

Supplementary Evaluation of Dusky Shark Bycatch Data

**Amendment 5b to the 2006 Consolidated Atlantic
Highly Migratory Species Fishery Management Plan**

**In Response to
April 19, 2019 Remand Order
Case No. 17-cv-829 (CRC)
OCEANA, INC v. WILBUR ROSS**

August 2, 2019

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I. INTRODUCTION

In April 2017, the National Marine Fisheries Service (NMFS) published the Final Rule implementing Amendment 5b to the 2006 Consolidated Atlantic Highly Migratory Species (HMS) Fishery Management Plan (FMP) (AR007564). In relevant part, Amendment 5b clarified that the annual catch limit (ACL) for prohibited shark species, including dusky sharks, is zero and established additional accountability measures to reduce fishing mortality on dusky sharks to end overfishing and rebuild the stock, as required by the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act). With the addition of those accountability measures, NMFS determined that the ACL of zero continued to be appropriate for the prohibited shark complex, including dusky sharks, and that only small amounts of catch, including bycatch, of those species would occur and were unlikely to result in overfishing, consistent with provisions in the National Standard 1 (NS1) guidelines. 50 CFR 600.310(g)(3). See discussion at AR007081-87; AR007564.

In May 2017, Oceana filed a complaint challenging the agency action claiming, in part, that “the Fisheries Service failed to establish accountability measures in Amendment 5b that will ensure that bycatch does not exceed the annual catch limit it set for dusky sharks and failed to demonstrate how the measures it did include will be sufficient to rebuild the dusky shark population and end overfishing.” (Plaintiff’s May 4, 2017 Complaint at 2.) Plaintiff specifically challenged whether NMFS appropriately considered certain data, including logbook data and data underlying NMFS’ National Bycatch Reports. In a March 11, 2019 Order, the U.S. District Court for the District of Columbia granted partial summary judgment to Oceana, remanding Amendment 5b to NMFS to conduct further analyses.

After reviewing the parties’ input regarding the appropriate scope and duration of the remand, the Court, in an April 19, 2019 Order (Remand Order), directed NMFS to:

1. Consider all relevant data related to dusky shark bycatch in the HMS and non-HMS fisheries, as it existed at the time of the agency decision, including logbook data and the data underlying the National Bycatch Reports.
2. Submit a document to the Court by August 2, 2019, which shall set forth the agency’s consideration of the above-referenced data, in light of the Court’s March 11, 2019 ruling. Specifically, the document must address the following:
 - Whether, considering all of the relevant data, the agency continues to conclude that additional accountability measures are not required because only small amount of catch (including bycatch) occur, and the catch is unlikely to result in overfishing. See 50 C.F.R. § 600.310(g)(3).
 - Whether there is a scientifically valid basis for using the logbook data in conjunction with the observer data and other sources, including by extrapolation, to estimate the amount of dusky shark bycatch occurring in the HMS and non-HMS fisheries.

This document constitutes the agency's response to the Court's direction in these first two steps of the Remand Order. Subsequent actions and steps anticipated by the Remand Order are dependent on the determinations made in this document. The analyses in this document supplement those in the Amendment 5b FEIS (AR007050), and those analyses, background information, and details from the FEIS and Final Rule are not repeated here.

Many of the analyses in this document were generated applying an assumption that NMFS can accept certain data at face value (e.g., logbook data, recreational extrapolations). NMFS generated such analyses, despite concerns about data reliability, in response to the Remand Order's direction to "consider all relevant data, including logbook data and the data underlying the National Bycatch Reports." NMFS explained in Amendment 5b (AR007095-96; AR007133-34) why certain data is unreliable and why conclusions drawn from, or extrapolations from, such data are highly uncertain and inappropriate for management purposes, and further explanation is provided below. The analyses in this document and the approach taken in relation to management decisions should not be treated as having precedential value, and are not necessarily standard practice.

II. CONSIDERATION OF ALL RELEVANT DATA RELATED TO DUSKY SHARK BYCATCH IN THE HMS AND NON-HMS FISHERIES

This section sets forth the agency's consideration of all relevant data related to dusky shark bycatch in the HMS and non-HMS fisheries, as it existed at the time of the agency decision, in light of the Court's March 11, 2019 ruling and as directed in the Remand Order. It also discusses the process NMFS undertook to compile and summarize this data.

NMFS first examined all data sources to identify potential sources of dusky shark bycatch.¹ This was a thorough, coordinated effort by NMFS' HMS Management Division, Office of Sustainable Fisheries; the Greater Atlantic Regional Fisheries Office; the Northeast Fisheries Science Center; and the Southeast Fisheries Science Center to ensure consideration of all locations where data could be provided. Detailed descriptions of every data source that contained dusky shark bycatch information are provided in Appendix 1. The Southeast Fisheries Science Center confirmed that all available sources of dusky shark catch data were included (see Appendix 3).

From those sources, NMFS then compiled all of the relevant data related to dusky shark bycatch in the HMS and non-HMS fisheries, as it existed at the time of the agency decision, including, as directed in the Remand Order, logbook data and the data underlying the National Bycatch Reports, as well as other sources. NMFS defined "relevant data" to include data from 2000 to 2015. The date range begins with the year that NMFS designated dusky sharks as a prohibited species and ends with the last year of data that was before NMFS when it finalized Amendment

¹The dusky shark fishery has been closed since 2000 with its listing as a prohibited species, so any catch of the species occurs as bycatch during directed fishing for other species or as mistaken/misidentified landings (AR007636; AR007076-7080).

5b. This span of years includes the entire time period after dusky shark prohibition in 2000 and is broader than that analyzed using observer data in Amendment 5b (2008-2015) to allow NMFS to see additional trends in the relevant data.

The time series used in Amendment 5b, “begins in 2008 to coincide with the implementation of Amendment 2 and ends in 2015, the most recent year for which data were available” because “Amendment 2 modified and established regulations in the shark fisheries that dramatically changed how the directed shark fisheries operate.” (AR007089). The early years—particularly those before 2008—are not reflective of fishery operations under the suite of management measures that were in place when NMFS adopted Amendment 5b. Nevertheless, NMFS chose to be over-inclusive by including the entire post-prohibition time period in this document.

As explained in detail below, NMFS summarized the relevant data both in terms of overall interactions and mortality. Interactions is a broad category that includes all reported or observed dusky shark interactions, regardless of disposition (i.e., whether released alive, discarded dead, or kept due to mistake/misidentification), and are informative in assessing the magnitude of bycatch generally.² Mortalities are a subset of interactions, including only dusky sharks reported or observed as kept or discarded dead, and excluding live releases. Mortalities are important because the focus of the management measures adopted in Amendment 5b was on reducing dusky shark mortality, consistent with the stock assessment recommendations. Furthermore, these distinctions are relevant in the definitions of “catch (including bycatch)” under the zero ACL provision of the NS1 guidelines on ACLs.³

NMFS considered this summarized data, as set out in detail below. In reviewing the data, NMFS identified three particularly relevant sub-periods to effectively analyze trends within the context of the regulatory landscape as it developed over 2000-2015:

- The “early” years. This group of years, 2000-2004, consists of the first few years immediately after NMFS prohibited dusky sharks and reflects the time it took to make responsive adjustments in the fisheries
- The years “after 2008.” Amendment 2, which implemented the dusky shark rebuilding plan, was implemented in 2008 and included measures to significantly reduce dusky shark bycatch mortality.
- The “recent” years. This group of years, 2013-2015, reflects the regulatory measures in place at the time Amendment 5b was adopted, including the dusky shark limits adopted in the shark research fishery in 2013. This time period is relevant for considering needed

² Under the Magnuson-Stevens Act, “bycatch” means fish which “are harvested in a fishery, but which are not sold or kept for personal use, and includes economic discards and regulatory discards. Such term does not include fish released alive under a recreational catch and release fishery management program.” 16 U.S.C. § 1802(2). A catch-and-release fishery management program “is one in which the retention of a particular species is prohibited. In such a program, those fish released alive would not be considered bycatch.” 50 C.F.R. § 600.350(c)(2)(ii).

³ The National Standard 1 Guidelines’ section on ACLs defines “catch” to include fish “taken in commercial, recreational, subsistence, tribal, and other fisheries,” including “fish that are retained for any purpose, as well as mortality of fish that are discarded.” 50 C.F.R. 600.310(f)(1)(i).

reductions in mortality and for comparison to the data in the early years to help identify impacts of the extensive management measures that have been adopted since 2000.

A. COMMERCIAL LOGBOOK DATA

Almost all federally-permitted commercial vessels are required by NMFS to report their fishing activities in a logbook, with some limited exceptions. Because commercial fishermen are reporting this data themselves, it is referred to as “self-reported” data. Different logbooks are required and used, depending on the data collection needs/requirements of the different fisheries. As a general matter, logbooks typically require information on the gear used, the date a fishing trip occurred, the quantity of fish landed, and the fishing location.

Three mandatory federal logbook reporting programs cover the universe of commercial fisheries that might interact with dusky sharks in federal waters of the Atlantic Ocean: the HMS Logbook, the Southeast (SE) Coastal Fisheries Logbook, and the Northeast (NE) Vessel Trip Reports. Owners of permitted vessels are required to maintain and submit logbooks as specified in federal regulations, consistent with the conditions of their federal permits. For a description of the fisheries that report in these various logbooks, refer to the detailed descriptions of each data source in Appendix 1. The Appendix also explains the different forms associated with each logbook and different reporting levels (percentages), to facilitate understanding of the analyses of the data in the tables below.

As described in detail below, NMFS gathered and summarized all of the relevant commercial logbook data about dusky sharks. NMFS then further analyzed and considered the data as directed by the Court in its Remand Order, in the context of Amendment 5b and the Court’s March 11, 2019 ruling, and addressed the specific questions posed by the Court in the Remand Order, as set out in Sections III and IV.

Summary of the Logbook Data

NMFS summarized all of the commercial logbook data reflecting dusky shark interactions during the years 2000 through 2015 in HMS and non-HMS fisheries. The summarized logbook data includes all federally-permitted fishing vessels in the U.S. Atlantic, Gulf of Mexico, and Caribbean Sea, including all fisheries (HMS and non-HMS) that may encounter dusky sharks. As described in Appendix 1, data in some of the logbook forms is reported in weight rather than number of individuals. NMFS therefore converted reported weights to numbers of sharks to facilitate appropriate comparisons and analyses across all the logbooks and logbook forms. The data and methods behind these conversions are detailed in Appendix 2.

The logbook data is summarized in Tables 1 and 2, and Figures 1 through 4. NMFS organized the columns of these tables by the three logbook programs in which the data was reported. For the SE Coastal Fisheries Logbook, the columns are also broken down by target species and the logbook form that was used (trip or discard form). Columns are further designated as including HMS or non-HMS fisheries (or both). NMFS included this designation in the tables because attention in the litigation has been paid to whether NMFS focused too narrowly on dusky shark bycatch occurring within the HMS fisheries and not on dusky shark bycatch that may have been

occurring in other, non-HMS Atlantic fisheries. The logbooks used by vessels in the Atlantic HMS commercial fisheries are the HMS Logbook, which is used primarily by vessels in the pelagic longline fishery, and the SE Coastal Fisheries Logbook, which is used by HMS directed shark fishermen primarily using bottom longline and gillnet. Other fisheries also report using the SE Coastal Fisheries Logbook, so this data is labeled as including data from “both” HMS and non-HMS fisheries.

For each column in Table 1, NMFS provides the total number of interactions reported each year. Using this information, NMFS calculated the cumulative number of interactions for each column, the average annual number of interactions for each column, the average number of interactions for the most recent three years of available data, and the total number of reported trips for each column. NMFS also calculated for each column the average number of dusky sharks caught per trip and the average number of trips it would take before one dusky shark is caught. This calculation provides information on which fisheries have the highest interaction rates. Additionally, this calculation provides a metric for comparison across logbooks and fisheries that have different reporting percentages or levels. Table 2 contains similar information as Table 1 but only regarding the subset of dusky sharks reported as kept or discarded dead.

Table 1. Total dusky shark *interactions* (including numbers RELEASED ALIVE, KEPT, or DISCARDED DEAD) self-reported by fishing vessels in all logbook programs, 2000-2015. Logbooks programs flagged with an asterisk (*) are programs where 100 percent of permitted vessels are required to report. Only 20 percent of permitted vessels are randomly selected to report in the SE Coastal Fisheries Logbook discard form. "N/A" indicates years where data were not available. Values denoted by ** are outliers and were excluded.

	HMS FISHERIES		BOTH		NON-HMS FISHERIES	
		SE Coastal Fisheries Logbook Discard Form (Shark Bottom Longline and Gillnet)	SE Coastal Fisheries Logbook Trip Form (All Fisheries, KEPT-ONLY)*	SE Coastal Fisheries Logbook Discard Form (GOM Reef Fish)	SE Coastal Fisheries Logbook Discard Form (SE Snapper-Grouper + Other)	NE Vessel Trip Reports*
YEAR	HMS Logbook*					
2000	1528	N/A	686	N/A	N/A	126
2001	618	5	83	0	2	45
2002	447	0	346	1	14	390
2003	696	9	392	3	1	358
2004	796	10	330	3	11	12
2005	1071	0	12	3	0	20
2006	840	28	19	20	1	14
2007	761	0	43	1	0	14
2008	411	6	0	1	35	7
2009	628	0	0	2	0	3
2010	745	94	0	0	46	18
2011	548	49	0	37	10	30
2012	909	233	0	0	15	45
2013	394	0	0	18	5	63
2014	164	39	3	22	2	120
2015	337	16	0	21	**	88
Total Interactions	10,893	489	1,915	132	142	1,353
Average # Interactions per Year	681	33	120	9	10	85
Average # Interactions 2013-2015	298	18	1	20	4	90
Total # Trips	24,792	3,906	664,321	57,377	108,909	1,801,421
Average # Dusky Sharks Per Trip	0.4394	0.1252	0.0029	0.0023	0.0013	0.0008
Average # Trips to Catch 1 Dusky Shark	2	8	347	435	767	1,332

Table 2. Total dusky shark *mortalities* (including numbers KEPT or DISCARDED DEAD) self-reported by fishing vessels in all logbook programs, 2000-2015. Logbooks programs flagged with an asterisk (*) are programs where 100 percent of permitted vessels are required to report. Only 20 percent of permitted vessels are randomly selected to report in the SE Coastal Fisheries Logbook discard form. “N/A” indicates years where data were not available. Values denoted by ** are outliers and were excluded.

	HMS FISHERIES	BOTH	NON-HMS FISHERIES			
YEAR	HMS Logbook*	SE Coastal Fisheries Logbook Discard Form (Shark Bottom Longline and Gillnet)	SE Coastal Fisheries Logbook Trip Form (All Fisheries, KEPT-ONLY)*	SE Coastal Fisheries Logbook Discard Form (GOM Reef Fish)	SE Coastal Fisheries Logbook Discard Form (SE Snapper-Grouper + Other)	NE Vessel Trip Reports*
2000	779	N/A	686	N/A	N/A	125
2001	87	5	83	0	0	45
2002	86	0	346	0	0	388
2003	124	0	392	0	0	311
2004	142	10	330	0	0	1
2005	43	0	12	0	0	2
2006	76	0	19	0	0	2
2007	95	0	43	0	0	10
2008	39	6	0	0	3	0
2009	68	0	0	2	0	3
2010	35	69	0	0	0	0
2011	12	8	0	0	0	0
2012	115	221	0	0	12	1
2013	38	0	0	0	0	0
2014	11	4	3	0	0	0
2015	20	5	0	0	**	0
Total Reported Mortality	1,770	328	1,915	2	15	887
Average # Mortalities per Year	111	22	120	0.13	1	55
Average # Mortalities 2013-2015	23	3	1	0	0	0
Total # Trips	24,792	3,906	664,321	57,377	108,909	1,801,421
Average # Dusky Sharks Mortalities Per Trip	0.0714	0.0840	0.0029	0.0000	0.0001	0.0005
Average # Trips to 1 Dusky Shark Mortality	14	12	347	28,689	7,261	2,030

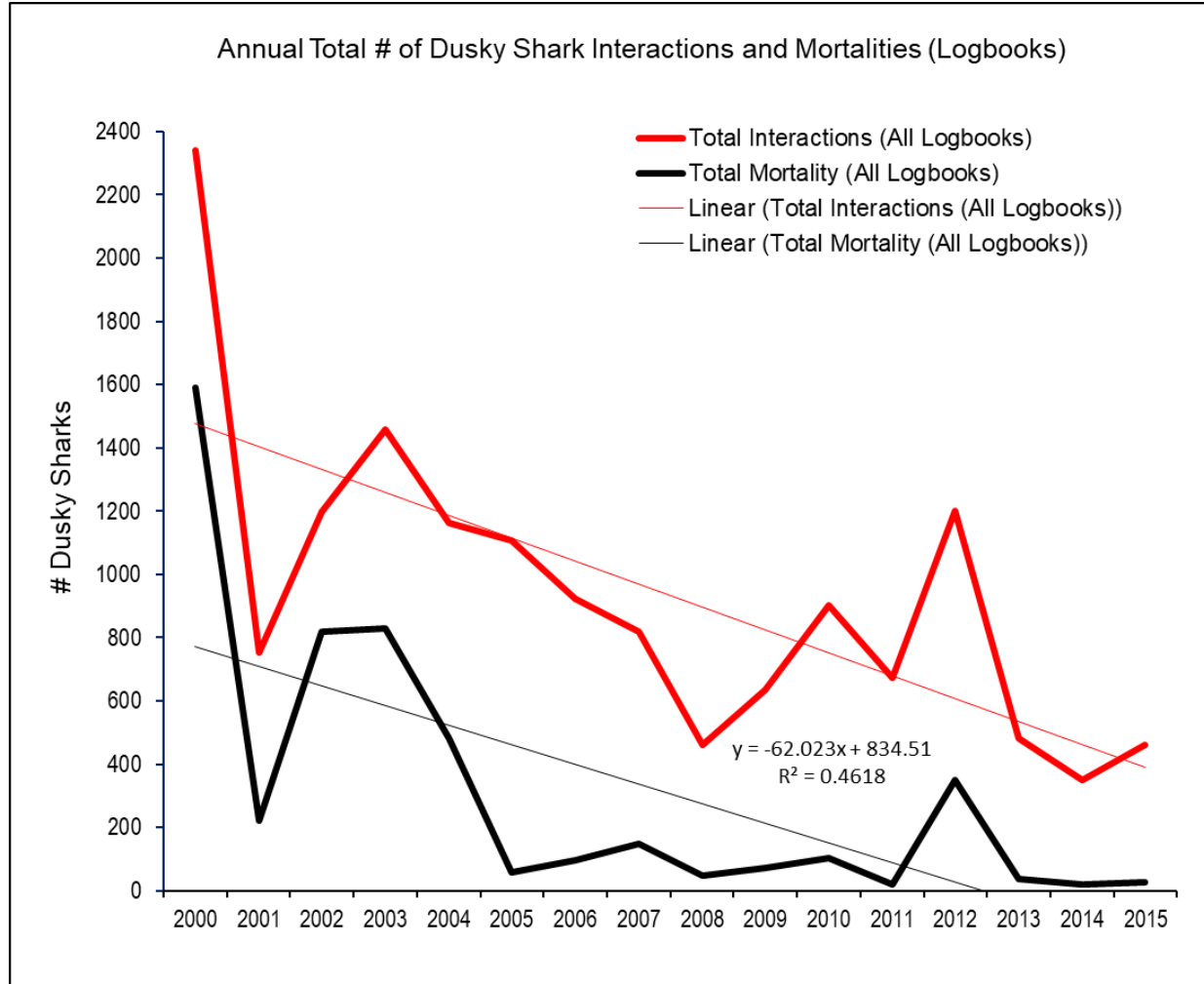


Figure 1. Annual number of reported dusky shark interactions (red line) and mortalities (black line) across all logbook programs.

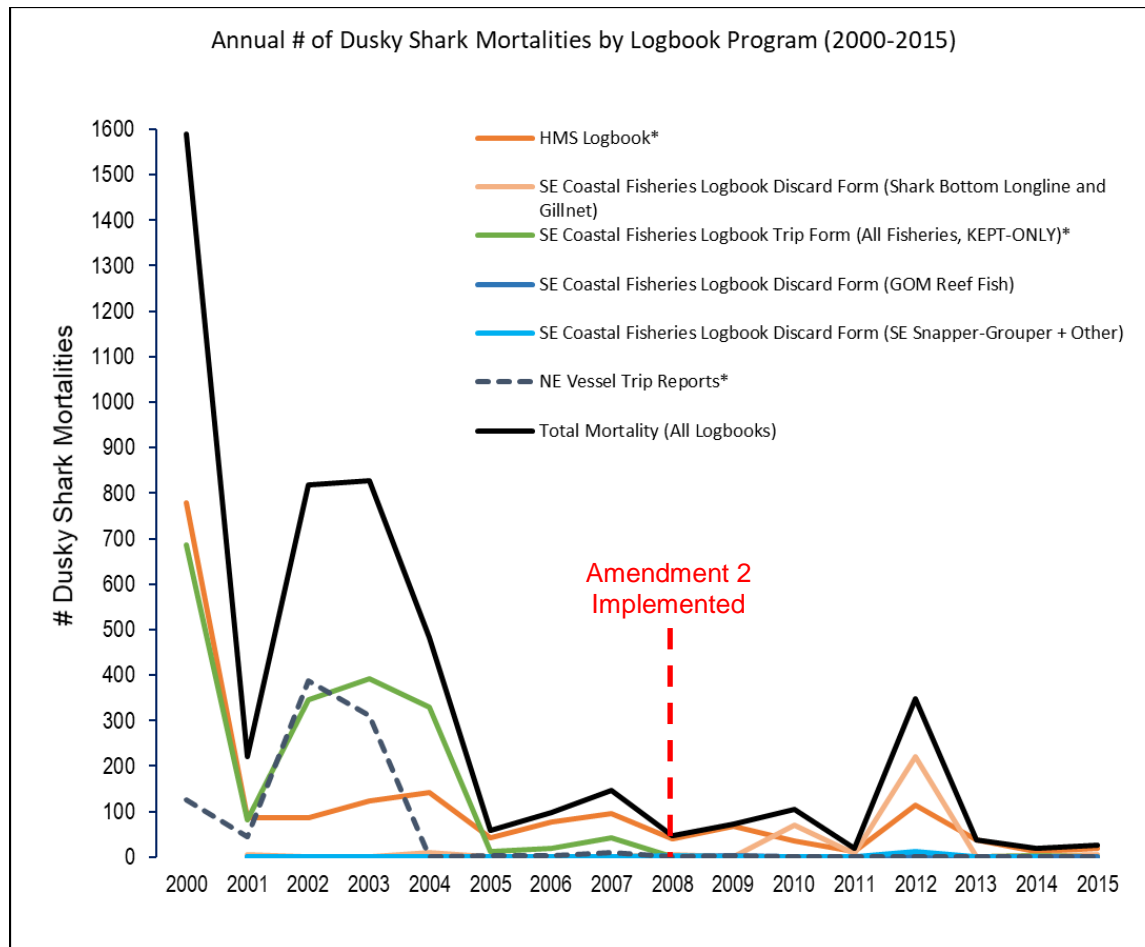


Figure 2. Annual number of dusky shark mortalities reported in logbooks, 2000-2015. Orange-shaded lines are logbooks that report from HMS fisheries, blue-shaded lines are logbooks that report from non-HMS fisheries, and green-shaded lines are logbooks that report from some HMS and non-HMS fisheries together. Logbooks programs flagged with an asterisk (*) are programs where 100 percent of permitted vessels are required to report. Only 20 percent of permitted vessels are randomly selected to report in the SE Coastal Fisheries Logbook Discard Form.

Consideration of the Summarized Data

Interactions

According to the logbook data considered from all three logbook programs, and as further broken down by fishery and/or logbook form, the average number of dusky sharks caught per year from 2000 to 2015 ranged from a low of 9 as reported on the discard form of the SE Coastal Fisheries Logbook for the Gulf of Mexico reef fish and snapper-grouper fisheries to a high of 681 for the HMS Logbook (Table 1).

Not all of the annual interactions numbers are directly comparable because of the different reporting requirements in the different logbook programs. While 100 percent of the vessels using the HMS Logbook or the NE Vessel Trip Reports are required to report discards, only 20 percent of the vessels using the SE Coastal Fisheries Logbook are randomly selected to report discards on the discard form. (Refer to Appendix 1 for more details about reporting

requirements; refer to Section IV for an explanation of why the SE Coastal Fisheries Logbook discard form data cannot validly be extrapolated). Nevertheless, for the entire timeframe examined, the majority of dusky shark interactions were reported in the HMS Logbook, even when compared to logbook forms that do require 100 percent reporting (e.g., HMS Logbook compared to the SE Coastal Fisheries Trip form, both of which require 100 percent reporting).

Given the variability in reporting levels, analyses on a per trip basis, rather than the annual numbers themselves, might provide a basis for more direct comparison and be more indicative of the level of impact each fishery has on dusky shark mortality overall. For example, the data show that it takes, on average, only 2 to 8 HMS fishery trips to result in one dusky shark interaction, while it takes 435 to 1,332 trips to result in one dusky shark interaction in the non-HMS fisheries (Table 1). This indicates that HMS fisheries by far have greater reported interaction rates with dusky sharks than non-HMS fisheries according to logbook data.

Overall, the number of dusky shark interactions being reported in each logbook program has decreased over time (Table 1; Figure 1). Using the numbers at face value, this decline in interactions is statistically significant⁴ ($p < 0.01$). From 2000-2004, the annual average number of reported interactions across all three logbooks was 1,382. Since 2008, the annual average declined to 670 interactions. In the most recent years (2013-2015), the average annual number of interactions ranged from a low of 1 interaction reported in the SE Coastal Fisheries Logbook trip form to a high of 298 interactions reported in the HMS Logbook, with an annual average of 430 interactions--a 69 percent decline from the early years.

Mortality

According to logbook data on mortalities (Table 2; Figures 1 and 2), the average number of dusky shark mortalities reported per year (2000-2015) ranged from a low of 0.1 (SE Coastal Fisheries Logbook discard form for the Gulf of Mexico reef fish fishery) to a high of 120 (SE Coastal Fisheries Logbook trip form). Adding all years and all columns together, the total number of dusky shark mortalities reported is 4,917 sharks, of which 3,939 (80 percent) were reported in the early years following prohibition (2000 to 2004). This is an average of 307 dusky shark mortalities per year across all 16 years, which is a small number of mortalities in these fisheries, even if changes in the regulatory landscape are not taken into account in interpreting the totals. Data from the recent years (2013-2015) is more reflective of current conditions in the fisheries (Figure 3), given the number of regulatory changes that have taken place over the time considered (e.g., closure of the directed fishery and designation of dusky sharks as prohibited, implementation of a rebuilding plan, and adoption of dusky shark limits in the shark research fishery). For the recent years across all three logbooks, the total number of dusky shark mortalities reported is 81 (also see the Outliers section, below).

⁴ “Statistical significance” testing provides a way to measure the likelihood that a relationship between two or more variables is caused by something other than chance. This likelihood or probability is represented by a “p value” between 0 and 1. The lower the p value, the more confidence there is that the results are not random. For example, $p=0.1$ means a 1% chance of getting the results if the null hypothesis were true; $p = .76$ means 76%, and so on. Here, the p value is less than 0.01, so there is a very high degree of confidence that the relationship (the decrease in numbers over time) is not just random.

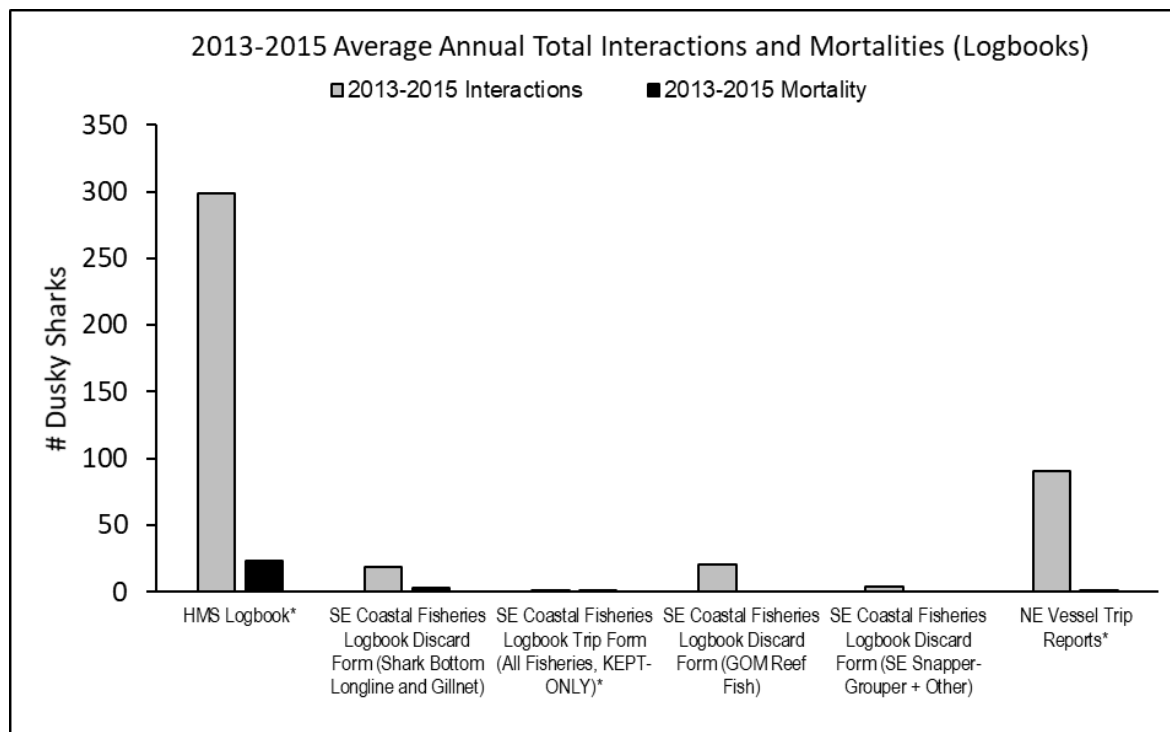


Figure 3. Reported average annual dusky shark interactions and mortalities by logbook program, 2013-2015.

As with Table 1, the numbers of mortalities in the columns of Table 2 are not directly comparable across logbooks and logbook forms because of the different reporting levels. Given this variability in reporting levels, analyses on a per trip basis, rather than on the annual numbers themselves, might be more indicative of the level of impact each fishery has on dusky shark mortality overall. For example, on average, the reported data indicates it takes 12 to 14 trips in HMS fisheries to kill one dusky shark, while it takes 2,030 to 28,689 trips in non-HMS fisheries to kill one dusky shark (Table 2; Figure 4). Thus, HMS fisheries by far have greater per trip mortality rates with dusky sharks than non-HMS fisheries according to logbook data (Figure 4).

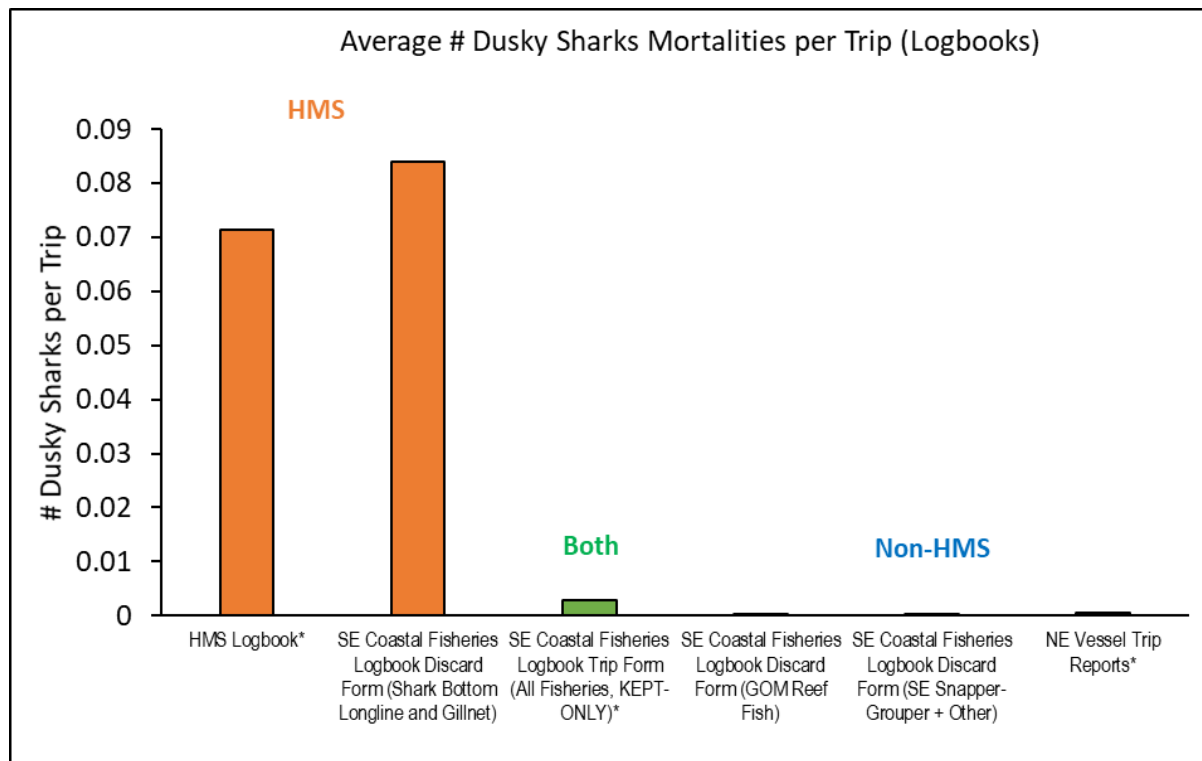


Figure 4. Average number of dusky shark mortalities per trip reported in each logbook program. Orange-shaded bars are HMS fisheries, blue-shaded bars are non-HMS fisheries, and green shaded bars include data from both HMS and non-HMS fisheries.

Overall, the number of dusky shark mortalities reported in all of the logbooks has declined since 2000 (Figures 1 and 2). Accepting the data at face value, this decline in mortalities is statistically significant ($p < 0.01$). During 2000-2004, the average number of reported annual mortalities from all logbooks was 788. Since 2008, the average mortalities per year declined to 90. In the most recent years (2013-2015), the reported annual average mortality declined further to 27 dusky sharks--a 97 percent decline in mortality from the early years. During those years, the average reported number of dusky shark mortalities per year ranged from a low of 0 (in two non-HMS fisheries) to a high of 23 (HMS Logbook) (Table 2).

This overall decline in the number of reported mortalities reflects the prohibition on retention of dusky sharks that began in 2000 and subsequent management measures, including the 2008 rebuilding plan. See, e.g., AR007636, AR007828, AR007943. Data also show that the post-prohibition decline in reported mortalities began in the HMS fisheries before the non-HMS fisheries. For example, on the NE Vessel Trip Report, almost 98 percent of all the mortality reported occurred before 2004. From 2000-2004 the number of dusky shark mortalities reported in the NE Vessel Trip Report database ranged from 45 to 311 per year, but from 2004 onward the reported mortalities have been near zero (Table 2; Figures 1 and 2). Similarly, almost 96 percent of the mortality reported on the SE Coastal Fisheries trip form occurred between 2000 and 2004. From 2000 to 2004, the SE Coastal Fisheries Logbook trip form reported numbers of dusky sharks kept ranged from 83 to 686 per year, but those numbers decreased from 2005 to 2015, with almost all years being zero since 2007. In contrast, in the HMS Logbook, 779 mortalities, or 44 percent of all reported mortalities, were reported in the year 2000. That

number dropped substantially in 2001, with reported mortalities from 2001-2004 ranging between 86 and 142 per year, a marked decrease from 779, albeit with some fluctuations within that time.

This data likely reflects that in HMS fisheries the understanding regarding the prohibition on the retention of dusky sharks and responsive action happened much faster than in the non-HMS fisheries. The comparatively delayed initial decline of reported mortalities in non-HMS fisheries could be expected, as it can take time for changes to occur throughout all fisheries, particularly by fishermen who do not usually fish for the species to which the management measure applies. Dusky shark mortalities first declined in non-HMS fisheries in 2003 in the NE Vessel Trip Reports and 2004 in the SE Coastal Logbook trip form. After those declines, Table 2 shows extremely low numbers of mortalities in non-HMS fisheries and the majority of dusky shark mortalities (whether in raw numbers or mortalities per trip) are reported in the HMS fisheries (Table 2; Figure 1). For these reasons and others described below, accountability measures are not necessary or appropriate in the non-HMS fisheries.

Additionally, almost all reports from non-HMS fisheries on the SE Coastal Fisheries Logbook discard form, including from the Gulf of Mexico reef fish and SE Atlantic snapper-grouper fisheries, were near zero for dusky shark mortalities in almost every year from 2001 through 2014 (average less than 1 dusky shark mortality per year; Table 2; Figure 2).

Outliers

For the data reported in the SE Coastal Fisheries Logbook discard form for the SE snapper-grouper plus other fisheries, NMFS used the years 2013-2014 to calculate the recent year averages for interactions and mortality, rather than 2013-2015. (See Tables 1 and 2, noting ** for 2015). The data for 2015 was an extreme outlier that came from one logbook form that NMFS determined: a) deviated markedly from other values in the logbook and observer data; b) upon investigation could not be valid given the reported circumstances in the logbook form; and c) would inappropriately skew the average if not excluded as an outlier. NMFS cannot release the details contained in the logbook form consistent with Magnuson-Stevens Act requirements regarding the confidentiality of data. Magnuson-Stevens Act, section 402(b), 16 U.S.C. 1881a(b). However, this logbook form reported anomalously high dusky shark interactions and mortalities compared to all other trips and years using similar gear types and fishing in a similar fashion. After reviewing the logbook form, NMFS concluded that the report cannot be valid given the gear used and the fishing effort reported on that trip, among other things. Additionally, the level of dusky shark interactions and mortalities reported on this trip was not reflected in any other non-HMS trips in recent years (Table 2). Furthermore, unusually high dusky shark interactions were not reflected in observer or other logbook reports from this fishery (see Section B below). Inclusion of this outlier data would inappropriately bias the average dusky shark interactions and mortalities in this fishery. Even if the data were included, it would not alter our overall conclusions described below because the average interactions and mortality would still be in the same “10s to 100s” range.

Conclusions of Commercial Logbook Consideration

After reviewing all the relevant logbook data, NMFS makes the following conclusions:

1. Across all logbook programs, reported dusky shark interactions and mortalities have declined substantially since 2000. Accepting this data at face value, this decline in reported interactions and mortalities is statistically significant.
2. Even considering the differences in reporting levels, NMFS can conclude that the vast majority of reported dusky shark interactions and mortalities occurred in HMS fisheries. Reported mortality is much lower in all non-HMS fisheries, and near zero in most years, particularly in recent years (2013-2015).
3. Interaction frequencies (dusky sharks encountered per trip) were highest in HMS fisheries compared to non-HMS fisheries.
4. The average annual reported numbers of dusky shark mortalities in all logbook programs, individually or combined, are in the 10s to low 100s of individuals per year.

B. OBSERVER DATA

Almost all federally-permitted commercial vessels are selected, at some point, by NMFS to carry a fisheries observer. A fisheries observer is a professionally trained scientist that observes fishing activity while on a fishing vessel with the fishermen. NMFS requires permitted vessels to carry observers to monitor commercial fisheries and collect data to support science and effective fishery conservation and management. In most cases, observers are not placed on every trip taken by all the vessels in a fishery. Instead, each observer program aims to place an observer on a certain percentage of the total number of trips taken within the relevant fisheries. To accomplish this, the observer program randomly selects vessels that reported fishing in the appropriate logbook (e.g., SE Coastal Fisheries or HMS logbook) for the relevant fishery the year before, and coordinates with the permit holder to place the observer on that vessel at some point(s) during the year. The exact percent of vessels and trips selected to carry an observer and the process for that selection differs between fisheries, based on the data needs and requirements for the different fisheries.

The specific data collected by observers also differs between fisheries. In general, observers not only record the fishing activity but also collect biological samples (e.g., fin clips and reproductive organs), determine whether the fish is dead or alive when it arrives at the vessel, take photographs of the fish, as appropriate, and collect different measurements of the fish. Observers also generally collect information regarding gear type, effort, catch attributes, gear performance, bycatch composition and mortality, protected species interactions, and biological samples. NMFS contracts with or certifies private companies that recruit, hire, and deploy independent observers to collect this data. All observers undergo extensive training in fish identification before being placed on a vessel.

Six mandatory federal observer programs exist that cover the commercial fisheries that might interact with dusky sharks in the U.S. Atlantic, including HMS and non-HMS fisheries. These include: the Northeast Fisheries Observer Program, the Southeast Bottom Longline Observer Program, the Southeast Gillnet Observer Program, the GOM Reef Fish Observer Program, the

GOM Shrimp Trawl Observer Program, and the Pelagic Observer Program. Appendix 1 contains detailed descriptions of the observer programs and the fisheries they cover.

NMFS gathered all of the relevant data about the dusky shark interactions observed from each of these programs and summarized the data in tables, shown below. NMFS then further analyzed and considered the data in the context of Amendment 5b and the Court's March 11, 2019 ruling, and addressed the specific questions posed by the Court in the Remand Order, as set out in Sections III and IV.

Summary of Observer Data

In this context, observer data generally is more reliable than logbook data in that there is higher confidence in the ability of trained observers to accurately identify dusky sharks when encountered. Additionally, the photographs and fin clips (for genetic testing) collected by observers can assist in ensuring accurate identification of species after the trip. For the HMS commercial fisheries, the Pelagic Observer Program in recent years (2013-2015) has placed an observer on approximately 10 percent of trips in the HMS pelagic longline fishery. NMFS mandates that observers be placed on 100 percent of the small number of vessels and trips in the bottom longline Shark Research Fishery. Outside the research fishery, observer placement rates on HMS shark bottom longline trips average 5 to 10 percent. These placement rates vary year-to-year, as do the locations, seasons, and characteristics of the trips selected for observer coverage.

NMFS summarized all available observer data from fisheries that could interact with dusky sharks in the U.S. Atlantic, including HMS and non-HMS fisheries, as reflected in Tables 3 and 4, and Figures 5 and 6. These numbers are reported by at-sea observers on a varying percentage of trips, based on the data needs/requirements of specific fisheries. The numbers were not extrapolated to reflect the total bycatch in each fishery for the reasons explained in Section IV. Table 3 includes all reported dusky shark interactions (released alive, kept, and discarded dead). Table 4 includes mortalities (kept and discarded dead) and excludes live releases.

Table 3. Total dusky shark interactions (including numbers RELEASED ALIVE, KEPT, or DISCARDED DEAD) recorded by at-sea observers in all available observer programs, 2000-2015. “N/A” indicates years prior to the implementation of the respective observer programs where data were not available. Note: Trip count information is not available for every observer program, so per-trip comparisons are not provided.

YEAR	HMS FISHERIES				NON-HMS FISHERIES				BOTH
	Pelagic Observer Program	SEFSC Shark Bottom Longline Observer Program (Research Fishery)	SEFSC Shark Bottom Longline Observer Program (non-Research Fishery)	SEFSC Gillnet Observer Program Targeting Sharks	SEFSC Shark Bottom Longline Observer Program (Non-HMS)	SEFSC Gillnet Observer Program (Non-HMS)	SEFSC Reef Fish Observer Program (Gears Combined)	SEFSC Gulf of Mexico Shrimp Trawl Observer Program	NEFSC Northeast Fisheries Observer Program
2000	110	N/A	19	0	N/A	0	N/A	N/A	25
2001	35	N/A	70	0	N/A	0	N/A	N/A	14
2002	8	N/A	51	0	N/A	0	N/A	N/A	10
2003	7	N/A	123	0	N/A	0	N/A	N/A	104
2004	64	N/A	38	0	N/A	0	N/A	N/A	10
2005	70	N/A	27	0	0	0	N/A	N/A	0
2006	84	N/A	26	21	0	0	0	N/A	3
2007	33	N/A	14	0	1	0	3	N/A	1
2008	34	21	0	3	0	0	0	N/A	1
2009	63	97	0	0	9	1	4	0	3
2010	31	192	0	0	6	1	4	0	3
2011	36	120	0	0	5	0	12	0	4
2012	25	252	9	1	0	0	1	0	3
2013	26	23	0	0	0	0	1	0	6
2014	29	248	0	0	0	0	3	0	7
2015	14	248	0	0	0	1	1	0	16
Total Interactions	669	1,201	377	25	21	3	29	0	210
Average # Interactions per Year	42	150	24	2	2	0	3	0	13
Average # Interactions 2013-2015	23	173	0	0	0	0	2	0	10

Table 4. Total dusky shark mortalities (including numbers KEPT or DISCARDED DEAD) recorded by observers in all available observer programs, 2000-2015. "N/A" indicates years prior to the implementation of the respective observer programs where data were not available. Note: Trip count information is not available for every observer program, so per-trip comparisons are not provided.

YEAR	HMS FISHERIES				NON-HMS FISHERIES			BOTH	
	Pelagic Observer Program	SEFSC Shark Bottom Longline Observer Program (Research Fishery)	SEFSC Shark Bottom Longline Observer Program (non-Research Fishery)	SEFSC Gillnet Observer Program Targeting Sharks	SEFSC Shark Bottom Longline Observer Program (Non-HMS)	SEFSC Gillnet Observer Program (Non-HMS)	SEFSC Reef Fish Observer Program (Gears Combined)	SEFSC Gulf of Mexico Shrimp Trawl Observer Program	NEFSC Northeast Fisheries Observer Program
2000	44	N/A	19	0	N/A	0	N/A	N/A	0
2001	8	N/A	66	0	N/A	0	N/A	N/A	2
2002	1	N/A	29	0	N/A	0	N/A	N/A	0
2003	2	N/A	96	0	N/A	0	N/A	N/A	11
2004	11	N/A	18	0	N/A	0	N/A	N/A	0
2005	13	N/A	13	0	0	0	N/A	N/A	0
2006	28	N/A	12	16	0	0	0	N/A	0
2007	18	N/A	11	0	0	0	0	N/A	0
2008	8	21	0	3	0	0	0	N/A	0
2009	25	54	0	0	0	0	0	0	0
2010	11	129	0	0	2	0	0	0	0
2011	9	59	0	0	0	0	0	0	0
2012	8	210	2	0	0	0	0	0	0
2013	5	7	0	0	0	0	0	0	0
2014	10	31	0	0	0	0	0	0	0
2015	7	23	0	0	0	0	0	0	0
Total Mortality	208	534	266	19	2	0	0	0	13
Average # Mortalities per Year	13	67	17	1	0	0	0	0	1
Average # Mortalities 2013-2015	7	20	0	0	0	0	0	0	0

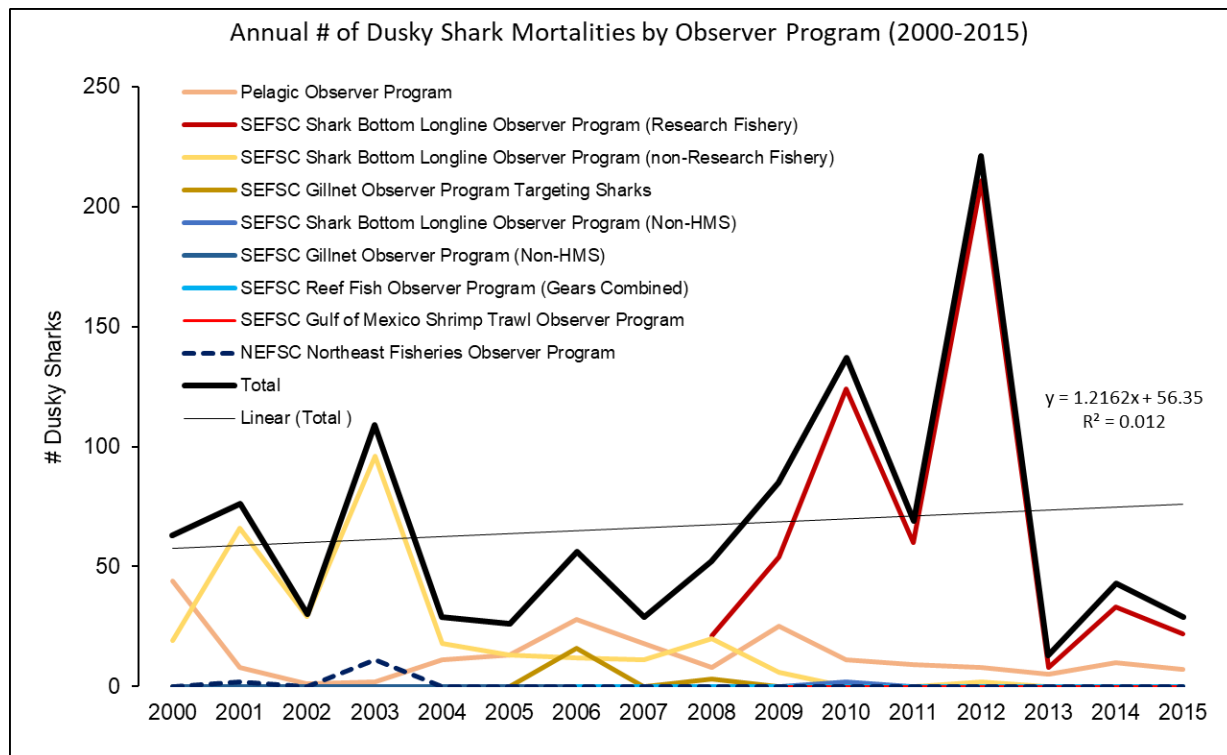


Figure 5. Annual number of dusky shark mortalities observed by observer programs, 2000 to 2015. NMFS attributes the majority of increases to the expansion of observer programs, particularly the SEFSC Shark Bottom Longline Observer Program for the Shark Research Fishery with 100 percent coverage which began in 2008 (dark red line).

Consideration of the Summarized Data

Interactions

The number of dusky shark interactions reported by observers has increased slightly since 2000, mainly due to expanded observer coverage (e.g., in the Shark Research Fishery) across multiple fisheries over time (Table 3). The numbers in Table 3 are not directly comparable across programs or between years in the same program due to changes in observer programs and coverage rates over time. Some observer programs were not in existence during the early years of this analysis, and those years are reported as Not Available (“N/A”).

Across all of the columns, interactions were highest in the Shark Research Fishery, particularly before 2013. Observed interactions and mortality for that fishery are higher than other programs because it has had 100 percent observer coverage since it was implemented in 2008. With implementation of the Shark Research Fishery observer coverage went from approximately 5 percent in the overall shark BLL fishery (Figure 5, yellow line, non-Shark Research Fishery) to 100 percent coverage in the Shark Research Fishery (Figure 5, dark red line), while remaining around 5 percent for the shark BLL fishery outside the Shark Research Fishery (which was no longer permitted to target sandbar sharks). The Shark Research Fishery was implemented in 2008 to ensure that critical fishery-dependent data for shark fisheries continued to be gathered after Amendment 2 significantly reduced certain commercial shark quotas. It is a small fishery of 5-10 vessels authorized annually to fish for sharks and gather critical data as specified in

consultation with shark fishery managers and scientists. Each vessel is allowed only one to two trips per month and is required to have an observer on every trip (i.e., 100 percent observer coverage). Regional caps on dusky shark mortality were adopted for the research fishery in 2013, and the numbers of observed interactions accordingly decreased from 2013 onward. (See discussion of Shark Research Fishery in Appendix 1.)

During 2000-2004, the average number of reported interactions across all observer programs operational in those years was 138. Since 2008, the average number of annual interactions was 215, an increase largely reflecting implementation of the Shark Research Fishery with 100 percent observer coverage. In the most recent years (2013-2015), the observed average number of interactions was 208 (Table 3; Figure 6).

The observer data show that dusky sharks are rarely encountered outside of HMS fisheries (Table 3; Figure 5-6). In all years in non-HMS fisheries, the average number of observed interactions per year ranges from 0 to 2 dusky sharks. In HMS fisheries, the average number of observed interactions per year ranges from 2 (in the shark gillnet fishery) to 150 (in the Shark Research Fishery). In the NE Fisheries Observer Program, which observes both HMS and non-HMS fisheries, the average number of dusky sharks observed from 2000 to 2015 is 13.

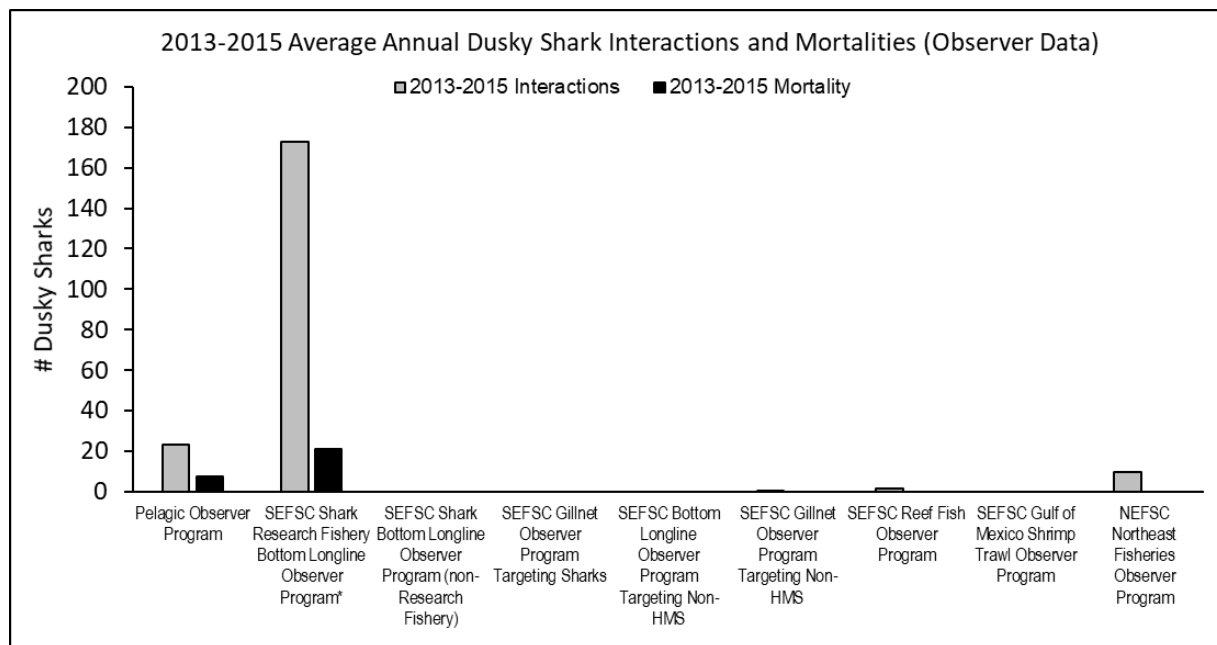


Figure 6. Average annual dusky shark interactions and mortality by observer program, 2013-2015.

Mortalities

The observer data also shows that from 2000 to 2015, the overall number of dusky shark mortalities observed has increased slightly due to expanded observer coverage (Table 4; Figure 5). Across all years, the total number of dusky shark mortalities reported is 1,042 sharks, or an average of 65 sharks per year. During 2000 to 2004, the average annual number of mortalities observed across all observer programs in operation at that time was 61. Since 2008, when the

Shark Research Fishery was implemented, the average number of mortalities per year was 85. In the most recent years (2013 to 2015), the reported annual average mortality was 28 dusky sharks—a 54 percent decline in observed mortality from the early time period, even with increased observer coverage (Figure 5-6).

According to observer data, almost all of the dusky shark mortalities from 2000 to 2015 are from the HMS fisheries (Table 4; Figure 6). Across all years (2000-2015), 1,027 out of 1,042 (99 percent) observed dusky shark mortalities were observed in HMS fisheries (Table 4). The Shark Research Fishery accounted for 534 (51 percent) of all the observed dusky shark mortalities for all 16 years, even though this fishery did not start until 2008. Starting in 2013, NMFS capped mortality on a regional basis in the Shark Research Fishery and implemented other specific requirements (e.g., limited number of hooks and sets per trip) to ensure reduced mortality in that very small fishery (AR007195; AR009252; AR009258). Since then, the number of dusky shark mortalities in the research fishery are substantially lower (from an average of 132 per year from 2010 to 2012 to an average of 21 from 2013 to 2015).

Most non-HMS observer programs reported zero dusky shark mortalities in the vast majority of years (Table 4; Figure 5). Observers reported zero dusky shark mortalities in all years in the following non-HMS fisheries: SE gillnet, reef fish longline, reef fish vertical line, reef fish handline, and Gulf of Mexico shrimp trawl. Only two dusky shark mortalities were observed in the SE non-HMS bottom longline fishery, including those on snapper-grouper trips. The NE Fisheries Observer Program reported 13 total dusky shark mortalities from 2000 to 2003, but 0 mortalities from 2004 onward.

Conclusions of Observer Data Consideration

After reviewing the observer data, NMFS makes the following conclusions:

1. Observer coverage across multiple fisheries has improved since 2000, improving the available information on dusky shark bycatch.
2. While the reported average annual numbers of dusky shark interactions has increased slightly over time, attributable to expanded observer coverage, the number of observed mortalities has declined in the most recent years.
3. The strict measures implemented to address dusky shark mortality in the shark research fishery in 2013 have since significantly reduced the mortality in that fishery.
4. Most observed interactions and mortality of dusky sharks occurred in the HMS pelagic longline and bottom longline fisheries. Observed mortality is near zero in most years in the non-HMS fisheries.
5. The number of dusky shark mortalities in all observer programs, individually or combined, is in the 10s to low 100s of individuals per year.

C. RECREATIONAL FISHERIES DATA

The programs collecting recreational data are more varied than the commercial logbook or observer programs. All anglers and charter/headboat fishermen who hold an HMS angling or HMS charter/headboat permit are required to report recreational activities through a variety of means, most often through surveys, as described in detail in Appendix 1. Permitted state and non-HMS federal recreational fishermen may also be asked to participate in such surveys. Some information collected via surveys is self-reported (e.g., the angler reporting the number of fish discarded) while some of the information is collected by the interviewer (e.g., the interviewer counting the number of fish landed at the dock). For many of these survey programs, but not all, NMFS partners with state agencies to collect the information, and NMFS then analyzes the data. The interviewers are all provided training on the purpose of the survey and fish identification for the species most likely to be encountered in their area before conducting interviews; the full extent of the training varies by state. Generally, the surveys collect information on the number of fishing trips the angler takes in a certain period of time, the number of fish caught, and the gear used.

There are four recreational surveys that collect information from anglers and charter/headboat fishermen who may interact with dusky sharks during their regular fishing activities. These surveys are: the Marine Recreational Information Program (MRIP), Large Pelagic Survey (LPS), Texas Parks and Wildlife Department (TPWD) recreational survey, and the Southeast Region Headboat Survey (SRHS). Appendix 1 contains detailed descriptions of the recreational survey programs.

NMFS gathered all of the relevant dusky shark data from each of these recreational survey databases and summarized the data in tables, shown below. NMFS then further analyzed and considered the data in the context of Amendment 5b and the Court's March 11, 2019 ruling, and addressed the specific questions posed by the Court in the Remand Order, as set out in Sections III and IV.

Summary of recreational fishery data

The survey databases included both raw intercept numbers collected by the survey interviewers and extrapolated estimates calculated by the relevant survey programs with a standardized process used for all recreational fisheries. For the analyses here, NMFS used and considered the extrapolated estimates already calculated by the survey programs rather than the raw intercept data because these estimates were previously used in Amendment 5b (AR007094) and considered in the stock assessments (AR000417). Table 5 provides the total number of estimated dusky shark interactions from all the recreational survey databases, while Table 6 provides the total number of estimated dusky shark mortalities in the recreational survey databases.

Table 5. Estimates of total dusky shark interactions (including numbers RELEASED ALIVE, KEPT, or DISCARDED DEAD) reported by all available recreational monitoring programs, 2000-2015.

YEAR	MRIP Estimates (Total Interactions)	Large Pelagic Survey Estimates (Total Interactions)	TPWD Estimates (# KEPT)	SRHS Estimates (# KEPT)
2000	58,039	n/a	35	200
2001	22,739	n/a	0	34
2002	4,967	257	0	85
2003	10,889	765	79	51
2004	7,433	1,571	54	36
2005	10,624	381	25	17
2006	5,805	2,241	114	22
2007	11,812	1,034	93	19
2008	19,115	1,411	0	67
2009	13,312	1,632	0	59
2010	7,398	1,015	72	19
2011	3,640	1,092	124	24
2012	4,567	810	0	24
2013	10,461	635	0	36
2014	7,654	451	0	3
2015	5,495	1,180	23	1
Total Interactions	203,952	14,475	619	697
Average # Interactions per Year	12,747	1,034	39	44
Average # Interactions 2013- 2015	7,870	755	8	13
Total # Trips	336,081,949	987,678	N/A	N/A
Average # Dusky Sharks Per Trip	0.00061	0.01466	N/A	N/A
Average # Trips to Catch 1 Dusky Shark	1,648	68	N/A	N/A

Table 6. Total dusky shark mortalities (including numbers KEPT or DISCARDED DEAD) reported or extrapolated estimates by all available recreational monitoring programs, 2000-2015.

YEAR	Large Pelagic			
	MRIP Estimates (#KEPT)	Survey Estimates (#KEPT)	TPWD Estimates (# KEPT)	SRHS Estimates (# KEPT)
2000	2,831	N/A	35	200
2001	8,143	N/A	0	34
2002	1,520	9	0	85
2003	3,926	40	79	51
2004	0	0	54	36
2005	6,155	0	25	17
2006	76	82	114	22
2007	0	42	93	19
2008	1,492	10	0	67
2009	487	0	0	59
2010	455	14	72	19
2011	0	0	124	24
2012	417	0	0	24
2013	0	0	0	36
2014	597	0	0	3
2015	0	0	23	1
Total Mortality	26,099	197	619	697
Average # Mortalities per Year	1,631	14	39	44
Average # Mortalities 2013-2015	199	0	8	13
Total # Trips	336,081,949	987,678	N/A	N/A
Average # Dusky Mortalities Per Trip	0.0001	0.0002	N/A	N/A
Average # Trips to 1 Dusky Shark Mortality	12877	5014	N/A	N/A
Average % Released Alive	87%	99%	N/A	N/A

Interactions

The MRIP database is the most comprehensive in terms of geographic coverage of recreational fishing trips. Extrapolated estimates for dusky sharks from MRIP data have “very low precision,” with margins of error ranging from plus or minus 68 to over 300 percent in most years, because dusky sharks are infrequently encountered and hard for fishermen to identify accurately, making the data inputs very uncertain. At face value, the MRIP data estimate that there was an average of 12,747 dusky shark interactions per year (range 3,640-58,039) in recreational fisheries (Table 5). However, 87 percent of dusky sharks were reported as released alive, with the remainder reported as kept (even though dusky sharks are prohibited from retention, so this was likely due to mistaken landings or misidentifications) (Table 6). Greater numbers were kept in earlier years (2000 to 2004 average = 3,284) than in recent years (2013-2015 average = 199). On average (from 2000 to 2015), the MRIP surveys estimate it takes 1,648 recreational fishing trips to interact with one dusky shark (Table 5).

The geographic coverage of the LPS program is not as wide as MRIP; however, the precision of LPS estimates is generally higher than MRIP estimates. In the MRIP surveys large pelagic species like sharks are considered “rare event” species that are only reported by a very small percent of interviewed anglers, thus leading to small sample sizes and very imprecise estimates of total catch. Conversely, the LPS targets known offshore fishing access sites, or samples anglers possessing HMS permits, rather than randomly sampling coastal households that may or may not target large pelagic species. As a result of this targeted sampling effort, these surveys obtain large sample sizes of trips landing large pelagic species and are able to generate far more precise extrapolated estimates of their total catch.

In contrast to the MRIP database, the LPS estimates an average of 1,034 dusky shark interactions per year (range 257 to 2,241) in the HMS recreational fishery (Table 5), with over 99 percent of those being released alive (Table 6).

Across the HMS recreational trips sampled by the LPS, it takes an average of 68 trips to interact with one dusky shark.⁵

Mortalities

Across all recreational survey databases for all 16 years, the total number of dusky shark mortalities in recreational fisheries (sum of MRIP extrapolated estimates, LPS extrapolated estimates, SRHS, and TPDW) is 27,612 sharks, an average of 1,726 per year. Of these, 17,053 (62 percent) were reported from 2000 to 2004, with an average of 3,409 per year. Since 2008, the average annual number of mortalities declined to 336. In more recent years (2013-2015), the average annual number of mortalities declined further to 220. Accepting the data at face value, this decline in recreational mortalities (Figure 7) is statistically significant ($p < 0.01$).

⁵ TPWD and SRHS do not provide interactions data and thus are not analyzed in this section.

Recreational mortality of dusky sharks in the MRIP database averaged 1,631 sharks per year (Table 6). On average (from 2000 to 2015), the MRIP surveys estimate it takes 12,877 recreational fishing trips to kill one dusky shark (Table 6).

According to the LPS, only 14 dusky shark mortalities occur per year on average, with zero mortalities reported in each of the most recent years dating back to 2011 (Table 6). Across the HMS recreational trips sampled by the LPS, it takes an average of 5,014 trips to kill one dusky shark.

The TPWD and SRHS have limited geographic coverage and only record shark numbers kept (mortalities). The SRHS shows an average of 44 dusky shark mortalities per year (range 1 to 200), with more dusky sharks kept in the early years of the range examined (2000 to 2004 average = 81) than in recent years (2013 to 2015 average = 13) (Table 6). The TPWD survey shows similar trends to the SRHS with an average of 39 dusky shark mortalities per year (range 0 to 124) (Table 6). Dusky shark mortalities reported in the TPWD peaked during 2005-2007 (77 mortalities per year on average) and again in 2010 - 2011 (98 mortalities per year on average), but have been low in recent years (2013 to 2015 average = 8) (Table 6).

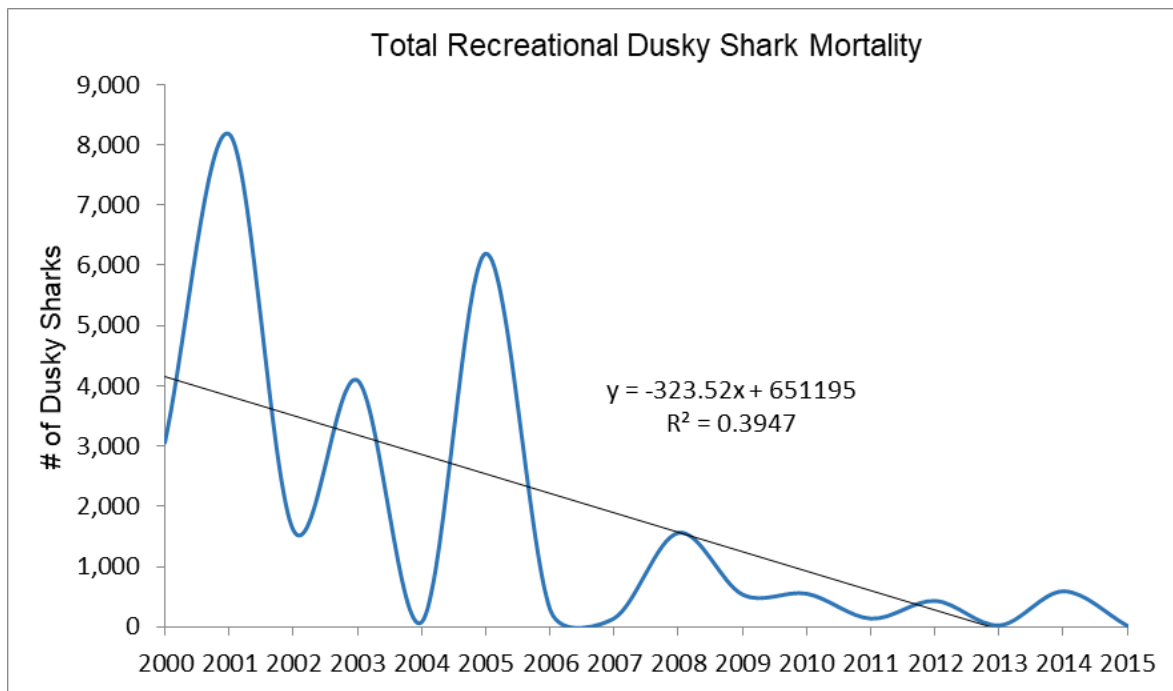


Figure 7. Total estimated annual recreational fishery mortality of dusky sharks, 2000-2015.

Conclusions of Recreational Data Examination

After reviewing all available recreational data, NMFS makes the following conclusions:

1. In the early years, there are substantial numbers of dusky shark interactions in recreational fisheries, although the available estimates are highly imprecise.
2. The frequency of dusky shark interactions and mortality has significantly declined over time in the recreational fisheries.

3. The vast majority (87 to 99 percent) of dusky shark interactions with recreational anglers and charter fishermen result in live releases. (Also see “Post-Release Mortality” section, below).
4. For recent years (2013-2015), mortality estimates of dusky sharks in recreational fisheries are in the 100s of individuals.

D. OTHER DATA SOURCES AND CONSIDERATIONS

In addition to logbook, observer, and recreational data, there are other data sets available that the agency examined for relevant dusky shark information. Collection of some of these data are mandatory (e.g., dealer reporting) while collection of other data are not. In this section, NMFS summarizes data from these other reporting programs including dealer programs and the HMS Exempted Fishing Permit (EFP) program. Appendix 1 contains detailed descriptions of these data collection programs and the kinds of data they collect. This section also discusses overarching issues that affect all data sources.

Dealer-reported dusky shark bycatch

Seafood dealer reports are an additional source of dusky shark mortality data, because dealers are required to report the amounts of sharks they purchase and sell from commercial fishing vessels (HMS and non-HMS vessels). As described in Appendix 1, combining reported landings across these reports would be inappropriate, because in some years the same landings of dusky sharks were reported to multiple state and federal programs, and it is not always possible to identify duplicate reports. These reports are also plagued by species misidentification problems, but they are another source of commercial fishery data that can help corroborate trends in other databases (e.g., logbook, observer). Before 2006, many shark dealers were not able to correctly identify sharks. However, since 2006, shark dealers or their proxies have been required to attend shark identification workshops every three years. These workshops have improved dealers’ proficiency in identifying sharks by instructing dealers on how to identify sharks to the species level, both as a whole shark and as a shark that is fully dressed. Additionally, these workshops include information about the fishery regulatory requirements and restrictions or prohibitions. The fact that reported landings of dusky sharks continued after the species became prohibited in 2000 indicates, as described in the Logbook discussion above, that it took a few years for awareness of the prohibition to reach all fisheries (particularly non-HMS fisheries). However, misidentification was also a problem, and many of these reported landings include other species.

A summary of dealer data on dusky shark landings is provided in Table 7. Reported landings of dusky sharks were highest in 2000, the year that the prohibition was first being implemented, but dropped substantially in subsequent years. From 2001 onward, the Pelagic Dealer Compliance system (PDC) and Electronic Dealer Reporting system (eDealer) data show an average of 2 dusky sharks kept per year, but the reported mortalities (i.e., sharks “kept”) have been zero every year since 2003 (Table 7). Similarly, excluding 2000, the Atlantic Coastal Cooperative Statistics Program (ACCSP) and Gulf Fisheries Information Network (GulfFIN) databases report an average of 47 kept dusky sharks per year, but those reports have also been zero in almost every

year since 2008. Excluding 2000, the NE Dealer database showed an average of 23 dusky shark mortalities per year, but has been 0-5 dusky sharks every year since 2008 (Table 7).

Table 7. Seafood dealer reports on the numbers of dusky shark landings, 2000-2015.

YEAR	PDC + eDealer (# KEPT)*	ACCSP + GulffIN (# KEPT)*	NE Dealer (# KEPT)*
2000	1,732	3,230	2,023
2001	3	19	13
2002	25	169	75
2003	6	335	244
2004	0	22	1
2005	0	19	5
2006	0	90	3
2007	0	43	7
2008	0	0	0
2009	0	0	2
2010	0	0	0
2011	0	0	0
2012	0	2	2
2013	0	0	0
2014	0	0	0
2015	0	0	0
Total	1,766	3,929	2,375
Average KEPT 2001-2015	2	47	23
Average KEPT 2013-2015	0	0	0

HMS Exempted Fishing Permit (EFP) Program (Scientific Research, not including the Shark Research Fishery)

The HMS EFP program authorizes certain scientific research activities throughout the U.S. Atlantic and Gulf of Mexico, including trips that target sharks--sometimes including dusky sharks (AR007194-96). A summary of dusky shark interactions and mortalities on EFP trips is provided in Table 8. Annual dusky shark interactions on EFP trips is highly variable, ranging from 0 (2000-2003) to 374 (2012). The interaction and mortality variability is dependent on the types of research being conducted, with some years reflecting studies operating in places or times that dusky sharks are frequently encountered. In some years, this included directed research on dusky sharks, or surveys in prime dusky shark habitat (e.g., 2009, 2012, and 2015). Annual mortalities from EFP trips ranged from 0 (2000-2003) to 103 (2015). NMFS has authorized these studies despite the potential for high dusky shark interactions because the data are needed to inform HMS management. For example, the NEFSC's bottom longline survey, which operated in 2009, 2012, and 2015, is a critical fishery-independent data source used in stock assessments for many shark species, including dusky sharks.

Table 8. Annual number of dusky shark interactions and mortalities reported in the HMS Exempted Fishing Permit (EFP) database, 2000-2015 (100 percent coverage of HMS EFP trips).

YEAR	Total Dusky Interactions	Total Dusky Mortality
2000	0	0
2001	0	0
2002	0	0
2003	0	0
2004	125	3
2005	60	9
2006	64	1
2007	57	9
2008	13	0
2009	311	96
2010	52	6
2011	46	18
2012	374	41
2013	7	1
2014	17	1
2015	103	103
Total	1229	288
Average per year	77	18
Average 2013-2015	42	35

Post-release mortality

Substantial numbers of dusky sharks are released alive, as reflected by the difference between overall interactions and mortalities in the logbook, observer, and recreational data. A number of these sharks die after they are released. Post-release mortality rates vary depending on the gear type, how long the shark is on the fishing gear (a number of studies have shown that sharks on the gear longer are more likely to die), the way the shark is handled upon capture (sharks kept in the water and released quickly are more likely to survive), and other conditions (such as water temperature). The mortality tables, which reflect the reported numbers of sharks kept and discarded dead do not reflect the mortality of fish that are released alive but later die. This means that actual mortality is some fraction higher than the reported mortality numbers, but less than the total interactions.

The 2011 stock assessment assumed certain post-mortality rates,⁶ which vary considerably based on gear type (Table 9) (AR000107-110; AR009032). In situations where the data *inputs* are reliable and valid, post-release mortality rates can, in certain circumstances, be applied to live release data to validly estimate the amount of post-release mortality. Here, however, given the

⁶ As discussed in Amendment 5b, however, the stock assessment scientists determined that the available catch data inputs were not reliable enough to use to produce scientifically valid results, and thus ultimately did not use any outputs from applying these post-release mortality assumptions (AR000416-417; AR008074).

uncertainty of the reported dusky shark data, such an approach would not yield scientifically valid results, for the same reasons that extrapolation does not work in this situation (see Section IV, below).

Of course, if one were to ignore the caveats about the data input reliability and the scientific misgivings about leveraging such data to draw conclusions for management purposes, one could physically calculate such estimates. For example, using the recreational estimates from the most recent years of data (2013-2015) and applying the stock assessment post-release mortality rate assumptions, the average annual number of dusky shark post-release mortalities in the recreational fisheries would be 726. This is calculated by first adding all of the estimated average interactions across all the recreational surveys from recent years (2013-2015), which totals 8,646 (Table 5). To obtain the total average live releases under this scenario, one would subtract the estimated mortalities in Table 6 (8,646-199-0-8-13), for a total of 8,426 average annual live releases (2013-2015). For recreational fisheries, the 2011 stock assessment assumed a post-release mortality rate of 6 percent, so $8,426 \times 0.06 = 506$ average post-release mortality in the recreational fisheries. Estimated post-release mortalities (506) + estimated mortalities from Table 6 (220) = 726. Thus, even looking at these extrapolations and estimates of post-release mortality, the result is consistent with the conclusion that dusky shark mortality is in the 100s per year. This example is offered only to show that if one were to insist that the estimates be generated using this methodology, the resulting numbers are small, even using an example with a high number of interactions. As emphasized and explained repeatedly in this document, however, the results could be highly flawed and inaccurate, and it would be irresponsible to rely on these estimates in any precise way for management purposes (also refer to Appendix 3).

Table 9. Dusky shark assumed post-release mortality rates by gear type (SEDAR 21 stock assessment; Marshall et al. 2015).

Gear	Post-Release Mortality Rate (%)
Pelagic Longline	44.2
Bottom Longline	29-65
Gillnet	50
Recreational	6

As discussed in Section III, below, the accountability measures adopted in Amendment 5b explicitly focused on addressing post-release mortality (AR007114-007136). Requirements to use circle hooks, minimize trailing gear, and educate fishermen on safe handling and release of sharks were all specifically aimed at reducing dusky shark post-release mortality rates. These measures reduce post-release mortality regardless of the true numbers of dusky sharks that are encountered. Thus, the mortality rates listed in Table 9, which were estimated prior to Amendment 5b, should be made smaller as a result of the measures implemented in Amendment 5b (AR007245-7341).

Conclusions on Other Data Sources

After reviewing all available other data sources, NMFS makes the following conclusions:

1. The dealer data indicate that dusky shark landings in commercial fisheries have been near zero since 2008, which is consistent with what is reported in the commercial logbooks. Improvements in species identification and quality control of dealer data submissions have increased confidence in the shark species reported in dealer data over time.
2. The EFP program for HMS fisheries interacts with 10s to 100s of dusky sharks each year depending on the research activities approved. Research on dusky sharks and other highly migratory species is critical for stock assessments and effective fisheries management.
3. Scientifically valid estimates of the amounts of post-release mortality cannot be generated. However, accounting for post-release mortality would increase the amount of dusky shark mortalities from those reported in logbook, observer, and recreational programs, by converting some portion of live releases into dead discards, depending on numerous variables. Certain accountability measures in Amendment 5b addressed this source of mortality even though there was no scientifically valid way to quantify the amount of dusky sharks.

E. DATA UNDERLYING THE NATIONAL BYCATCH REPORTS

The Remand Order directed NMFS to “consider all relevant data related to dusky shark bycatch in the HMS and non-HMS fisheries, as it existed at the time of the agency decision, including logbook data *and the data underlying the National Bycatch Reports.*” (emphasis added). NMFS considered all of the relevant logbook data, above. All of the data that the National Bycatch Reports might have drawn from as of 2015—including logbook, observer, and other sources—have been presented and considered within this document. Summaries of the logbook and observer data covering the HMS and non-HMS fisheries used in the National Bycatch Reports and subsequent Updates are shown in Tables 1, 2, 3, and 4 above. Consideration of those data is also presented above.

Regarding the extrapolations in the National Bycatch Reports, NMFS continues to reject these extrapolations for management purposes, as they are deeply flawed and inconsistent with the stock assessment, which represents the best scientific information available (AR007095-96). The Court in its March 11, 2019 ruling and the subsequent Remand Order directed NMFS to consider the data underlying the reports, not the extrapolations included in the National Bycatch Reports. The Court emphasized that the relevant question is whether full consideration of the logbook data underlying the National Bycatch Reports would change the Agency’s determinations in Amendment 5b. In this document, NMFS fully considers all such data, including the logbook data.

Even if NMFS were to accept the National Bycatch Reports’ extrapolations at face value (see Table 1.6, AR007095), however, NMFS notes that its conclusions regarding the magnitude of bycatch and the measures needed to end overfishing would remain the same. Across a five year

period (2006-2010) in five fisheries (the Gulf of Mexico reef fish BLL, Gulf of Mexico reef fish vertical line fishery, South Atlantic pelagic troll, South Atlantic snapper grouper BLL, and South Atlantic snapper grouper BLL), across a massive spatial scale (from North Carolina to Texas) the total extrapolation was 3,872 dusky sharks. This averages to 774 sharks per year across the entire South Atlantic for those years. Averaging 2011-2013, the extrapolated total is 727 sharks per year. For the reasons further discussed in Section IV below, any extrapolations remain scientifically invalid and not acceptable for management purposes; however, these annual estimates remain small.

F. OVERALL CONCLUSIONS REGARDING THE RELEVANT DATA

- Reported dusky shark interactions and mortalities have declined significantly since the species was prohibited in 2000.
- Across all years, the commercial fisheries data show that average annual interactions have been in the 100s to low 1000s, with average annual mortalities in the 10s to 100s of dusky sharks.
- For the recreational fishery, the survey-extrapolated estimates of average annual dusky shark interactions are in the 1000s to low 10,000s, but again, the vast majority of these interactions result in live releases, and the post-release mortality rate in the recreational fishery is low. Estimated average annual recreational mortalities are in the 100s to low 1000s.
- The available data show that the numbers and per-trip rates of dusky shark interactions and mortalities are much higher in HMS fisheries than in non-HMS fisheries.
- For the most recent years, commercial mortalities are in the 10s of dusky sharks and recreational mortalities are in the 100s of dusky sharks.

The next section provides detailed analyses and conclusions regarding NMFS' consideration of all of the relevant data.

III. CONSIDERING ALL OF THE RELEVANT DATA, DOES THE AGENCY CONTINUE TO CONCLUDE THAT ADDITIONAL ACCOUNTABILITY MEASURES ARE NOT REQUIRED BECAUSE ONLY SMALL AMOUNT OF CATCH (INCLUDING BYCATCH) OCCURS, AND THE CATCH IS UNLIKELY TO RESULT IN OVERFISHING?

NMFS has considered all of the relevant data summarized in Section II above and continues to conclude that additional accountability measures beyond those adopted in Amendment 5b are not required because only a small amount of catch (including bycatch) occurs, and the catch is unlikely to result in overfishing.

A. Only a small amount of catch (including bycatch) occurs

Using the commercial and recreational fishing data discussed in Section II, the average annual number of dusky shark interactions and mortalities for all fisheries combined is shown in Table 10.

Table 10. Summary of total average annual dusky shark interactions and mortalities from early years (2000-2004), 2008-2015, and recent years (2013-2015). Data sources denoted with * are those that include 100 percent coverage or are already extrapolated estimates.

Data Source	2000-2004		2008-2015		2013-2015	
	Average Annual Interactions	Average Annual Mortality	Average Annual Interactions	Average Annual Mortality	Average Annual Interactions	Average Annual Mortality
All Logbooks	1,382	788	645	84	430	27
All Observer	138	61	196	78	208	28
All Dealer*	N/A	1,579	N/A	1	N/A	0
All Recreational*	21,447	3,409	10,040	490	8,646	220
All EFP*	25	1	115	33	42	35

As explained in Section IV below, it is not possible to calculate a scientifically valid estimate of the amount of dusky shark bycatch (also refer to Appendix 3). Data in Table 10 are presented as reported and are not further extrapolated (as explained in Section IV regarding extrapolation generally, below). There is some duplication in this data, as logbook data, observer data, and dealer data are from the same commercial fisheries, and data from the same trip can appear in all three programs (e.g., a vessel carrying an observer also must report its catch to a logbook program, and a dealer will report the amounts purchased from that trip, so the same data could appear in all three places). There are also differences in reporting requirements and the percentage of vessels or permit holders reporting. Thus, the data from each column are not directly comparable or additive, and each row should be considered independently.

As discussed throughout this document and in Amendment 5b, dusky shark management measures have changed significantly from 2000-2015, and the data show that these measures have resulted in statistically significant decreases in dusky shark interactions and mortality. Given these changes, the most relevant data in assessing the magnitude of catch is from the recent period (2013-2015) as it reflects interactions and mortalities occurring with the entire pre-Amendment 5b suite of management measures in place (See Table 10, two columns on the far right). In the commercial fisheries, between 2013 and 2015, the data show that dusky shark mortalities were in the 10s of sharks per year, with interactions in the 100s. For the recreational fisheries, the data reflect that these fisheries may interact with thousands of dusky sharks per year. However, 87-99 percent of those interactions are released alive (Tables 5 and 6), resulting in mortalities in the 100s of dusky sharks in recreational fisheries. Across all the fisheries, the magnitude of mortality would remain the same (100s of dusky sharks) even if NMFS were to assume that post-release mortality rates could be factored in reliably (6-65 percent depending on the gear type; Table 9).

Furthermore, looking at dusky sharks specifically, the average annual number of mortalities in recent years is small, especially when considering the average annual number of mortalities in the early years. For example, in the logbook data, the annual average number of reported dead dusky sharks in the early years is 788 while in recent years it is 27. While the drop was not as large looking at observer data (61 to 28), considering the increase in observer coverage across all fisheries (starting with partial coverage in 5 fisheries and ending in partial coverage in 8 fisheries and full coverage in the fishery the targets sharks), the drop in number of mortalities is considered to be quite large. The drop in the number of dead dusky sharks in recreational fisheries is even larger than the drop in the commercial logbook (3,409 to 220). NMFS also considers the current level of bycatch to be small considering the high number of trips involved (tens of thousands) compared to the number of mortalities, as reflected by the low per-trip levels in most fisheries.

The National Standard 1 Guidelines at 50 C.F.R. § 600.310(g)(3) do not define what a “small” amount of catch is, leaving this as a fact-specific determination. After reviewing all of the relevant data in Section II, NMFS continues to consider the overall level of dusky shark catch (including bycatch) to be small. Prohibited sharks, including dusky sharks, have observed mortality amounts in the 10s and 100s of individuals, compared to many fish stocks that have observed mortality amounts estimated in the hundreds and thousands of metric tons. Moreover, prohibited shark species collectively represent a limited portion of total shark bycatch across all fisheries. After a thorough consideration of all the available data in Section II of this document, NMFS concludes that the analyses in Amendment 5b remain valid regarding the magnitude of catch (AR007089-94) and that only a small amount of catch (including bycatch) occurs.

B. The level of catch, including bycatch, is not likely to result in overfishing.

Under the National Standard 1 Guidelines, an ACL may be set at zero with no additional accountability measures, if there is a fishery closure that prohibits fishing for a stock, there are only small amounts of catch (including bycatch), and catch is unlikely to result in overfishing. 50 C.F.R. § 600.310(g)(3) (emphasis added). Above, NMFS explains why it believes catch of dusky sharks to be small. However, the key question is whether overfishing is being prevented,

as required under the Magnuson-Stevens Act. *See* 16 U.S.C. §§ 1853(a)(15) (requiring ACLs and accountability measures to prevent overfishing), 1851(a)(1) (requiring preventing overfishing). Amendment 5b implemented additional accountability measures in the HMS commercial and recreational fisheries because the stock assessment found that a low level of overfishing was occurring (median F_{2015}/F_{MSY} is 1.18) (AR007100-007108). Only a small reduction (12%) in fishing mortality was needed to end overfishing (AR007101). Amendment 5b was implemented to reduce mortality on dusky sharks and end overfishing and continue to rebuild the stock consistent with the findings of the stock assessment.

In developing effective measures to achieve the needed mortality reductions, NMFS focused on accountability measures that would reduce mortality in HMS commercial and recreational fisheries. Review of all available data (see Section II) clearly shows that dusky shark interactions and mortalities in non-HMS commercial fisheries (including SE snapper-grouper and reef fish fisheries) are near zero in recent years, and therefore have negligible ongoing impacts on the stock. The accountability measures implemented in Amendment 5b focus appropriately on the HMS fisheries to achieve the needed mortality reductions to end overfishing and to rebuild the stock. These accountability measures (AR007114-007136) not only further reduce the amount of dusky shark bycatch, but also reduce the mortality rate of any dusky sharks that continue to be occasionally encountered such that bycatch is unlikely to lead to further overfishing. The purpose of ACLs and accountability measures to ensure that overfishing does not occur. 16 U.S.C. § 1853(a)(15), and the accountability measures are designed to accomplish that. The analyses in Amendment 5b stand after considering the additional data in this document.

C. Additional accountability measures are not required.

Additional accountability measures beyond those implemented in Amendment 5b are not required. The accountability measures established in Amendment 5b appropriately focus management actions in the HMS fisheries to achieve the needed mortality reductions (AR007114-007136). In Amendment 5b, NMFS considered how each management measure implemented would reduce dusky shark mortality (AR007245-007341). NMFS determined that the reductions achieved would be greater than the reduction needed to end overfishing consistent with the stock assessment (12 percent). Additionally, NMFS determined that the measures adopted in Amendment 5b, in conjunction with the continuation of the ongoing rebuilding plan measures adopted in 2008, would reduce dusky shark mortality by at least 35 percent overall to rebuild the stock by 2107.

As described in Section II, the logbook data support NMFS' determination in Amendment 5b that HMS fisheries interact with and result in more dusky shark mortality compared to non-HMS fisheries. Specifically, these data indicate that it takes between 12 and 14 HMS trips to kill one dusky shark while it takes 2,030 to 28,689 non-HMS trips to kill one dusky shark (Table 2). Similarly, the observer data supports NMFS' determination that HMS fisheries interact with and kill more dusky sharks compared to non-HMS fisheries. On average, according to the observer data, HMS fisheries had between 1 and 67 dusky shark mortalities per year while non-HMS fisheries had on average zero mortalities each year (Table 4). Therefore, neither the logbook nor observer data suggest that non-HMS fisheries are a substantial source of dusky shark mortality

that would necessitate additional accountability measures. It would not make sense to implement accountability measures in non-HMS fisheries, where annual interaction rates and mortality are near zero. Measures in non-HMS fisheries would not effectively contribute to needed dusky shark mortality reductions.

Regarding the recreational fisheries, the accountability measures in Amendment 5b directly address dusky shark bycatch in the recreational fishery (AR007245-55). The selected recreational measures reduce mortality by requiring the use of circle hooks in recreational shark fisheries, training HMS anglers how to safely handle and quickly release sharks to reduce post-release mortality rates, and training them on prohibited shark identification to reduce mortality associated with mistaken landings (AR007245-55).

Based upon the complete record and this analysis, NMFS reaffirms its conclusion that the measures in Amendment 5b are justified and that no additional accountability measures are needed. Nothing in the additional data presented and considered within this document suggests that large sources of dusky shark mortality were overlooked in the prior analyses described in Amendment 5b, nor that the accountability measures adopted in Amendment 5b were insufficient to address the low level of overfishing and recommendations in the dusky shark stock assessment.

IV. IS THERE A SCIENTIFICALLY VALID BASIS FOR USING THE LOGBOOK DATA IN CONJUNCTION WITH THE OBSERVER DATA AND OTHER SOURCES, INCLUDING BY EXTRAPOLATION, TO ESTIMATE THE AMOUNT OF DUSKY SHARK BYCATCH OCCURRING IN THE HMS AND NON-HMS FISHERIES?

Consistent with the Remand Order, NMFS considered whether there is a scientifically valid basis for using the logbook data in conjunction with the observer data and other sources, including by extrapolation, to estimate the amount of dusky shark bycatch occurring in the HMS and non-HMS fisheries. NMFS concludes there is not.

Many shark species are considered to be “data poor” in the sense that one or more of the main sources of data that are traditionally used in stock assessments (total catches, indices of abundance, and life history) are lacking or unreliable. The assessment of dusky sharks has been historically problematic because of misidentification and mis-reporting of total catches, issues which have been identified in all stock assessments conducted thus far (AR000001; AR004757; AR008047). Owing to the unreliability of the catch data that are available, the stock assessment scientists have determined several times that the use of a “catch-free” stock assessment model is appropriate for dusky sharks. As previously explained, the stock assessment acknowledged--and NMFS continues to acknowledge--that catch data exists for dusky sharks, all of which is

summarized in this document. Use of a “catch-free” model does not mean that no catch data exists; it indicates that the catch statistics that are available are unreliable and not useful for assessment purposes (e.g., AR008074; Porch et al. 2006). For dusky sharks, stock assessment experts have repeatedly rejected the use of the available catch data for the reasons detailed below.

All of the available dusky shark data that NMFS could use to estimate the amounts of dusky shark bycatch are included in this document. However, every source of data is subject to a variety of serious caveats that limit its utility in producing scientifically valid bycatch estimates for dusky sharks. The data considered herein were previously reviewed and considered in preparation for multiple dusky shark stock assessments and were repeatedly determined by NMFS scientists to be inaccurate and so uncertain as to be rendered useless for purposes of estimating absolute overall catch or population levels (AR000107; AR000416; AR004387). Thus, as discussed below, NMFS reaffirms its determination that, at this time, there is no scientifically valid basis for producing an estimate of the amount of dusky shark bycatch occurring within or across fisheries due to the numerous caveats detailed below (also refer to Appendix 3).

A. What is a Catch Extrapolation?

NMFS regularly conducts extrapolations for numerous purposes in fisheries science and management and is very familiar with various extrapolation methods using catch data. The agency is not averse to conducting such extrapolations, even in data limited circumstances. However, there must be some minimum level of confidence in the underlying data for any extrapolations to hold validity. This is not the case with dusky sharks (AR008074).

Extrapolation, by definition, involves inferring something unknown from something that is known. In its simplest terms, a “catch extrapolation” means using the known sampled catch data to estimate what the unknown total catch data could look like. A basic assumption of any extrapolation is that 1) the characteristics of the known data match the characteristics of the unknown data and 2) the proportion of all the catch sampled is known. Because the match between “known” and “unknown” data is not going to be perfect, any extrapolation will have some level of uncertainty associated with it.

To reduce such uncertainty to the extent practicable, a variety of statistical methods may be used when conducting extrapolations. NMFS uses these methods by, for example, estimating catches by smaller areas, by gear types, or by fishing season (known as “strata”) in order to help ensure that the known data being extrapolated are more likely to match the unknown data. None of those techniques can be effectively used for any of the data sources here because the gaps (number of zeros) in the data are large and the species are caught infrequently and in greatly varying conditions and circumstances. For example, estimating catches by smaller geographic area does not work to reduce the uncertainty about the unknown data in relation to the known data because the geographic range of the dusky shark bycatch is extremely broad, and the conditions vary across those areas. Dusky sharks can be caught in federal waters from Massachusetts through Texas. Commercial fishermen who use the NE Vessel Trip Report logbooks catch dusky sharks using different gears and techniques (e.g., trawl and gillnet gear)

compared to commercial fishermen in the Gulf of Mexico who use the SE Coastal Fisheries Logbook (e.g., handline). Applying dusky shark catch rates from mid-Atlantic fishermen to extrapolate dusky shark catch for Gulf of Mexico fishermen would not produce reliable or scientifically valid catches estimates, because the conditions are vastly different. In other words, if the characteristics of the portion of the catch sampled do not match the characteristics of all the catch data, or if the proportion of all catch sampled is unknown, then total catch cannot be estimated through extrapolation.⁷

Furthermore, where catches greater than zero are rare, as with dusky sharks (see Tables 1 through 4), the very limited non-zero data makes it impossible to test whether the sampled catch data matches the characteristics of all the catch data or what proportion of overall catch the sampled data represents. Because the data in numerous years is zero (see Tables 2 and 4) there is not a sample random and large enough to be statistically representative. Even if it were appropriate to extrapolate total catch, the number of zeros in the sampled catch would cause the extrapolation to result in a very low total catch (see below). In addition, the number of zeros would mean there would be few matches between strata, which could mean the models NMFS uses to calculate extrapolations would not work or would produce extremely uncertain estimates. These problems are magnified when considering the difficulties in determining total effort by fishery and some of the other caveats explained below.

B. Caveats to Consider Regarding the Logbook Data

Logbooks have a variety of uses in fisheries management and are often one of the best sources of fishery-dependent data. For dusky sharks, logbook-reported catches may be informative for assessing, in general terms, which fisheries have the largest dusky shark interaction rates and the geographic area of the interactions, the trends of those interactions between years, and, depending on the logbook, information about the final disposition of catches (i.e., percentages of animals kept, released alive, and discarded dead). But the logbook-reported data are not an acceptable basis for quantifying the total amounts of dusky shark catches in any particular fishery, or across fisheries, for three main reasons, as further discussed below:

1. Species misidentification.
2. Under- and over-reporting.
3. Different and incomplete logbook information across fisheries.

⁷ Again, while bad extrapolations physically *can* be generated, this does not mean that they *should* be used in a management context. NMFS itself has on occasion generated bad extrapolations, usually in response to some request from outside the fisheries management or stock assessment process. For example, the National Bycatch Report dusky shark extrapolations were generated at the request of the National Bycatch Report preparers and with the understanding that they were not provided for fishery management purposes. AR008226. This practice should not be relied upon for management nor should the results be considered “best available science” for management purposes, especially when the agency expert scientists and fishery managers have concluded that such extrapolations have no scientific value given the uncertainty of the data inputs. See Appendix 3.

Species misidentification

Dusky sharks, especially smaller individuals, are very difficult to distinguish from other shark species that are found in the same areas of the ocean, including sandbar sharks and silky sharks (AR004387). Accurate species identification among these similar-looking species is challenging for trained experts (including observers) and even more challenging for fishermen, especially those who have not been trained in species identification (AR004387). Thus, the reported numbers presented in this document come with significant caveats.

Dusky sharks are very similar in appearance to silky, sandbar, and other shark species of the genus *Carcharhinus* (Figure 8). Dusky sharks and these other species have similar size, coloration, snout shape, and fin sizes, and an interdorsal ridge. Training is required to identify the external characteristics of dusky sharks that differentiate them from other sharks (Figure 8). These other species also overlap in range with dusky sharks along the U.S. Atlantic coast, making it possible to encounter multiple species on a single trip.

There are several factors that have led to species misidentification by fishermen, especially prior to 2006, which was before many species-specific management measures were implemented. First, many of the commercial fishermen reporting in these logbooks, such as the pelagic longline fishermen or fishermen in non-HMS fisheries, are not fishing for sharks, but for other species, such as tunas and swordfish. Therefore, while any sharks caught could be seen as a potential source of additional profit, they are also seen as a nuisance because they could eat the target species, or the extra profit is not considered worth the processing and handling cost and hassle (because of the chemicals naturally found in their blood, shark meat can contaminate other fish meat and must be kept in separate containers). If they decided to land a shark, these fishermen generally rely on the dealer purchasing the shark to correctly identify it. If they decided it was not worth the time and effort to land the shark, they may have just cut the shark free without attempting to correctly identify it.

Second, crew members on fishing vessels often change and move between fisheries. These crew members are the ones hauling the gear and dressing any fish. If they are not expecting to work on a vessel that harvests sharks, they may decide not to learn the correct identification or interact with sharks on a regular basis. Lastly, while some shark fishermen clearly know how to identify sharks, many do not, mainly because until NMFS began implementing more species-specific regulations (AR007076; AR007138) there were few incentives for them to learn correct shark identification. They would learn enough to know which characteristics (e.g., large fins) brought in the most profit, but may have relied on the dealer to identify the species. Therefore, historically, fishermen-reported catches of these shark species (dusky, silky, and sandbar sharks particularly) are known to be inaccurate and must be considered with caution (AR004387). This inability of many fishermen to correctly identify sharks is the primary reason that Amendment 5b implemented improved species identification training among its measures (AR007114-7132). With these and other management measures going forward, self-reported data should become a more credible source over time.

As a result of misidentification, an unknown fraction of catches reported as dusky sharks are, in fact, other species. Likewise, an unknown fraction of catches reported as sandbar, silky, or other

sharks, are likely dusky sharks. Exacerbating this issue are catches before 2006 that were reported as “unidentified shark,” “shark,” “large coastal shark,” or “brown shark,” some unknown fraction of which are dusky sharks. The unknown and unquantifiable magnitude of the species misidentification problem for dusky sharks is the primary reason that the 2006, 2011, and 2016 SEDAR stock assessments, after considering all of the available catch data, decided that the logbook and other sources of total commercial and recreational catch data could not be used in the final assessment models:

“In fisheries where there is a high degree of uncertainty in reported catches, or catches are not reported at all, stock assessment models that rely on catch data may not be appropriate. For numerous shark species there is uncertainty about the magnitude of commercial and recreational catches, in part due to identification problems. The level of reported discards is especially uncertain and may be underestimated because sharks are often not brought aboard for positive identification and may therefore go unreported. **Without accurate knowledge of the magnitude of total catches and discards, it is not possible to estimate absolute abundance levels for the population...**In the present application, dusky shark landings are first available in the early 1980s at very low levels. Commercial landings during this time period are 2 to 3 orders of magnitude lower than those from the recreational fishery. **It is not believed that this is a real trend in landings, but rather reflects underreporting and lack of species identification...**With such high uncertainty in the series of reported catch and discard, the catch-free methodology was selected as an appropriate application (Cortes et al. 2006; AR008074, emphasis added).”

These findings are echoed in the subsequent dusky shark stock assessments (AR000113; AR000416; AR004387). The prohibition of dusky sharks in 2000 further exacerbated the issue because accurate reporting of sharks discarded is even more challenging than reporting of sharks landed (AR000113).

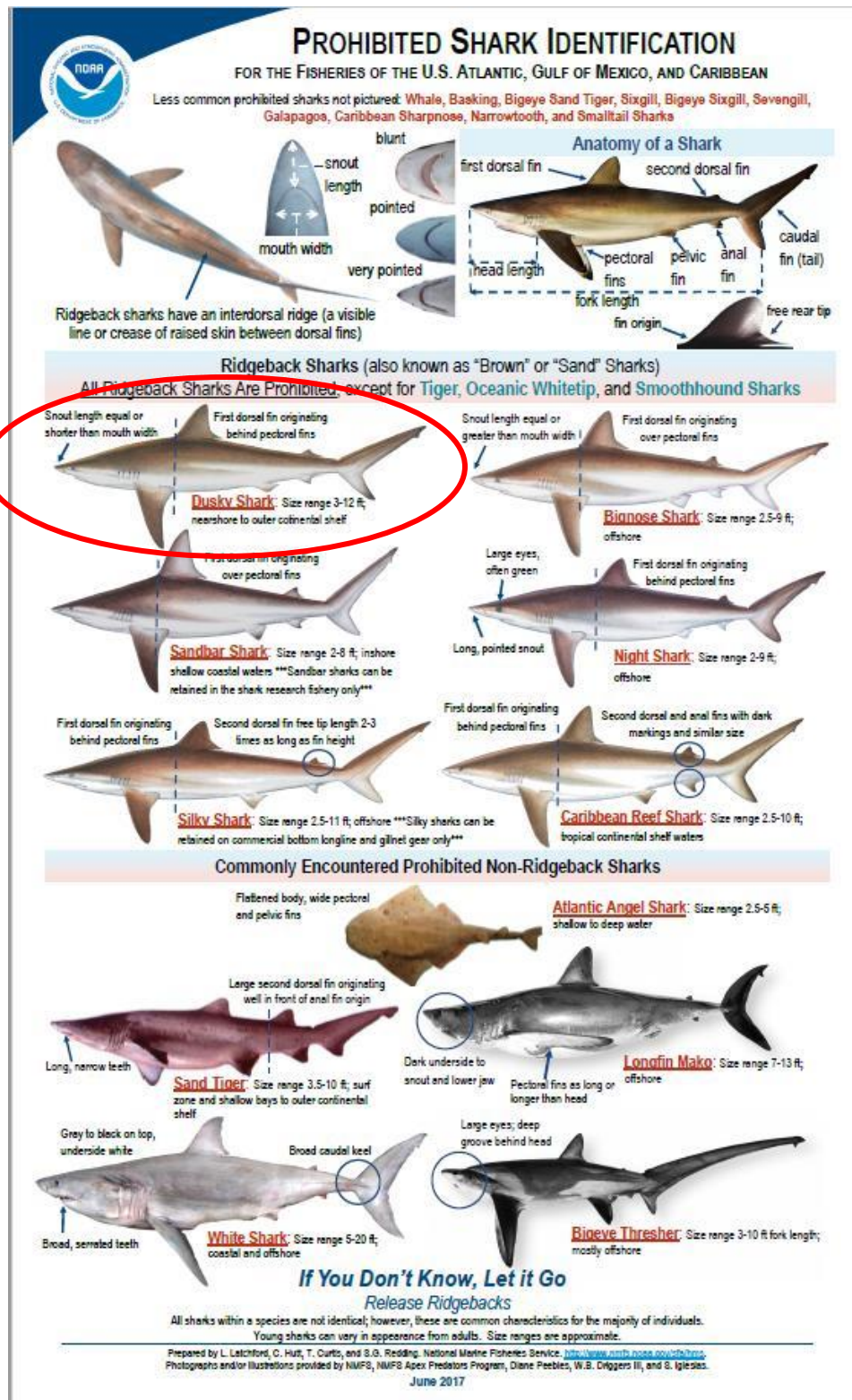


Figure 8. Prohibited shark identification placard developed by the HMS Management Division as part of the implementation of Amendment 5b. Note the similarities between dusky sharks (circled in red) and other species that make positive identification very difficult.

Under- and over-reporting of dusky shark catches

Species misidentification issues aside, there is misreporting by fishermen of their dusky shark interactions as reported in their logbooks (AR000107; AR000113; AR000416; AR004387; AR008074). The clearest indication of this is that in some fisheries the numbers of dusky sharks reported by observers (which cover a small fraction of total trips: ~3 to 10 percent in most cases) are greater than the numbers reported in logbooks (which cover many more trips – 20 to 100 percent in most cases). For example, in 2007 and 2009, the SE Coastal Fisheries Logbook discard form data for the shark bottom longline fishery reported zero dusky shark interactions (Table 1). However, the observer data from the same fishery recorded 14 and 97 dusky shark interactions, respectively (Table 3). This may be a result of different vessels being selected for the SE Coastal Fisheries Logbook discard form and observer programs in the same year, but even that likelihood highlights another limitation of relying solely on logbook data.

When releasing sharks, fishermen often do not bring them on board for positive identification, and these events go unreported (AR008074). The history of regulations that have been implemented in HMS and non-HMS fisheries over the years (AR007076; AR007138) may also inadvertently create incentives to deliberately under- or over-report catches of certain species. For example, fishermen that are concerned that catching too many dusky sharks could result in additional unwanted regulations on their fishery may deliberately under-report the frequency of their interactions in their logbooks. Conversely, fishermen that want certain regulations relaxed try to argue that shark populations are increasing, and may over-report the amounts of dusky sharks they catch. NMFS has received reports of both forms of misreporting, but the overall extent of this problem is unknown. The unknown and unquantifiable amount of misreporting of dusky shark catches by fishermen exacerbates the species misidentification problem discussed above (AR004387).

Different and incomplete logbook information across fisheries

As described above, the logbook programs implemented by NMFS are all different depending on the region and the fishery covered. Some require 100 percent reporting of dusky shark interactions (HMS Logbook) and some do not (SE Coastal Fisheries Logbook discard form). These discrepancies generally get worse the further back in time one goes. For instance, the discard form for the SE Coastal Fisheries Logbook did not begin to be used until 2001. Until that time, fishermen reporting in that logbook only reported landed fish. Additionally, specifics about the gears used (e.g., types of gear, number of hooks, length of net) have added over the years. While logbook programs have added these and other data elements to help solve some of these issues, even at the current time, 100 percent logbook reporting (of both landings and discards) is not mandatory in all federal or state fisheries. Additionally, one of the critical pieces in conducting any type of catch extrapolations is fishing effort. Fishing effort is usually derived from the information provided on the logbook forms. Unfortunately, unlike the HMS Logbook set forms which provide the total effort for each set, the SE Coastal Logbook trip form requires additional calculations to derive the total fishing effort for any particular trip (refer to Appendix 1). Those added calculations combined with the uncertainty in the dusky shark numbers, add to the uncertainty of any extrapolation.

C. Caveats to Consider Regarding the Observer Data

As with logbook data, observer data have a variety of uses in fisheries management, and because observers are trained in species-identification and collect data that can be used to verify those identifications, observer data produces the most accurate fishery-dependent data. However, because observers are generally not placed on all trips, these data are subject to some bias that can affect quantification of total catches of infrequently encountered species like dusky sharks, but can be used to derive indices of relative abundance within fisheries.

Extrapolating observer data to estimate total bycatch of a particular species in a particular fishery can be challenging even when large numbers of a species are caught. However, as the observer data indicates (Tables 3 and 4), dusky shark interactions are relatively infrequent especially in non-HMS fisheries. Similar to the logbook situation, infrequent and highly variable interaction frequencies introduce significant uncertainty into any estimates.

While the agency does produce extrapolated catches of many different species in different fisheries using observer data, when it does so, it uses both a combination of effort (e.g., total number of trips or number of hooks) from the logbooks and a combination of scientifically derived catch rate (CPUE) data from the observer program. The process is fairly complex and requires enough non-zero data for estimations to be feasible. While there might be specific years for specific fisheries in the entire time frame where extrapolation might be feasible (e.g., in the early 2000s using the southeast shark bottom longline observer program data and effort from the Coastal Fisheries Logbook), because the observer data shows zero interactions in most years after 2007, any extrapolations would be incomplete and would not produce a total catch estimates across all fisheries and all years (i.e., zero multiplied by any number equals zero). Overall, given the number of zeros in the observer data and the lack of confidence in the logbook data (see Section II above), the stock assessment scientists have repeatedly determined that such extrapolations for dusky sharks are not appropriate and would not be valid (AR000416; AR004387; AR008074; Appendix 3).

Spatial and temporal variability in dusky shark catch rates, which are already low, can result in extrapolations with high variability. This variability in dusky shark catch rates is apparent in the observer data. For example, in the Shark Research Fishery (with 100 percent observer coverage), from 2011-2013, the observed dusky shark mortalities went from 59 to 210 to 7, respectively (Table 4). This is reflective of the times and areas fished in those years, some of which had high dusky shark catch rates, and others that had low catch rates.

D. Caveats to Consider when Interpreting Recreational Data

As with the commercial data, there are a few caveats to consider when interpreting recreational data. First, the estimates of recreational catch (kept, discarded dead, and released alive) are extrapolated estimates based on multiple complementary statistical surveys with varying levels of precision. Dusky sharks are infrequently encountered species in the general MRIP surveys, and to a lesser extent in the LPS. NMFS considers dusky shark a “rare event” species for these surveys because this species is seen much less than most species that anglers are actually allowed to legally harvest (e.g., other sharks, bluefish, striped bass, tunas, snapper, or cod). As a result,

most annual estimates of dusky shark catch in these surveys have extremely wide confidence intervals⁸ ranging from plus or minus 68 to over 300 percent of the total annual estimate, meaning that the range of estimates includes zero in some cases.

Second, it should be noted again that the MRIP surveys cover the full Atlantic Coast, and Gulf of Mexico coast through Mississippi. The LPS only covers the states of Maine south to Virginia because this area has the greatest concentration of recreational fishing for HMS managed species, especially bluefin tuna. Recreational interactions with dusky sharks tend to be highest in the Mid-Atlantic region, which is covered by the LPS.

Lastly, all estimates of dusky sharks released depend on self-reported data by recreational anglers, and their species identification cannot be confirmed by the interviewers. As discussed above with logbooks, dusky sharks can easily be confused with several other common species of shark. This species mis-identification is highly likely with the recreational data.

E. Is There A Scientifically Valid Basis to Estimate Dusky Shark Bycatch in HMS and Non-HMS Fisheries?

There is no scientifically valid basis to estimate dusky shark bycatch in HMS and non-HMS fisheries. (See Appendix 3.)

The available data for dusky sharks has significant gaps for some fisheries and years, making it difficult to match strata or calculate the proportion of overall catch that was sampled. The data available, particularly in the earlier years of the data series, is extremely uncertain due to problems with species identification and over- and under-reporting. Both reported and observed mortalities in most of the commercial fisheries have values of zero, particularly starting several years after dusky sharks were prohibited. As explained above, even if there were some valid way to extrapolate total catch, the number of zeros in the samples would cause the extrapolation to result in a very low total catch. If we were to calculate these estimates, the results would be small (100s of individuals) but too uncertain to use in stock assessment models or to responsibly use for management purposes, including for specifying catch limits.

Although species identification in logbooks is particularly unreliable for dusky sharks, and accurate reporting of catch for different time periods is questionable, on their face, data from all logbooks for 16 years (2000-2015) indicate that total mortality (the number of kept and discarded dead dusky sharks) did not exceed 5,000 individuals (Table 2). There are caveats to this data, as discussed throughout this document, including that the SE Coastal Fisheries Logbook discard forms include information from 20 percent of selected permitted vessels. Total mortality reported from those SE Coastal Fisheries discard forms amounted to 345 individuals for the same 16-year period. The trend in total mortalities from all logbooks combined also shows a statistically significant decline ($p < 0.01$) from 2000 to 2015, with only 81 mortalities in the last three years of the time series combined (2013-2015). Thus, identification and reporting issues aside, the logbook data show that total dusky shark mortalities have remained very low (zero or less than 100 individuals for the vast majority of logbook-year combinations since 2005). Given

⁸ A confidence interval is a range of values that is likely to include the actual value. The probability that the range of values includes the “true value” is the confidence level (typically 95 percent).

the overall low number of interactions, particularly in recent years, this result is the same (very low mortalities) even when considering some of the individuals released alive could die as a result of post-release mortality.

Arguably, as discussed below, one could conduct certain analyses to try to extrapolate the data. It is NMFS' scientific view, however, that these are not valid approaches for extrapolating the total amount of bycatch (for reasons explained above) and, even if one attempted to use these approaches, the results would still show small catch. To try to account for the lack of reporting, for example, one could, arguably, simply scale up the available logbook catches (i.e., use a linear extrapolation), even though the 20 percent reporting vessels were not selected based on a fully random sample but on a random sample weighted by area and fishing gear and ranked based on the previous year's effort (ideally, extrapolations should be based on a fully random sample). For the recent period of 2013-2015, such an extrapolation would yield an average mortality of 15 dusky sharks per year (i.e., multiplying the reported mortalities in the SE Coastal Fisheries Logbook discard form in Table 2 by 5). Given data limitations, this approach could be valid only to confirm that the extrapolated number would be small, and more precision is not possible.

Alternatively, as is done for other more data-rich shark species, one could, arguably, use the catch per unit effort (CPUE) from the observer programs covering those fisheries in conjunction with effort data from the SE Coastal Fishery Logbook for trips targeting those species to estimate total dead discards (see, e.g., Carlson et al. 2018). However, data from the Southeast Shark Bottom Longline Observer Program and the Southeast Shark Gillnet Observer Program for fisheries targeting sharks (outside of the shark research fishery), and from those same observer programs for fisheries not targeting sharks, as well as data from the Gulf of Mexico Reef Fish Observer Program, show that virtually no dusky sharks were reported dead ("discarded dead" or "kept") in these fisheries, with the exception of a total of 264 mortalities during 2000-2007 in the Southeast Shark Bottom Longline Observer Program, which observes a commercial fishery that targets non-prohibited sharks. After 2007, only 2 sharks were observed dead (in 2012) in that observer program. Given the very low numbers of observed dead dusky sharks in these fisheries, extrapolating the catches in combination with the effort data reported in the SE Coastal Fisheries Logbook would still result in zero or very low numbers of dead dusky sharks, in particular since 2008. Again, given data limitations, this approach could be valid only to confirm that the extrapolated number would be small, and more precision is not possible.

Thus, given the available data that could be used (i.e., logbook and observer data), either scaling up the logbook mortalities directly or extrapolating the observer CPUE with SE Coastal Fisheries Logbook effort would yield mortalities in the 10s of individuals in recent years for commercial fisheries. Given data limitations, this approach is only valid to confirm that the extrapolated totals for recent years would be in the 10s and more precision is not possible.

V. FINAL CONCLUSIONS

Within this document, NMFS presents and summarizes all relevant dusky shark bycatch data (2000-2015) from all available logbook, observer, recreational, and other data sources. The presentation of this data is detailed in Section II.

Based on a review of all available data, NMFS continues to conclude that the amount of dusky shark bycatch occurring on an annual basis is small (i.e., 10s to 100s of dusky sharks per year). As determined in the most recent stock assessment, a small amount of overfishing was occurring on the dusky shark stock as a result of bycatch, and reductions in fishing mortality were needed. NMFS adopted such measures to reduce mortality as needed in Amendment 5b. Those measures focused on changes in the HMS fisheries, where the majority of dusky shark bycatch occurs and where the small amount of needed mortality decrease could most effectively be achieved to quickly address overfishing. The information analyzed in this document reinforces the rationality of that approach, and NMFS concludes that additional accountability measures beyond those implemented in Amendment 5b are not warranted. The rationale for this determination is detailed in Section III.

Based on available data, while bycatch is likely in the 100s of dusky sharks per year across all commercial and recreational fisheries, more precise estimates of the true amount of bycatch are not possible to produce at this time, mainly due to misidentification and misreporting problems (AR000113; AR000416; AR004387). The rationale for this determination is detailed in Section IV. Stock assessments, which involve an extensive, scientifically rigorous process involving broad participation and careful review,⁹ are the most scientifically valid forum in which to attempt to estimate dusky shark catches. That process determined that total catch (including bycatch) estimates of dusky sharks were so unreliable that they could not be used in models traditionally used for most species, and hence used a “catch-free” methodology in the first place.

Fortunately, by design, the accountability measures will work to reduce dusky shark mortality regardless of the actual amounts of bycatch. In Amendment 5b, NMFS implemented a suite of new, additional measures that will reduce dusky shark fishing mortality without relying on quantifying catch. The types of measures in Amendment 5b are used in other fisheries, will work with or without associated catch limits, and will meet the Amendment 5b goals of ending overfishing and rebuilding the dusky shark stock.

The HMS Management Division coordinates with the SEFSC through the SEDAR process to prioritize and schedule stock assessments. As part of that process, at some point in the future NMFS will conduct a new stock assessment for dusky sharks. Such an assessment will provide another opportunity to revisit all of these data sources, consider new methods and models for estimating dusky shark catches and abundance trends, and make updated determinations on the status of the stock. However, the problems with historical species misidentification and mis-

⁹ For more information on this extensive, thorough process, see AR000001, AR004370, and the SEDAR webpage at www.sedarweb.org.

reporting will persist. The stock assessment process remains the most comprehensive and scientifically valid approach to account for such uncertainty and to make such determinations, and uses the best scientific data available. NMFS will continue to monitor dusky shark bycatch on an annual basis (AR007089-92), and has the authority to take additional steps if needed to ensure that the amounts of bycatch remain small. At this time, the needed measures are in place to meet the requirements to end overfishing and rebuild the stock.

APPENDICES

Appendix 1

Detailed descriptions of dusky shark bycatch data sources

A. Logbook Data

HMS Logbook: Atlantic HMS permit holders using pelagic longline gear are required to use this logbook; however, HMS permit holders that are selected to report and that use other gears, including rod and reel, green-stick, and bottom longline gear, may also report fishing activities in this logbook. The fishermen using this logbook primarily target swordfish and tunas.

The HMS Logbook includes three forms: the trip form, the set form, and the no-fishing form. The trip form provides information on the trip itself, such as the start and end dates, the vessel name and identification number, and economic information such as the total cost of groceries or fuel for the trip. The set form provides information on an individual fishing “set,” including the specific latitude/longitude coordinates at which gear was set and hauled back, the amount of gear used, and the number and species of fish and protected species kept, released alive, and discarded dead. If applicable, the number of dusky sharks with which the vessel interacted would be reported on this set form. Each logbook submission will include only one trip form, but will typically include numerous set forms, as most of these trips last several days to a week (sometimes an entire month) and contain numerous sets. The no-fishing form is required if a permit holder took no fishing trips during a month, which allows the Agency to confirm that permit holders are not fishing, as opposed to not reporting.

Permit holders who use the HMS Logbook are also required to submit “weigh-out slips” when they submit the logbooks to NMFS. Permitted dealers are required to provide these slips to the fishermen and must include, at a minimum, the numbers and weights of the fish landed.

Southeast (SE) Coastal Fisheries Logbook: This logbook is primarily used by fishermen with commercial shark permits who do not use pelagic longline gear and by fishermen with permits in the South Atlantic and Gulf of Mexico regions to report fishing activity in the Gulf of Mexico Reef Fish, South Atlantic Snapper-Grouper, King and Spanish Mackerel, Shark, and Atlantic Dolphin/Wahoo fisheries. This logbook is primarily used for bottom longline, gillnet, vertical line (including bandit gear), but other gears can also be reported here.

As with the HMS Logbook, the SE Coastal Fisheries Logbook has several associated forms. One such form is the trip form. As with the HMS Logbook trip form, this trip form includes information specific to the trip such as vessel name and identification number, dates of the trip, and economic information such as total cost of groceries and fuel. However, unlike the trip form in the HMS Logbook, the SE Coastal Fisheries logbook trip form collects information on the gear used, location, and species kept for an *entire trip* rather than on every *set* of the fishing trip. As a result, the “fishing location” data reported on the form is fairly general, and is provided on a grid indicating where the majority of the catch of each species occurred, rather than specific longitude and latitude coordinates for each set like on the HMS Logbook. Gear effort (e.g., number of hooks, lines fished, length of longline) information is reported as the average for an entire trip as opposed to the specific number of hooks or length of line for each set. This summary of trip level landings and gear by area fished increases the difficulty in calculating the

shark targeted fishing effort for a trip. Another important difference is that “species kept” is reported in total weight for the entire trip, not in numbers of fish per set like for the HMS Logbook.

The SE Coastal Fisheries Logbook trip form includes only species kept, and no information regarding the weight or number of released or discarded fish or protected species. Instead, this type of information is reported in the logbook discard form. Not all permit holders using the logbook are required to complete a discard form. Every year, NMFS randomly selects approximately 20 percent of the fishermen who are required to report to the coastal logbook program to also report discards using a discard logbook form. This discard form is also trip based and does not have specific location data available for each set. Additionally, this logbook form does not provide specific information on individual fish that are discarded dead or alive. Instead, fishermen use this form to report the total number of discards of each species and their estimates of the average weight of those discarded individuals. This differs from the SE Coastal Fisheries Logbook trip report form, on which species are reported in total pounds (i.e., there are no individual counts in the trip report form). For each species reported on the discard form, fishermen are also required to report whether all the fish were discarded dead, most were discarded dead, all were discarded alive, most were discarded alive, some were kept but not sold (e.g., if they used the fish as bait), or if the fishermen was unable to determine which category to check. Fishermen may also report “no discards” when submitting a discard logbook form and remain in reporting compliance. Such reporting means that no individuals of any species were discarded during the fishing trip. Like over-reporting, under-reporting (such as false zero discard trips) may occur, which makes accurate calculation of discards from the fishery very challenging.

This logbook also has a no-fishing form. As with the HMS Logbook, fishermen are required to submit this form if they took no fishing trips during a month.

Northeast (NE) Vessel Trip Reports: Any fisherman with a permit issued out of the NMFS Greater Atlantic Regional Fisheries Office is required to use this logbook to report all fish landed, regardless of species. Most non-HMS fishermen from the mid-Atlantic north to Maine use this logbook program to report their landings. For the most part, the fishermen reporting in this logbook use trawls, dredges, or gillnet gear and are fishing for non-HMS such as scallops, squid, herring, groundfish (e.g., cod, haddock, flounders, monkfish), skates, and spiny dogfish. Except for some smoothhound shark permit holders who hold NE permits that require reporting, and a few swordfish permit holders that target *Loligo* squid and land swordfish incidentally, no HMS permit holders use this logbook.

Unlike the HMS Logbook and the SE Coastal Fisheries Logbook, this logbook is used not only by commercial permit holders but also by charter/headboat fishermen when fishing recreationally. Unlike the SE Coastal Fisheries Logbook and the HMS Logbook, this logbook has only one form. On that form, permit holders report trip level information, gear information, location by both grid and longitude and latitude, and, for commercial trips, the weight (not number like the HMS Logbook) of each species kept or discarded. There is no indication on the form whether the discards are alive or dead. A new form must be filled out when the fisherman moves to a new area or uses a different gear, similar to how fishermen use the HMS Logbook set

form. From 2000 to 2015, fishermen using this logbook were required to submit a monthly no-fishing report if they did not fish.

B. Observer Data

NE Fisheries Observer Program: This program covers the states in the Northeast and Mid-Atlantic regions in non-HMS fisheries such as groundfish, monkfish, squid, skates, herring, and scallops, and the HMS mid-Atlantic smoothhound shark fishery. These fisheries primarily use trawls, gillnets, and dredges. Trips in each fishery are randomly selected for observer coverage. Coverage rates vary year-to-year and by gear type and fishery, but on average this program observes approximately 8 percent of trips in this region.

SE Bottom Longline Observer Program: This observer program collects data on temporal and spatial catch, release mortality, bycatch, and discards on trips targeting HMS, primarily sharks, and non-HMS, such as snapper-grouper, on vessels that fish from North Carolina to Louisiana. Vessels are selected at random each quarter based on reported use of longline and targeted shark interactions in the same season of the previous year with a coverage level of 5 to 10 percent of all SE and Gulf of Mexico (GOM) trips that use bottom longline gear.

In addition to observing the primary shark bottom longline fleet, this observer program also observes the Shark Research Fishery. The Shark Research Fishery started in 2008 to ensure that data critical to effective shark management could continue to be gathered, even after commercial shark quotas were significantly cut in Amendment 2 that year. The research fishery and is comprised of approximately 5 to 10 vessels each year, which must carry an observer on 100 percent of all trips and generally make only one or two trips per month. Vessels participating in the Shark Research Fishery must abide by very strict regulations beyond those otherwise required of the fleet, such as a limited number of hooks and a limited number of sets. Dusky shark mortalities in the research fishery are capped on a regional basis, which is possible given the small number of vessels and 100 percent observer coverage. Only commercial shark fishermen participating in the Shark Research Fishery are allowed to land sandbar sharks, which are otherwise prohibited.

SE Gillnet Observer Program: This observer program focuses on all anchored, sink, strike, or drift gillnet fishing by vessels that fish from Florida to North Carolina and in the Gulf of Mexico. Similar to the SE Bottom Longline Observer Program, vessels are randomly selected on a quarterly basis from a pool of vessels that had reported fishing with gillnet gear during the same quarter the previous year in the NMFS SE Coastal Fisheries Logbook. The coverage level for this observer program is approximately 8 to 10 percent of all trips in the SE that use gillnet gear.

GOM Reef Fish Observer Program: This observer program, which began in 2006, provides quantitative biological, vessel, and some gear-selectivity information relative to the directed reef fish fishery in the Gulf of Mexico. This program primarily focuses on bottom longline, vertical line (bandit or handline), and more recently, limited observer coverage on modified buoy gear trips. Although many reef fish species are retained, the predominant target species are snapper-grouper. The coverage level for this observer program is approximately 2-5 percent of all GOM trips that fish for reef fish.

GOM Shrimp Trawl Observer Program: This observer program provides quantitative biological, vessel, and gear-selectivity information relative for the southeastern shrimp fishery. This program provides general fishery bycatch characterization and catch rates for finfish species by area and target species, and provides catch rates to estimate protected species bycatch levels. Until the late 2000s, this observer program did not identify sharks to species. The coverage level for this observer program is approximately 2 percent of all GOM shrimp trawl trips.

Pelagic Observer Program: Data from the Pelagic Observer Program is collected during trips on pelagic longline vessels with HMS permits, generally targeting swordfish and yellowfin and bigeye tunas. Once a set is retrieved, information (e.g., length, dressed weight, sex, tag number) on each individual fish captured is recorded. Typically, the Pelagic Observer Program target coverage level is approximately 10-15 percent of the vessels, based on the fishing effort of the fleet, although there have been times and areas where the agency has required 100 percent coverage, including a number of years in the Gulf of Mexico (during bluefin tuna spawning time periods) and in the mid-Atlantic bight area.

C. Recreational Data

MRIP: The Marine Recreational Information Program (MRIP) uses a network of complementary surveys to collect recreational fishing data to estimate fishing effort and catch along the Atlantic and Gulf of Mexico coasts (Maine to Mississippi). The primary MRIP surveys are the Access Point Angler Intercept Survey (APAIS), the Coastal Household Telephone Survey (CHTS), and the For-Hire Survey (FHS).

MRIP resulted from a requirement under the Magnuson-Stevens Act to establish a program to improve NMFS' Marine Recreational Fishery Statistics Survey (MRFSS). See 16 U.S.C. § 1881(g)(3) (providing for review of and recommendations regarding MRFSS by National Research Council and requiring use of surveys, intercepts, and other approaches, unless alternative methods would be more efficient and effective).

The APAIS is conducted by state fisheries agency partners. Interviewers survey individual recreational anglers at known fishing access sites (e.g., marinas) to collect data on the angler's catch including length, weight, and species of fish caught; the number of fish released; and general information about the fishing trip including its length and mode (i.e., shore, private boat, or for-hire boat – charter or headboat). The primary purpose of this survey is to estimate average catch rates (i.e., fish caught or harvested per trip by species) per angler. In this survey, most harvested fish are directly observed by the on-site interviewers that are trained to identify fish to the species level, while the collection of data on released fish relies on anglers to identify the species or a more generic category like "shark." As such, species-specific data on the number of fish released is less reliable.

The CHTS was a telephone survey of randomly selected coastal households used to collect data on the number of saltwater fishing trips taken by recreational anglers on privately owned boats or from shore. Data was collected at the end of two-month "waves" to minimize recall bias that would result from asking individuals to recollect the number of trips taken over a longer period. In 2018, the CHTS was replaced by the Fishing Effort Survey (FES), a mail survey of licensed recreational anglers and coastal households; however, this was after the implementation of

Amendment 5b and data collected by the FES was not used in this rulemaking. The primary purpose of the CHTS was to estimate recreational fishing effort (i.e., total days fished) by recreational anglers fishing from private boats and shore.

The FHS is a telephone survey of known charter and headboat vessel operators used to collect data on the number of saltwater fishing trips taken by recreational anglers on for-hire vessels. To minimize recall bias, the FHS asks vessel operators to report vessel fishing activity during one-week periods including the number of anglers fishing per trip, hours spent fishing, area fished, and species targeted. The primary purpose of the FHS is to estimate total fishing effort (i.e., total days fished) by recreational anglers fishing from for-hire charter and headboat vessels. MRIP estimates total annual catch and harvest per species and mode (i.e., private boat, shore, for-hire) by multiplying average catch rates obtained by the APAIS by estimates of total fishing effort obtained by the CHTS and the FHS. Thus, MRIP estimates are extrapolated estimates of catch. When data is extracted, the MRIP database provides confidence intervals.

Large Pelagic Survey: The Large Pelagic Survey (LPS), which began in 2001, collects information regarding the recreational fishery directed at large pelagic species (e.g. tunas, billfishes, swordfish, sharks, wahoo, dolphinfish, and amberjack) in the offshore waters from Maine through Virginia from June through October. The purpose of the LPS is to collect more precise estimates of fishing effort and catch for large pelagic species that are rarely encountered in the general MRIP surveys. The LPS includes two independent surveys (Large Pelagics Telephone Survey (LPTS) and Large Pelagics Intercept Survey (LPIS)) which provide effort and average catch per trip estimates needed to estimate total catch by species.

Like the APAIS, the LPIS is a dockside survey of known offshore fishing access sites, primarily designed to collect catch data from private and charter boat captains who completed fishing trips directed at large pelagic species. LPIS data are used to estimate the average recreational catch per large pelagic boat trip by species. Unlike the APAIS, the LPIS collects aggregate catch data for all anglers fishing on a given vessel.

The LPTS is a telephone survey that collects data used to estimate the total number of boat trips on which anglers fished with rod and reel or handline for large pelagic species. For-hire HMS vessels are covered by the FHS listed above which is a weekly survey, and private boats are covered by the LPTS, a biweekly survey. The LPTS covers both commercial fishing by vessels with General category HMS permits, and true recreational fishing by vessels with Angling category HMS permits.

The LPS estimates total annual catch and harvest per large pelagic species and mode (i.e., private boat, for-hire) by multiplying average catch rates obtained by the LPIS by estimates of total fishing effort obtained by the LPTS and the FHS. Thus, LPS estimates are extrapolated estimates of catch. As with MRIP confidence intervals, LPS confidence intervals are generated online when reviewing the extrapolated estimates (See <https://www.st.nmfs.noaa.gov/recreational-fisheries/data-and-documentation/queries/index>)

Texas Parks and Wildlife Department (TPWD) Recreational Survey: For the State of Texas, marine recreational fishing is monitored by the Texas Parks and Wildlife Department. The Texas Parks and Wildlife Marine Recreational Fishing Survey collects recreational data regarding bait and gear used, species composition and size, trip length, etc. Information is collected via on site post-fishing trip interviews of anglers at coastal boat-access sites. The amount of angling activity and harvest are estimated with data collected from anglers during coastal harvest surveys (<https://tpwd.texas.gov/fishboat/fish/didyouknow/coastal/creel.phtml>). This survey is the only source of recreational landings estimates for the State of Texas. The landings estimates are extrapolated estimates.

SE Headboat Survey: The Southeast Region Headboat Survey (SRHS) focuses on monitoring and sampling data from the recreational headboat fisheries in the South Atlantic and Gulf of Mexico. A headboat is a large capacity vessel that charges anglers on a per-person basis, rather than a charter fee for the whole vessel. Data collected from this survey consist of trip-level logbook records submitted by captains and biological samples collected dockside by port agents. The SRHS is composed of three main components, the dockside intercept biological sampling program which collects data on the length, weight, age, and sex of fish caught on headboats; the headboat activity report which collects data on the number and type of trips taken by headboats and the number of anglers per trip; and the logbook/trip report which collects data on the number of fish caught and released per headboat trip by species. SRHS landings estimates are extrapolated from the logbook data to account for non-reporting.

D. Seafood Dealer Data

Pelagic Dealer Compliance (PDC) System: This reporting system was implemented for federally-permitted HMS seafood dealers primarily to monitor landings of tunas and swordfish, but sharks purchased by these dealers were also reported. Dealers are people who purchase fish from commercial fishermen. Dealers finish processing the fish and then sell the fish to restaurants, grocery stores, other dealers, importers, or exporters. All commercial HMS permit holders are required to sell to federally permitted dealers and all federally permitted dealers are required to report fish purchases to the PDC system. This system was replaced in 2013 with the eDealer system described below.

eDealer: Since 2013, the Electronic Dealer Reporting System (eDealer) provides self-reported data from federally permitted dealers. For HMS, eDealer pulls in all information from other electronic dealer reporting systems to provide one complete dataset for all HMS dealer data. NMFS regularly cross-validates the weight of fish and the purchase dates provided in dealer reports with the logbook trip information, including the weigh out slips, to ensure all fish are accounted for throughout the fishery. When discrepancies are found, NMFS works to ensure the fish are correctly entered in the appropriate dealer reporting system and in the logbook. When it is confirmed that a dealer purchased a prohibited species, such as dusky shark, that information is provided to the NMFS Office of Law Enforcement for appropriate action.

Gulf Fisheries Information Network (GulfFIN): GulfFIN is a self-reported, state-federal cooperative program among agencies to collect, manage, and disseminate statistical data and information on the marine and estuarine commercial and recreational fisheries by the states in the Gulf (Texas to Florida), as well as Puerto Rico. The program originally collected data via paper

“trip tickets” and now are collected on both paper and via electronic methods. Electronic reporting by federal dealers was implemented and made available to dealers in Texas, Louisiana, Alabama, and Florida by 2011, and in Mississippi by 2014. Federal dealers were always required to report landings to both state and federal agencies. State regulations dictated whether or not a state-only dealer (purchasing fish caught within the EEZ) was required to report or could report voluntarily. GulfFIN metadata indicates that landings exist for all five Gulf States and Puerto Rico from 1985-2019. The GulfFIN commercial landings database stores Gulf landings data captured by state commercial dealers, via the Trip Ticket Program, which are reported by state commercial fishermen. The data used in the GulfFIN data management system for Recreational catch, harvest and effort estimates are based on NMFS MRFSS survey; however, in 2017, GulfFIN completed its MRIP Regional Implementation Plan. Non-confidential data include yearly summary landings, marine recreational fishery catch and effort estimates, and biological samples. Commercial dealer reports are comprised by year, state, and species.

Atlantic Coastal Cooperative Statistics Program (ACCSP): ACCSP is the Atlantic coast complement to GulfFIN. It includes state “trip ticket” reports from seafood dealers that purchase fish from both state and federal fisheries. This program covers landings from Maine to Florida’s east coast. ACCSP and GulfFIN data, when combined, reflect landings across all states from Maine to Texas.

NE Dealer database: The NE Dealer database contains data from federally permitted seafood dealers in the Northeast (Virginia to Maine). Prior to May 2004, northeast landings data were collected directly from federally permitted dealers through federal field agents during dockside interviews, and nonfederal data were obtained through a state’s trip ticket program. After May 2004, regulations mandated that all dealers with a Federal permit issued by the Greater Atlantic Regional Fisheries Office (GARFO) submit their landings data for each trip electronically. GARFO also made available to all dealers the Standard Atlantic Fisheries Information System (SAFIS): an online application allowing seafood dealers in the Northeast Region to enter landings statistics which met both the respective state and NMFS reporting requirements. An exception for electronic reporting by these dealers through SAFIS would include those dealers in northeast states that are required to electronically report to the ACCSP (Atlantic Coastal Cooperative Statistics Program). These data are instead supplied to GARFO by ACCSP. Some federally permitted dealers in northeast states are not required to report electronically to ACCSP or using SAFIS, under these situations, dealers are to report to their local port agents who enter the landings data using the Commercial Data Entry Statement (CODES). For each species purchased, dealers provide the following information: fisherman; vessel; trip data (start date, end date, etc.); gears used; and the unit of measure, quantity, market information, and price paid for the species.

E. Exempted Fishing Permits

EFP database: EFPs are issued to individuals for the purpose of conducting scientific research or other fishing activities aboard private (non-research) vessels. NMFS can also issue other types of EFPs such as scientific research permits (SRPs) or letters of acknowledgement (LOAs) to Agency or state scientists or academics who are conducting research aboard research vessels (e.g., NOAA vessels or state research vessels). The type of EFP issued depends not only on the type of fishing vessel but also on the species being researched. Display permits, another type of

EFP, are issued to individuals who are fishing for, catching, and then transporting HMS to certified aquariums for public display. Since 2008, no dusky sharks have been allowed to be collected under a display permit; collection under EFPs and SRPs are permitted on a case by case basis. One hundred percent of HMS catches on all EFP trips are reported to NMFS (including all dusky sharks). The EFP database provides raw observed numbers of shark interactions on trips that have been issued an EFP.

F. Potential undocumented sources of dusky shark bycatch

Dusky shark bycatch, dead discards in particular, occurs on some level outside of the data collection programs covered here, including from state water fisheries (typically 0 to 3 miles from shore) and some international catches from Mexico and Caribbean nations. Other than the recreational surveys and some commercial dealer purchases of kept dusky sharks reported to ACCSP and GulfFIN (discussed above), NMFS is not aware of any data collection programs available to quantify or estimate the amounts of dusky shark bycatch from those areas. Any such bycatch likely would be of negligible amounts.

Appendix 2

Methods used to convert dusky shark weights to numbers

This appendix documents an analysis performed by the National Marine Fisheries Service's (NMFS) Highly Migratory Species (HMS) Management Division in support of NMFS' response to an April 19, 2019 Remand Order in *Oceana v. Ross*, Case No. 17-cv-829 (CRC). This litigation is regarding Amendment 5b to the 2006 Consolidated Atlantic HMS Fishery Management Plan (Amendment 5b).

In part, the Remand Order required that NMFS, "[c]onsider all relevant data related to dusky shark bycatch in the HMS and non-HMS fisheries, as it existed at the time of the agency decision, including logbook data and the data underlying the National Bycatch Reports." NMFS proceeded to compile and analyze the relevant data. However, some sources report dusky shark data in weights rather than numbers of individuals. Therefore, it was necessary to convert reported weights to numbers of dusky sharks. The following text describes how this conversion of units was performed.

Dusky shark weights were converted to numbers using these general steps:

1. Calculate the length of an average dusky shark.
2. Convert that average length to an average weight using published length-weight conversions for dusky sharks.
3. Divide total weights of dusky sharks reported in the relevant data sources by this average weight to estimate the number of dusky sharks.

Each step is further detailed below.

Step 1

The best source of dusky shark length measurements is from the NMFS Southeast Fisheries Science Center's Bottom Longline Observer Program, which includes the Shark Research Fishery. Observers on shark bottom longline trips measure the length (but not weight) of every shark caught. Summaries of length distributions of dusky sharks in this program are provided annually in NMFS technical reports (e.g., AR009629). NMFS examined raw observer data on dusky shark length measurements from this program for the years 2008 to 2015. During this period, 294 dusky sharks were measured to the nearest cm in straight-line fork length (i.e., the shortest distance in a straight line from the tip of the snout to the fork of the tail). These lengths are listed in Table A1.

From these 294 dusky shark measurements, ranging from 59-276 cm, the average length was calculated to be 136 cm.

Step 2

The average dusky shark length of 136 cm was converted to weight using a published length-

weight relationship (Kohler et al. 1996). The conversion formula for dusky sharks is:

$$W = 0.000032415 \times FL^{2.7862}$$

Where W is whole weight (i.e., the weight of the entire shark including the heads, fins, and viscera) in kilograms (kg) and FL is the fork length in cm.

Thus, on average, an entire dusky shark with a length of 136 cm has a whole weight of approximately 29 kg (64 lb).

Because some weights in the relevant data sources are reported in lb dressed weight (i.e., the weight of a shark carcass after it has had its head, fins, and viscera removed), NMFS also determined the average dressed weight of dusky sharks. The dressed weight of a dusky shark is approximately 72 percent of the whole weight. Therefore, multiplying 29 kg by 0.72, results in an average dressed weight of 21 kg (46 lb) for a 136 cm dusky shark.

Step 3

Total dusky shark weights reported in pounds whole weight were converted to numbers using the average dusky shark whole weight of 64 lb (i.e., total weight divided by the average weight per shark equals the number of sharks). For example, Northeast Vessel Trip Report data are reported in whole weights. In 2000, a total of 8,091 lb of dusky sharks were reported caught in this logbook program. Dividing this total weight by the 64 lb average weight results in an estimate of 126 dusky sharks (Table 1 of the Remand Document).

Total weights reported in pounds dressed weight were similarly converted to numbers using the average dusky shark dressed weight of 46 lb.

This procedure was repeated every year for programs that have reported weights rather than reported numbers.

References

Kohler, NE, JG Casey, and PA Turner. 1996. Length-length and length-weight relationships for 13 shark species from the western North Atlantic. *NOAA Technical Memorandum NMFS-NE-110*. 29 pp.

Table A1. List of dusky shark fork lengths (cm) from the SE Bottom Longline Observer Program (2008-2015) used to calculate the length of an average dusky shark.

59	84	98	106	114	121	128	146	201	223
61	84	99	106	114	121	128	146	203	224
62	86	99	107	115	121	128	150	203	224
63	86	99	107	115	121	129	151	203	225
63	87	100	107	116	122	129	152	203	225
63	87	100	108	116	122	130	153	204	226
66	88	101	108	116	122	131	154	206	227
67	88	101	108	116	122	131	158	208	228
68	88	101	108	116	123	131	163	209	230
68	89	101	108	116	124	132	182	210	230
69	90	101	109	116	124	132	183	210	231
69	91	102	109	117	124	132	185	210	232
69	91	102	109	117	124	133	186	211	233
70	92	103	110	117	124	133	186	212	238
71	93	103	110	118	124	134	186	213	240
71	93	103	110	118	126	135	188	214	244
71	93	104	110	118	126	136	191	214	247
72	93	104	111	118	126	136	191	214	247
75	93	104	111	118	126	138	192	215	251
77	93	104	111	119	126	138	192	215	253
77	94	105	111	119	126	140	192	216	254
78	95	105	111	119	126	141	193	217	257
78	95	105	111	119	126	141	195	217	259
79	95	105	112	119	127	142	196	218	276
81	95	106	112	120	127	142	197	218	
82	95	106	112	120	127	142	198	219	
82	96	106	113	120	127	143	199	220	
83	96	106	113	120	127	143	200	220	
83	97	106	113	121	127	144	200	220	
83	97	106	114	121	128	145	201	222	

Appendix 3



UNITED STATES DEPARTMENT OF COMMERCE
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July 22, 2019

MEMORANDUM FOR: Alan D. Risenhoover
Director, Office of Sustainable Fisheries

FROM: Clarence Porch, Ph.D. Science Director
BRAINERD.THEOPHILUS.R.DR.136
US.R.DR.1365819285

SUBJECT: Review of Questions regarding NMFS Draft Response to District Court Remand Order in Oceana, Inc. v. Wilbur Ross et al, Case No. 17-cv-829 (CRC) (April 19, 2019)

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This memorandum is in response to the Atlantic Highly Migratory Species (HMS) Management Division, Office of Sustainable Fisheries' June 28, 2019 e-mail request that the Southeast Fisheries Science Center (SEFSC) review three documents that are draft responses to the Remand Order in the above-referenced case (Draft Remand Document, Draft Appendix 1, and Draft Appendix 2) and provide a memo that: A) confirms that HMS has considered all of the datasets available that might contain dusky shark interactions; B) agrees that there is no confidentiality issue in releasing the summary tables, particularly in relation to the observer data; and C) confirms that the explanation of why there is no scientific basis for extrapolating the data to estimate dusky shark numbers is accurate and appropriate, along with additional clarifications or examples as needed.

A) Confirm that HMS has considered all of the datasets available that might contain dusky shark interactions

SEFSC staff, along with staff from the Northeast Fisheries Science Center, the HMS Division, and the Greater Atlantic Regional Fisheries Office, participated in identifying all available federal data sources to identify potential sources of dusky shark bycatch. Our review of the documents provided indicates that, to our knowledge, NMFS mined all the available data sources that may contain catch information on dusky sharks, which include commercial logbook, observer, and seafood dealer data, as well as recreational survey and exempted fishing permit data.

For commercial catches based on logbooks, the documents include the HMS logbooks, Southeast (SE) Coastal Fishery Logbooks discard and trip forms, and the Northeast (NE) Vessel Trip reports, which collectively cover the pelagic longline fishery, the shark bottom longline and gillnet fisheries, the Gulf of Mexico (GOM) Reef Fish fishery, the SE Snapper and Grouper fishery, and multiple fisheries in the NE region. The documents also include the Observer Programs that correspond to those logbook programs, which include the Pelagic Longline Observer Program, the Southeast Shark Bottom Longline Observer Program, the Southeast Shark Gillnet Observer Program, the Gulf

of Mexico (GOM) Reef Fish Observer Program, the Northeast (NE) Fisheries Observer Program, and additionally the GOM Shrimp Trawl Observer Program. For commercial catches based on seafood dealer reports, the documents include the Pelagic Dealer Compliance (PDC) system, the eDealer system (which replaced the PDC in 2013), the Gulf Fisheries Information Network (GulFIN), the Atlantic Coastal Cooperative Statistics Program (ACCSP), and the NE Dealer database.

For recreational catches, HMS included the four surveys in existence, i.e., the MRIP (Marine Recreational Information Program), the Texas Parks and Wildlife Department (TXPWD) Recreational Survey, the SE Headboat Survey, and the Large Pelagic Survey.

Additionally, the documents included catches from the HMS Exempted Fishing Permit database. The SEFSC is not aware of any other available data sources that could reflect catch data regarding dusky sharks.

B) Agree that there is no confidentiality issue in releasing the summary tables, particularly in relation to the observer data

All the summary tables HMS provided in the Draft Remand Document contain data aggregated annually for all vessels (observer programs), commercial logbooks, seafood dealer reports, and recreational surveys, with wide geographic and temporal scope. Thus, we believe there are no confidentiality issues that would allow identification of individual fishers, vessels, or vessel owners in the data as presented.

C) Confirm that the explanation of why there is no scientific basis for extrapolating the data to estimate dusky shark numbers is accurate and appropriate

Background

Catch-free stock assessment model—Many shark species are considered to be “data poor” in the sense that one or more of the main sources of data that are traditionally used in stock assessments (total catches, indices of abundance, and life history) are lacking or unreliable. The assessment of dusky sharks has been historically problematic because of mis-identification and mis-reporting of total catches, issues which have been identified in all stock assessments conducted thus far (Cortés et al. 2006; SEDAR 21; SEDAR 21 2016 update). This has led the SEFSC to use a “catch-free” stock assessment model owing to the unreliability of the total catches that were available.

The Age-Structured Catch-Free Stock Assessment Model (ASCFM; “catch-free” model) uses the biological inputs, the available indices of relative abundance, information on the relative effort exerted by the different fisheries catching dusky sharks, and information on the known length of a fraction of the animals caught in different fisheries or surveys to determine the proportional population level compared to virgin stock levels (unexploited level or the population level that prevailed before fishing on the species began). Although absolute catch data were not directly used in the ASCFM to determine the relative stock abundance and stock status, the effects of catch were implicitly integrated into the indices of relative abundance. Because the catch-free model does not use absolute catch data, the model cannot provide the scale or absolute abundance levels; it can only provide estimates of the relative proportion of abundance from one time period to another. These proportional estimates allow determination of whether the stock is overfished and/or overfishing is occurring. The ASCFM cannot, however, provide estimates of the absolute level of bycatch or catch levels needed to rebuild the stock. The ASCFM, first used in 2006 (Cortés et al. 2006), was

found appropriate to use for dusky sharks in the (2011) SEDAR 21 Benchmark Stock Assessment by the Stock Assessment Panel and Center for Independent Experts peer reviewers, and was subsequently used in the 2016 SEDAR 21 Update Stock Assessment.

Logbook data—Problems with logbook data associated with species mis-identification and under-reporting and over-reporting of some shark species have been identified in the scientific literature (Burgess et al. 2005), for example in the context of deriving indices of abundance (also known as Catch Per Unit of Effort or CPUE). Identification problems are particularly accentuated with dusky sharks because of their resemblance to other large Carcharhinid shark species, which makes their identification very difficult, even for trained observers, and mis-reporting is also possible because of varying incentives for the fishermen to report dusky shark catch based on the prevailing management measures in place.

Data extrapolation

As indicated above, although species identification in logbooks is particularly unreliable for dusky sharks and accurate reporting of catches for different time periods is questionable, the draft document shows that total mortality (kept + discarded dead) reported in all logbooks in 16 years (2000-2015) did not exceed 5,000 individuals, with the caveat that the SE Coastal Fisheries Logbook discard forms only include information from 20% of randomly selected permitted vessels. Notwithstanding this, total mortality from these three discard forms (shark bottom longline and gillnet; GOM reef fish; and SE snapper, grouper, and other) amounted only to less than 400 individuals for the same 16-year period. The trend in total mortalities from all logbooks combined also shows a statistically significant decline ($P = 0.005$) from 2000 to 2015, with only 81 mortalities in the last three years of the time series (2013-2015). Thus, identification and reporting issues aside, the logbook data show that total dusky shark mortalities have remained very low (zero or less than 100 individuals for the vast majority of logbook-year combinations since 2005).

The lack of 100% reporting in the three discard forms could be of concern if catches in these fisheries were substantial. To attempt to account for the lack of reporting, one could, arguably, simply scale up the available logbook catches (i.e., use a linear extrapolation), even though the 20% reporting vessels were not selected based on a fully random sample but on a random sample weighted by area and fishing gear and ranked based on the previous year's effort (ideally, extrapolations should be based on a fully random sample). For the recent period of 2013-2015, such an extrapolation would yield an average mortality of 15 dusky sharks per year. Given data limitations, this approach could be valid only to confirm that the extrapolated number would be small, and more precision is not possible.

Alternatively, as is done for other more data-rich shark species, one could, arguably, use the CPUE (catch per unit effort) from the observer programs covering those fisheries in conjunction with effort data from the SEFSC Coastal Fishery Logbook Program (CFL) for trips targeting those species to estimate total dead discards (see, e.g., Carlson et al. 2018). However, data from the Southeast Shark Bottom Longline Observer Program and the Southeast Shark Gillnet Observer Program for fisheries targeting sharks (outside of the shark research fishery), and from those same observer programs for fisheries not targeting sharks, as well as data from the Gulf of Mexico Reef Fish Observer Program, show that virtually no dusky sharks were reported dead ("discarded dead" or "kept") in these fisheries, with the exception of a total of 264 mortalities during 2000-2007 in the Southeast Shark Bottom Longline Observer Program for a fishery targeting sharks. After 2007, only 2 sharks were observed dead (in 2012) in that observer program. Given the very low numbers

of observed dead dusky sharks in these fisheries, extrapolating the catches in combination with the CFL effort data would still result in zero or very low numbers of dead dusky sharks, in particular since 2008. Again, given data limitations, this approach could be valid only to confirm that the extrapolated number would be small, and more precision is not possible.

Thus, given the available data that could be used (i.e., logbook and observer data), either scaling up the logbook mortalities directly or extrapolating the observer CPUE with CFL effort would yield mortalities in the 10s of individuals in recent years. Given data limitations, this approach is only valid to confirm that the extrapolated totals would be in the 10s and more precision is not possible. Thus, while we can confirm that the explanation of why there is no scientific basis for extrapolating the data to estimate dusky shark numbers is accurate and appropriate in this case, we also conclude that the amount of dusky shark mortalities in all commercial fisheries combined is small (in the 100s per year).

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