

BLUEFIN TUNA CATCH REVIEW OF THE “BRAZILIAN EPISODE” FOR THE MSE OM ROBUSTNESS TEST

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SUMMARY

The current assumptions for the Atlantic Bluefin tuna catch include within the West stock unit the catches off Brazil in the late 1950's to the early 1960's, commonly known as the “Brazilian episode”. Under the development of the BFT MSE, a robustness test has been requested that proposes that all these catches are assumed to be part of the eastern stock. This document reviews the ICCAT database used in the current OM's, and provides the catch at age for the robustness test.

RÉSUMÉ

Les postulats actuels concernant les prises de thon rouge de l'Atlantique incluent dans l'unité de stock de l'Ouest les prises au large du Brésil de la fin des années 50 au début des années 60, communément appelées « période brésilienne ». Dans le cadre du développement de la MSE pour le thon rouge, un test de robustesse a été demandé qui propose de postuler que toutes ces captures font partie du stock oriental. Ce document passe en revue la base de données de l'ICCAT utilisée dans les OM actuels et fournit la prise par âge pour le test de robustesse.

RESUMEN

Los supuestos actuales para la captura de atún rojo del Atlántico incluyen dentro de la unidad de stock occidental las capturas en aguas de Brasil desde finales de los 50 hasta principios de los 60, comúnmente conocidas como el «episodio brasileño». En el marco del desarrollo de una MSE para el atún rojo, se ha solicitado una prueba de robustez que propone que todas estas capturas formen parte del stock oriental. Este documento revisa la base de datos de ICCAT utilizada en los OM actuales y proporciona la captura por edad para la prueba de robustez.

KEYWORDS

Bluefin tuna, western stock, robustness test, OM, catch-at-age

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1. Introduction

The current assumptions for the Atlantic Bluefin tuna catch include within the West stock unit the catches off Brazil in the late 1950's to the early 1960's, commonly known as the "Brazilian episode" (Fromentin and Powers, 2006). These catches represented primarily the fishing operations by Japanese longliners off the North-east coast of Brazil in the period between 1962 and 1967, which caught 5000 to 12000 t of bluefin tuna (Takeuchi *et al.*, 2009). A comprehensive analysis of the Japanese fishing effort (Takeuchi *et al.*, 1999) indicated a predominance of Atlantic bluefin between north of 20° latitude south and 15° latitude north (**Figure 1**), but covering a large area of the Tropical waters of the Atlantic at both sides of the stock division line between East and West stocks (**Figure 2**).

This episode rapidly ended and since then relatively limited amounts of bluefin have been caught in the Southwest Atlantic. Several hypotheses have been proposed for the fate of this subpopulation and the reasons for the sudden decline of bluefin tuna in this area.

Under the development of the BFT MSE, the catches of the Brazilian episode are assumed to be fish of western origin in a reference set. A robustness test has been requested that proposes that all these catches are assumed to be part of the eastern stock, and to allocate them from the West Atlantic (OM area 2: WATL) to the East Atlantic (OM area 4 SATL: south of 40N).

This document reviews the ICCAT database used in the current OMs, and provides the dataset for the robustness test.

2. Methods

The ICCAT Secretariat database of catch (Task 1 NC) and catch distribution (Task 2 CE) has been used to estimate historically the catches of bluefin tuna by stock and by 5°x5° latitude-longitude grids (CATDIS), however back in time there is limited information on the actual location of the catches.

Figures 3 and 4 and Table 1 show the spatial distribution (5x5 lat-lon) of the West bluefin tuna stock unit in the 1960's and in the 1970's as estimated by CATDIS. After the huge catches in the area between 0 and 10° latitude south in 1963 and 1964 were observed, the catches in this area became much smaller.

Considering the area analyzed by Takeuchi *et al.* 1999 and the current OM area structure that combines the catch in the Caribbean Sea to the West Atlantic, it was suggested to use catches between 20°N latitude and 20°S latitude in the West stock area for the "Brazilian episode". The high catches in this area were observed from 1962 to 1965 (**Figure 5**). To cover enough time period, it is suggested to use catches between 1950 and 1970 for the robustness test.

Table 2 and Figure 6 show the current catches in Task 1 under the current hypothesis for the west and east bluefin tuna stocks. For the robustness test, it was suggested that the following catches will be reallocated from the west stock to the east stock units:

- a) Catches between 1950 and 1970.
- b) Catches between 20°N latitude and 20°S latitude in the West stock area.
- c) All flags and gears, remove minor catches (< 10 t in total) if the catches occurred only for a several years.

Regarding size distribution of the "Brazilian episode" catch, there is very limited information. For the OM input data, catch at age by quarter and year before 1964 is required while only quarterly catch is required after 1965, but the size information is very scarce and only the lengths for 5 fish are available before 1970. To produce catch at length and finally to convert to catch at age, it was assumed that the size of bluefin in the area was similar to the one in the West Atlantic (OM area 2) in the year 1973 to 1978. The estimated catch at length was converted using the ALK for the West stock (delivered from growth curve with 25cm bin in the BFT MSE package) (Kimoto *et al.*, 2019).

3. Results and discussion

Overall the ‘Brazilian episode’ catches represent 19,394 t of fish in the period between 1957 and 1970 that are moved from the West Atlantic (OM area 2 WATL) to the East Atlantic (OM area 4 SATL) (**Table 3 and Figure 7**). At the peak of the episode in 1964, the total of 8,660 t represents about 47% of the total West BFT catch. This estimated catch matched to the one used in Fromentin *et al.*, 2014 (**Figure 8**).

The catches between 1950 and 1970 in the area between 20 N latitude and 20 S latitude took 22 % of the total catch in the entire West stock area (**Table 4**), while it was 1% for the catch after 1970. The high catches (more than 1200 t) in this area were observed from 1962 to 1965 (Figure 5). The major area for the West BFT catches is the north of 20 N latitude (Table 3 and Figure 5). After removing the minor catches less than 10 t (9.4 t in 1968, and 6.5 t in 1969 by Chinese Taipei longline), the catches were composed by only Japanese longline.

The quarterly catch between 1950 and 1970 is available in Table 5, and these were reallocated to the East Atlantic for this robustness test. The size distribution of the “Brazilian episode” catch was assumed to be similar to the ones in the West Atlantic used in the calculation for a reference set (Kimoto *et al.*, 2019). The assumed length compositions are shown in Figure 9 only come from Japanese longline, and are mainly 220 cm to 280 cm (**Figure 9**). The estimated catch by quarter before 1964 was converted to catch at age for the robustness test input.

All analyzed files are available in the Owncloud Analysis folder for the second BFT MSE Technical Group meeting in September 2020. Main summaries are available in “OffBrazil_Check2020Aug_rev.xlsx”. The final OM input files for the robustness test are “Cobs_JPLLsplit_BRArobustness.csv” and “HCobs5064_final_BRArobustness.csv”. Comparisons of catches by OM area for a reference set and this robustness test is available in “comparisons_offBrazil.xlsx” and “HCob_BRArobustness_Aug2020.xlsx” is for creating catch at age before 1964.

References

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Table 1. The estimated decadal catch of bluefin tuna by aggregated 5 x 5 grid in the West Atlantic in the 1960's and the 1970's.

| 1960s | | Longitude | | | | | | | | | | | | | | |
|----------|----------|-----------|-----|------|------|-----|------|-------|------|------|------|-----|------|------|------|-----|
| Latitude | location | -95 | -90 | -85 | -80 | -75 | -70 | -65 | -60 | -55 | -50 | -45 | -40 | -35 | -30 | -25 |
| | | -100 | -95 | -90 | -85 | -80 | -75 | -70 | -65 | -60 | -55 | -50 | -45 | -40 | -35 | -30 |
| Latitude | 45 | 50 | | | | | | | 30 | | 1853 | | | | | |
| | 40 | 45 | | | | | | 12635 | 2774 | 38 | 21 | 76 | 89 | | | |
| | 35 | 40 | | | | | 1228 | 12003 | 118 | 14 | 12 | 5 | 28 | | | |
| | 30 | 35 | | | | 56 | 7763 | 2748 | 417 | 76 | 108 | 23 | 23 | | | |
| | 25 | 30 | 3 | 2459 | 24 | | 9244 | 498 | 71 | 88 | 6 | 2 | 9 | | | |
| | 20 | 25 | 1 | 22 | 13 | | 2 | 126 | 227 | 171 | 22 | 13 | 12 | | | |
| | 15 | 20 | 1 | 0 | | 3 | 3 | 1 | 29 | 111 | 138 | 24 | 10 | | | |
| | 10 | 15 | | | | 0 | 1 | 1 | 2 | | 20 | 105 | 24 | | | |
| | 5 | 10 | | | | | | | | 1 | 19 | 194 | 151 | 579 | | |
| | 0 | 5 | | | | | | | | | 0 | 54 | 627 | 1548 | 1520 | |
| | -5 | 0 | | | | | | | | | | 1 | 2587 | 4802 | 226 | |
| | -10 | -5 | | | | | | | | | | | 53 | 4695 | 101 | |
| | -15 | -10 | | | | | | | | | | | 203 | 647 | 208 | |
| | -20 | -15 | | | | | | | | | | | 98 | 270 | 81 | |
| | -25 | -20 | | | | | | | | | | | 7 | 16 | 11 | 9 |
| | -30 | -25 | | | | | | | | | | | 2 | 16 | 21 | 8 |
| | -35 | -30 | | | | | | | | | | | 164 | 53 | 52 | 17 |
| | -40 | -35 | | | | | | | | | | | 451 | 95 | 48 | 13 |
| | -45 | -40 | | | | | | | | | | | 0 | | | 0 |
| 1970s | | Longitude | | | | | | | | | | | | | | |
| Latitude | location | -95 | -90 | -85 | -80 | -75 | -70 | -65 | -60 | -55 | -50 | -45 | -40 | -35 | -30 | -25 |
| | | -100 | -95 | -90 | -85 | -80 | -75 | -70 | -65 | -60 | -55 | -50 | -45 | -40 | -35 | -30 |
| | 45 | 50 | | | | | | | 314 | 2262 | 0 | 479 | 6 | | | |
| | 40 | 45 | | | | | | | 9035 | 2411 | 3363 | 389 | 2086 | 982 | | |
| | 35 | 40 | | | | | 795 | 12812 | 3065 | 899 | 2 | 38 | 42 | | | |
| | 30 | 35 | | 63 | | 135 | 89 | 11 | 8 | 5 | 2 | 3 | | | | |
| | 25 | 30 | 114 | 4490 | 4401 | 78 | 6005 | 3 | 0 | | | 0 | | | | |
| | 20 | 25 | 15 | 6 | 18 | | 7 | 21 | 8 | 0 | 1 | | | | | |
| | 15 | 20 | | | | 1 | 0 | 21 | 30 | 2 | 9 | | | | | |
| | 10 | 15 | | | | | 73 | 50 | 1 | 16 | 1 | 1 | 1 | | | |
| | 5 | 10 | | | | | | | | 4 | 1 | 15 | 15 | 9 | | |
| | 0 | 5 | | | | | | | | | 6 | 19 | 12 | 34 | | |
| | -5 | 0 | | | | | | | | | | 0 | 5 | 5 | 5 | |
| | -10 | -5 | | | | | | | | | | 5 | 6 | 11 | | |
| | -15 | -10 | | | | | | | | | | 1 | 1 | 9 | | |
| | -20 | -15 | | | | | | | | | | 1 | 6 | 7 | | |
| | -25 | -20 | | | | | | | | | | 0 | 0 | 2 | 0 | |
| | -30 | -25 | | | | | | | | | | 0 | 17 | 4 | 0 | |
| | -35 | -30 | | | | | | | | | | 22 | 7 | 2 | 0 | |
| | -40 | -35 | | | | | | | | | | 0 | 10 | 12 | 2 | 0 |
| | -45 | -40 | | | | | | | | | | 0 | 1 | 7 | 4 | |

Table 2. Total bluefin catch (Task 1) by stock in the period between 1950 and 2019.

| Year | West BFT | East BFT |
|------|----------|----------|
| 1950 | 1,017 | 26,812 |
| 1951 | 1,123 | 30,211 |
| 1952 | 694 | 39,007 |
| 1953 | 1,084 | 39,275 |
| 1954 | 823 | 37,157 |
| 1955 | 544 | 44,092 |
| 1956 | 247 | 30,186 |
| 1957 | 546 | 35,873 |
| 1958 | 1,207 | 33,353 |
| 1959 | 1,649 | 26,334 |
| 1960 | 1,032 | 26,113 |
| 1961 | 1,620 | 28,083 |
| 1962 | 5,799 | 29,457 |
| 1963 | 13,838 | 16,357 |
| 1964 | 18,608 | 17,208 |
| 1965 | 14,167 | 17,095 |
| 1966 | 8,080 | 15,084 |
| 1967 | 5,940 | 19,734 |
| 1968 | 3,176 | 13,545 |
| 1969 | 3,012 | 15,024 |
| 1970 | 5,466 | 10,808 |
| 1971 | 6,591 | 11,185 |
| 1972 | 3,948 | 10,830 |
| 1973 | 3,871 | 11,012 |
| 1974 | 5,390 | 19,285 |
| 1975 | 5,072 | 21,465 |
| 1976 | 5,880 | 22,368 |
| 1977 | 6,695 | 18,980 |
| 1978 | 5,765 | 15,115 |
| 1979 | 6,255 | 12,435 |
| 1980 | 5,784 | 14,059 |
| 1981 | 5,770 | 14,105 |
| 1982 | 1,660 | 22,421 |
| 1983 | 2,554 | 21,699 |
| 1984 | 2,301 | 24,473 |
| 1985 | 2,680 | 22,063 |
| 1986 | 2,329 | 19,260 |
| 1987 | 2,504 | 18,271 |
| 1988 | 2,902 | 24,129 |
| 1989 | 2,766 | 21,161 |
| 1990 | 2,782 | 23,599 |
| 1991 | 2,929 | 26,389 |
| 1992 | 2,296 | 31,831 |
| 1993 | 2,384 | 34,258 |
| 1994 | 2,113 | 46,769 |
| 1995 | 2,448 | 47,303 |
| 1996 | 2,512 | 51,497 |
| 1997 | 2,334 | 51,211 |
| 1998 | 2,657 | 50,000 |
| 1999 | 2,772 | 50,000 |
| 2000 | 2,775 | 50,000 |
| 2001 | 2,784 | 50,000 |
| 2002 | 3,319 | 50,000 |
| 2003 | 2,305 | 50,000 |
| 2004 | 2,125 | 50,000 |
| 2005 | 1,756 | 50,000 |
| 2006 | 1,811 | 50,000 |
| 2007 | 1,638 | 61,000 |
| 2008 | 2,000 | 24,460 |
| 2009 | 1,980 | 19,818 |
| 2010 | 1,857 | 11,338 |
| 2011 | 2,007 | 9,774 |
| 2012 | 1,754 | 10,934 |
| 2013 | 1,482 | 13,243 |
| 2014 | 1,627 | 13,261 |
| 2015 | 1,842 | 16,201 |
| 2016 | 1,901 | 19,131 |
| 2017 | 1,850 | 23,616 |
| 2018 | 2,027 | 27,757 |
| 2019 | 2,305 | 28,760 |

Table 3. Total bluefin catch by stock in the period between 1950 and 2019, after moving the West BFT catches in the area between 20N and 20S latitude to the East Atlantic.

| Year | West BFT removed | East BFT added |
|------|------------------|----------------|
| 1950 | 1,017 | 26,812 |
| 1951 | 1,123 | 30,211 |
| 1952 | 694 | 39,007 |
| 1953 | 1,084 | 39,275 |
| 1954 | 823 | 37,157 |
| 1955 | 544 | 44,092 |
| 1956 | 247 | 30,186 |
| 1957 | 516 | 35,903 |
| 1958 | 1,175 | 33,385 |
| 1959 | 1,449 | 26,534 |
| 1960 | 693 | 26,452 |
| 1961 | 1,247 | 28,456 |
| 1962 | 4,587 | 30,670 |
| 1963 | 7,841 | 22,354 |
| 1964 | 9,948 | 25,868 |
| 1965 | 11,839 | 19,423 |
| 1966 | 7,942 | 15,222 |
| 1967 | 5,890 | 19,784 |
| 1968 | 3,167 | 13,554 |
| 1969 | 2,998 | 15,038 |
| 1970 | 5,455 | 10,819 |
| 1971 | 6,591 | 11,185 |
| 1972 | 3,948 | 10,830 |
| 1973 | 3,871 | 11,012 |
| 1974 | 5,390 | 19,285 |
| 1975 | 5,072 | 21,465 |
| 1976 | 5,880 | 22,368 |
| 1977 | 6,695 | 18,980 |
| 1978 | 5,765 | 15,115 |
| 1979 | 6,255 | 12,435 |
| 1980 | 5,784 | 14,059 |
| 1981 | 5,770 | 14,105 |
| 1982 | 1,660 | 22,421 |
| 1983 | 2,554 | 21,699 |
| 1984 | 2,301 | 24,473 |
| 1985 | 2,680 | 22,063 |
| 1986 | 2,329 | 19,260 |
| 1987 | 2,504 | 18,271 |
| 1988 | 2,902 | 24,129 |
| 1989 | 2,766 | 21,161 |
| 1990 | 2,782 | 23,599 |
| 1991 | 2,929 | 26,389 |
| 1992 | 2,296 | 31,831 |
| 1993 | 2,384 | 34,258 |
| 1994 | 2,113 | 46,769 |
| 1995 | 2,448 | 47,303 |
| 1996 | 2,512 | 51,497 |
| 1997 | 2,334 | 51,211 |
| 1998 | 2,657 | 50,000 |
| 1999 | 2,772 | 50,000 |
| 2000 | 2,775 | 50,000 |
| 2001 | 2,784 | 50,000 |
| 2002 | 3,319 | 50,000 |
| 2003 | 2,305 | 50,000 |
| 2004 | 2,125 | 50,000 |
| 2005 | 1,756 | 50,000 |
| 2006 | 1,811 | 50,000 |
| 2007 | 1,638 | 61,000 |
| 2008 | 2,000 | 24,460 |
| 2009 | 1,980 | 19,818 |
| 2010 | 1,857 | 11,338 |
| 2011 | 2,007 | 9,774 |
| 2012 | 1,754 | 10,934 |
| 2013 | 1,482 | 13,243 |
| 2014 | 1,627 | 13,261 |
| 2015 | 1,842 | 16,201 |
| 2016 | 1,901 | 19,131 |
| 2017 | 1,850 | 23,616 |
| 2018 | 2,027 | 27,757 |
| 2019 | 2,305 | 28,760 |

Table 4. The summary table of catch by zone ($\geq 20N$, $20N-20S$, $< 20S$, and the entire area) in the West Atlantic or by period (before and after 1970, and the whole period).

| | West(North of 20N) | West(20S-20N) | West(South of 20S) | all West area |
|-----------|--------------------|---------------|--------------------|---------------|
| 1950-1970 | 69270 | 19410 | 992 | 89672 |
| 1971-2016 | 139165 | 1571 | 170 | 140905 |
| 1950-2016 | 208435 | 20980 | 1162 | 230577 |

Table 5. Estimated quarterly catch at age of “Brazilian episode”, used for the robustness test.

| Year | Quarter | Catch |
|------|---------|---------|
| 1958 | 1 | 15.28 |
| 1959 | 1 | 139.39 |
| 1960 | 1 | 26.69 |
| 1961 | 1 | 180.21 |
| 1962 | 1 | 133.85 |
| 1963 | 1 | 900.08 |
| 1964 | 1 | 3894.22 |
| 1965 | 1 | 1303.08 |
| 1966 | 1 | 60.33 |
| 1967 | 1 | 0.59 |
| 1969 | 1 | 0.80 |
| 1970 | 1 | 10.19 |
| 1957 | 2 | 3.39 |
| 1958 | 2 | 13.42 |
| 1959 | 2 | 15.79 |
| 1960 | 2 | 123.46 |
| 1961 | 2 | 29.20 |
| 1962 | 2 | 276.07 |
| 1963 | 2 | 4479.99 |
| 1964 | 2 | 4469.33 |
| 1965 | 2 | 1000.88 |
| 1966 | 2 | 74.88 |
| 1967 | 2 | 15.40 |
| 1968 | 2 | 3.25 |
| 1969 | 2 | 11.74 |
| 1970 | 2 | 0.94 |
| 1957 | 3 | 0.26 |
| 1959 | 3 | 1.94 |
| 1960 | 3 | 19.84 |
| 1961 | 3 | 4.19 |
| 1962 | 3 | 109.92 |
| 1963 | 3 | 86.23 |
| 1964 | 3 | 31.88 |
| 1965 | 3 | 6.27 |
| 1966 | 3 | 1.48 |
| 1967 | 3 | 19.15 |
| 1968 | 3 | 4.97 |
| 1969 | 3 | 0.97 |
| 1957 | 4 | 26.35 |
| 1958 | 4 | 3.30 |
| 1959 | 4 | 42.74 |
| 1960 | 4 | 169.02 |
| 1961 | 4 | 159.40 |
| 1962 | 4 | 692.57 |
| 1963 | 4 | 530.79 |
| 1964 | 4 | 264.90 |
| 1965 | 4 | 17.85 |
| 1966 | 4 | 1.70 |
| 1967 | 4 | 14.41 |
| 1968 | 4 | 0.38 |
| 1969 | 4 | 0.64 |

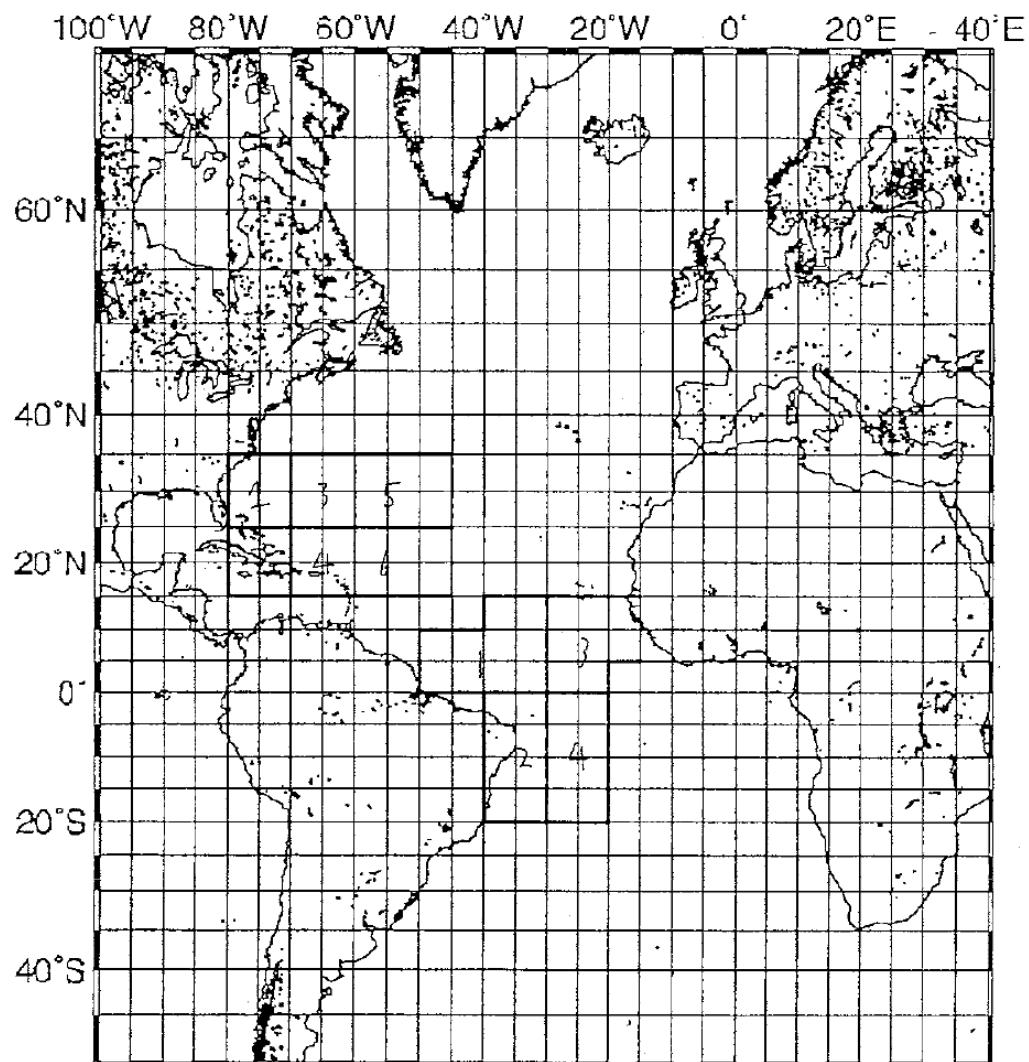


Figure 1. Area used in the analysis by Takeuchi *et al.*, 1999 of off Brazil and off Florida data. (Figure 5 in SCRS/1998/085)

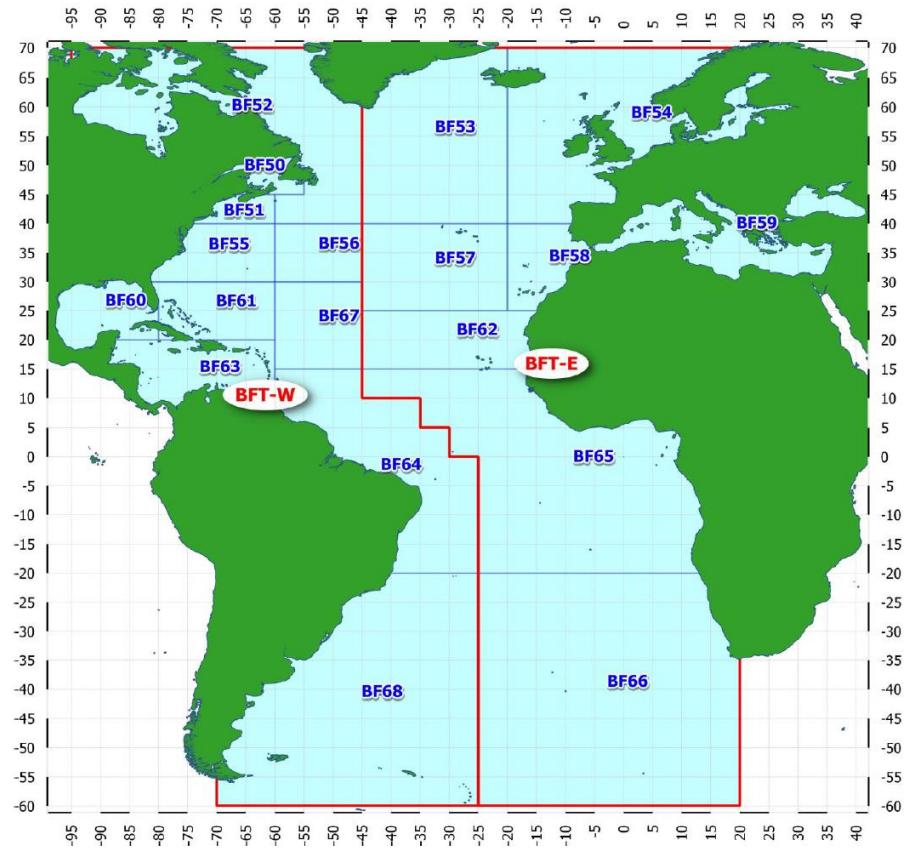


Figure 2. ICCAT current definition of the stock boundaries for Atlantic bluefin tuna (red lines) and the corresponding sampling areas for fisheries statistics reports (BF codes).

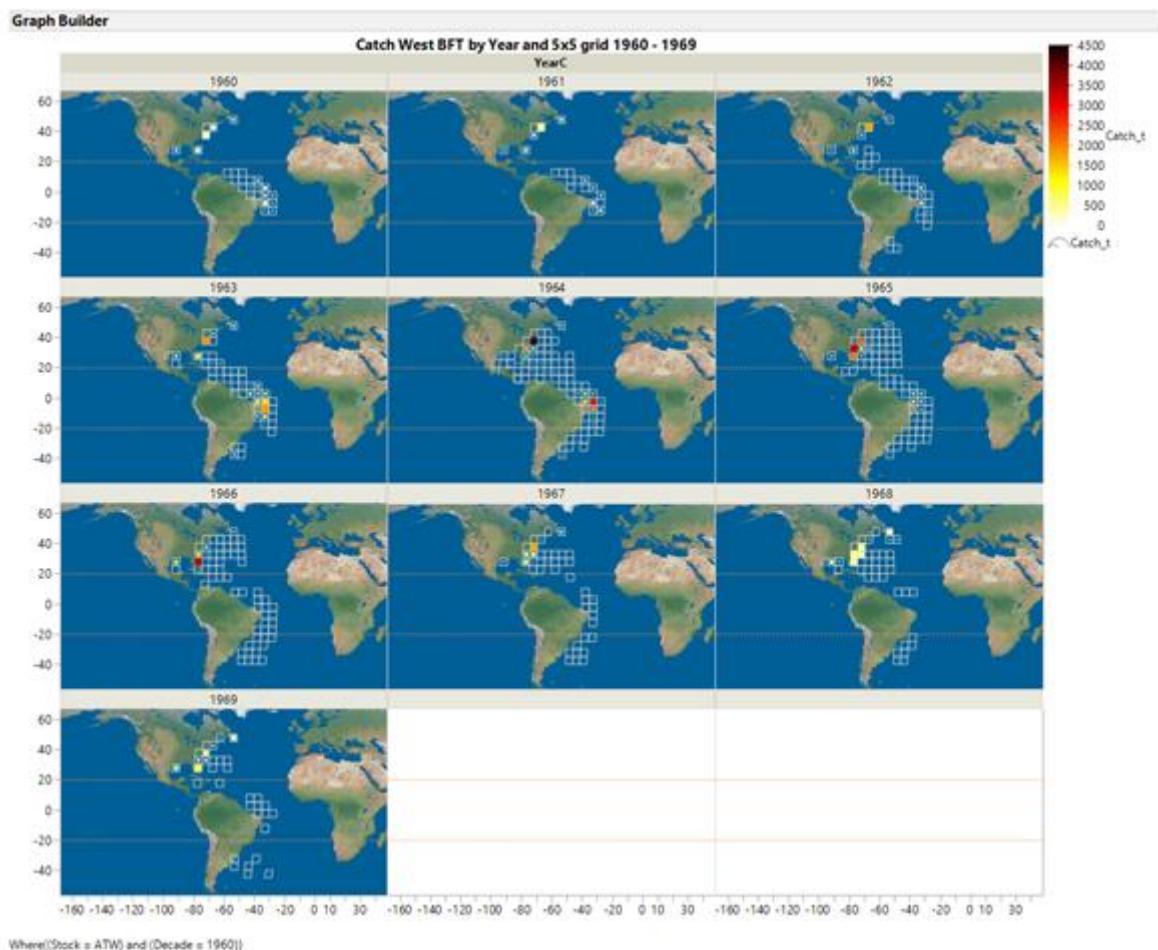
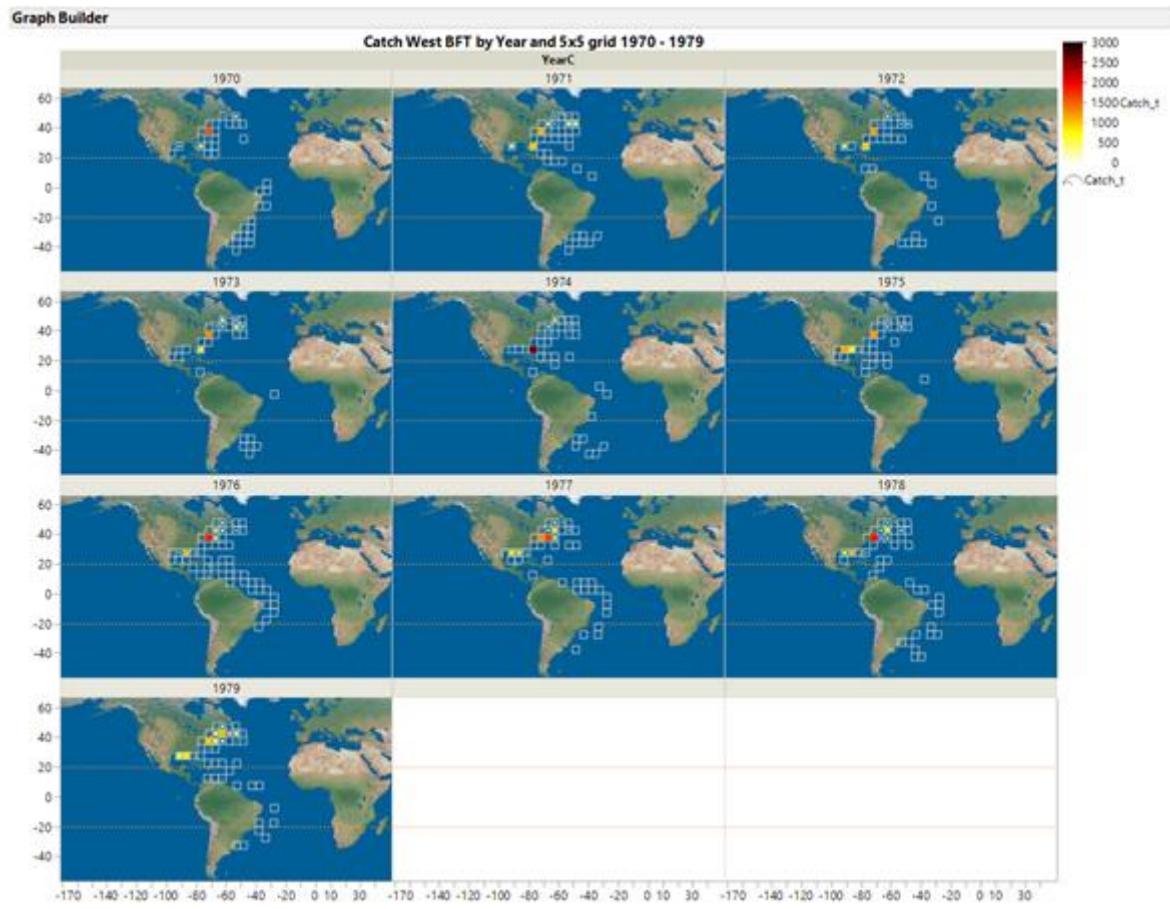


Figure 3. Annual spatial distribution (5x5 lat-lon) of the West bluefin tuna stock unit in the 1960's as estimated by CATDIS.



Where([Stock = ATW] and [Decade = 1970])
Map shape not found: -87.5/32.5.

Figure 4. Annual spatial distribution (5x5 lat-lon) of the West bluefin tuna stock unit in the 1970's as estimated by CATDIS.

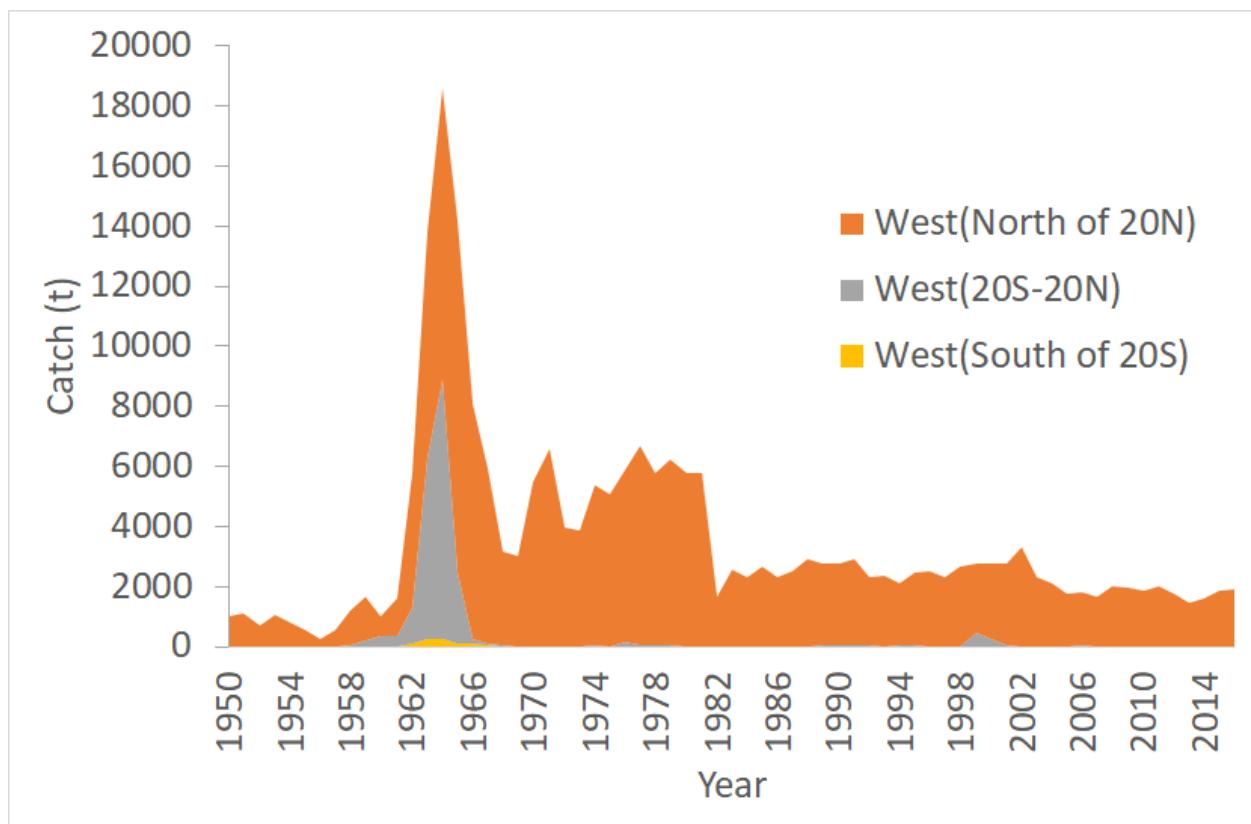


Figure 5. The West BFT catch by zone (North of 20N, 20S-20N, South of 20S) in 1950-2016 using CATDIS.

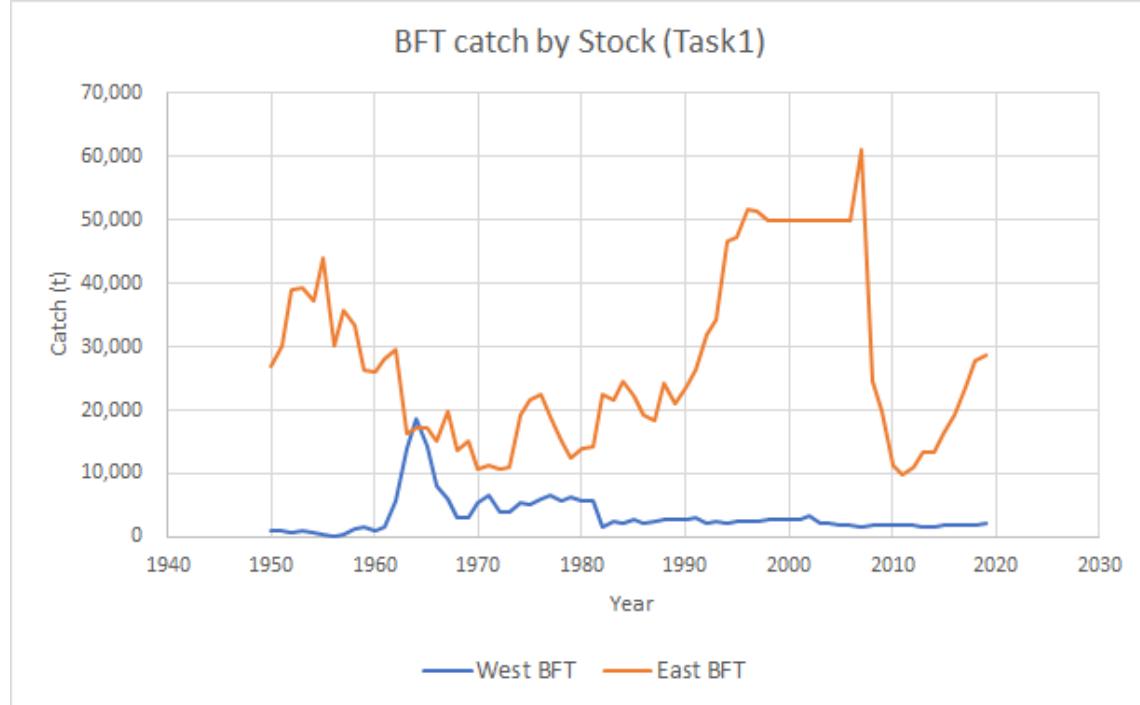


Figure 6. Total bluefin catch (Task 1) by stock used in an OM reference set in the period between 1950 and 2016.

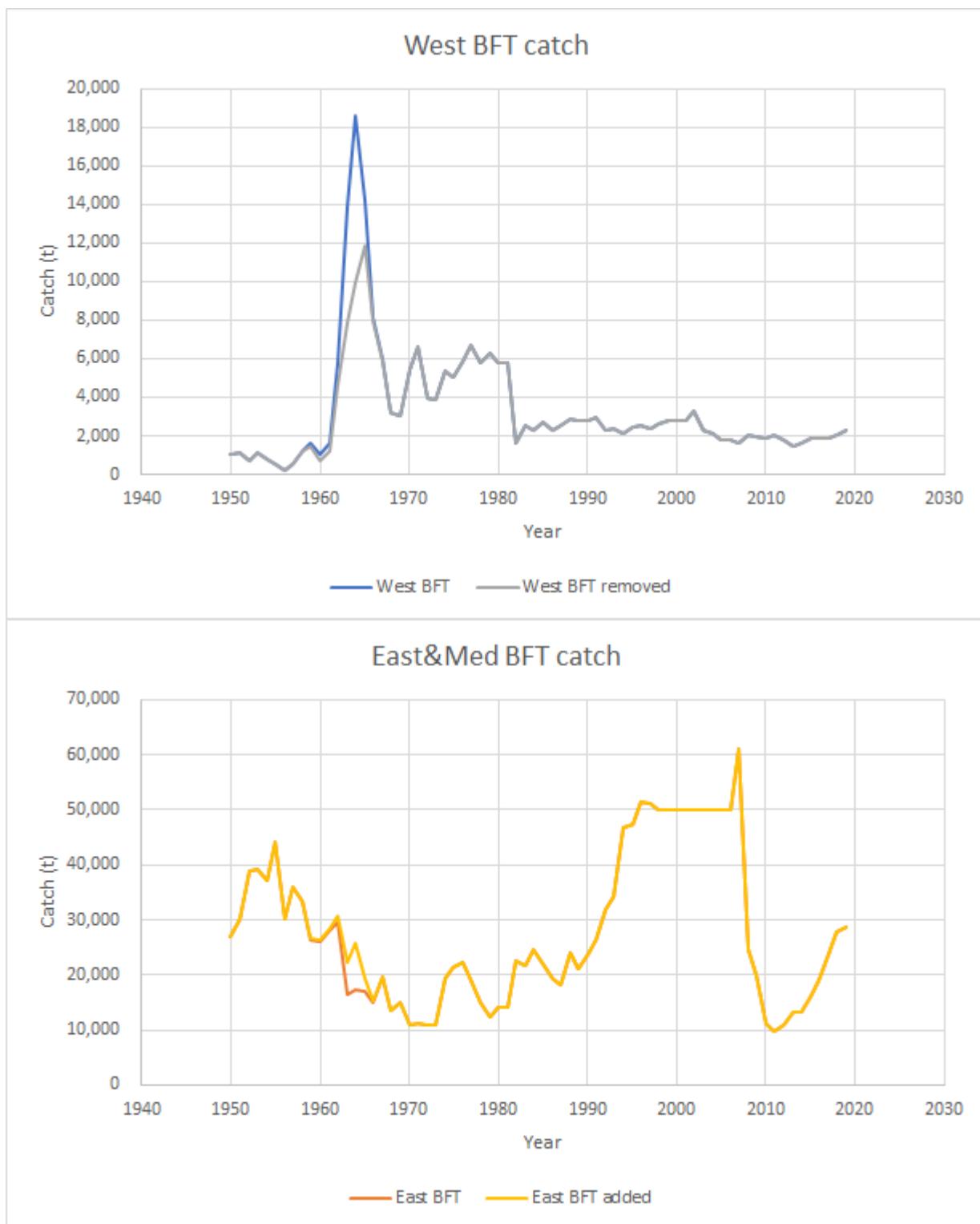


Figure 7. Total bluefin catch by stock in the period between 1950 and 2019, after moving the West BFT catches in the area between 20N and 20S latitude to the East Atlantic. The grey line for the West catch (above) and the yellow line for the East catch (bottom) are used in the robustness test for the “Brazilian episode”.

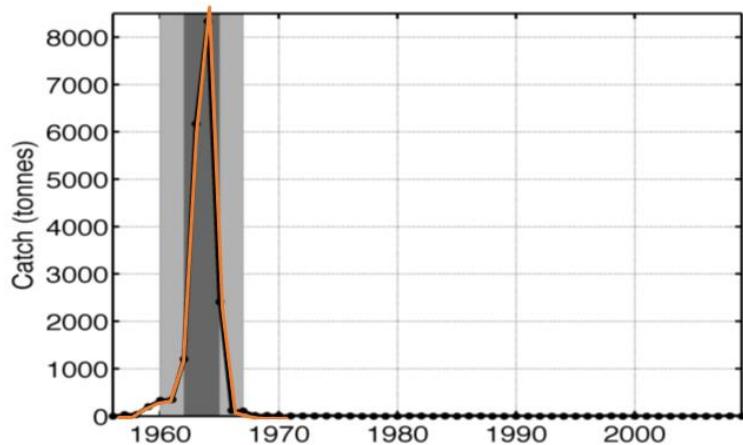


Figure 8. Comparisons of the estimated catch for “Brazilian episode” between this study and Fromentin *et al.*, 2014.

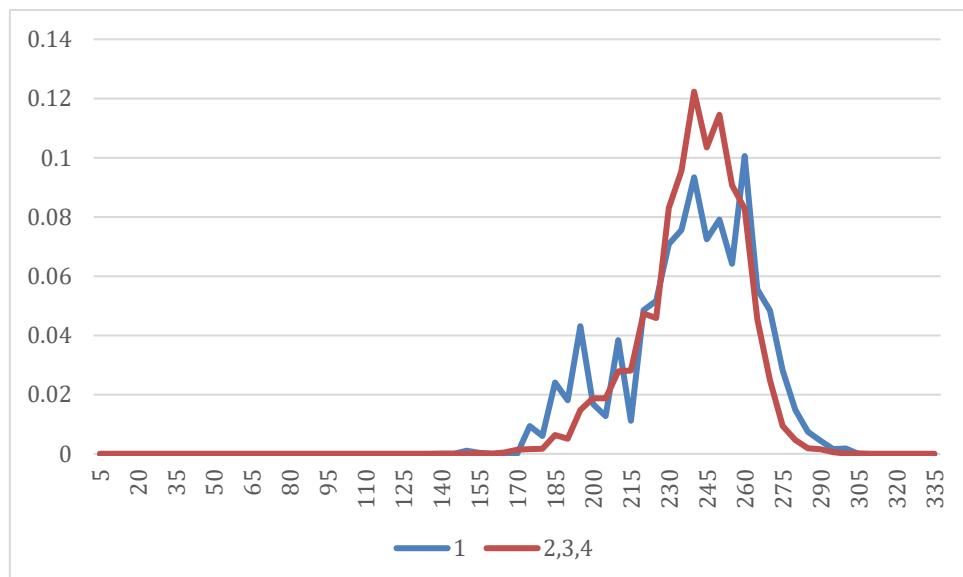


Figure 9. Assumed length composition for the catch of “Brazilian episode” for the 1st quarter (blue) and for the rest of quarters (red). The label of length shows its lower limit of 5 cm bin.