Collect. Vol. Sci. Pap. ICCAT, 72(1): 197-227 (2016)

HISTORICAL CATCH ESTIMATE RECONSTRUCTION FOR THE ATLANTIC OCEAN BASED ON SHARK FIN TRADE DATA

S. Clarke[1]

SUMMARY

This paper estimates blue and shortfin mako shark catches in the North and South Atlantic Ocean by all fleets based on a characterization of the global shark fin trade as of 2000. Catch estimates using this method were applied to ICCAT blue and shortfin mako assessments in 2004 and 2008. Estimates were constructed using four steps. First, estimates of the number and biomass of blue and shortfin mako shark represented in the global shark fin trade in 2000 were reconstructed using triangular distributions, and then adjusted using annual imports into Hong Kong for 1980-2011. Figures were then further adjusted based on the diminishing share of Hong Kong's shark fin trade as compared to the total global trade in recent years. Finally, these adjusted global estimates were scaled by ocean area (km2), by target species catch, and by longline effort to represent potential shark catches in the North and South Atlantic Ocean. It is important to note that these estimates capture only a portion of the potential blue and shortfin mako shark catches (i.e. only those sharks' whose fins are traded).

RÉSUMÉ

Le présent document estime les captures de requin peau bleue et de requin-taupe bleu dans l'Atlantique Nord et Sud de toutes les flottilles, en se fondant sur une caractérisation du commerce mondial d'ailerons de requins à partir de 2000. Les estimations des prises réalisées avec cette méthode ont été appliquées aux évaluations de requin peau bleue et de requin-taupe bleu en 2004 et 2008. Les estimations ont été construites suivant quatre étapes. Tout d'abord, les estimations du nombre et de la biomasse du requin peau bleue et du requin-taupe bleu représentées dans le commerce mondial d'ailerons de requins en 2000 ont été reconstruites à l'aide de distributions triangulaires et ont ensuite été ajustées avec les importations annuelles dans Hong Kong entre 1980 et 2011. Les chiffres ont alors été davantage ajustés en fonction de la part décroissante du commerce d'ailerons de requins de Hong Kong par rapport à l'ensemble du commerce mondial au cours de ces dernières années. Enfin, ces estimations globales ajustées ont été mises à l'échelle par zone de l'océan (km2), par espèce cible capturée et par effort palangrier pour représenter les prises potentielles de requins dans l'Atlantique Nord et du Sud. Il est important de noter que ces estimations ne captent qu'une partie des prises potentielles de requin peau bleue et de requin-taupe bleu (c'est-à-dire seulement les requins dont les ailerons sont commercialisés).

RESUMEN

En este documento se realiza una estimación de las capturas de marrajo dientuso y tintorera en el Atlántico norte y sur por parte de todas las flotas basándose en una descripción del comercio de aletas de tiburón global desde 2000. Las estimaciones de captura que utilizan este método se aplicaron a las evaluaciones de marrajo dientuso y de tintorera de ICCAT en 2004 y 2008. Las estimaciones se realizaron siguiendo cuatro pasos. En primer lugar, se reconstruyeron las estimaciones del número y la biomasa de tintorera y marrajo dientuso representados en el comercio mundial de aletas de tiburón en 2000 utilizando distribuciones triangulares y después se ajustaron utilizando las importaciones anuales a Hong Kong durante el periodo 1980 a 2011. Posteriormente se ajustaron más las cifras basándose en la parte reducida del comercio de aletas de tiburón de Hong Kong respecto al comercio total mundial de años recientes. Por último, estas estimaciones mundiales ajustadas se escalaron por zona oceánica (km2), por captura de especies objetivo y por esfuerzo de palangre para representar las posibles capturas de tiburones en el océano Atlántico norte y sur. Es importante señalar que estas estimaciones representan solo una parte de las posibles capturas de tintorera y marrajo dientuso (es decir, solo aquellos tiburones cuyas aletas se comercializan).

[1] Technical Coordinator-Sharks and By-catch-Areas Beyond National Jurisdiction (ABNJ) Tuna Project, Western and Central Pacific Fisheries Commission, Pohnpei, Federated States of Micronesia. Email: shelley.clarke@wcpfc.int

KEYWORDS

Shark fisheries, Catch statistics, Trade, Mathematical models

1. Introduction

The International Commission for the Conservation of Atlantic Tunas (ICCAT) must find ways of overcoming the lack of historical catch data in order to assess the status of shark species, in particular blue (*Prionace glauca*) and shortfin mako (*Isurus oxyrinchus*) sharks scheduled for assessment in 2015 and 2016. This paper adapts and applies a methodology used to produce estimates of catches of sharks utilised in the shark fin trade for the International Commission for the Conservation of Atlantic Tunas (Clarke 2008), the Western and Central Pacific Fisheries Commission (Clarke 2009) and the Indian Ocean Tuna Commission (Clarke 2014). These estimates are not direct substitutes for species-specific catch time series primarily because they capture only a portion of the potential shark mortality, i.e. only those sharks' whose fins are internationally traded. As a result, figures produced by this study should be considered minimum estimates of shark mortality in the Atlantic Ocean. Nevertheless, they may be useful for comparison with other, more conventional sources of catch data or as minimum plausible estimates if other catch series are not available.

2. Materials and Methods

2.1 Data Sources

The algorithm for estimating the Atlantic Ocean shark catch represented in historical shark fin trade data is based on Clarke (2008, 2009 and 2014). It consists of four data components, each of which is discussed separately below:

1. Estimates, by species, of the number and biomass of sharks used in the global shark fin trade in 2000 (the "anchor point" estimates);
2. A standardized estimate of the quantity of shark fins imported to Hong Kong for each year of interest before and after 2000;
3. An estimate of the Hong Kong market share, relative to the global market, for each year of interest before and after 2000;
4. Estimates of the proportion of the global total of shark fins that are derived from the Atlantic Ocean (calculated using three alternative methods).

2.1.1 Data Source 1

The "anchor point" estimates of the number and biomass of sharks used in the global shark fin trade are taken from Clarke *et al.* (2006a). That study used matches of Chinese trade names and taxa from market sampling and genetic testing (Clarke *et al.* 2006b), in combination with 18 months of Hong Kong auction records to impute missing data and produce an annual estimate of traded fin weights by species and fin size category. These fin weights were then converted to number of sharks and biomass using a series of conversion factors. For each species, three independent estimates based on dorsal, pectoral and caudal fins, respectively, were produced and extrapolated using trade data to represent the global market. A composite estimate for all fin types was then produced using a mixture distribution computed with the density function for each fin position weighted proportionally to its precision. Since a probabilistic modelling framework was applied, the results were presented as probability intervals.

Of the eleven categories of species, or groups of species, presented in that study, this analysis uses the results for blue and shortfin mako sharks only. The estimates (**Table 1**) were provided both in number (million sharks) and biomass (thousand tonnes). These estimates are based on the shark fin trade as of 2000 when Hong Kong imported 6,788 t of fins and was estimated to control 44-59% of the global market (Clarke 2004a, Clarke *et al.* 2006a).

2.1.2 Data Source 2

Standardized estimates of the quantity of shark fin imported by Hong Kong in each year since 1980 were prepared from unpublished Hong Kong government records (HKSARG 2012). Prior to 1998, Hong Kong recorded imports of shark fins in dried or frozen ("salted") categories without distinguishing between processed and unprocessed fins. In order to avoid double-counting fins returning to Hong Kong after processing in Mainland China, imports from the Mainland prior to 1998 were subtracted from total imports following methods used by TRAFFIC (1996). In 1998 Hong Kong established separate customs codes for dried and frozen (i.e. the latter listed as "salted" in commodity coding lists), processed and unprocessed fins. After 1998, only unprocessed dried and frozen fins were included in the annual totals. All frozen fin weights were normalized for water content by multiplying by 0.25 (Clarke 2004a).

Although the data series continues through to the present, changes in the commodity coding scheme in 2012, in parallel with reports of a sharp drop in both market demand and price, suggest that Hong Kong import data after 2011 may not reflect trends in shark catches to the same extent as prior data (Clarke and Dent, 2014; Eriksson and Clarke, 2015). For this reason, only data prior to 2012 were used in the estimation (**Figure 1**). The adjusted annual imports of shark fin to Hong Kong from 1980-2011 are shown in **Table 2**.

2.1.3 Data Source 3

Hong Kong's share of the global shark fin trade was studied in detail for 1996-2000 and was calculated from empirical data to range from 44-59% (Clarke *et al*. 2006a). Since reliable empirical data for estimating Hong Kong's market share in previous and subsequent years (i.e. 1980-1995 and 2001-2011) are lacking, ranges of values for these years were specified based on expert judgment.

Difficulties in estimating Hong Kong's share of the global trade in previous years (i.e. 1980-1995) are mainly due to the lack of access to customs statistics, especially for Mainland China. Nevertheless, a general understanding of trade patterns in Hong Kong during the 1980s (Clarke *et al*. 2007) suggests that Hong Kong's market share was higher in 1980-1995 than during 1996-2000. The earliest accounts of the shark fin trade state that Hong Kong's share of world imports was 50% (Tanaka 1994, based on data through 1990) or 85% (Vannuccini 1999, based on 1992 data). A range of 65-80% was thus selected for the period 1980-1990. A transitional period for the shark fin trade in Hong Kong occurred in 1991-1995 as demand began to rise appreciably in Mainland China. It is likely that Hong Kong's share began to drop, but not to the extent observed in the period 1996-2000 (i.e. 44-59%), thus a range of 50-65% was selected.

Estimation of Hong Kong's market share since 2000 is less plagued by data gaps but still subject to a number of potential biases. Previous analysis has shown that Hong Kong imports of shark fin rose at a rate of 6% per year from 1992-2000 (Clarke 2004a), but afterwards showed a nearly level but slightly declining linear trend (Clarke *et al.* 2007). Hong Kong shark fin traders attribute this trend to a loss of market share to Mainland China. While this explanation is supported by the well-known liberalization of the Mainland China economy just prior to and as a result of entry to the World Trade Organization in December 2001 (WTO 2014), Mainland China's shark fin imports do not show a strong trend of increase since 2000. One reason for this lack of trend may be that in 2000 Mainland China began importing frozen shark fins under a category previously used only for frozen shark meat and therefore from 2000 onward frozen fins, which comprise a substantial portion of the trade, are no longer distinguishable in the statistics (Clarke 2004b). Complications in trade reporting by Mainland China and their implications for assessing global trade in shark fins are discussed in detail in Clarke *et al.* (2007). On balance it was considered that even without strong evidence of increasing imports by Mainland China, it was likely that Hong Kong's share of global trade declined sharply after 2000. A range of 30-50% was thus specified for 2001-2006 to account for the initial decline, and a lower range of 25-40% was specified for 2007-2011 as the trend is believed to have become even more pronounced.

2.1.4 Data Source 4

Three methods were used for proportioning global fin trade-based catch estimates to Atlantic Ocean-specific quantities. Each index has various inherent biases acting over the entire time series or over portions of the time series. Therefore, when patterns appear in results derived from one proportioning method only, careful consideration of the credibility of that particular proportioning method is warranted.

The first proportioning method is based on calculating the area of blue and shortfin mako sharks' potential habitat in the North and South Atlantic relative to their potential habitat in the world ocean as a whole. This method assumes that both sharks are evenly distributed throughout global waters between the northern-most and southern-most extent of their ranges. For simplicity, this range was considered to be 50ºN-50ºS worldwide based on Compagno (1984). The global area of habitat between 50ºN-50ºS was considered to be 287.84 million km^2 (Clarke et al. 2006), whereas the North Atlantic (using ICCAT's definition of "North Atlantic" as north of 5ºN) habitat was 29.65 million km^2 and the South Atlantic was 38.74 million km^2. The area-based habitat ratios for the Atlantic Ocean were thus calculated as:

$$\text{North Atlantic: } \frac{29.65\ Mkm^2}{287.84\ Mkm^2}=0.103$$
$$\text{South Atlantic: } \frac{38.74\ Mkm^2}{287.84\ Mkm^2}=0.134$$

No plot is shown for the first proportioning method because the ratios are constant throughout the time series.

The second proportioning method involved scaling against a ratio of tuna and tuna-like species catches in global waters versus those in the North and South Atlantic. Catch data were taken from the FAO Capture Production database's ISSCAAP group "tunas, bonitos and billfishes" for all oceans and for the Atlantic Ocean alone (FAO 2014). The Atlantic Ocean catch was then split using ICCAT target species catch figures for the North (north of 5ºN) and South Atlantic. These figures, and the resulting ratios, are shown in **Table 3** and **Figure 2**.

The third proportioning method involved constructing an index of longline effort. Although a number of gear types catch sharks, this index was chosen because it was assumed that longline gear both catches a large number of sharks and is relatively easy to quantify on a global basis (unlike other gear types). The number of longline hooks (in millions) fished annually in the Indian Ocean was provided by IOTC staff (IOTC 2014), and were extracted from a database of raised longline effort for the WCPO (CES 2014). For the Eastern Pacific, longline effort was only available in nominal form for fleets from China, Japan, Korea, French Polynesia, Taiwan-China and the United States. Effort for other fleets, and for all fleets prior to 1984 has not been compiled (IATTC 2014). Longline effort in the Atlantic has been estimated under ICCAT's EFFDIS project through 2009 only (ICCAT 2015a; ICCAT Secretariat, personal communication). In order to extend the series through 2011, nominal effort for 2005-2009 was extracted from the ICCAT Task II (Catch and Effort database, ICCAT 2015b) by the ICCAT Secretariat and used to create a 5-year averaged conversion factor between nominal and EFFDIS effort (4.27) and an average proportion of Atlantic hooks fished in the South Atlantic (0.53). This conversion factor was used to construct annual effort values for 2010-2011 and thus complete the EFFDIS series in a rudimentary way[2]. These data, the total global longline effort figures and the ratio of North and South Atlantic Ocean to global longline effort are shown in **Table 4** and **Figure 3**.

2.2 Model and Modelling Methods

The model was implemented with Markov chain Monte Carlo (MCMC) methods using the Gibbs sampler (Gelfand and Smith 1990) via WinBUGS software version 1.4.3 (Imperial College London 2015). Since the original posterior distributions presented in Clarke *et al.* (2006a) require many hours of computing time to replicate, simplified representations of these complex distributions were approximated using triangular distributions (Step 1). Other uncertain parameters, such as Hong Kong's share of the global fin trade (Step 3), were specified as expert judgement-based ranges with uniformly distributed random variables. The annual quantity of Hong Kong imports (Step 2) and the proportioning indices (Step 4) were based on empirical data for each year, except for the geographic area which does not vary from year to year. Although there is uncertainty in these data it is not possible to quantify the variance and thus these parameters were specified using deterministic equations. The model was executed in four steps covering each of the four data sources given above (**Annex 1**):

[2] It is noted that at the time of writing, a consultant engaged by ICCAT is updating the EFFDIS data series and a new series is expected to be available in the next few months.

Step 1

The probability distributions representing the range of estimates of the two shark species in the global trade by number (**Table 1**) were approximated as triangular distributions using the reported lower limit of the 95% probability interval as the minimum, the upper limit of the 95% probability interval as the maximum, and the median as the mode. The model drew a random variable from each of the triangular distributions representing each species' number or biomass in 2000 in each iteration.

Step 2

Each random variable drawn in Step 1 was multiplied by the ratio of the standardized quantity of fins traded through Hong Kong in each year from 1980-1999 and 2001-2011 (**Table 2**) to the quantity of fins traded through Hong Kong in 2000 (i.e. 6,788 t). This step serves to scale the species-specific number or biomass estimates from 2000 to quantities representing trade levels in each of the other years. Due to a lack of quantitative data on trends in species composition this step assumes that the species composition in 2000, the only year for which the species composition is known, remains constant over the years 1980-2011. It is likely, however, that the relative proportion of blue sharks in trade has increased in recent years due to the relatively higher productivity of that species (Eriksson and Clarke, 2015).

Step 3

Hong Kong's share in four alternative periods (S_a), i.e. 1980-1990, 1991-1995, 2001-2006 and 2007-2011, relative to its share in 1996-2000 (0.44-0.59, S) was specified as a series of uniformly distributed random variables using endpoints based on expert judgment (Section 2.1.3). The ratio of S and S_a was then computed and multiplied by the result from Step 2. The result of Step 3 is a species-specific number or biomass value representing sharks used in the global trade for each year from 1980-2011.

Step 4

The final step required proportioning the annual values from Step 3 to the North and South Atlantic Ocean. Proportioning based on area used constants of 0.103 for the North Atlantic and 0.134 for the South Atlantic overall years in the time series. The target species catch-based (**Table 3** and **Figure 2**) and longline effort-based (**Table 4** and **Figure 3**) proportioning methods applied unique values for each year as deterministic calculations.

The model was run for 100,000 iterations, and medians and 95% probability interval endpoints were sampled from the final 10,000 iterations.

3. Results

The algorithm outlined above will, by definition, produce the same patterns of results in number (**Figures 4, 5, 9** and **10**) and in biomass (**Figures 6, 7, 11** and **12**). This is because the same scaling factors were applied to the anchor point estimates thus only the absolute value of the starting point differs. Similarly, as the anchor point estimates for shortfin mako are on the order of 10% those of blue shark, the quantities estimated for shortfin mako shark in each year are generally 10% of those estimated for blue shark. In general the area-based proportioning method, which used constant annual values, produced the highest estimates. The target species catch-based method produced the lowest estimates and these were approximately one-third of the area-based estimates. The effort-based method produced mid-range estimates with probability intervals often overlapping the median values from the target species catch-based and area-based methods.

In addition to considering the absolute differences between the estimates in any given year, the trends in the estimates can also be interpreted with reference to which proportioning method was applied. For example, the area-based series is based on constant (over time) geographical proportioning of the annual observed fluctuations in the Hong Kong trade quantities. All of the other proportioning methods superimpose an annually varying index over these Hong Kong trade fluctuations. Therefore, if peaks or troughs in Hong Kong trade combine with peaks or troughs in the Atlantic Ocean proportioning indices, variations in the target species catch-based or effort-based methods may occur which are not reflected in the other series. In contrast, if all proportioning methods show a similar variation, e.g. the dip in estimates in 2006, this effect likely originates in the trade data applied in Steps 1-3.

Focusing on the 1998-2011 period and accounting for the full width of the 95% probability intervals, North Atlantic Ocean catch estimates for blue shark ranged from minima (target catch-based) of ~0.25 million sharks per year to maxima (area-based) of up to 2.5 million sharks per year. In biomass, these North Atlantic Ocean blue shark catches were estimated with minima of at least ~10,000 t (target catch-based) and maxima of at most ~90,000 t (area-based) per year over the same period. North Atlantic Ocean median estimates for all of the proportioning methods were centred on 0.8 million blue sharks (~30,000 t) per year in the most recent decade. For the South Atlantic Ocean, accounting for the full width of the 95% probability intervals since 1998, blue shark catches ranged from ~0.25-~3.25 million sharks per year. In biomass, these South Atlantic Ocean estimates were at least ~10,000 t and at most ~125,000 t. South Atlantic Ocean median estimates for all of the proportioning methods centred on 1.25 million blue shark (40,000 t) per year in the most recent decade.

With regard to shortfin mako shark, the full width of the 95% probability interval for the North Atlantic Ocean estimates ranged from minima (target catch-based) of ~0.01 million to a maxima (area-based) of up to ~0.15 million sharks per year. In biomass, these North Atlantic Ocean shortfin mako shark estimates ranged over all methods and their 95% probability intervals from just under 1,000 t to over 8,000 t. The North Atlantic Ocean median estimates centred on 0.05 million sharks (~3,000 t) per year in the most recent decade. For the South Atlantic Ocean, accounting for the full width of the 95% probability intervals since 1998, shortfin mako shark catches ranged from a minimum of ~0.02 to up to ~0.2 million sharks per year. In biomass, South Atlantic Ocean shortfin mako estimates were at least ~1,000 t and at most ~11,000 t. South Atlantic Ocean median estimates for shortfin mako for all of the proportioning methods centred on 0.06 million sharks (4,000 t) per year in the most recent decade.

4. Discussion

Catch data for most shark species are insufficient to support stock assessment, yet concerns about the status of shark populations continue to grow. Under such circumstances, development of alternative historic shark catch time series and careful evaluation of whether these alternative series can fill some of the existing critical data gaps is a worthwhile exercise.

The estimates produced by this study were based on "anchor point" estimates derived from a shark fin trade data set compiled in Hong Kong in 2000 (Clarke *et al.* 2006a). To date these are the only quantitative, species-specific data on the shark fin trade and represent a snapshot of the centre of the global shark fin trade at that time. Using these data to estimate the number and biomass of shark catches in the North and South Atlantic Ocean requires a number of assumptions, namely:

1. The species composition of the sampled portion of the Hong Kong shark fin trade in Clarke *et al.* (2006a) is representative of global species composition. As discussed in Clarke et al. (2006b), there is a lack of information to evaluate the strength of this assumption, but there are no other datasets that are considered more representative.

2. The species composition of the fin trade observed in 2000, and the relationships between fin sizes/weights and whole shark weights observed at that time, are constant throughout the time series. While some stock composition shifting would be expected over time, there are few existing data with which to explore alternative assumptions. It may be the case that the proportion of blue shark in the shark fin trade has increased as other, less productive species have been depleted (Eriksson and Clarke, 2015). In such a case the estimates presented here would under-estimate the actual blue shark catch in recent years.

3. Each of the species assessed is equally likely to be found in the North and South Atlantic Ocean as in any other ocean. This appears to be a reasonable assumption given what is known regarding the distribution of these sharks.

Overlying these assumptions is the fact that estimating catches based on shark fin trade data will in theory underestimate the true quantities of sharks caught. First, the original "anchor point" estimates are in themselves conservative because they are based only on those fins which could be confirmed to derive from the species of interest. More than half (54%) of the fins observed by Clarke *et al.* (2006a) could not be characterized by species and could have contained additional quantities of the species of interest (Clarke *et al.* 2006b). Second, only those sharks whose fins enter the international shark fin trade are enumerated. This is because there is no means in this study of accounting for mortality associated with sharks which are a) discarded dead with their fins attached; b) released with their fins attached but subsequently die due to injury or stress; or c) are retained but whose fins are either not used or used without being internationally traded. For these reasons, even if the methodology used in this study is accurate, actual shark mortality would be expected to be greater than the estimates provided here.

Robust estimation requires use of a number of different algorithms to explore various assumptions and biases. However, this approach in combination with reporting of probability intervals rather than point estimates can lead to considerable uncertainty when drawing conclusions about the estimation results. It is thus important to discuss, qualitatively if necessary, the relative credibility of each of the three estimates (**Figures 4-7** and **9-12**; Annexes 2-5).

Of the three proportioning methods (area-, target species catch-, and effort--based methods), the most arbitrary is the area-based method. Although it is useful as a reference case, setting catch proportional to geographic area makes the unlikely assumption that shark abundance and fishing operations are distributed in direct proportion to the area of each of the world's oceans. For this reason the proportioning methods relating to fishing activity are more credible. The target species catch-proportioning method assumes that when tuna and billfish catches in the Atlantic Ocean are low relative to other oceans, shark catches in the Atlantic Ocean are also low relative to other oceans. This assumption may be erroneous, particularly if trends of increase in tuna catches by purse seine fisheries have occurred predominantly in other oceans (i.e. because this gear type does not often catch blue and shortfin mako sharks).

Another method for proportioning global to Atlantic Ocean totals using fishing activity was based on effort statistics, specifically longline effort in hooks. This method is considered to be more reliable that the area- or target species catch-based methods because its main assumption, i.e. that shark catch is proportional to longline effort, seems reasonable. The main source of bias associated with the effort-based method is the under- or non-reporting of longline effort particularly in small coastal longline fleets. For example, it is known that longline effort is under-represented for the Eastern Pacific because of lack of effort data for many of the smaller fleets (IATTC 2014). This would tend to inflate the catch estimates in other oceans. Unless and until there is a common method for compiling effort statistics across all oceans, potential biases will exist due to different statistical procedures applied by each t-RFMO[3].

There are few existing estimates of Atlantic Ocean shark catches which with to compare the results of this study. Murua *et al*. (2013) used ratios of shark catches to target species catches over the period 2000-2010 to produce a point estimate of annual catches for each of 24 types of sharks (including "other sharks") and 16 fleet types (including "other"). The sum of the point estimates across the 16 fleet types ranged from 72,000-102,000 t yr^{-1} for blue sharks and 7,000-11,000 t yr^{-1} for shortfin mako sharks. The higher Murua *et al*. (2013) estimate for blue sharks is similar to but overall lies slightly below the area-based estimate produced here (this study's median range: 95,000-125,000 t per year; **Figure 8**). The lower Murua *et al.* (2013) estimate (72,000 t) overall lies slightly above this study's effort-based estimate (median range: 55,000-85,000 t). The high and low Murua *et al*. (2013) estimates for shortfin mako shark show similar relationships to the shortfin mako shark area-based and effort-based estimates in this study (**Figure 13**).

The general agreement of these two independent methods of estimating historical catches for the 2000-2010 period suggests that the magnitude of the shark fin trade-based estimates by area and effort presented in this study may be reasonably accurate. If so, and given that the Hong Kong shark fin data have been shown to closely follow the trends in global chondrichthyan capture production as reported to FAO (Eriksson and Clarke, 2015), the area- and effort-based series presented here appear to represent credible historical catch time series. However, there are some important uncertainties which cannot be resolved on the basis of existing data. Given the urgent need for improvement in historic catch data to support shark stock assessment, further work on this and other methods is strongly encouraged.

[3] Note that inconsistent statistical procedures also bias global catch statistics and thus the target species catch-based proportioning method.

Acknowledgements

The author would like to thank the following for assistance with compiling data for this study: F. Arocha (Instituto Oceanográfico de Venezuela Universidad de Oriente), A. DaSilva (IATTC), P. de Bruyn (ICCAT), S. Martin and M. Herrera (IOTC), S. Taufao and L. Manarangi-Trott (WCPFC), and P. Williams (SPC). Funding support for this work was provided by the Areas Beyond National Jurisdiction Tuna Project implemented as a whole by the United Nations Food and Agriculture Organization and for shark data improvement and assessment by the Western and Central Pacific Fisheries Commission.

References

CES (Tuna Fishery Catch and Effort Query System). 2014. Aggregate Catch/Effort Data - Raised for longline gear type, 1950-2014. Secretariat of the Pacific Community, Nouméa, New Caledonia.

Clarke, S. 2004a. Understanding pressures on fishery resources through trade statistics: a pilot study of four products in the Chinese dried seafood market. Fish and Fisheries 5: 53-74.

Clarke, S. 2004b. Shark product trade in Hong Kong and Mainland China, and implementation of the shark CITES listings. TRAFFIC East Asia, Hong Kong.

Clarke, S. 2008. Use of shark fin trade data to estimate historic total shark removals in the Atlantic Ocean. Aquatic Living Resources 21: 373-381.

Clarke, S. 2009. An Alternative Estimate of Catches of Five Species of Sharks in the Western and Central Pacific Ocean based on Shark Fin Trade Data. WCPFC-SC5-2009/EB-WP-02. Available online at https://www.wcpfc.int/system/files/SC5-EB-WP-02%20%5BAn%20Alternative%20Estimate%20of%20Catches%20of%20Five%20Species%20of%20Sharks%5D.pdf

Clarke, S. 2014. Historical catch estimate reconstruction for the Indian Ocean based on shark fin trade data. IOTC-2014-WPEB10-INF26, available online at http://www.iotc.org/documents/historical-catch-estimate-reconstruction-indian-ocean-based-shark-fin-trade-data

Clarke, S. and Dent, F. 2014. State of the Global Market for Shark Commodities: Summary of the Draft FAO Technical Paper. 27th CITES Animals Committee, Twenty-seventh meeting of the Animals Committee, Veracruz, 28 April – 3 May 2014. AC17, Inf. 14. Available online at http://www.cites.org/sites/default/files/eng/com/ac/27/E-AC27-Inf-14.pdf

Clarke, S.C., McAllister, M.K., Milner-Gulland, E.J., Kirkwood, G.P., Michielsens, C.G.J., Agnew, D.J., Pikitch, E.K, Nakano, H. and Shivji, M.S. 2006a. Global estimates of shark catches using trade records from commercial markets. Ecology Letters 9: 1115-1126.

Clarke, S.C., Magnussen, J.E., Abercrombie, D.L., McAllister, M.K. and Shivji, M.S. 2006b. Identification of shark species composition and proportion in the Hong Kong shark fin market based on molecular genetics and trade records. Conservation Biology 20: 201-211.

Clarke, S, Milner-Gulland, E.J. and Bjørndal, T. 2007. Social, economic and regulatory drivers of the shark fin trade. Marine Resource Economics 22: 305-327.

Compagno, L.J.V. 1984. Sharks of the World. An annotated and illustrated catalogue of shark species known to date. Part 2. Carcharhiniformes. FAO Species Catalogue (Fish. Synop., (125)), Vol. 4, Part 2: 251-655.

Eriksson, H. and Clarke, S. 2015. Chinese market responses to overexploitation of sharks and sea cucumbers. Biological Conservation 184: 163-173.

FAO (Food and Agriculture Organization). 2014. FishSTAT Capture Production (1950-2011) Database. Accessed online at http://www.fao.org

Gelfand, A.E. and Smith, A.F.M. 1990. Sampling-based approaches to calculating marginal densities. J. Am. Stat. Asso. 85: 398-409.

HKSARG (Hong Kong Special Administrative Region Government). 2012. Census and Statistics Department, unpublished data, 1996-2011.

IATTC (Inter-American Tropical Tuna Commission). 2014. Fishery Status Report No. 12 – Tunas and Billfishes in the Eastern Pacific Ocean in 2013 (Table A-9). Available online at http://www.iattc.org/PDFFiles2/FisheryStatusReports/FisheryStatusReport12.pdf

ICCAT (International Commission for the Conservation of Atlantic Tunas). 2015a. Preliminary estimates of numbers of hooks for major fleets and total. Available online at https://www.iccat.int/en/SCRS.htm

ICCAT (International Commission for the Conservation of Atlantic Tunas). 2015b. Raw nominal Task II (catch and effort) data from ICCAT database, 2005-2013. Available online at https://www.iccat.int/en/t2ce.asp

Imperial College London. 2015. WinBUGS software (version 1.4.3). Available online at http://www.mrc-bsu.cam.ac.uk/bugs/

IOTC (Indian Ocean Tuna Commission). 2014. Estimate of longline hooks fished in the Indian Ocean, 1952-2013, provided by S. Martin on 20 December 2014.

Murua, H., Santos, M.N., Chavance, P., Amande, J., Abascal, F.J., Ariz, J., Bach, P., Korta, M., Poisson, F., Coelho, R. and Seret, B. 2013. EU project for the Provision of Scientific Advice for the Purpose of the implementation of the EUPOA sharks. Available online at ec.europa.eu/fisheries/.../studies/sharks/scientific-advice-sharks_en.pdf

Tanaka, S. 1994. East Asian fin trade. Shark News 2: 6.

TRAFFIC. 1996. The World Trade in Sharks: A Compendium of TRAFFIC's Regional Studies (Volumes 1 and 2). TRAFFIC International, Cambridge, United Kingdom.

World Trade Organization (WTO). 2014. China and the WTO. Accessed online at http://www.wto.org/english/thewto_e/countries_e/china_e.htm

Vannuccini, S. 1999. Shark utilization, marketing and trade. Food and Agriculture Organization, Rome. FAO Fisheries Technical Paper 389.

Table 1. Number and biomass of blue and shortfin mako sharks (median and 95% probability interval) used in the global shark fin trade in 2000 (Clarke *et al.* 2006a).

Shark Species	*Number (million)*	*Biomass ('000 t)*
Blue	10.741 (4.640 – 15.762)	364 (204 – 619)
Shortfin mako	0.485 (0.320 – 0.978)	38 (20 – 56)

Table 2. Adjusted total imports of shark fin (t) to Hong Kong, 1980-2011 (see text for adjustment methods). The "anchor point" estimate is shown in bold (Source: HKSARG 2012)

Year	*Quantity (t)*	*Year*	*Quantity (t)*
1980	2,739	1996	4,513
1981	2,741	1997	4,868
1982	2,704	1998	5,196
1983	2,512	1999	5,824
1984	2,748	2000	6,788
1985	2,613	2001	6,435
1986	2,788	2002	6,513
1987	3,317	2003	6,960
1988	3,272	2004	6,142
1989	3,003	2005	5,887
1990	3,018	2006	5,337
1991	3,526	2007	5,798
1992	4,265	2008	5,536
1993	3,856	2009	5,559
1994	4,144	2010	5,759
1995	4,706	2011	6,175

Table 3. FAO-reported capture production of tunas, bonitos and billfishes globally and in the Atlantic Ocean, 1980-2011 (FAO 2014). Estimated North and South Atlantic catches were derived by applying the proportion of ICCAT target species catches in the north (north of 5 degrees North) to the FAO Atlantic total to obtain North Atlantic catches, and its inverse to obtain south Atlantic (south of 5 degrees North) catches. All catch values are in million t.

Year	*FAO Global Catch Total*	*Atlantic Ocean Catch Total*	*Proportion of ICCAT catches in North Atlantic*	*Estimated North Atlantic Catch*	*Proportion of North Atlantic: Global*	*Estimated South Atlantic Catch*	*Proportion of South Atlantic: Global*
1980	2.676	0.492	0.438	0.216	0.081	0.277	0.103
1981	2.700	0.531	0.418	0.222	0.082	0.309	0.114
1982	2.800	0.604	0.443	0.267	0.095	0.336	0.120
1983	2.961	0.566	0.447	0.253	0.085	0.313	0.106
1984	3.152	0.498	0.503	0.250	0.079	0.248	0.079
1985	3.239	0.537	0.452	0.243	0.075	0.294	0.091
1986	3.548	0.518	0.449	0.232	0.065	0.285	0.080
1987	3.678	0.520	0.420	0.219	0.059	0.302	0.082
1988	4.108	0.564	0.432	0.244	0.059	0.320	0.078
1989	4.105	0.602	0.401	0.242	0.059	0.361	0.088
1990	4.371	0.639	0.366	0.234	0.054	0.405	0.093
1991	4.508	0.652	0.355	0.232	0.051	0.420	0.093
1992	4.541	0.641	0.348	0.223	0.049	0.418	0.092
1993	4.653	0.692	0.387	0.268	0.058	0.425	0.091
1994	4.788	0.676	0.422	0.285	0.060	0.391	0.082
1995	4.944	0.635	0.421	0.267	0.054	0.368	0.074
1996	4.900	0.645	0.380	0.245	0.050	0.400	0.082
1997	5.165	0.584	0.408	0.238	0.046	0.346	0.067
1998	5.723	0.633	0.432	0.273	0.048	0.360	0.063
1999	5.936	0.636	0.426	0.271	0.046	0.365	0.062
2000	5.832	0.596	0.370	0.220	0.038	0.375	0.064
2001	5.762	0.620	0.428	0.266	0.046	0.355	0.062
2002	6.135	0.543	0.362	0.197	0.032	0.346	0.056
2003	6.291	0.531	0.399	0.212	0.034	0.319	0.051
2004	6.336	0.546	0.407	0.222	0.035	0.324	0.051
2005	6.517	0.509	0.396	0.202	0.031	0.307	0.047
2006	6.542	0.480	0.434	0.208	0.032	0.272	0.042
2007	6.617	0.472	0.410	0.194	0.029	0.278	0.042
2008	6.609	0.490	0.349	0.171	0.026	0.319	0.048
2009	6.732	0.530	0.351	0.186	0.028	0.344	0.051
2010	6.765	0.556	0.379	0.210	0.031	0.345	0.051
2011	6.825	0.592	0.351	0.208	0.030	0.384	0.056

Table 4. Estimates of longline fishing effort (in million hooks) compiled from t-RFMO databases, and the ratio of total effort in the North and South Atlantic, 1980-2011 (see text for derivation details).

Year	*North Atlantic (ICCAT 2015a)*	*South Atlantic (ICCAT 2015a)*	*Western and Central Pacific Longline Effort (CES 2014)*	*Eastern Pacific Longline Effort (IATTC 2014)*	*Indian Ocean Longline Effort (IOTC 2014)*	*Total Longline Effort*	*Ratio (North Atlantic Ocean : Total)*	*Ratio (South Atlantic Ocean : Total)*
1980	117	130	695	na N	268	na	na	na
1981	121	111	737	na	255	na	na	na
1982	129	136	667	na	303	na	na	na
1983	115	101	756	na	330	na	na	na
1984	113	108	724	135	302	1383	0.082	0.078
1985	123	154	1,053	130	301	1762	0.070	0.087
1986	149	137	742	196	333	1557	0.096	0.088
1987	112	158	884	237	362	1753	0.064	0.090
1988	112	166	838	235	419	1771	0.063	0.094
1989	112	171	755	230	547	1814	0.062	0.094
1990	124	208	767	238	688	2025	0.061	0.103
1991	134	190	667	283	666	1941	0.069	0.098
1992	138	183	800	270	669	2059	0.067	0.089
1993	114	239	683	225	875	2136	0.053	0.112
1994	137	244	586	223	842	2031	0.067	0.120
1995	135	212	596	190	759	1892	0.072	0.112
1996	183	216	567	152	941	2059	0.089	0.105
1997	168	211	569	140	1,006	2093	0.080	0.101
1998	179	218	639	175	1,239	2449	0.073	0.089
1999	183	244	731	166	1,073	2397	0.076	0.102
2000	222	253	787	140	961	2363	0.094	0.107
2001	232	225	966	238	891	2552	0.091	0.088
2002	152	198	1,009	315	888	2561	0.059	0.077
2003	141	236	993	302	806	2480	0.057	0.095
2004	193	180	1,100	213	931	2617	0.074	0.069
2005	151	146	874	152	935	2258	0.067	0.065
2006	135	158	856	107	877	2133	0.063	0.074
2007	132	175	947	103	956	2312	0.057	0.075
2008	148	152	952	89	742	2081	0.071	0.073
2009	128	152	1,069	100	724	2173	0.059	0.070
2010	127	144	950	154	665	2040	0.062	0.070
2011	142	160	1,072	152	637	2163	0.065	0.074

Figure 1. Annual imports of unprocessed shark fins, adjusted for water content, by Hong Kong 1980-2013.

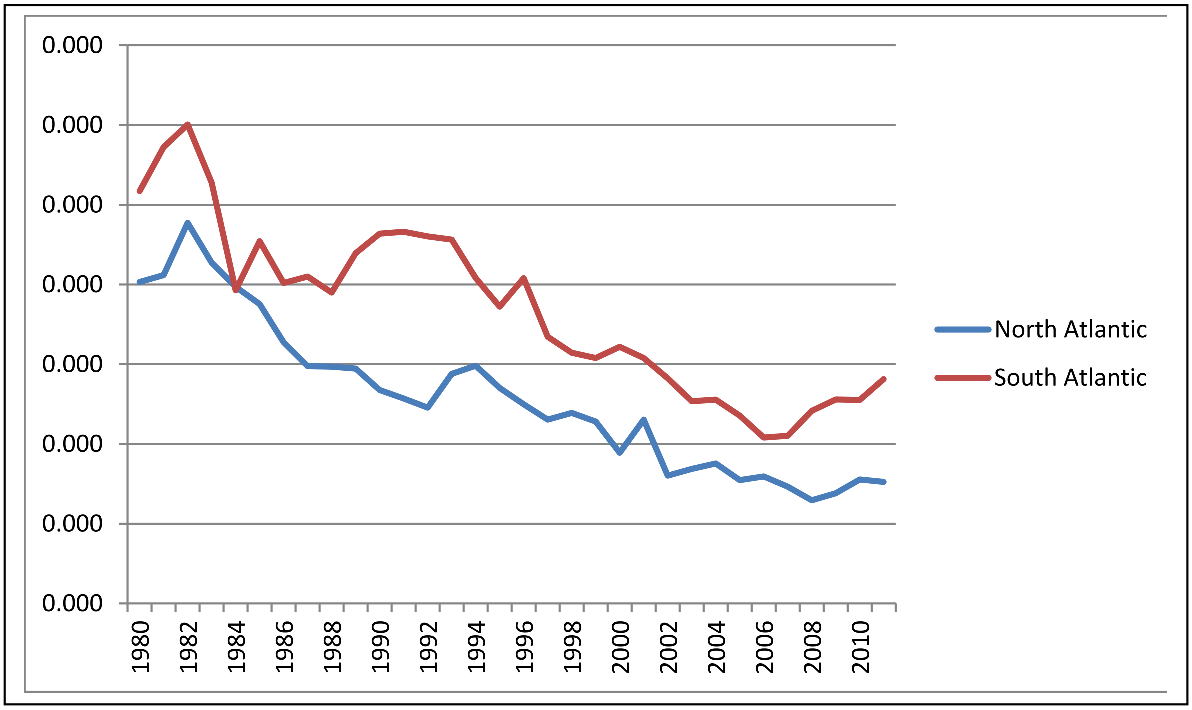

Figure 2. Annual proportion of FAO-reported capture production of tunas, bonitos and billfishes in the Atlantic Ocean North (north of 5 degrees North) and South (south of 5 degrees North) to the global catch of these species, 1980-2011 (data given in **Table 2**).

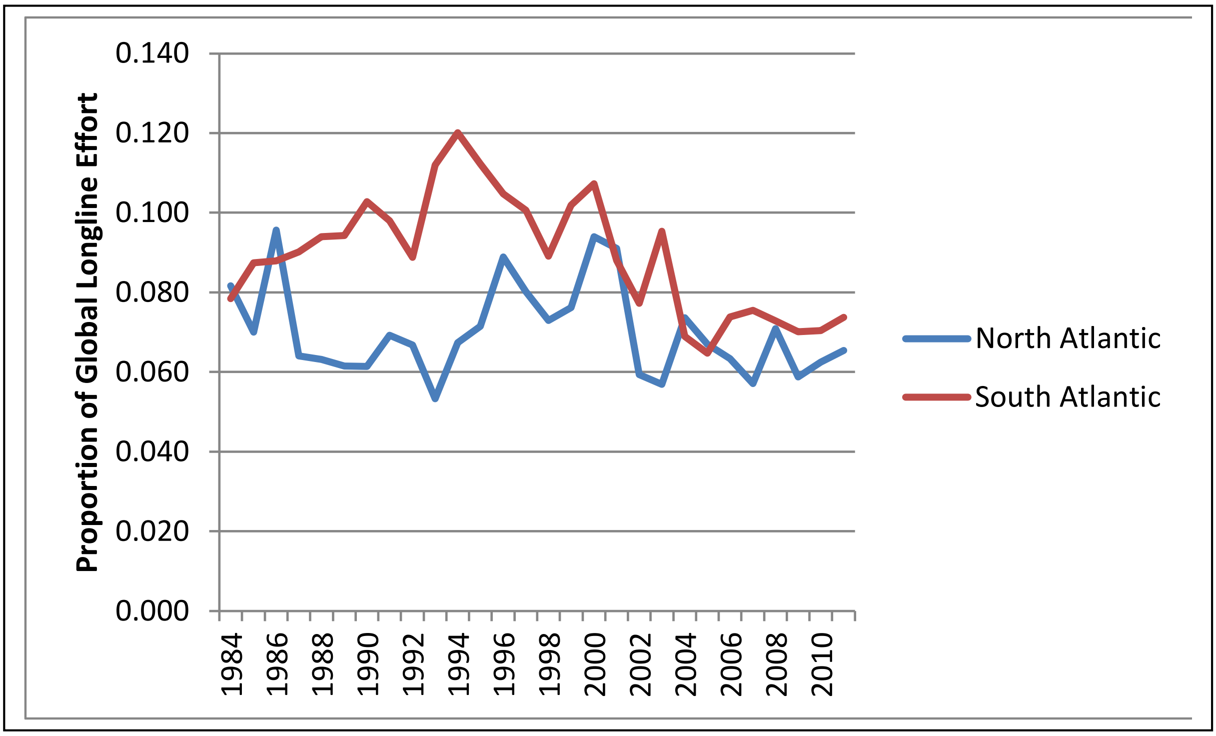

Figure 3. Annual ratios of longline effort in the North and South Atlantic Ocean to global longline effort, 1984-2011 (data given in **Table 3**).

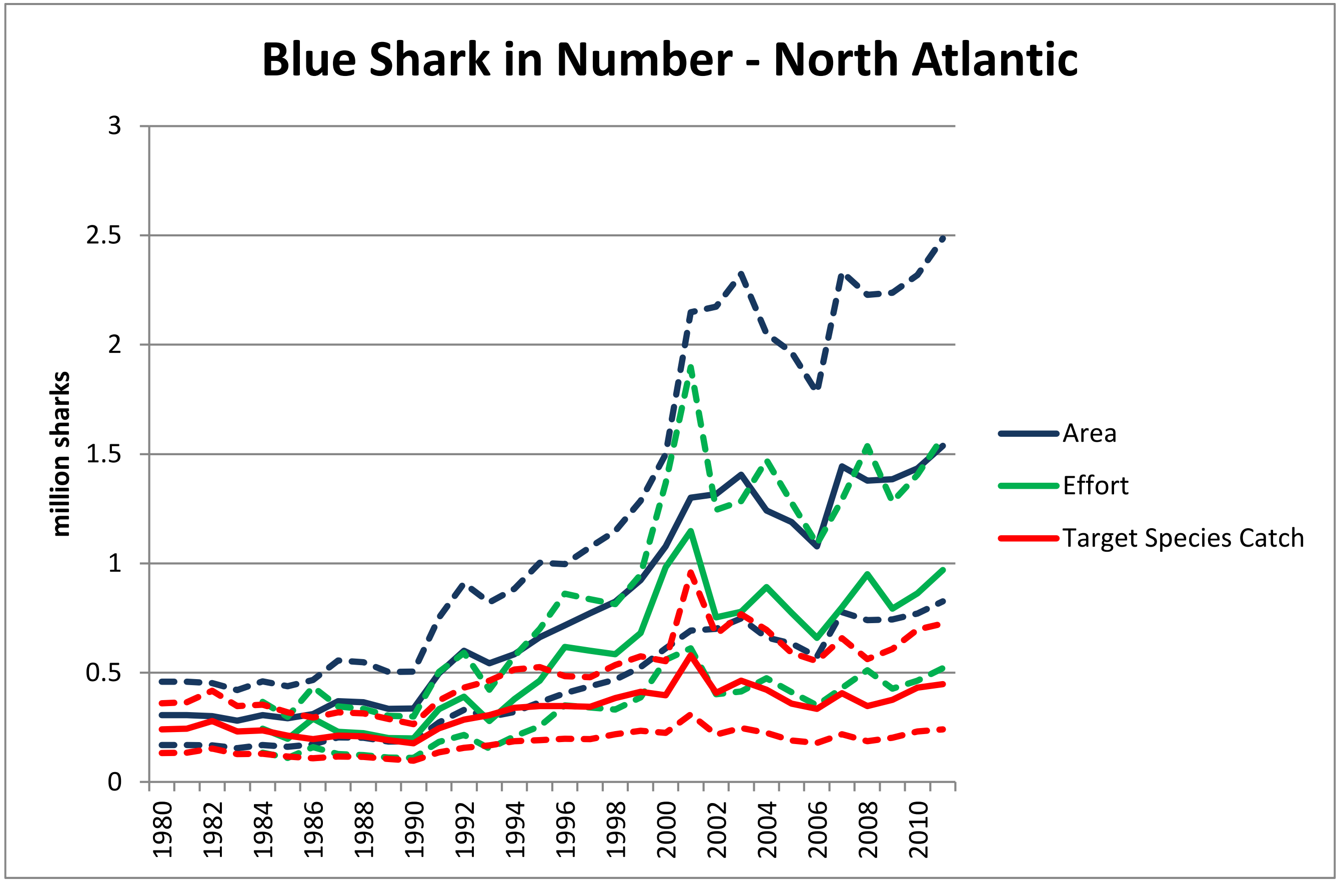

Figure 4. Annual median (solid line) and 95% confidence interval (dashed lines) estimates for blue shark (in million sharks), using area, longline effort and target species catch proportioning methods to scale the number of sharks present in the global shark fin trade to those derived from the North Atlantic Ocean.

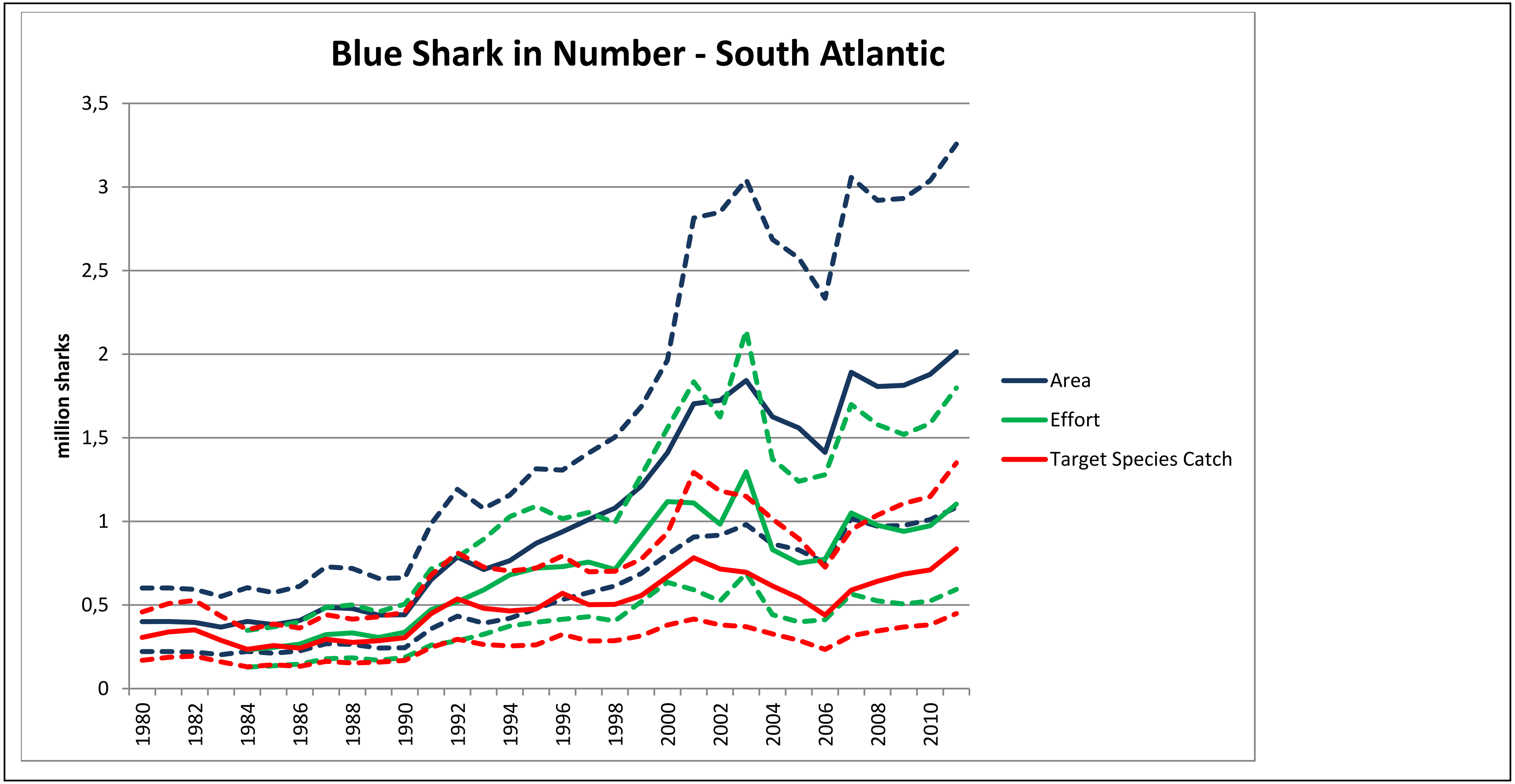

Figure 5. Annual median (solid line) and 95% confidence interval (dashed lines) estimates for blue shark (in million sharks), using area, longline effort and target species catch proportioning methods to scale the number of sharks present in the global shark fin trade to those derived from the South Atlantic Ocean.

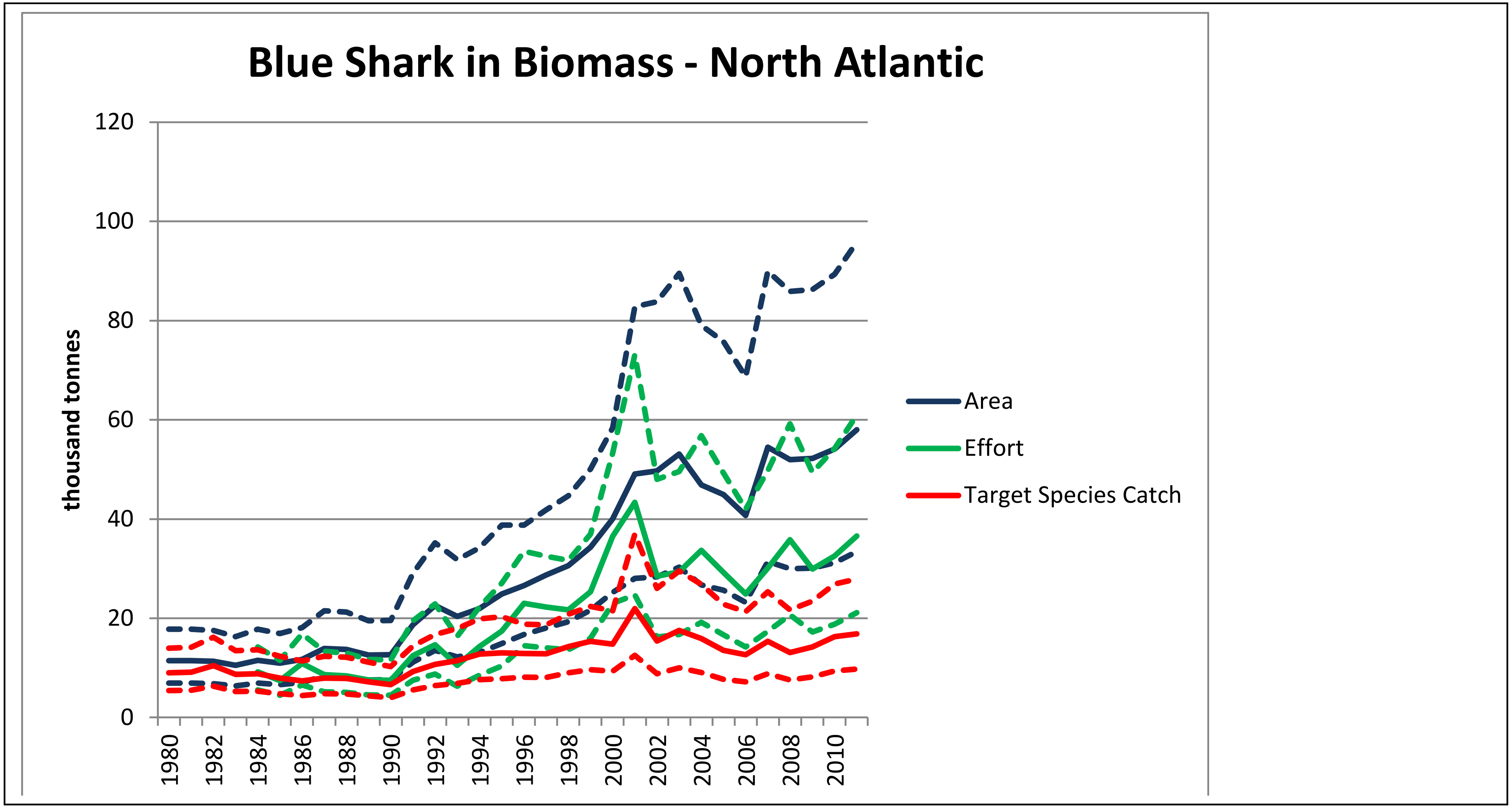

Figure 6. Annual median (solid line) and 95% confidence interval (dashed lines) estimates for blue shark (in thousand t using area, longline effort and target species catch proportioning methods to scale sharks present in the global shark fin trade to those derived from the North Atlantic Ocean.

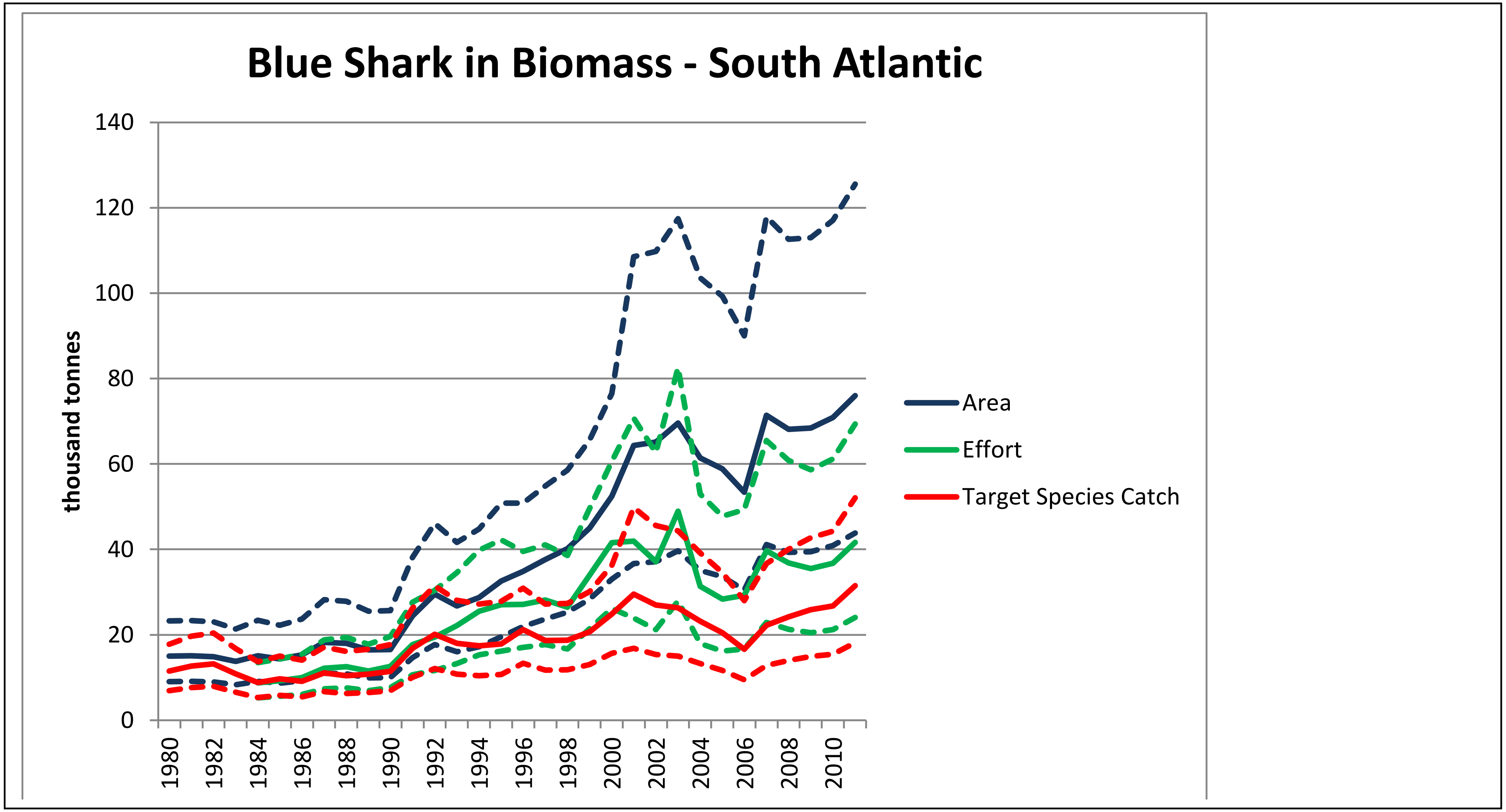

Figure 7. Annual median (solid line) and 95% confidence interval (dashed lines) estimates for blue shark (in thousand t) using area, longline effort and target species catch proportioning methods to scale the sharks present in the global shark fin trade to those derived from the South Atlantic Ocean.

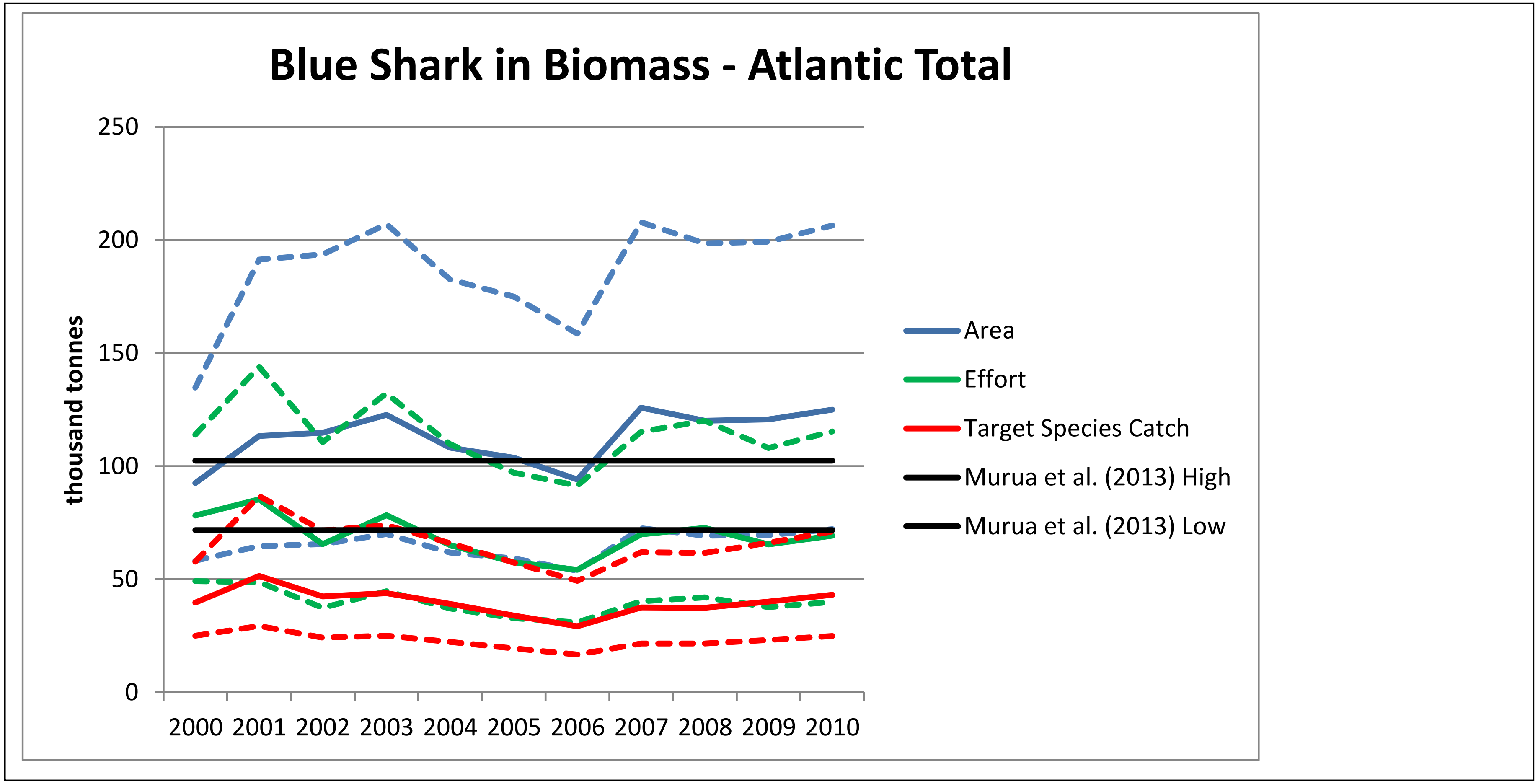

Figure 8. Comparison of total Atlantic (North + South) biomass-based estimates of blue shark for area-, effort-, and target species-based proportioning methods used in this study with the high and low blue shark annual catch estimates for the Atlantic during the period 2000-2010 from Murua *et al.* (2013).

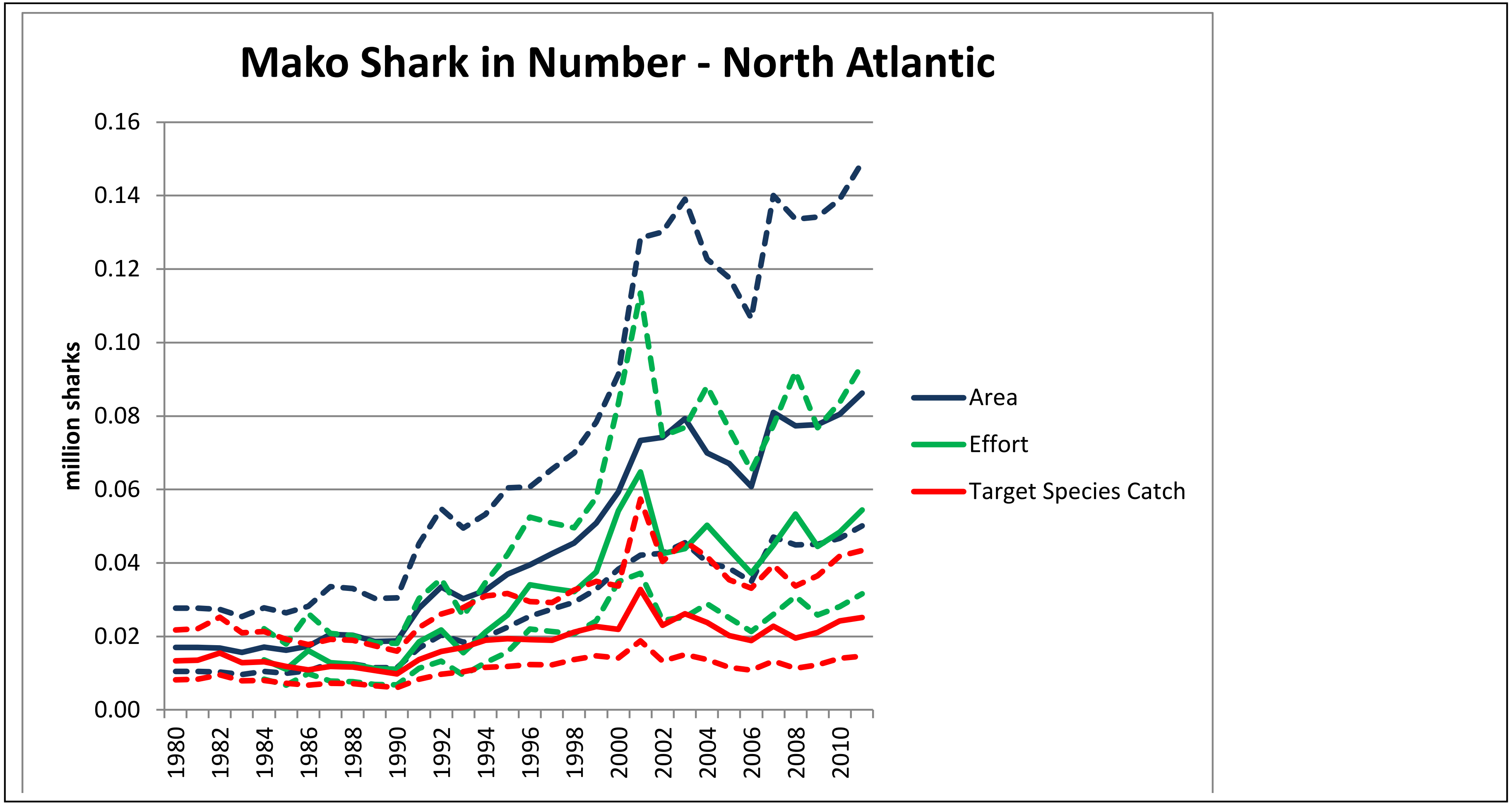

Figure 9. Annual median (solid line) and 95% confidence interval (dashed lines) estimates for shortfin mako shark (in million sharks), using area, longline effort and target species catch proportioning methods to scale the number of sharks present in the global shark fin trade to those derived from the North Atlantic Ocean.

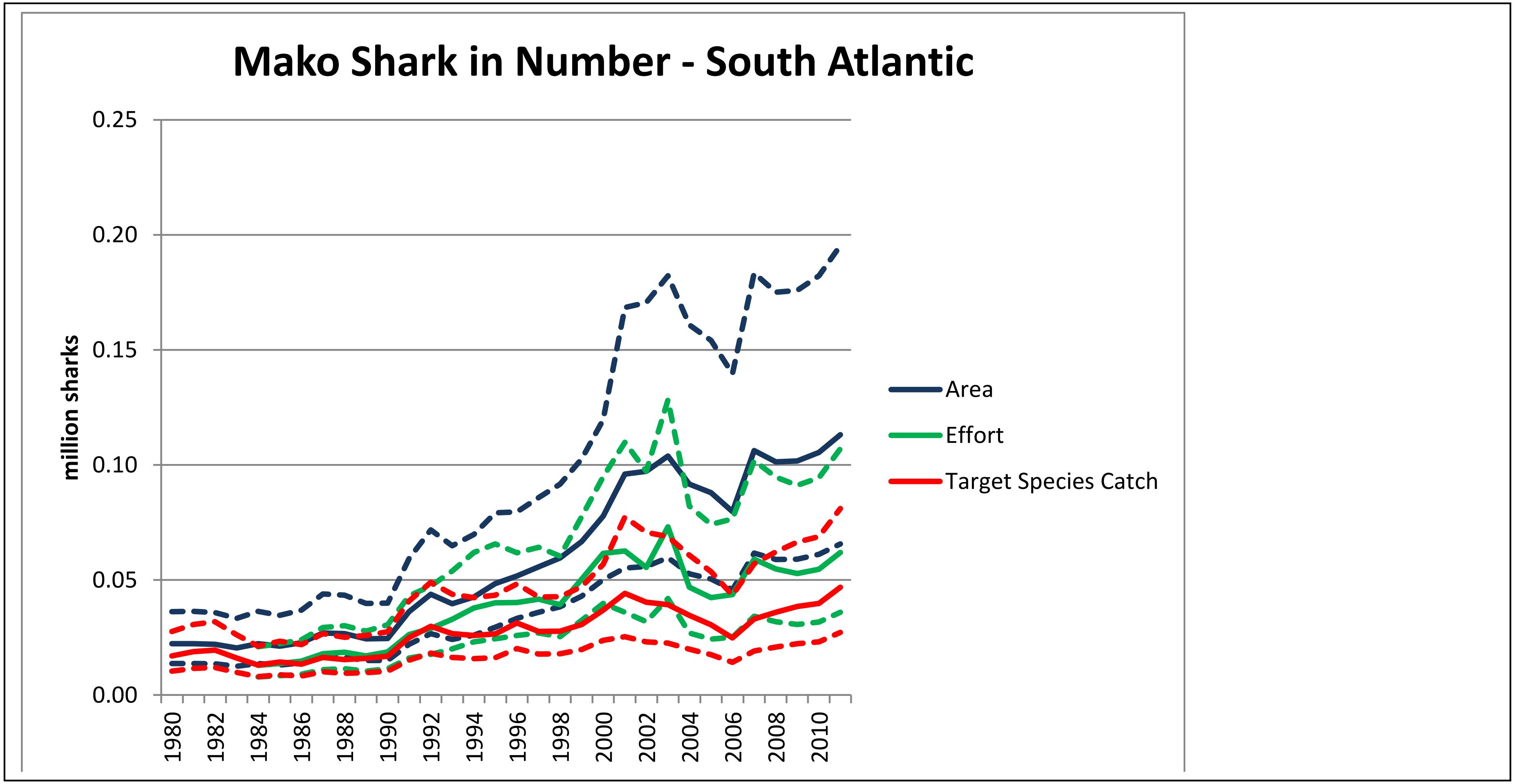

Figure 10. Annual median (solid line) and 95% confidence interval (dashed lines) estimates for shortfin mako shark (in million sharks), using area, longline effort and target species catch proportioning methods to scale the number of sharks present in the global shark fin trade to those derived from the South Atlantic Ocean.

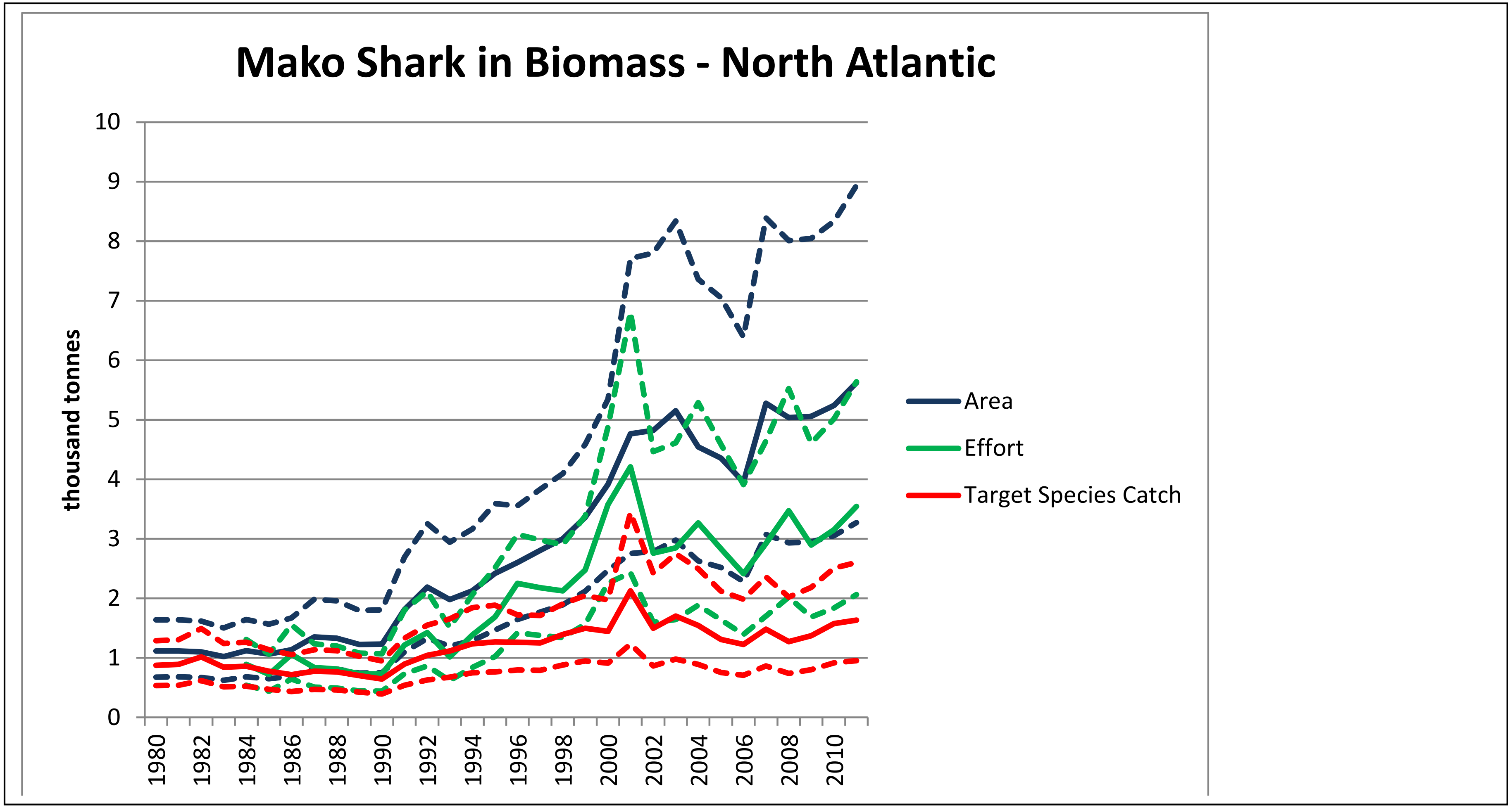

Figure 11. Annual median (solid line) and 95% confidence interval (dashed lines) estimates for shortfin mako shark (in thousand t) using area, longline effort and target species catch proportioning methods to scale sharks present in the global shark fin trade to those derived from the North Atlantic Ocean.

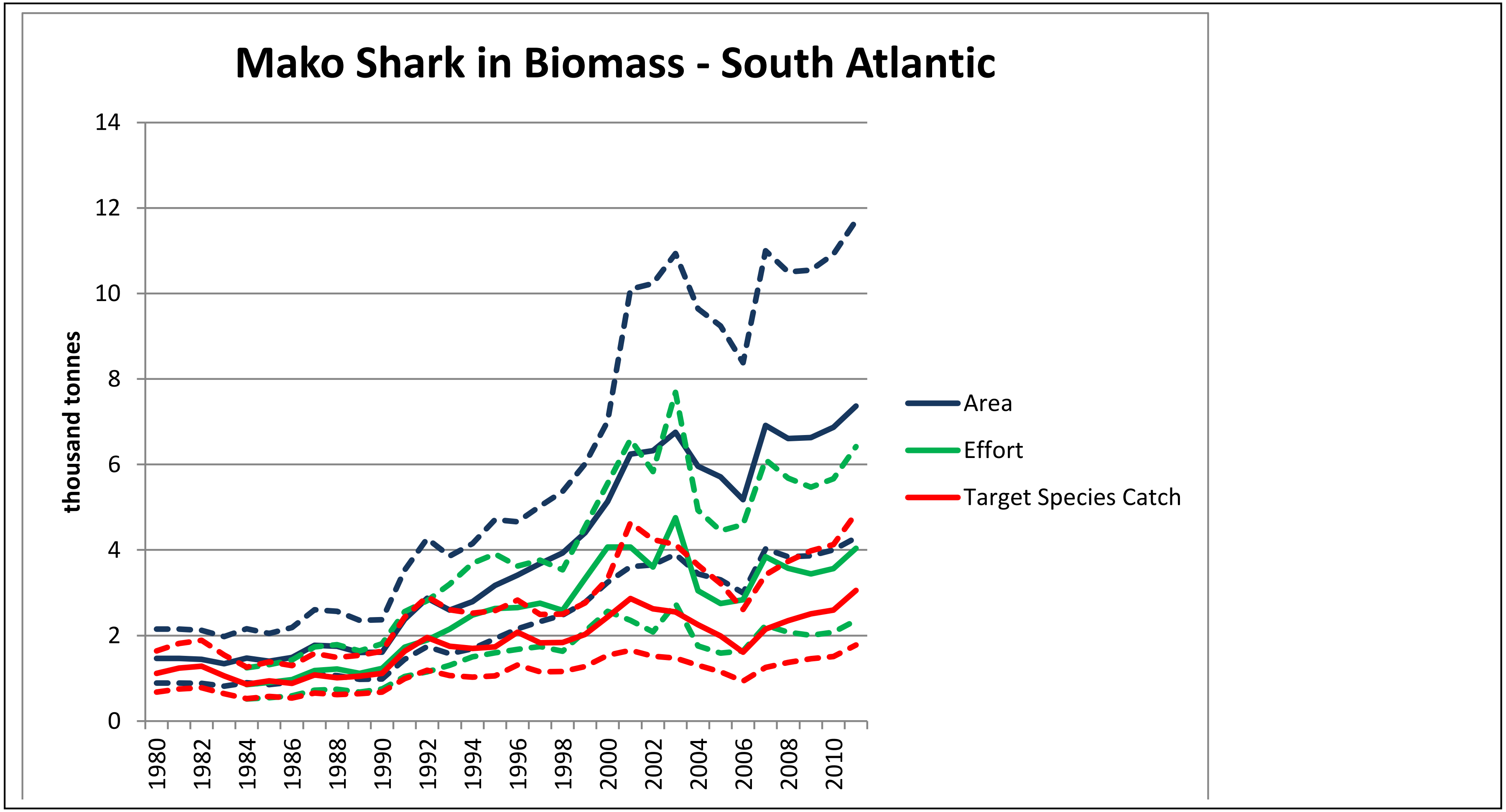

Figure 12. Annual median (solid line) and 95% confidence interval (dashed lines) estimates for shortfin mako shark (in thousand t) using area, longline effort and target species catch proportioning methods to scale the sharks present in the global shark fin trade to those derived from the South Atlantic Ocean.

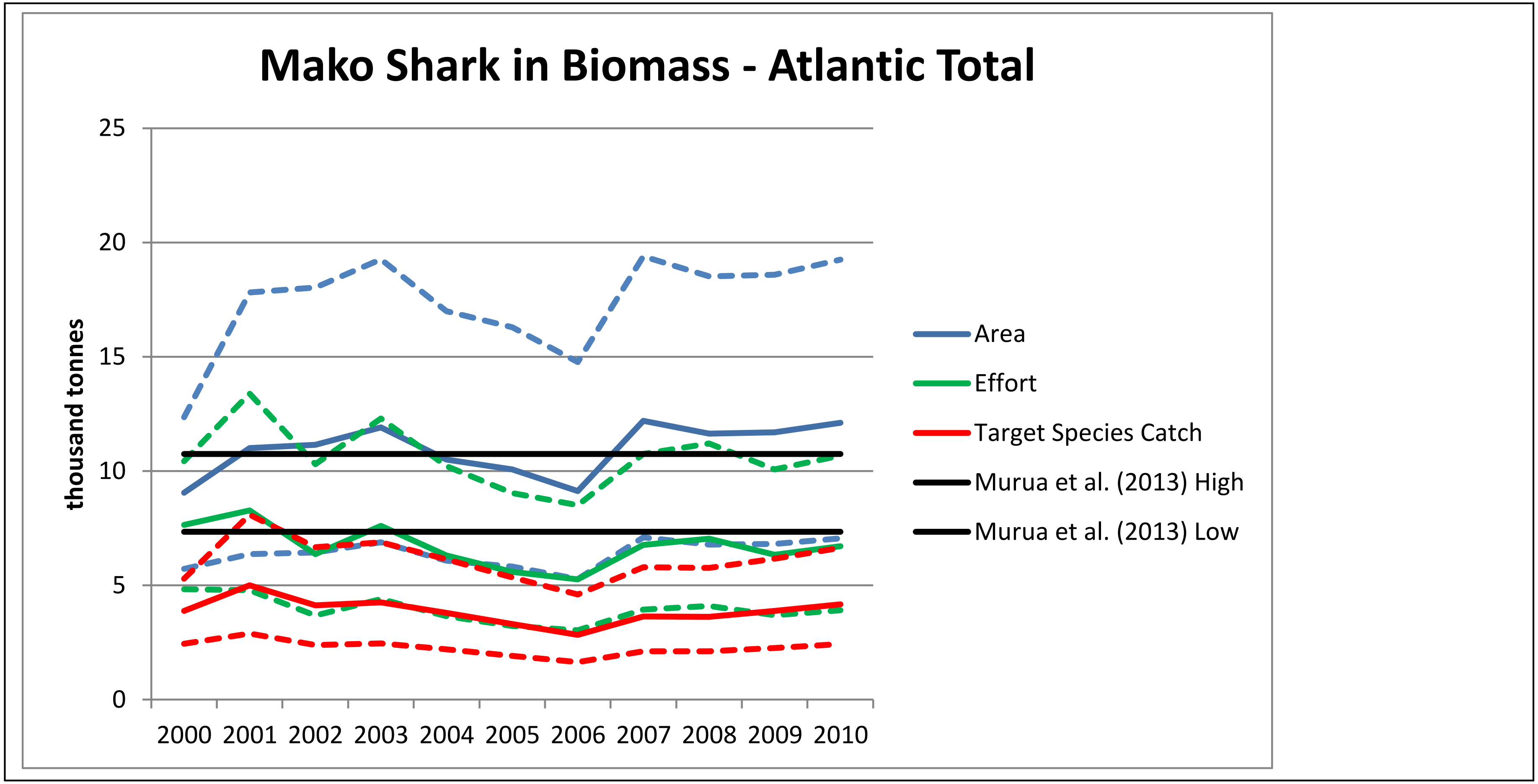

Figure 13. Comparison of total Atlantic (North + South) biomass-based estimates of shortfin mako shark for area-, effort-, and target species-based proportioning methods used in this study with high and low shortfin mako shark annual catch estimates for the Atlantic during the period 2000-2010 from Murua *et al*. (2013).

Annex 1

WinBUGS code
#run separately for numbers and biomass

```
model
{
	#these are HK's assumed share of the global totals in each period
	shar8090~dunif(0.65,0.80)
	shar9195~dunif(0.50, 0.65)
	shar9600~dunif(0.44,0.59)
	shar0006~dunif(0.30,0.50)
	shar0711~dunif(0.25,0.40)

for (z in 1:11){
	ratio[z] <- shar9600/shar8090
	}

for (z in 12:16){
	ratio[z] <- shar9600/shar9195
	}
for (z in 17:21){		for 1996-2000 (this is the base period)
	ratio[z] <- 1
	}
for (z in 22:27){
	#2001-2006  (Note:  as HK's share declines the scaling factor goes up 1-->1.3)
	ratio[z] <- shar9600/shar0006
	}
for (z in 28:32){
	ratio[z] <- shar9600/shar0711	#2007-2011 (Note:  as HK's share declines further the factor goes up further 1-->1.6)
	}

for (g in 1:2) {			#this is a triangular distribution for the biomass of BSH, SMA in 2000
	rv[g]~dunif(0,1000)		#to run for all five species, change this loop to in 1:5; fix DATA trimin, trimode, trimax
	x[g]<-rv[g]/1000

	gate[g]<-((trimode[g]-trimin[g]) / (trimax[g]-trimin[g]))
	A[g]<-min(x[g],gate[g])			# find out whether x is higher or lower than criterion
	B[g]<-equals(x[g],A[g])	# if x IS lower then B will be 1, if x>calculation then B will be 0
	C[g]<-equals(B[g],0)		# sets C to zero if B=1 or sets C to 1 if b=0; so B and C are binary and opposite

	draw[g]<-(B[g]*(trimin[g]+sqrt(x[g]*(trimode[g]-trimin[g])*(trimax[g]-trimin[g]))))
		+(C[g]*(trimax[g]-sqrt((1-x[g])*(trimax[g]-trimode[g])*(trimax[g]-trimin[g]))))

for (h in 1:32) {
	scaled[g,h] <- draw[g] * (HKimport[h]/HKimport[21])#biomass x (imports in year X relative to 2000 i.e. Year 21)
	share[g,h] <- scaled[g,h] * ratio[h]  #scale by whether HK's share was more or less than in 2000
	areapropN[g,h] <- share[g,h] * GISNoATL[g]		#area scalling for North Atl
	areapropS[g,h] <- share[g,h] * GISSoATL[g]		#area scaling for South Atl
tunapropN[g,h] <- share[g,h] * tunaNoATL[h]		#scale by total tuna catch (FISHSTAT) for North Atl
	tunapropS[g,h] <- share[g,h] * tunaSoATL[h]		#scale by total tuna catch for South Atl
	hookpropN[g,h] <- share[g,h] * LLNorth[h]		#scale by LL hook effort for North Atl
	hookpropS[g,h] <- share[g,h] * LLSouth[h]		#scale by LL hook effort for South Atl
	}
}	}
```

```
#DATA
list(

#BIOMASS (in '000 t)
trimin=c(204,20),          #species order is blue, mako
trimode=c(364,38),         # these are inputs for shark biomass from Ecology Letters (2006)
trimax=c( 619,56),         #all values in '000 t

#NUMBER OF SHARKS (in millions)
#trimin=c(4.640,0.320),      #species order is blue, mako
#trimode=c(10.741,0.485),    # these are inputs for shark numbers
#trimax=c(15.762,0.978),     #values in million sharks


HKimport=c(
2739,2741,2704,2512,2748,2613,2788,3317,3272,3003,3018,
3526,4265,3856,4144,4706,
4513,4868,5196,5824,6788,
6435,6513,6960,6142,5887,5337,
5798,5536,5559,5759,6175),        #HK adjusted imports of dried and salted unprocessed shark fins

GISNoATL=c(0.103,0.103),      #North of 5 degrees N/global total between 50N-50S: 29.646816/287.84
GISSoATL=c(0.135,0.135),      #South of 5 degrees N/global total between 50N-50S: 38.743973/287.84

(#ratio of LL hooks fished in ATL versus the rest of the world; first four values are dummies (adjusted for 5oN boundary)

LLNorth=c(
0.100,0.100,0.100,0.100,0.082,
0.070,0.096,0.064,0.063,0.062,
0.061,0.069,0.067,0.053,0.067,
0.072,0.089,0.080,0.073,0.076,
0.094,0.091,0.059,0.057,0.074,
0.067,0.063,0.057,0.071,0.059,
0.062,0.065),

LLSouth=c(
0.100,0.100,0.100,0.100,0.078,
0.087,0.088,0.090,0.094,0.094,
0.103,0.098,0.089,0.112,0.120,
0.112,0.105,0.101,0.089,0.102,
0.107,0.088,0.077,0.095,0.069,
0.065,0.074,0.075,0.073,0.070,
0.070,0.074),

#from FISHSTAT catches of tunas, bonitos, billfishes; split by an ICCAT-provided ratio (adjusted for 5oN boundary)

tunaNoATL=c(
0.081,0.082,0.095,0.085,0.079,
0.075,0.065,0.059,0.059,0.059,
0.054,0.051,0.049,0.058,0.060,
0.054,0.050,0.046,0.048,0.046,
0.038,0.046,0.032,0.034,0.035,
0.031,0.032,0.029,0.026,0.028,
0.031,0.030),
```

```
tunaSoATL=c(
0.103,0.114,0.120,0.106,0.079,
0.091,0.080,0.082,0.078,0.088,
0.093,0.093,0.092,0.091,0.082,
0.074,0.082,0.067,0.063,0.062,
0.064,0.062,0.056,0.051,0.051,
0.047,0.042,0.042,0.048,0.051,
0.051,0.056))
```

Annex 2

Blue shark results in number in numerical format (shown in Figures 4 and 5): for North Atlantic (top) and South Atlantic (bottom) in million sharks.

NORTH	node	val2.5pc	median	val97.5pc	node	val2.5pc	median	val97.5pc	node	val2.5pc	median	val97.5pc
1980	areapropN[1,1]	0.1692	0.3059	0.4589		#N/A	#N/A	#N/A	tunapropN[1,1]	0.1331	0.2406	0.3609
1981	areapropN[1,2]	0.1693	0.3061	0.4593		#N/A	#N/A	#N/A	tunapropN[1,2]	0.1348	0.2437	0.3656
1982	areapropN[1,3]	0.167	0.302	0.4531		#N/A	#N/A	#N/A	tunapropN[1,3]	0.1541	0.2785	0.4179
1983	areapropN[1,4]	0.1552	0.2805	0.4209		#N/A	#N/A	#N/A	tunapropN[1,4]	0.1281	0.2315	0.3474
1984	areapropN[1,5]	0.1698	0.3069	0.4605	hookpropN[1,5]	0.1351	0.2443	0.3666	tunapropN[1,5]	0.1302	0.2354	0.3532
1985	areapropN[1,6]	0.1614	0.2918	0.4378	hookpropN[1,6]	0.1097	0.1983	0.2976	tunapropN[1,6]	0.1175	0.2125	0.3188
1986	areapropN[1,7]	0.1722	0.3114	0.4672	hookpropN[1,7]	0.1605	0.2902	0.4354	tunapropN[1,7]	0.1087	0.1965	0.2948
1987	areapropN[1,8]	0.2049	0.3705	0.5558	hookpropN[1,8]	0.1273	0.2302	0.3454	tunapropN[1,8]	0.1174	0.2122	0.3184
1988	areapropN[1,9]	0.2021	0.3654	0.5483	hookpropN[1,9]	0.1236	0.2235	0.3353	tunapropN[1,9]	0.1158	0.2093	0.3141
1989	areapropN[1,10]	0.1855	0.3354	0.5032	hookpropN[1,10]	0.1117	0.2019	0.3029	tunapropN[1,10]	0.1063	0.1921	0.2882
1990	areapropN[1,11]	0.1864	0.3371	0.5057	hookpropN[1,11]	0.1104	0.1996	0.2995	tunapropN[1,11]	0.09774	0.1767	0.2651
1991	areapropN[1,12]	0.2732	0.4969	0.7517	hookpropN[1,12]	0.183	0.3329	0.5036	tunapropN[1,12]	0.1353	0.246	0.3722
1992	areapropN[1,13]	0.3305	0.601	0.9092	hookpropN[1,13]	0.215	0.391	0.5914	tunapropN[1,13]	0.1572	0.2859	0.4326
1993	areapropN[1,14]	0.2988	0.5434	0.822	hookpropN[1,14]	0.1537	0.2796	0.423	tunapropN[1,14]	0.1682	0.306	0.4629
1994	areapropN[1,15]	0.3211	0.584	0.8834	hookpropN[1,15]	0.2089	0.3799	0.5747	tunapropN[1,15]	0.1871	0.3402	0.5146
1995	areapropN[1,16]	0.3647	0.6632	1.003	hookpropN[1,16]	0.2549	0.4636	0.7013	tunapropN[1,16]	0.1912	0.3477	0.526
1996	areapropN[1,17]	0.4067	0.716	0.9969	hookpropN[1,17]	0.3514	0.6186	0.8614	tunapropN[1,17]	0.1974	0.3476	0.4839
1997	areapropN[1,18]	0.4387	0.7723	1.075	hookpropN[1,18]	0.3407	0.5998	0.8352	tunapropN[1,18]	0.1959	0.3449	0.4802
1998	areapropN[1,19]	0.4683	0.8243	1.148	hookpropN[1,19]	0.3319	0.5842	0.8134	tunapropN[1,19]	0.2182	0.3841	0.5349
1999	areapropN[1,20]	0.5249	0.9239	1.286	hookpropN[1,20]	0.3873	0.6817	0.9492	tunapropN[1,20]	0.2344	0.4126	0.5745
2000	areapropN[1,21]	0.6117	1.077	1.499	hookpropN[1,21]	0.5583	0.9828	1.368	tunapropN[1,21]	0.2257	0.3973	0.5532
2001	areapropN[1,22]	0.6921	1.3	2.148	hookpropN[1,22]	0.6114	1.148	1.897	tunapropN[1,22]	0.3091	0.5805	0.9591
2002	areapropN[1,23]	0.7004	1.316	2.174	hookpropN[1,23]	0.4012	0.7536	1.245	tunapropN[1,23]	0.2176	0.4087	0.6753
2003	areapropN[1,24]	0.7485	1.406	2.323	hookpropN[1,24]	0.4142	0.778	1.285	tunapropN[1,24]	0.2471	0.4641	0.7667
2004	areapropN[1,25]	0.6605	1.241	2.05	hookpropN[1,25]	0.4746	0.8914	1.473	tunapropN[1,25]	0.2245	0.4216	0.6965
2005	areapropN[1,26]	0.6331	1.189	1.965	hookpropN[1,26]	0.4118	0.7735	1.278	tunapropN[1,26]	0.1906	0.3579	0.5913
2006	areapropN[1,27]	0.574	1.078	1.781	hookpropN[1,27]	0.3511	0.6594	1.089	tunapropN[1,27]	0.1783	0.3349	0.5534
2007	areapropN[1,28]	0.7763	1.444	2.333	hookpropN[1,28]	0.4296	0.799	1.291	tunapropN[1,28]	0.2186	0.4065	0.657
2008	areapropN[1,29]	0.7412	1.378	2.228	hookpropN[1,29]	0.5109	0.9502	1.536	tunapropN[1,29]	0.1871	0.348	0.5624
2009	areapropN[1,30]	0.7443	1.384	2.237	hookpropN[1,30]	0.4263	0.7929	1.282	tunapropN[1,30]	0.2023	0.3763	0.6082
2010	areapropN[1,31]	0.7711	1.434	2.318	hookpropN[1,31]	0.4641	0.8628	1.405	tunapropN[1,31]	0.2321	0.4316	0.6976
2011	areapropN[1,32]	0.8268	1.538	2.485	hookpropN[1,32]	0.5217	0.9699	1.579	tunapropN[1,32]	0.2408	0.4478	0.7238
SOUTH	node	val2.5pc	median	val97.5pc	node	val2.5pc	median	val97.5pc	node	val2.5pc	median	val97.5pc
1980	areapropS[1,1]	0.2218	0.4009	0.6015		#N/A	#N/A	#N/A	tunapropS[1,1]	0.1692	0.3059	0.4589
1981	areapropS[1,2]	0.2219	0.4012	0.602		#N/A	#N/A	#N/A	tunapropS[1,2]	0.1874	0.3388	0.5083
1982	areapropS[1,3]	0.2189	0.3958	0.5938		#N/A	#N/A	#N/A	tunapropS[1,3]	0.1946	0.3518	0.5279
1983	areapropS[1,4]	0.2034	0.3677	0.5517		#N/A	#N/A	#N/A	tunapropS[1,4]	0.1597	0.2887	0.4332
1984	areapropS[1,5]	0.2225	0.4023	0.6035	hookpropS[1,5]	0.1286	0.2324	0.3487	tunapropS[1,5]	0.1302	0.2354	0.3532
1985	areapropS[1,6]	0.2116	0.3825	0.5739	hookpropS[1,6]	0.1363	0.2465	0.3698	tunapropS[1,6]	0.1426	0.2578	0.3868
1986	areapropS[1,7]	0.2257	0.4081	0.6123	hookpropS[1,7]	0.1471	0.266	0.3991	tunapropS[1,7]	0.1338	0.2418	0.3628
1987	areapropS[1,8]	0.2686	0.4855	0.7285	hookpropS[1,8]	0.179	0.3237	0.4856	tunapropS[1,8]	0.1631	0.2949	0.4425
1988	areapropS[1,9]	0.2649	0.479	0.7186	hookpropS[1,9]	0.1845	0.3335	0.5004	tunapropS[1,9]	0.1531	0.2767	0.4152
1989	areapropS[1,10]	0.2431	0.4396	0.6595	hookpropS[1,10]	0.1693	0.3061	0.4592	tunapropS[1,10]	0.1585	0.2865	0.4299
1990	areapropS[1,11]	0.2444	0.4418	0.6628	hookpropS[1,11]	0.1864	0.3371	0.5057	tunapropS[1,11]	0.1683	0.3043	0.4566
1991	areapropS[1,12]	0.3581	0.6513	0.9852	hookpropS[1,12]	0.26	0.4728	0.7152	tunapropS[1,12]	0.2467	0.4486	0.6787
1992	areapropS[1,13]	0.4332	0.7877	1.192	hookpropS[1,13]	0.2856	0.5193	0.7857	tunapropS[1,13]	0.2952	0.5368	0.8121
1993	areapropS[1,14]	0.3916	0.7122	1.077	hookpropS[1,14]	0.3249	0.5909	0.8939	tunapropS[1,14]	0.264	0.4801	0.7263
1994	areapropS[1,15]	0.4209	0.7654	1.158	hookpropS[1,15]	0.3741	0.6804	1.029	tunapropS[1,15]	0.2556	0.4649	0.7033
1995	areapropS[1,16]	0.4779	0.8692	1.315	hookpropS[1,16]	0.3965	0.7211	1.091	tunapropS[1,16]	0.262	0.4764	0.7208
1996	areapropS[1,17]	0.5331	0.9384	1.307	hookpropS[1,17]	0.4146	0.7299	1.016	tunapropS[1,17]	0.3238	0.57	0.7936
1997	areapropS[1,18]	0.575	1.012	1.409	hookpropS[1,18]	0.4302	0.7573	1.054	tunapropS[1,18]	0.2854	0.5024	0.6995
1998	areapropS[1,19]	0.6138	1.08	1.504	hookpropS[1,19]	0.4046	0.7123	0.9917	tunapropS[1,19]	0.2864	0.5042	0.702
1999	areapropS[1,20]	0.6879	1.211	1.686	hookpropS[1,20]	0.5198	0.915	1.274	tunapropS[1,20]	0.3159	0.5562	0.7744
2000	areapropS[1,21]	0.8018	1.411	1.965	hookpropS[1,21]	0.6355	1.119	1.558	tunapropS[1,21]	0.3801	0.6691	0.9317
2001	areapropS[1,22]	0.9071	1.704	2.815	hookpropS[1,22]	0.5913	1.111	1.835	tunapropS[1,22]	0.4166	0.7824	1.293
2002	areapropS[1,23]	0.9181	1.724	2.849	hookpropS[1,23]	0.5236	0.9835	1.625	tunapropS[1,23]	0.3808	0.7153	1.182
2003	areapropS[1,24]	0.9811	1.843	3.044	hookpropS[1,24]	0.6904	1.297	2.142	tunapropS[1,24]	0.3706	0.6961	1.15
2004	areapropS[1,25]	0.8658	1.626	2.687	hookpropS[1,25]	0.4425	0.8311	1.373	tunapropS[1,25]	0.3271	0.6143	1.015
2005	areapropS[1,26]	0.8298	1.559	2.575	hookpropS[1,26]	0.3995	0.7504	1.24	tunapropS[1,26]	0.2889	0.5426	0.8965
2006	areapropS[1,27]	0.7523	1.413	2.334	hookpropS[1,27]	0.4124	0.7745	1.28	tunapropS[1,27]	0.234	0.4396	0.7263
2007	areapropS[1,28]	1.017	1.892	3.058	hookpropS[1,28]	0.5653	1.051	1.699	tunapropS[1,28]	0.3166	0.5887	0.9515
2008	areapropS[1,29]	0.9715	1.807	2.92	hookpropS[1,29]	0.5253	0.977	1.579	tunapropS[1,29]	0.3454	0.6424	1.038
2009	areapropS[1,30]	0.9755	1.814	2.932	hookpropS[1,30]	0.5058	0.9407	1.52	tunapropS[1,30]	0.3685	0.6854	1.108
2010	areapropS[1,31]	1.011	1.88	3.038	hookpropS[1,31]	0.524	0.9742	1.586	tunapropS[1,31]	0.3818	0.71	1.148
2011	areapropS[1,32]	1.084	2.015	3.257	hookpropS[1,32]	0.5939	1.104	1.798	tunapropS[1,32]	0.4495	0.836	1.351

Annex 3

Blue shark results in biomass in numerical format (shown in Figures 6 and 7): for North Atlantic (top) and South Atlantic (bottom) in thousand tonnes

NORTH	node	val2.5pc	median	val97.5pc	node	val2.5pc	median	val97.5pc	node	val2.5pc	median	val97.5pc
1980	areapropN[1,1]	6.916	11.48	17.77		#N/A	#N/A	#N/A	tunapropN[1,1]	5.439	9.024	13.98
1981	areapropN[1,2]	6.921	11.48	17.78		#N/A	#N/A	#N/A	tunapropN[1,2]	5.51	9.142	14.16
1982	areapropN[1,3]	6.828	11.33	17.54		#N/A	#N/A	#N/A	tunapropN[1,3]	6.298	10.45	16.18
1983	areapropN[1,4]	6.343	10.52	16.3		#N/A	#N/A	#N/A	tunapropN[1,4]	5.235	8.685	13.45
1984	areapropN[1,5]	6.939	11.51	17.83	hookpropN[1,5]	5.524	9.166	14.19	tunapropN[1,5]	5.322	8.83	13.68
1985	areapropN[1,6]	6.598	10.95	16.95	hookpropN[1,6]	4.484	7.44	11.52	tunapropN[1,6]	4.804	7.971	12.35
1986	areapropN[1,7]	7.04	11.68	18.09	hookpropN[1,7]	6.562	10.89	16.86	tunapropN[1,7]	4.443	7.371	11.42
1987	areapropN[1,8]	8.376	13.9	21.52	hookpropN[1,8]	5.204	8.635	13.37	tunapropN[1,8]	4.798	7.96	12.33
1988	areapropN[1,9]	8.262	13.71	21.23	hookpropN[1,9]	5.054	8.385	12.99	tunapropN[1,9]	4.733	7.852	12.16
1989	areapropN[1,10	7.583	12.58	19.48	hookpropN[1,10]	4.564	7.573	11.73	tunapropN[1,10]	4.344	7.207	11.16
1990	areapropN[1,11	7.621	12.64	19.58	hookpropN[1,11]	4.513	7.488	11.6	tunapropN[1,11]	3.995	6.629	10.27
1991	areapropN[1,12	11.16	18.65	29.07	hookpropN[1,12]	7.477	12.49	19.48	tunapropN[1,12]	5.526	9.233	14.4
1992	areapropN[1,13	13.5	22.56	35.17	hookpropN[1,13]	8.781	14.67	22.88	tunapropN[1,13]	6.422	10.73	16.73
1993	areapropN[1,14	12.21	20.39	31.79	hookpropN[1,14]	6.28	10.49	16.36	tunapropN[1,14]	6.873	11.48	17.9
1994	areapropN[1,15	13.12	21.92	34.17	hookpropN[1,15]	8.532	14.26	22.23	tunapropN[1,15]	7.641	12.77	19.9
1995	areapropN[1,16	14.9	24.89	38.8	hookpropN[1,16]	10.41	17.4	27.12	tunapropN[1,16]	7.809	13.05	20.34
1996	areapropN[1,17	16.75	26.61	38.8	hookpropN[1,17]	14.48	22.99	33.52	tunapropN[1,17]	8.133	12.92	18.83
1997	areapropN[1,18	18.07	28.7	41.85	hookpropN[1,18]	14.04	22.29	32.5	tunapropN[1,18]	8.07	12.82	18.69
1998	areapropN[1,19	19.29	30.64	44.67	hookpropN[1,19]	13.67	21.71	31.66	tunapropN[1,19]	8.989	14.28	20.82
1999	areapropN[1,20	21.62	34.34	50.07	hookpropN[1,20]	15.95	25.34	36.94	tunapropN[1,20]	9.655	15.34	22.36
2000	areapropN[1,21	25.2	40.02	58.35	hookpropN[1,21]	23	36.53	53.26	tunapropN[1,21]	9.296	14.77	21.53
2001	areapropN[1,22	28.01	49.08	82.79	hookpropN[1,22]	24.74	43.36	73.15	tunapropN[1,22]	12.51	21.92	36.98
2002	areapropN[1,23	28.35	49.68	83.8	hookpropN[1,23]	16.24	28.46	48	tunapropN[1,23]	8.807	15.43	26.03
2003	areapropN[1,24	30.29	53.09	89.55	hookpropN[1,24]	16.76	29.38	49.56	tunapropN[1,24]	9.999	17.52	29.56
2004	areapropN[1,25	26.73	46.85	79.02	hookpropN[1,25]	19.21	33.66	56.77	tunapropN[1,25]	9.084	15.92	26.85
2005	areapropN[1,26	25.62	44.9	75.74	hookpropN[1,26]	16.67	29.21	49.27	tunapropN[1,26]	7.712	13.51	22.8
2006	areapropN[1,27	23.23	40.71	68.67	hookpropN[1,27]	14.21	24.9	42	tunapropN[1,27]	7.217	12.65	21.33
2007	areapropN[1,28	31.4	54.45	89.94	hookpropN[1,28]	17.38	30.13	49.77	tunapropN[1,28]	8.841	15.33	25.32
2008	areapropN[1,29	29.98	51.99	85.87	hookpropN[1,29]	20.67	35.84	59.19	tunapropN[1,29]	7.568	13.12	21.68
2009	areapropN[1,30	30.11	52.21	86.23	hookpropN[1,30]	17.25	29.9	49.39	tunapropN[1,30]	8.184	14.19	23.44
2010	areapropN[1,31	31.19	54.08	89.33	hookpropN[1,31]	18.78	32.54	54.22	tunapropN[1,31]	9.387	16.28	26.89
2011	areapropN[1,32	33.44	57.99	95.79	hookpropN[1,32]	21.11	36.58	60.95	tunapropN[1,32]	9.74	16.89	27.9
SOUTH	node	val2.5pc	median	val97.5pc	node	val2.5pc	median	val97.5pc	node	val2.5pc	median	val97.5pc
1980	areapropS[1,1]	9.065	15.04	23.29		#N/A	#N/A	#N/A	tunapropS[1,1]	6.916	11.48	17.77
1981	areapropS[1,2]	9.072	15.05	23.31		#N/A	#N/A	#N/A	tunapropS[1,2]	7.661	12.71	19.68
1982	areapropS[1,3]	8.949	14.85	23		#N/A	#N/A	#N/A	tunapropS[1,3]	7.955	13.2	20.44
1983	areapropS[1,4]	8.314	13.79	21.36		#N/A	#N/A	#N/A	tunapropS[1,4]	6.528	10.83	16.77
1984	areapropS[1,5]	9.095	15.09	23.37	hookpropS[1,5]	5.255	8.719	13.5	tunapropS[1,5]	5.322	8.83	13.68
1985	areapropS[1,6]	8.648	14.35	22.22	hookpropS[1,6]	5.573	9.247	14.32	tunapropS[1,6]	5.829	9.672	14.98
1986	areapropS[1,7]	9.227	15.31	23.71	hookpropS[1,7]	6.015	9.979	15.46	tunapropS[1,7]	5.468	9.072	14.05
1987	areapropS[1,8]	10.98	18.21	28.21	hookpropS[1,8]	7.319	12.14	18.81	tunapropS[1,8]	6.668	11.06	17.13
1988	areapropS[1,9]	10.83	17.97	27.83	hookpropS[1,9]	7.54	12.51	19.37	tunapropS[1,9]	6.257	10.38	16.08
1989	areapropS[1,10]	9.939	16.49	25.54	hookpropS[1,10]	6.92	11.48	17.78	tunapropS[1,10]	6.479	10.75	16.65
1990	areapropS[1,11]	9.988	16.57	25.67	hookpropS[1,11]	7.621	12.64	19.58	tunapropS[1,11]	6.881	11.42	17.68
1991	areapropS[1,12]	14.63	24.44	38.11	hookpropS[1,12]	10.62	17.74	27.66	tunapropS[1,12]	10.08	16.84	26.25
1992	areapropS[1,13]	17.69	29.56	46.09	hookpropS[1,13]	11.66	19.49	30.39	tunapropS[1,13]	12.06	20.15	31.41
1993	areapropS[1,14]	16	26.73	41.67	hookpropS[1,14]	13.27	22.18	34.57	tunapropS[1,14]	10.78	18.02	28.09
1994	areapropS[1,15]	17.19	28.73	44.79	hookpropS[1,15]	15.28	25.53	39.81	tunapropS[1,15]	10.44	17.45	27.2
1995	areapropS[1,16]	19.52	32.62	50.86	hookpropS[1,16]	16.2	27.06	42.19	tunapropS[1,16]	10.7	17.88	27.88
1996	areapropS[1,17]	21.96	34.88	50.85	hookpropS[1,17]	17.08	27.13	39.55	tunapropS[1,17]	13.34	21.18	30.89
1997	areapropS[1,18]	23.69	37.62	54.85	hookpropS[1,18]	17.72	28.15	41.04	tunapropS[1,18]	11.75	18.67	27.22
1998	areapropS[1,19]	25.28	40.16	58.55	hookpropS[1,19]	16.67	26.47	38.6	tunapropS[1,19]	11.8	18.74	27.32
1999	areapropS[1,20]	28.34	45.01	65.62	hookpropS[1,20]	21.41	34.01	49.58	tunapropS[1,20]	13.01	20.67	30.14
2000	areapropS[1,21]	33.03	52.46	76.48	hookpropS[1,21]	26.18	41.58	60.62	tunapropS[1,21]	15.66	24.87	36.26
2001	areapropS[1,22]	36.71	64.33	108.5	hookpropS[1,22]	23.93	41.93	70.74	tunapropS[1,22]	16.86	29.54	49.84
2002	areapropS[1,23]	37.15	65.11	109.8	hookpropS[1,23]	21.19	37.14	62.64	tunapropS[1,23]	15.41	27.01	45.56
2003	areapropS[1,24]	39.7	69.58	117.4	hookpropS[1,24]	27.94	48.96	82.59	tunapropS[1,24]	15	26.29	44.34
2004	areapropS[1,25]	35.04	61.4	103.6	hookpropS[1,25]	17.91	31.38	52.94	tunapropS[1,25]	13.24	23.2	39.13
2005	areapropS[1,26]	33.58	58.85	99.27	hookpropS[1,26]	16.17	28.34	47.8	tunapropS[1,26]	11.69	20.49	34.56
2006	areapropS[1,27]	30.45	53.35	90	hookpropS[1,27]	16.69	29.25	49.33	tunapropS[1,27]	9.472	16.6	28
2007	areapropS[1,28]	41.16	71.37	117.9	hookpropS[1,28]	22.86	39.65	65.49	tunapropS[1,28]	12.8	22.2	36.67
2008	areapropS[1,29]	39.3	68.14	112.6	hookpropS[1,29]	21.25	36.85	60.86	tunapropS[1,29]	13.97	24.23	40.02
2009	areapropS[1,30]	39.46	68.43	113	hookpropS[1,30]	20.46	35.48	58.6	tunapropS[1,30]	14.91	25.85	42.7
2010	areapropS[1,31]	40.88	70.89	117.1	hookpropS[1,31]	21.2	36.74	61.22	tunapropS[1,31]	15.44	26.78	44.23
2011	areapropS[1,32]	43.83	76.01	125.5	hookpropS[1,32]	24.03	41.64	69.39	tunapropS[1,32]	18.18	31.53	52.08

Annex 4

Shortfin mako shark results in number in numerical format (shown in Figures 9 and 10): for North Atlantic (top) and South Atlantic (bottom) in million sharks

NORTH	node	val2.5pc	median	val97.5pc	node	val2.5pc	median	val97.5pc	node	val2.5pc	median	val97.5pc
1980	areapropN[2,1]	0.01046	0.01702	0.02769		#N/A	#N/A	#N/A	tunapropN[2,1]	0.008224	0.01339	0.02178
1981	areapropN[2,2]	0.01047	0.01704	0.02771		#N/A	#N/A	#N/A	tunapropN[2,2]	0.008332	0.01356	0.02206
1982	areapropN[2,3]	0.01032	0.01681	0.02734		#N/A	#N/A	#N/A	tunapropN[2,3]	0.009522	0.0155	0.02522
1983	areapropN[2,4]	0.009591	0.01561	0.0254		#N/A	#N/A	#N/A	tunapropN[2,4]	0.007915	0.01288	0.02096
1984	areapropN[2,5]	0.01049	0.01708	0.02778	hookpropN[2,5]	0.008353	0.0136	0.02212	tunapropN[2,5]	0.008047	0.0131	0.02131
1985	areapropN[2,6]	0.009977	0.01624	0.02642	hookpropN[2,6]	0.00678	0.01104	0.01795	tunapropN[2,6]	0.007265	0.01182	0.01924
1986	areapropN[2,7]	0.01064	0.01733	0.02819	hookpropN[2,7]	0.009921	0.01615	0.02627	tunapropN[2,7]	0.006718	0.01093	0.01779
1987	areapropN[2,8]	0.01266	0.02061	0.03354	hookpropN[2,8]	0.007869	0.01281	0.02084	tunapropN[2,8]	0.007254	0.01181	0.01921
1988	areapropN[2,9]	0.01249	0.02034	0.03308	hookpropN[2,9]	0.007641	0.01244	0.02023	tunapropN[2,9]	0.007156	0.01165	0.01895
1989	areapropN[2,10]	0.01147	0.01866	0.03036	hookpropN[2,10]	0.006902	0.01123	0.01828	tunapropN[2,10]	0.006568	0.01069	0.01739
1990	areapropN[2,11]	0.01152	0.01876	0.03051	hookpropN[2,11]	0.006824	0.01111	0.01807	tunapropN[2,11]	0.006041	0.009834	0.016
1991	areapropN[2,12]	0.01687	0.02767	0.0453	hookpropN[2,12]	0.0113	0.01853	0.03035	tunapropN[2,12]	0.008351	0.0137	0.02243
1992	areapropN[2,13]	0.0204	0.03347	0.05479	hookpropN[2,13]	0.01327	0.02177	0.03564	tunapropN[2,13]	0.009705	0.01592	0.02607
1993	areapropN[2,14]	0.01844	0.03026	0.04954	hookpropN[2,14]	0.009491	0.01557	0.02549	tunapropN[2,14]	0.01039	0.01704	0.02789
1994	areapropN[2,15]	0.01982	0.03252	0.05324	hookpropN[2,15]	0.01289	0.02115	0.03463	tunapropN[2,15]	0.01155	0.01894	0.03101
1995	areapropN[2,16]	0.02251	0.03693	0.06046	hookpropN[2,16]	0.01574	0.02581	0.04226	tunapropN[2,16]	0.0118	0.01936	0.0317
1996	areapropN[2,17]	0.02546	0.03945	0.06072	hookpropN[2,17]	0.022	0.03408	0.05247	tunapropN[2,17]	0.01236	0.01915	0.02948
1997	areapropN[2,18]	0.02747	0.04255	0.0655	hookpropN[2,18]	0.02133	0.03305	0.05087	tunapropN[2,18]	0.01227	0.019	0.02925
1998	areapropN[2,19]	0.02932	0.04542	0.06991	hookpropN[2,19]	0.02078	0.03219	0.04955	tunapropN[2,19]	0.01366	0.02116	0.03258
1999	areapropN[2,20]	0.03286	0.0509	0.07836	hookpropN[2,20]	0.02425	0.03756	0.05782	tunapropN[2,20]	0.01468	0.02273	0.035
2000	areapropN[2,21]	0.0383	0.05933	0.09133	hookpropN[2,21]	0.03495	0.05415	0.08335	tunapropN[2,21]	0.01413	0.02189	0.03369
2001	areapropN[2,22]	0.0421	0.07332	0.1285	hookpropN[2,22]	0.0372	0.06478	0.1135	tunapropN[2,22]	0.0188	0.03275	0.05739
2002	areapropN[2,23]	0.04261	0.07421	0.1301	hookpropN[2,23]	0.02441	0.04251	0.07451	tunapropN[2,23]	0.01324	0.02306	0.04041
2003	areapropN[2,24]	0.04554	0.0793	0.139	hookpropN[2,24]	0.0252	0.04389	0.07692	tunapropN[2,24]	0.01503	0.02618	0.04588
2004	areapropN[2,25]	0.04019	0.06998	0.1227	hookpropN[2,25]	0.02887	0.05028	0.08813	tunapropN[2,25]	0.01366	0.02378	0.04168
2005	areapropN[2,26]	0.03852	0.06708	0.1176	hookpropN[2,26]	0.02506	0.04363	0.07648	tunapropN[2,26]	0.01159	0.02019	0.03539
2006	areapropN[2,27]	0.03492	0.06081	0.1066	hookpropN[2,27]	0.02136	0.03719	0.06519	tunapropN[2,27]	0.01085	0.01889	0.03311
2007	areapropN[2,28]	0.04703	0.08101	0.14	hookpropN[2,28]	0.02603	0.04483	0.07745	tunapropN[2,28]	0.01324	0.02281	0.0394
2008	areapropN[2,29]	0.04491	0.07735	0.1336	hookpropN[2,29]	0.03096	0.05332	0.09211	tunapropN[2,29]	0.01134	0.01952	0.03373
2009	areapropN[2,30]	0.0451	0.07767	0.1342	hookpropN[2,30]	0.02583	0.04449	0.07686	tunapropN[2,30]	0.01226	0.02111	0.03648
2010	areapropN[2,31]	0.04672	0.08046	0.139	hookpropN[2,31]	0.02812	0.04843	0.08368	tunapropN[2,31]	0.01406	0.02422	0.04184
2011	areapropN[2,32]	0.05009	0.08628	0.1491	hookpropN[2,32]	0.03161	0.05445	0.09406	tunapropN[2,32]	0.01459	0.02513	0.04341
SOUTH	node	val2.5pc	median	val97.5pc	node	val2.5pc	median	val97.5pc	node	val2.5pc	median	val97.5pc
1980	areapropS[2,1]	0.01371	0.02231	0.0363		#N/A	#N/A	#N/A	tunapropS[2,1]	0.01046	0.01702	0.02769
1981	areapropS[2,2]	0.01372	0.02233	0.03632		#N/A	#N/A	#N/A	tunapropS[2,2]	0.01158	0.01885	0.03067
1982	areapropS[2,3]	0.01353	0.02203	0.03583		#N/A	#N/A	#N/A	tunapropS[2,3]	0.01203	0.01958	0.03185
1983	areapropS[2,4]	0.01257	0.02046	0.03329		#N/A	#N/A	#N/A	tunapropS[2,4]	0.00987	0.01607	0.02614
1984	areapropS[2,5]	0.01375	0.02238	0.03642	hookpropS[2,5]	0.007945	0.01293	0.02104	tunapropS[2,5]	0.008047	0.0131	0.02131
1985	areapropS[2,6]	0.01308	0.02128	0.03463	hookpropS[2,6]	0.008427	0.01372	0.02232	tunapropS[2,6]	0.008814	0.01435	0.02334
1986	areapropS[2,7]	0.01395	0.02271	0.03695	hookpropS[2,7]	0.009095	0.0148	0.02408	tunapropS[2,7]	0.008268	0.01346	0.02189
1987	areapropS[2,8]	0.0166	0.02702	0.04396	hookpropS[2,8]	0.01107	0.01801	0.0293	tunapropS[2,8]	0.01008	0.01641	0.0267
1988	areapropS[2,9]	0.01637	0.02665	0.04336	hookpropS[2,9]	0.0114	0.01856	0.03019	tunapropS[2,9]	0.009461	0.0154	0.02505
1989	areapropS[2,10]	0.01503	0.02446	0.03979	hookpropS[2,10]	0.01046	0.01703	0.02771	tunapropS[2,10]	0.009796	0.01595	0.02594
1990	areapropS[2,11]	0.0151	0.02458	0.03999	hookpropS[2,11]	0.01152	0.01876	0.03051	tunapropS[2,11]	0.0104	0.01694	0.02755
1991	areapropS[2,12]	0.02211	0.03626	0.05937	hookpropS[2,12]	0.01605	0.02632	0.0431	tunapropS[2,12]	0.01523	0.02498	0.0409
1992	areapropS[2,13]	0.02674	0.04386	0.07181	hookpropS[2,13]	0.01763	0.02892	0.04734	tunapropS[2,13]	0.01822	0.02989	0.04894
1993	areapropS[2,14]	0.02417	0.03966	0.06493	hookpropS[2,14]	0.02006	0.0329	0.05387	tunapropS[2,14]	0.0163	0.02673	0.04377
1994	areapropS[2,15]	0.02598	0.04262	0.06978	hookpropS[2,15]	0.02309	0.03788	0.06202	tunapropS[2,15]	0.01578	0.02589	0.04238
1995	areapropS[2,16]	0.0295	0.0484	0.07924	hookpropS[2,16]	0.02448	0.04015	0.06574	tunapropS[2,16]	0.01617	0.02653	0.04344
1996	areapropS[2,17]	0.03338	0.0517	0.07958	hookpropS[2,17]	0.02596	0.04021	0.0619	tunapropS[2,17]	0.02027	0.0314	0.04834
1997	areapropS[2,18]	0.036	0.05577	0.08584	hookpropS[2,18]	0.02693	0.04172	0.06422	tunapropS[2,18]	0.01787	0.02768	0.0426
1998	areapropS[2,19]	0.03843	0.05952	0.09163	hookpropS[2,19]	0.02533	0.03924	0.06041	tunapropS[2,19]	0.01793	0.02778	0.04276
1999	areapropS[2,20]	0.04307	0.06672	0.1027	hookpropS[2,20]	0.03254	0.05041	0.0776	tunapropS[2,20]	0.01978	0.03064	0.04717
2000	areapropS[2,21]	0.0502	0.07776	0.1197	hookpropS[2,21]	0.03979	0.06163	0.09488	tunapropS[2,21]	0.0238	0.03687	0.05675
2001	areapropS[2,22]	0.05518	0.0961	0.1684	hookpropS[2,22]	0.03597	0.06264	0.1098	tunapropS[2,22]	0.02534	0.04414	0.07736
2002	areapropS[2,23]	0.05585	0.09727	0.1705	hookpropS[2,23]	0.03186	0.05548	0.09724	tunapropS[2,23]	0.02317	0.04035	0.07072
2003	areapropS[2,24]	0.05969	0.1039	0.1822	hookpropS[2,24]	0.042	0.07314	0.1282	tunapropS[2,24]	0.02255	0.03927	0.06882
2004	areapropS[2,25]	0.05267	0.09173	0.1608	hookpropS[2,25]	0.02692	0.04688	0.08217	tunapropS[2,25]	0.0199	0.03465	0.06074
2005	areapropS[2,26]	0.05049	0.08792	0.1541	hookpropS[2,26]	0.02431	0.04233	0.07419	tunapropS[2,26]	0.01758	0.03061	0.05365
2006	areapropS[2,27]	0.04577	0.0797	0.1397	hookpropS[2,27]	0.02509	0.04369	0.07658	tunapropS[2,27]	0.01424	0.0248	0.04346
2007	areapropS[2,28]	0.06165	0.1062	0.1834	hookpropS[2,28]	0.03425	0.05899	0.1019	tunapropS[2,28]	0.01918	0.03303	0.05707
2008	areapropS[2,29]	0.05886	0.1014	0.1751	hookpropS[2,29]	0.03183	0.05482	0.09471	tunapropS[2,29]	0.02093	0.03605	0.06227
2009	areapropS[2,30]	0.05911	0.1018	0.1759	hookpropS[2,30]	0.03065	0.05278	0.09119	tunapropS[2,30]	0.02233	0.03846	0.06644
2010	areapropS[2,31]	0.06123	0.1055	0.1822	hookpropS[2,31]	0.03175	0.05468	0.09447	tunapropS[2,31]	0.02313	0.03984	0.06883
2011	areapropS[2,32]	0.06566	0.1131	0.1954	hookpropS[2,32]	0.03599	0.06198	0.1071	tunapropS[2,32]	0.02723	0.04691	0.08104

Annex 5

Shortfin mako shark results in biomass in numerical format (shown in Figures 11 and 12): for North Atlantic (top) and South Atlantic (bottom) in thousand tonnes

NORTH	node	val2.5pc	median	val97.5pc	node	val2.5pc	median	val97.5pc	node	val2.5pc	median	val97.5pc
1980	areapropN[2,1]	0.68	1.117	1.641		#N/A	#N/A	#N/A	tunapropN[2,1]	0.5347	0.8784	1.29
1981	areapropN[2,2]	0.6805	1.118	1.642		#N/A	#N/A	#N/A	tunapropN[2,2]	0.5417	0.8899	1.307
1982	areapropN[2,3]	0.6713	1.103	1.62		#N/A	#N/A	#N/A	tunapropN[2,3]	0.6191	1.017	1.494
1983	areapropN[2,4]	0.6236	1.024	1.505		#N/A	#N/A	#N/A	tunapropN[2,4]	0.5146	0.8453	1.242
1984	areapropN[2,5]	0.6822	1.121	1.646	hookpropN[2,5]	0.5431	0.8921	1.31	tunapropN[2,5]	0.5232	0.8595	1.262
1985	areapropN[2,6]	0.6487	1.066	1.565	hookpropN[2,6]	0.4408	0.7242	1.064	tunapropN[2,6]	0.4723	0.7759	1.14
1986	areapropN[2,7]	0.6921	1.137	1.67	hookpropN[2,7]	0.6451	1.06	1.556	tunapropN[2,7]	0.4368	0.7175	1.054
1987	areapropN[2,8]	0.8234	1.353	1.987	hookpropN[2,8]	0.5117	0.8405	1.235	tunapropN[2,8]	0.4717	0.7748	1.138
1988	areapropN[2,9]	0.8123	1.334	1.96	hookpropN[2,9]	0.4968	0.8161	1.199	tunapropN[2,9]	0.4653	0.7643	1.123
1989	areapropN[2,10	0.7455	1.225	1.799	hookpropN[2,10]	0.4487	0.7371	1.083	tunapropN[2,10]	0.427	0.7015	1.03
1990	areapropN[2,11	0.7492	1.231	1.808	hookpropN[2,11]	0.4437	0.7289	1.071	tunapropN[2,11]	0.3928	0.6452	0.9477
1991	areapropN[2,12	1.099	1.812	2.693	hookpropN[2,12]	0.7359	1.214	1.804	tunapropN[2,12]	0.5439	0.8971	1.333
1992	areapropN[2,13	1.329	2.191	3.257	hookpropN[2,13]	0.8643	1.426	2.119	tunapropN[2,13]	0.6321	1.043	1.55
1993	areapropN[2,14	1.201	1.981	2.945	hookpropN[2,14]	0.6182	1.02	1.515	tunapropN[2,14]	0.6765	1.116	1.658
1994	areapropN[2,15	1.291	2.129	3.165	hookpropN[2,15]	0.8398	1.385	2.059	tunapropN[2,15]	0.7521	1.24	1.844
1995	areapropN[2,16	1.466	2.418	3.594	hookpropN[2,16]	1.025	1.69	2.512	tunapropN[2,16]	0.7686	1.268	1.884
1996	areapropN[2,17	1.644	2.605	3.555	hookpropN[2,17]	1.42	2.251	3.072	tunapropN[2,17]	0.798	1.264	1.726
1997	areapropN[2,18	1.773	2.809	3.835	hookpropN[2,18]	1.377	2.182	2.979	tunapropN[2,18]	0.7919	1.255	1.713
1998	areapropN[2,19	1.893	2.999	4.093	hookpropN[2,19]	1.341	2.125	2.901	tunapropN[2,19]	0.882	1.397	1.908
1999	areapropN[2,20	2.121	3.361	4.588	hookpropN[2,20]	1.565	2.48	3.385	tunapropN[2,20]	0.9475	1.501	2.049
2000	areapropN[2,21	2.473	3.917	5.348	hookpropN[2,21]	2.257	3.575	4.88	tunapropN[2,21]	0.9122	1.445	1.973
2001	areapropN[2,22	2.753	4.764	7.709	hookpropN[2,22]	2.432	4.209	6.81	tunapropN[2,22]	1.23	2.128	3.443
2002	areapropN[2,23	2.787	4.822	7.802	hookpropN[2,23]	1.596	2.762	4.469	tunapropN[2,23]	0.8657	1.498	2.424
2003	areapropN[2,24	2.978	5.153	8.337	hookpropN[2,24]	1.648	2.851	4.614	tunapropN[2,24]	0.983	1.701	2.752
2004	areapropN[2,25	2.628	4.547	7.358	hookpropN[2,25]	1.888	3.267	5.286	tunapropN[2,25]	0.8929	1.545	2.5
2005	areapropN[2,26	2.519	4.358	7.052	hookpropN[2,26]	1.638	2.835	4.587	tunapropN[2,26]	0.7581	1.312	2.122
2006	areapropN[2,27	2.283	3.951	6.393	hookpropN[2,27]	1.397	2.417	3.91	tunapropN[2,27]	0.7094	1.228	1.986
2007	areapropN[2,28	3.073	5.277	8.392	hookpropN[2,28]	1.701	2.921	4.644	tunapropN[2,28]	0.8653	1.486	2.363
2008	areapropN[2,29	2.935	5.039	8.012	hookpropN[2,29]	2.023	3.473	5.523	tunapropN[2,29]	0.7408	1.272	2.023
2009	areapropN[2,30	2.947	5.06	8.046	hookpropN[2,30]	1.688	2.898	4.609	tunapropN[2,30]	0.801	1.376	2.187
2010	areapropN[2,31	3.053	5.242	8.335	hookpropN[2,31]	1.838	3.155	5.017	tunapropN[2,31]	0.9188	1.578	2.509
2011	areapropN[2,32	3.273	5.621	8.937	hookpropN[2,32]	2.066	3.547	5.64	tunapropN[2,32]	0.9534	1.637	2.603
SOUTH	node	val2.5pc	median	val97.5pc	node	val2.5pc	median	val97.5pc	node	val2.5pc	median	val97.5pc
1980	areapropS[2,1]	0.8912	1.464	2.15		#N/A	#N/A	#N/A	tunapropS[2,1]	0.68	1.117	1.641
1981	areapropS[2,2]	0.8919	1.465	2.152		#N/A	#N/A	#N/A	tunapropS[2,2]	0.7531	1.237	1.817
1982	areapropS[2,3]	0.8798	1.445	2.123		#N/A	#N/A	#N/A	tunapropS[2,3]	0.7821	1.285	1.887
1983	areapropS[2,4]	0.8173	1.343	1.972		#N/A	#N/A	#N/A	tunapropS[2,4]	0.6418	1.054	1.548
1984	areapropS[2,5]	0.8941	1.469	2.157	hookpropS[2,5]	0.5166	0.8486	1.246	tunapropS[2,5]	0.5232	0.8595	1.262
1985	areapropS[2,6]	0.8502	1.397	2.051	hookpropS[2,6]	0.5479	0.9	1.322	tunapropS[2,6]	0.5731	0.9414	1.383
1986	areapropS[2,7]	0.9071	1.49	2.189	hookpropS[2,7]	0.5913	0.9713	1.427	tunapropS[2,7]	0.5376	0.883	1.297
1987	areapropS[2,8]	1.079	1.773	2.604	hookpropS[2,8]	0.7195	1.182	1.736	tunapropS[2,8]	0.6556	1.077	1.582
1988	areapropS[2,9]	1.065	1.749	2.569	hookpropS[2,9]	0.7413	1.218	1.789	tunapropS[2,9]	0.6151	1.01	1.484
1989	areapropS[2,10]	0.9771	1.605	2.358	hookpropS[2,10]	0.6804	1.118	1.642	tunapropS[2,10]	0.6369	1.046	1.537
1990	areapropS[2,11]	0.982	1.613	2.369	hookpropS[2,11]	0.7492	1.231	1.808	tunapropS[2,11]	0.6765	1.111	1.632
1991	areapropS[2,12]	1.44	2.375	3.529	hookpropS[2,12]	1.045	1.724	2.562	tunapropS[2,12]	0.9919	1.636	2.431
1992	areapropS[2,13]	1.742	2.872	4.269	hookpropS[2,13]	1.148	1.894	2.814	tunapropS[2,13]	1.187	1.957	2.909
1993	areapropS[2,14]	1.575	2.597	3.86	hookpropS[2,14]	1.306	2.154	3.202	tunapropS[2,14]	1.061	1.75	2.602
1994	areapropS[2,15]	1.692	2.791	4.148	hookpropS[2,15]	1.504	2.481	3.687	tunapropS[2,15]	1.028	1.695	2.52
1995	areapropS[2,16]	1.922	3.169	4.711	hookpropS[2,16]	1.594	2.629	3.908	tunapropS[2,16]	1.053	1.737	2.582
1996	areapropS[2,17]	2.155	3.414	4.66	hookpropS[2,17]	1.676	2.655	3.624	tunapropS[2,17]	1.309	2.074	2.831
1997	areapropS[2,18]	2.324	3.682	5.027	hookpropS[2,18]	1.739	2.755	3.761	tunapropS[2,18]	1.153	1.827	2.495
1998	areapropS[2,19]	2.481	3.93	5.365	hookpropS[2,19]	1.635	2.591	3.537	tunapropS[2,19]	1.158	1.834	2.504
1999	areapropS[2,20]	2.781	4.405	6.014	hookpropS[2,20]	2.101	3.329	4.544	tunapropS[2,20]	1.277	2.023	2.762
2000	areapropS[2,21]	3.241	5.135	7.009	hookpropS[2,21]	2.569	4.07	5.555	tunapropS[2,21]	1.536	2.434	3.323
2001	areapropS[2,22]	3.608	6.244	10.1	hookpropS[2,22]	2.352	4.07	6.586	tunapropS[2,22]	1.657	2.868	4.64
2002	areapropS[2,23]	3.652	6.32	10.23	hookpropS[2,23]	2.083	3.605	5.833	tunapropS[2,23]	1.515	2.621	4.242
2003	areapropS[2,24]	3.903	6.753	10.93	hookpropS[2,24]	2.746	4.752	7.69	tunapropS[2,24]	1.474	2.551	4.128
2004	areapropS[2,25]	3.444	5.96	9.643	hookpropS[2,25]	1.76	3.046	4.929	tunapropS[2,25]	1.301	2.251	3.643
2005	areapropS[2,26]	3.301	5.712	9.243	hookpropS[2,26]	1.589	2.75	4.45	tunapropS[2,26]	1.149	1.989	3.218
2006	areapropS[2,27]	2.993	5.179	8.379	hookpropS[2,27]	1.64	2.839	4.593	tunapropS[2,27]	0.9311	1.611	2.607
2007	areapropS[2,28]	4.028	6.917	11	hookpropS[2,28]	2.238	3.843	6.11	tunapropS[2,28]	1.253	2.152	3.422
2008	areapropS[2,29]	3.846	6.604	10.5	hookpropS[2,29]	2.08	3.571	5.679	tunapropS[2,29]	1.368	2.348	3.734
2009	areapropS[2,30]	3.862	6.632	10.55	hookpropS[2,30]	2.003	3.439	5.468	tunapropS[2,30]	1.459	2.505	3.984
2010	areapropS[2,31]	4.001	6.87	10.92	hookpropS[2,31]	2.075	3.562	5.665	tunapropS[2,31]	1.512	2.596	4.127
2011	areapropS[2,32]	4.29	7.367	11.71	hookpropS[2,32]	2.352	4.038	6.421	tunapropS[2,32]	1.78	3.056	4.859