Revision of estimates of catch in weight from the US recreational fishery from 1993 to 2014

Steven L. H. Teo[1], Jenny M. Suter[1], John Childers[1], and Alexandre Aires-da-Silva[2]

[1]Southwest Fisheries Science Center, 8901 La Jolla Shores Drive, La Jolla, CA 92037, USA

[2]Inter-American Tropical Tuna Commission (IATTC), 8901 La Jolla Shores Drive, La Jolla, CA 92037, USA

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Abstract

The US recreational fishery for Pacific bluefin tuna (PBF) has been the most important US fishery for PBF in recent years. Although the most recent stock assessment uses catch in number of fish for this fishery, the US also submits the estimated catch in weight (metric tons) to the ISC and tuna RFMOs. The catch in weight was estimated by multiplying the monthly average weight of PBF caught by the US recreational fishery with the monthly number of PBF caught. The average weight of PBF caught by the US recreational fishery was estimated from the measured lengths of PBF sampled at the dock. In this paper, we revise the monthly average weights used in the catch in weight calculation because we simplified the algorithm used to calculate the monthly average weight, and used a length-weight relationship that is consistent with the stock assessment. There are three main periods of size sampling on the CPFV fishery: (1) 1993-2012 – IATTC sampling; (2) 2013 – No sampling; and (3) 2014 onwards – NOAA sampling. The monthly mean weights using the current algorithm are mostly within 10% of the previous algorithm, if actual size samples were used in the calculation instead of substitutions. When substitutions were used by the current or previous algorithm, this can result in large differences in monthly mean weight. However, the small amount of catch in those months limits the impact on the estimated annual catch in weight. Nevertheless, some future research is needed to improve on the current substitution method, taking into account the intra-annual seasonal variability and inter-annual variability in the size of PBF caught. The revised catch in weight for the US recreational fishery from 1993 to 2014 is shown, and this time series is considered to be the best currently available scientific information on the catch in weight for this fishery. It is important to note that this revision in the catch in weight does not affect the results of the stock assessment because the assessment uses the number of fish caught for this fishery, not the estimated catch in weight.

Introduction

The US recreational fishery for Pacific bluefin tuna (PBF) has been the most important US fishery for PBF in recent years since the decline of the US commercial purse-seine fishery after the 1970s. In the latest stock assessment conducted by the ISC Pacific bluefin working group (ISC 2014), the units used for the catch of PBF from the US recreational fishery were thousands of fish. This was calculated as the sum of the number of PBF caught that were

recorded in logbooks from the Commercial Passenger Fishing Vessel (CPFV) fleet, based in California, and the estimated number of PBF caught by anglers on non-CPFV (i.e., private) vessels from the RecFIN database. However, independent of the stock assessment, the US also submits the estimated catch in weight (metric tons) of PBF by the US recreational fishery to the ISC and tuna RFMOs. The catch in weight was estimated by multiplying the monthly average weight of PBF caught by the US recreational fishery with the monthly number of PBF caught.

The average weight of PBF caught by the US recreational fishery was estimated from the measured lengths of PBF sampled at the dock. From 1993 to 2012, the Inter-American Tropical Tuna Commission (IATTC) used a 2-stage sampling design (Stage 1: trip; stage 2: individual fish) to sample PBF landed by the CPFV fleet based in San Diego. A monthly length distribution was developed and subsequently converted into an age distribution (P. Tomlinson, pers. comm.). Using the average weight-at-age, the monthly age distribution was converted into monthly average weight. However, the IATTC ended the CPFV sampling program after the 2012 season, and NOAA agreed to take over the sampling program. The IATTC also provided all available historical size data from the sampling program to NOAA.

In this paper, we revise the monthly average weights used in the catch in weight calculation because we simplified the algorithm used to calculate the monthly average weight, and used a length-weight relationship that is consistent with the stock assessment. Firstly, we present a new algorithm used to calculate the monthly average weight of PBF caught by the CPFV fishery. Secondly, we revise the estimated catch in weight (metric tons) of PBF by the US recreational fishery from 1993 to 2014. It is important to note that this revision in the catch in weight does not affect the results of the stock assessment because the assessment uses the number of fish caught for this fishery, not the estimated catch in weight.

Materials and Methods

There are three main periods of size sampling on the CPFV fishery: (1) 1993-2012 – IATTC sampling; (2) 2013 – No sampling; and (3) 2014 onwards – NOAA sampling. Until 2012, IATTC staff produced the monthly mean weights and NOAA staff produced the monthly catch in numbers of fish. In all periods, monthly mean weight was multiplied by the number of

PBF caught in each month to obtain the monthly catch in weight, which was reported by both IATTC and NOAA.

In period 1 and 3, IATTC and NOAA both used a 2-stage sampling design (Stage 1: trip; stage 2: individual fish) to sample PBF landed by the CPFV fleet based in San Diego. CPFV trips were arbitrarily chosen and assumed to be representative of the CPFV fleet. Within each chosen trip, individual PBF were randomly chosen and measured to the nearest mm. In period 2, no size sampling was conducted by IATTC or NOAA. Therefore, we could not calculate the monthly mean weights for 2013. Instead, we assumed the monthly mean weights for 2013 were similar to those of 2012 and 2014, and calculated monthly mean weights based on data for those years.

To calculate the mean monthly weight, the weight of fish j from trip i ($w_{i,j}$) was converted from the corresponding measured fork length ($L_{i,j}$) using the length-weight relationship,

$$w_{i,j} = a \times {L_{i,j}}^{b} \qquad \text{(eq. 1)}$$

and the mean weight from trip i ($\bar{w}_i$) was calculated. Previously, the IATTC used $a = 5.9 \times 10^{-8}$ and $b = 2.855811$ as the parameters in eq. 1, with length in mm. However, in this study, we used parameters consistent with the stock assessment model, $a = 1.7117 \times 10^{-5}$ and $b = 3.0382$, with length in cm (Kai 2007) for all three periods. Subsequently, the mean weight ($\widehat{w_k}$) for month k was calculated as an weighted average of fish caught on sampled trips within the month,

$$\widehat{w_k} = \frac{\sum_i N_i \bar{w}_i}{\sum_i N_i} \qquad \text{(eq. 2)}$$

where N_i is the number of PBF caught in trip i.

A substitution process was necessary for some months, when PBF were caught by the US recreational fishery but no PBF were sampled. Previously, the IATTC method was to substitute a mean weight from a previous month and year, or from the commercial fishery for the same month and year. Here, we use the mean weight for the year to substitute for months with catch, but no samples. Doing so might result in a biased mean weight but we are continuing research on an appropriate substitution process. However, given that these months without samples have

only relatively low catches in numbers, the annual catch in weight should not be substantially affected.

The relative percentage differences in estimated monthly mean weights and annual catch in weight of PBF were calculated as $100 \times ((u - v)/v)$, where u is the monthly mean weight calculated using the current NOAA algorithm and v is the monthly mean weight calculated using the previous IATTC algorithm.

Results and Discussion

The monthly mean weights using the current algorithm (Table 1) are mostly within 10% of the previous algorithm, if actual size samples were used in the calculation instead of substitutions (Tables 2 & 3). The largest differences occurred in 2011 when the current algorithm resulted in monthly mean weights that were about 50% smaller than previously. Based on discussions with IATTC staff, the previous estimates of monthly mean weights for 2011 were likely erroneous because current recalculations by IATTC staff using the previous algorithm resulted in smaller differences. Similar errors also likely occurred for 2012.

However, when substitutions were used by the current or previous algorithm, this can result in large differences in monthly mean weight, up to 224% in February 2003 (Table 3). This suggests that some future research is needed to improve on the substitutions, taking into account the intra-annual seasonal variability and inter-annual variability in the size of PBF caught.

For most of the months with large catches, size sampling was conducted and the monthly mean weights were calculated from sampled lengths. Given that, the effect of substitution in the monthly mean weights when no size sampling occurred was likely limited because this occurred when catches were relatively small.

The revised catch in weight for the US recreational fishery from 1993 to 2014 is shown in Table 4, and we consider this time series to be the best currently available scientific information on the catch in weight for this fishery. However, it should be noted that the catch in weight for 2013 and 2014 are preliminary.

References

ISC. 2014. Stock Assessment of Pacific Bluefin Tuna 2014. Report of the 2014 Intercessional Meeting of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean - Annex 4. http://isc.ac.affrc.go.jp/reports/stock_assessments.html

Kai, M. 2007. Weight-length relationship of North Western PBF. Working paper submitted to the ISC PBF Working Group Meeting, 11-18 December 2007, Shimizu, Japan. ISC/07/PBFWG-3/07.

Tables

Table 1. Estimated monthly mean weights of Pacific bluefin tuna caught by the US recreational fishery from 1993-2014 using the current algorithm. For months with catch, but no samples, the annual average weight is used. Estimates for months with samples are in bold. All weights are in kg.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1993						26.8	**26.7**	**27.1**	**26.8**	26.8	26.8		26.8
1994				37.3	37.3	**42.9**	**35.1**	**38.9**	37.3	37.3	37.3		37.3
1995					14.6	14.6	**14.4**	**16.0**	14.6	14.6			14.6
1996	13.3	13.3			13.3	**12.4**	**19.2**	13.3	13.3	13.3	13.3		13.3
1997					17.3	**10.9**	**17.8**	17.3	17.3	17.3	17.3	17.3	17.3
1998	20.8			20.8	20.8	**12.8**	20.8	**20.9**	20.8	20.8	20.8	20.8	20.8
1999			12.0		12.0	12.0	**13.2**	**11.1**	**9.5**	12.0	12.0		12.0
2000	15.9		15.9	15.9	**11.8**	**14.5**	**18.9**	**13.0**	15.9	15.9	15.9	15.9	15.9
2001	15.8	15.8	**53.7**	15.8	**17.6**	**12.5**	**15.6**	**16.0**	**15.0**	15.8	15.8	15.8	15.8
2002	17.7				17.7	**14.8**	**14.1**	**18.8**	**18.8**	17.7	17.7		17.7
2003	16.4	**44.7**	16.4		16.4	**29.0**	**16.7**	**15.7**	**14.1**	16.4	16.4		16.4
2004			18.1	18.1	**17.1**	**18.9**	**30.8**	**8.9**	18.1	18.1	18.1		18.1
2005				12.2	12.2	**12.0**	**12.6**	12.2	12.2	12.2			12.2
2006				12.2	12.2	**11.6**	**14.4**	12.2	12.2	12.2			12.2
2007			11.7		11.7	11.7	**11.7**	11.7	11.7	11.7			11.7
2008					**10.3**	**11.5**	**6.1**	**5.5**	6.5	6.5	6.5		6.5
2009					11.8	**11.0**	**11.7**	**13.6**	11.8	11.8			11.8
2010			10.3		**9.9**	**10.1**	**11.1**	10.3	10.3	10.3			10.3
2011	9.1					**12.5**	**6.3**	**6.8**	**6.4**	**8.9**	9.1		9.1
2012					10.5	**11.6**	**10.9**	**8.6**	10.5	10.5	10.5		10.5
2013			12.3			**11.6**	**11.9**	**13.1**	12.3	12.3			12.3
2014			15.2		15.2	**12.1**	**13.9**	**17.8**	**13.4**	15.2	15.2	15.2	15.2

Table 2. Estimated monthly mean weights of Pacific bluefin tuna caught by the US recreational fishery from 1993-2012 using the previous IATTC algorithm. Monthly mean weights based on samples are in bold and substituted monthly mean weights from the corresponding decade or commercial fishery data for the decade are in regular font. All weights are in kg.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993						18.9	**27.7**	**27.8**	**27.8**	15.5	37.4	
1994				20.9	12.2	**42.8**	**35.4**	**38.9**	18.2	15.5	37.4	
1995					12.2	19.7	**17.8**	**17.3**	18.2	15.5		
1996	14.3	13.8			12.2	**12.2**	**17.8**	21.3	18.2	15.5	37.4	
1997					12.2	**12.1**	**19.1**	21.3	18.2	15.5	37.4	34.1
1998	14.3			20.9	12.2	**14.1**	20.6	**22.0**	18.2	15.5	37.4	34.1
1999			14.7		12.2	18.6	**14.4**	**12.4**	**10.6**	15.5	37.4	
2000	14.3		48.8	20.9	**12.9**	**15.7**	**20.0**	**14.2**	14.8	15.5	37.4	34.1
2001	14.3	13.8	**50.7**	20.9	**18.8**	**13.7**	**16.6**	**17.2**	**16.2**	15.5		34.1
2002	14.3				15.9	**16.9**	**15.7**	**19.9**	**19.8**	15.5	37.4	
2003	14.3	13.8	50.7		15.9	**9.7**	**13.5**	**16.1**	**19.2**	15.5	37.4	
2004			50.7	20.9	**18.4**	**19.9**	**31.1**	**10.1**	19.2	15.5	37.4	
2005				20.9	15.1	**13.3**	**13.8**	10.2	19.2	15.5		
2006				20.9	15.1	**12.8**	**15.6**	10.2	19.2	15.5		
2007			50.7		15.1	14.9	**12.9**	10.2	19.2	15.5		
2008					**11.5**	**12.8**	**7.1**	**6.5**	19.2	15.5	37.4	
2009					14.6	**12.3**	**13.0**	**14.9**	19.2	15.5		
2010			50.7		**11.2**	**11.3**	**12.3**	14.4	19.2	15.5		
2011	14.3					**13.8**	**14.9**	**14.4**	19.2	15.5	37.4	
2012					14.1	13.8	14.9	14.4	19.2	15.5		

Table 3. Relative differences in estimated monthly mean weights of Pacific bluefin tuna caught by the US recreational fishery using the current versus previous algorithm. All differences are in percentages. Negative percentages indicate that current estimates are smaller than previous, and vice versa. Bold numbers indicate months when both current and previous algorithms used samples to calculate monthly mean weights instead of substitutions. * IATTC staff found errors in previous estimates of mean weights for 2011 and 2012, which resulted in larger than expected differences in 2011 and 2012. Upon correction of these errors (unpublished), the resulting differences were in line with previous years.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993						41.8	**-3.6**	**-2.5**	**-3.6**	72.9	-28.3	
1994				78.5	205.7	**0.2**	**-0.8**	**0.0**	104.9	140.6	-0.3	
1995					19.7	-25.9	**-19.1**	**-7.5**	-19.8	-5.8		
1996	-7.0	-3.6			9.0	**1.6**	**7.9**	-37.6	-26.9	-14.2	-64.4	
1997					41.8	**-9.9**	**-6.8**	-18.8	-4.9	11.6	-53.7	-49.3
1998	45.5			-0.5	70.5	**-9.2**	1.0	**-5.0**	14.3	34.2	-44.4	-39.0
1999			-18.4		-1.6	-35.5	**-8.3**	**-10.5**	**-10.4**	-22.6	-67.9	
2000	11.2		-67.4	-23.9	-8.5	-7.6	**-5.5**	**-8.5**	**7.4**	2.6	-57.5	-53.4
2001	10.5	14.5	**5.9**	-24.4	**-6.4**	**-8.8**	**-6.0**	**-7.0**	-7.4	1.9		-53.7
2002	23.8				11.3	**-12.4**	**-10.2**	**-5.5**	**-5.1**	14.2	-52.7	
2003	14.7	223.9	-67.7		3.1	**199.0**	**23.7**	**-2.5**	**-26.6**	5.8	-56.1	
2004			-64.3	-13.4	**-7.1**	**-5.0**	**-1.0**	**-11.9**	-5.7	16.8	-51.6	
2005				-41.6	-19.2	**-9.8**	**-8.7**	19.6	-36.5	-21.3		
2006				-41.6	-19.2	**-9.4**	**-7.7**	19.6	-36.5	-21.3		
2007			-76.9		-22.5	-21.5	**-9.3**	14.7	-39.1	-24.5		
2008					**-10.4**	**-10.2**	**-14.1**	**-15.4**	-66.1	-58.1	-82.6	
2009					-19.2	**-10.6**	**-10.0**	**-8.7**	-38.5	-23.9		
2010			-79.7		**-11.6**	**-10.6**	**-9.8**	-28.5	-46.4	-33.5		
2011*	-36.4					**-9.4**	**-57.7**	**-52.8**	-66.7	-42.6	-75.7	
2012*					-25.5	-15.9	-26.8	-40.3	-45.3	-32.3		

Table 4. Revised and previous annual catch in weight of Pacific bluefin tuna (metric tons) by the US recreational fishery from 1993-2014 (CPFV + Private). *The catches for 2013 and 2014 are considered preliminary.

Year	Revised catch (mt)	Previous catch (mt)	Difference (%)
1993	283	292	-3.2
1994	86	80	7.0
1995	245	280	-12.4
1996	40	42	-4.9
1997	131	140	-6.6
1998	422	432	-2.3
1999	408	458	-10.9
2000	319	348	-8.4
2001	344	368	-6.6
2002	613	646	-5.1
2003	355	358	-0.7
2004	50	52	-4.4
2005	73	77	-5.6
2006	94	101	-7.2
2007	12	14	-13.1
2008	63	103	-38.6
2009	156	178	-12.4
2010	88	121	-27.3
2011	225	498	-54.9
2012	400	615	-35.0
2013*	809	982	-17.6
2014*	398		