Values are based on the complete dataset.

| Year | 2012 Index | Lower CI | Upper CI | Nominal cpue | 2018 Index | Lower CI | Upper CI |
|---|---|---|---|---|---|---|---|
| 1986 | 0.576 | 0.411 | 0.808 | 0.680 | 0.661 | 0.473 | 0.991 |
| 1987 | 0.560 | 0.402 | 0.780 | 0.755 | 0.624 | 0.446 | 0.936 |
| 1988 | 0.563 | 0.403 | 0.785 | 0.711 | 0.546 | 0.387 | 0.827 |
| 1989 | 0.541 | 0.384 | 0.764 | 0.612 | 0.651 | 0.464 | 0.981 |
| 1990 | 0.709 | 0.513 | 0.979 | 0.666 | 0.745 | 0.536 | 1.111 |
| 1991 | 0.799 | 0.587 | 1.089 | 0.790 | 0.910 | 0.664 | 1.339 |
| 1992 | 0.910 | 0.700 | 1.183 | 1.024 | 0.997 | 0.732 | 1.457 |
| 1993 | 1.259 | 0.982 | 1.612 | 1.227 | 1.258 | 0.938 | 1.811 |
| 1994 | 1.136 | 0.879 | 1.467 | 1.268 | 1.151 | 0.848 | 1.675 |
| 1995 | 1.194 | 0.914 | 1.561 | 1.314 | 1.052 | 0.761 | 1.561 |
| 1996 | 1.147 | 0.860 | 1.530 | 1.187 | 1.045 | 0.753 | 1.557 |
| 1997 | 1.309 | 0.995 | 1.723 | 1.418 | 1.120 | 0.807 | 1.666 |
| 1998 | 1.069 | 0.801 | 1.427 | 1.155 | 1.085 | 0.783 | 1.615 |
| 1999 | 0.955 | 0.687 | 1.327 | 1.079 | 1.062 | 0.755 | 1.603 |
| 2000 | 0.777 | 0.554 | 1.089 | 0.917 | 0.865 | 0.613 | 1.310 |
| 2001 | 1.043 | 0.750 | 1.450 | 1.195 | 1.127 | 0.810 | 1.682 |
| 2002 | 0.980 | 0.702 | 1.367 | 0.950 | 1.084 | 0.772 | 1.633 |
| 2003 | 0.931 | 0.657 | 1.319 | 0.878 | 1.060 | 0.757 | 1.593 |
| 2004 | 1.005 | 0.718 | 1.408 | 0.895 | 0.965 | 0.682 | 1.465 |
| 2005 | 1.271 | 0.939 | 1.719 | 0.973 | 1.252 | 0.905 | 1.858 |
| 2006 | 1.105 | 0.802 | 1.522 | 1.007 | 1.062 | 0.753 | 1.607 |
| 2007 | 1.205 | 0.884 | 1.641 | 1.142 | 1.212 | 0.877 | 1.799 |
| 2008 | 1.153 | 0.845 | 1.575 | 0.984 | 1.061 | 0.772 | 1.566 |
| 2009 | 1.304 | 0.992 | 1.714 | 1.118 | 1.177 | 0.867 | 1.714 |
| 2010 | 1.498 | 1.133 | 1.981 | 1.555 | 1.231 | 0.899 | 1.810 |
| 2011 | | | | 1.061 | 1.089 | 0.806 | 1.580 |
| 2012 | | | | 1.268 | 1.126 | 0.833 | 1.634 |
| 2013 | | | | 1.089 | 0.751 | 0.547 | 1.106 |
| 2014 | | | | 1.061 | 0.710 | 0.514 | 1.053 |
| 2015 | | | | 0.674 | 0.683 | 0.497 | 1.008 |
| 2016 | | | | 0.683 | 0.726 | 0.526 | 1.075 |
| 2017 | | | | 0.666 | 0.801 | 0.584 | 1.178 |