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A. APPENDIX: SPECIES COMPLEXES, QUOTAS, AND RETENTION LIMIT CALCULATIONS

For alternative suites 2 through 4 in the Draft Environmental Impact Statement (DEIS), the National Marine Fisheries Service (NMFS) calculated quotas and retention limits based on total allowable catches (TAC) recommended in the 2005 and 2006 stock assessments; fishing effort and landings reported from 2003 to 2005 in the Highly Migratory Species (HMS) Logbook and Coastal Fisheries Logbook; and discards from the bottom longline (BLL) and gillnet 2005 to 2006 observer reports. In all cases, NMFS accounted for total mortality from all fishing sectors (*e.g.*, commercial and recreational), including landings and discards. By reducing the quota below this TAC, NMFS should reduce fishing mortality below the level that would cause overfishing. The quotas and retention limits in this rulemaking are specific to the 2005/2006 LCS stock assessment, the 2006 dusky assessment, and the 2005 porbeagle shark stock assessment, but NMFS anticipates changing these quotas and retention limits via framework actions in the future, as necessary. In subsequent rulemakings, NMFS would determine quotas and retention limits, based on the recommendations from the most recent stock assessments and/or estimates of landings, discards, and effort in fisheries that interact with sharks using the same process used in this rulemaking as outlined below. In addition, shark landings estimates in the Final Environmental Impact Statement (FEIS) for alternative suites 1 and 4 have been updated according to landings reported in Federal and state shark dealer reports. This is discussed in Appendix C of this document.

A.1 Sandbar quota and retention limit

The 2005/2006 LCS assessment assessed sandbars separately and recommended a sandbar specific TAC of 158.3 mt dw (220 mt ww). The assessment stated that this TAC provides a 70-percent chance of rebuilding sandbar sharks by the year 2070. Based on this recommendation, NMFS is proposing to remove sandbar sharks from the LCS complex. This would allow sandbar sharks to be managed separately and gives NMFS the ability to track this separate quota more efficiently, which is critical given the overfished and overfishing status of sandbar sharks.

To determine the proportion of the 158.3 mt dw TAC for sandbar that would be available for the commercial fishery, NMFS accounted for mortality of sandbar sharks in all sectors of recreational and commercial fisheries. NMFS first determined the commercial TAC by subtracting the average number of recreational sandbar shark landings (27 mt dw) per year from the 158.3 mt dw TAC, resulting in a commercial TAC of 131.3 mt dw (Table A.1). NMFS then determined the available commercial quota by subtracting discards in the HMS pelagic longline (PLL) fishery and non-HMS fisheries (*e.g.*, the snapper-grouper and tilefish fisheries) as well as the set-aside for display and research quota (see below under discussion of alternative suite 2). NMFS also accounted for landings recorded in the Coastal Fisheries Logbook by fishermen who did not have valid or current HMS shark permits. NMFS subtracted dead discards/landings from non-permit holders and recreational fishermen because it is assumed that mortality will continue regardless of directed fishery management measures. The total landings and discards from each of these data sources can be found in Table A.1. By removing these landings and/or mortalities

from the commercial TAC (131.3 mt dw; Table A.1), NMFS has determined that the available commercial sandbar quota is 116.6 mt dw (or 6,347 sandbar sharks, which is 116.6 mt dw / average commercial sandbar weight of 40.5 lb dw (Cortés and Neer, 2005)).

Table A.1 Calculation of sandbar quota.

	mt dw
Total sandbar shark TAC	158.3
Average Annual Recreational Landings	27
Resultant Commercial TAC (158.3 mt dw – 27 mt dw)	131.3 (7,147.3* sandbar sharks)
Average annual number of sandbars landed/discarded by non-HMS permit holders in Coastal Fisheries Logbook	6.1
Average annual number of sandbars discarded by incidental permit holders in Coastal Fisheries Logbook	2.3
Average annual number of dead discards on PLL gear in the HMS Logbook	4.3
Public display quota	1
Research quota	1
All gillnet discards	0.018
Extrapolated number of discards in snapper-grouper and tilefish BLL fishery based on BLL observer program	0
<i>Total discards</i>	<i>14.7</i>
Resultant sandbar shark quota (131.3 mt dw – 14.7 mt dw)	116.6 (6,346.9* sandbar sharks)

* assumes an average commercial sandbar shark weight of 40.5 lb dw (Cortés and Neer, 2005)

To determine sandbar retention limits for the different alternative suites, NMFS projected the number of trips that could be taken by directed and incidental permit holders based on past fishing effort. However, this level of effort may not be realized in the future given the reduced sandbar TAC; therefore, retention limits could be changed as necessary via proposed rule or framework actions based on quota monitoring and realized fishing effort.

The sandbar retention limit is dependent on which part of the commercial fishery (*i.e.*, directed and/or incidental permit holders) is allowed to retain sandbar sharks. For instance, alternative suite 2 would allow only directed shark permit holders to retain any shark species, and there would be no retention of sandbar sharks with PLL gear. Therefore, the 116.6 mt dw of sandbar quota was averaged over the average annual number of directed shark permit holder trips reported in the Coastal Fisheries Logbook from 2003 through 2005. This would result in a sandbar trip limit of 8 sandbar sharks for directed permit holders (Table A.2).

Table A.2 Calculation of sandbar retention limit for alternative suites 2 through 4.

Alternative Suite	Average annual trips taken by directed permit holder that landed sharks in the Coastal Fisheries Logbook	Average annual trips taken by incidental permit holder that landed sharks in the Coastal Fisheries Logbook	Average annual BLL, directed permit holder trips taken in the HMS Logbook landing sharks	Average annual PLL trips, directed permit holder trips in the HMS Logbook landing sharks	Average annual PLL, incidental permit holder trips in the HMS Logbook landing sharks	Total Trips	Retention Limit (6,346.9 sandbars / total trips)
2*	790	*	†	β	*	790	8 sharks/trip
3	790	49.7	80	237.7	255.3	1,413	4 sharks/trip
4						92 [#]	0 outside research fishery

*only directed permit holders would be allowed to land sharks

β no retention of sandbar sharks on PLL gear

† since sandbar sharks cannot be retained on PLL gear, it is assumed that BLL sets will not be made on PLL vessels; fishermen primarily report PLL sets in HMS Logbook, but some BLL sets may also be reported in the HMS Logbook by PLL vessels.

[#] number of trips with 4,000 lb dw trip limit for sandbar sharks that would fulfill the 116.6 mt dw sandbar shark quota (assuming 2,800 lb dw sandbar sharks/trip)

To help estimate the appropriate number of fishing trips by directed permit holders, NMFS also investigated individual vessel's average annual sandbar landings and trips made that landed sandbar sharks from 2003 through 2005 in the Coastal Fisheries and HMS Logbooks (see Figure A.1 and Figure A.2). In doing so, NMFS investigated whether or not there was a portion of the commercial directed shark fishery that made a majority of the sandbar landings. If a small proportion of the fishermen possessing directed shark permits landed a majority of the sandbar sharks, then the predicted number of directed fishing trips could be based on the number of trips taken by those vessels in the past. This could lower the number of trips by directed shark permit holders and potentially increase the retention limit of sandbar sharks. However, after examining the average annual sandbar landings and average annual number of trips taken that landed sandbar sharks, there was no obvious portion of the directed shark fishery that made a majority of the sandbar landings. Rather, most of the directed shark fishermen had moderate sandbar landings (see Figure A.1) with only a few vessels landing more than 3,000 lb dw of sandbars on an average trip (Figure A.3). Therefore, NMFS averaged the available 116.6 mt dw of sandbar quota over the average annual number of all trips made by directed shark permit holders in the Coastal Fisheries Logbook (Table A.2).

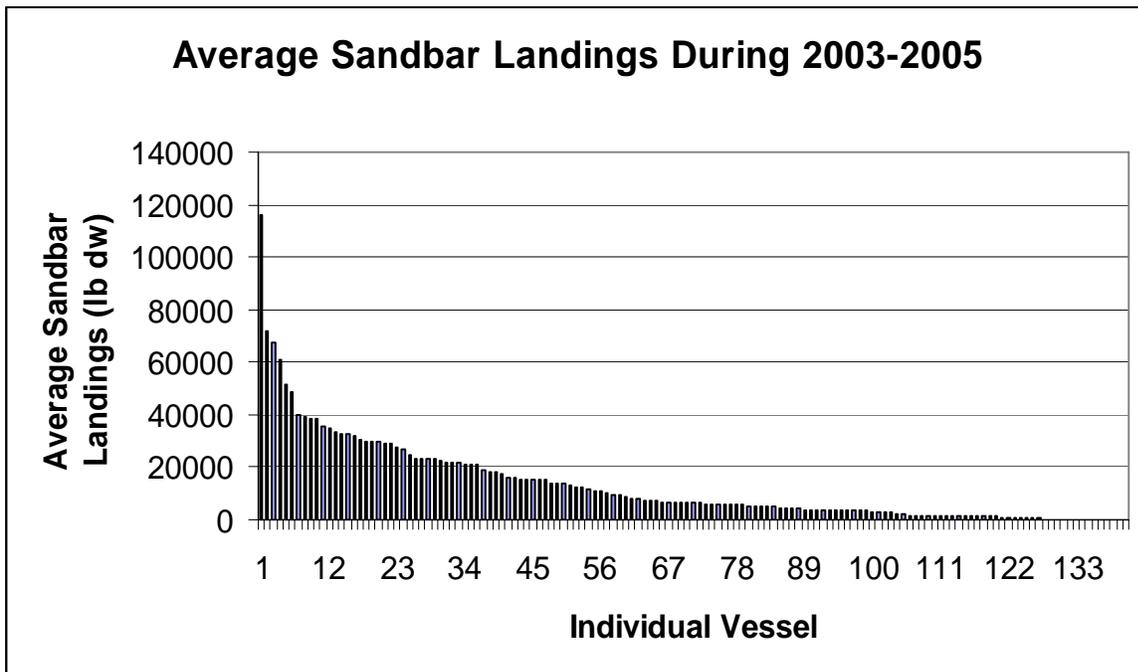


Figure A.1 Average annual sandbar landings (lb dw) for individual vessels during 2003 to 2005. The average sandbar landings per vessel was 13,150 lb dw per year. Source: Coastal Fisheries Logbook and HMS Logbook.

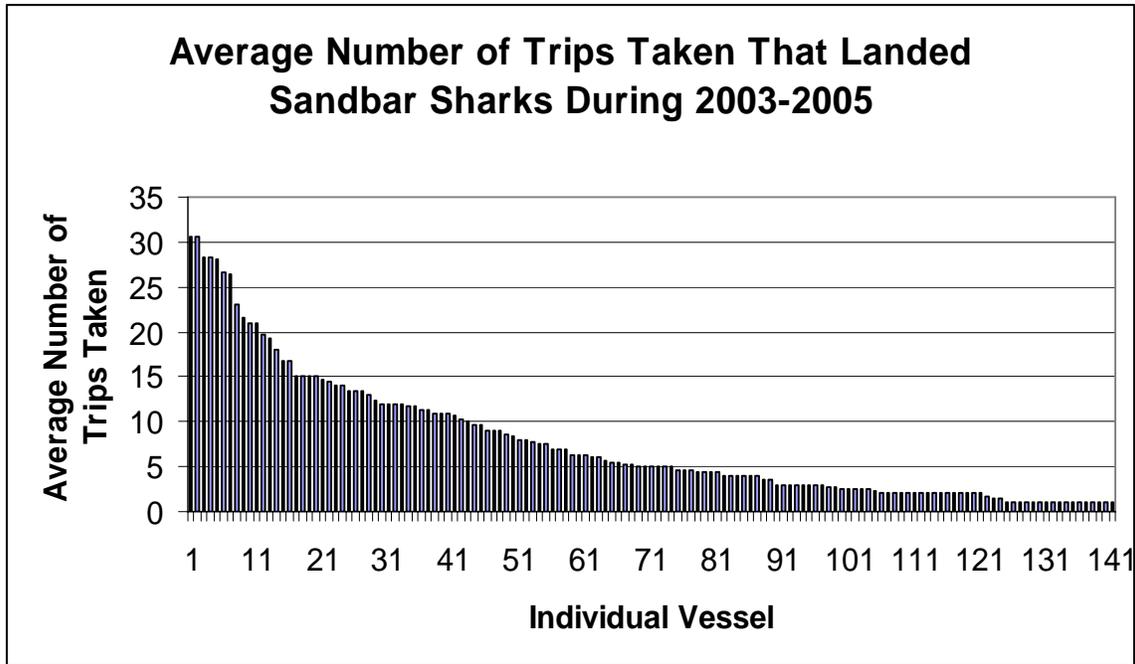


Figure A.2 Average annual number of trips taken that landed sandbar sharks for individual vessels from 2003 to 2005. Source: Coastal Fisheries Logbook and HMS Logbook.

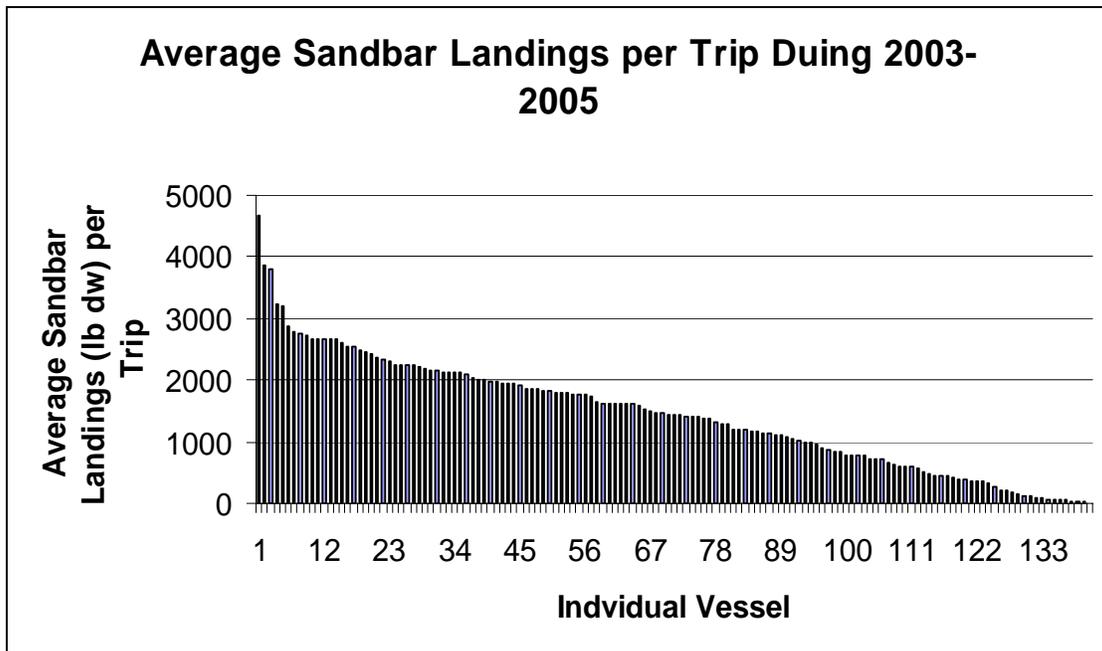


Figure A.3 Average sandbar landings (lb dw) per trip taken for individual vessels from 2003 to 2005. The average sandbar landings was 1,417.5 lb dw per trip. Source: Coastal Fisheries Logbook and HMS Logbook.

Similarly for alternative suite 3, which would allow sandbar landings by both directed and incidental shark permit holders, NMFS spread the 116.6 mt dw of sandbar quota over the average annual number of trips that made sandbar landings by directed and incidental permit holders recorded in both Coastal Fisheries logbook and the HMS logbook to determine a retention limit of 4 sandbar sharks/trip (Table A.2).

Finally, alternative suite 4 would establish a small research fishery that could harvest the 116.6 mt dw sandbar quota and retain other shark species and would be afforded higher trip limits for sandbar sharks and non-sandbar LCS than vessels operating outside the research fishery. Vessels outside this research fishery would not be allowed to retain sandbar sharks. NMFS first determined the number of trips it would take to land the sandbar quota, assuming a 4,000 lb dw sandbar and non-sandbar LCS trip limit (however, this trip limit would be based on the research objectives for a given year). The number of trips was determined by looking at the catch composition of directed BLL trips reported in the BLL observer program (Hale and Carlson, 2007). The observer program data indicated that 70 percent of the catch on directed shark BLL trips in the South Atlantic region was comprised of sandbar sharks whereas 30 percent of the catch on directed shark BLL trips in the Gulf of Mexico region was comprised of sandbar sharks. By taking a precautionary approach and assuming that 70 percent of a 4,000 lb dw trip limit would be made up of sandbar sharks and that the average sandbar shark is 40.5 lb dw (Cortés and Neer, 2005), the 116.6 mt dw of sandbar quota could be caught in approximately 92 trips (see Table A.2). Therefore, for the purposes of analysis relative to other alternatives, a small universe of vessels in the research program would be able to make approximately 92 trips with a 4,000 lb dw sandbar and non-sandbar LCS trip limit, which would fulfill the sandbar quota. Specifics of the research program, including trip limits, would be determined to meet specific research objectives and may not be structured based on a 4,000 lb dw trip limit. For additional details on the research program, see Chapters 2 and 4.

A.2 Non-sandbar quota and retention limits

The 2005/2006 LCS assessment also assessed blacktip sharks separately and recommended that the catch of Atlantic and Gulf of Mexico blacktip populations not change or increase, respectively, given the unknown status for the Atlantic blacktip population and the relatively healthy status for the Gulf of Mexico population. Based on this LCS assessment, NMFS also determined that the status of the LCS complex is unknown. Given the unknown or healthy status of these species and the larger available quota relative to the sandbar quota, management for these species would be based on a new non-sandbar LCS complex in alternative suites 2 through 4, which has sandbar sharks removed from the complex (non-sandbar LCS complex = silky, tiger, blacktip, spinner, bull, lemon, nurse, scalloped hammerhead, great hammerhead, and smooth hammerhead sharks). The non-sandbar LCS quota is based on the average annual catch of these species from 2003 to 2005, as recommended by the most recent LCS stock assessment (Table A.3a). A TAC was established for non-sandbar LCS based on total catch and discards from all sectors of the LCS fishery (Table A.3b). It should be noted that the TAC for non-sandbar LCS under the preferred alternative suite 4 was updated in the FEIS based on Southeast Fisheries Science Center's (SEFSC) recommendations. This discussion can be found in Appendix C.

Table A.3 Calculation of non-sandbar LCS quota and TAC.

	mt dw
a) Non-sandbar LCS Quota	
Average annual number of non-sandbar LCS landed by non-HMS permit holders in Coastal Fisheries Logbook	15.1
Average annual number of non-sandbar LCS landed by incidental permit holders in Coastal Fisheries Logbook	16.3
Average annual number of non-sandbar LCS landed by directed permit holders in Coastal Fisheries Logbook	503
Average annual number of non-sandbar LCS kept on PLL gear in the HMS Logbook	19.9
Average annual number of non-sandbar LCS kept on BLL gear in the HMS Logbook	28.1
<i>total</i>	582.4
Research and Public Display Quota	41.2
Resultant Quota (582.4 mt dw – 41.2 mt dw)	541.2
b) Non-sandbar LCS TAC	
Average Annual Recreational Landings	309.8
Total gillnet discards (both shark and non-directed shark fisheries)	19.9
Extrapolated number of discards in snapper/grouper and tilefish BLL fishery based on BLL observer program	3.5
Extrapolated number of discards in directed shark BLL fishery based on BLL observer program	116.7
Average annual number of dead discards on PLL gear in the HMS Logbook	12.6
Average annual number of dead discards on BLL gear in the HMS Logbook	0.7
<i>Total discards and recreational landings</i>	463.2
Total TAC (582.4 mt dw of landings + 463.2 mt dw of discards & recreational landings)	1,045.6

Retention limits for non-sandbar LCS were calculated in different ways, depending on the alternative suite being considered. Since the overall quota for non-sandbar LCS is higher than the overall sandbar quota, retention limits are higher for non-sandbar LCS than they are for sandbar sharks. To reduce the number of sandbar sharks that would be discarded as fishermen fulfill their non-sandbar LCS retention limits in alternative suites 2 and 3, the non-sandbar LCS retention limits were based on the ratio of sandbar sharks to non-sandbar LCS caught in the BLL observer program (Hale and Carlson, 2007). However, the ratio of sandbar sharks to non-sandbar LCS caught varied between the Gulf of Mexico and South Atlantic regions. In the Gulf of Mexico region, there was a 1:4 ratio (1 sandbar for 4 non-sandbar LCS) whereas in the South Atlantic region there was a 1:1.4 ratio. In addition, the fishing effort varied among regions, with 2/3 of the BLL effort occurring in the Gulf of Mexico region and 1/3 of the BLL effort occurring in the South Atlantic region (Coastal Fisheries Logbook). Therefore, NMFS had to accommodate for differences in catch composition and fishing effort in the different regions when setting the non-sandbar LCS retention limit for alternative suites 2 and 3.

This balance was important to limit discards of sandbar sharks in the region with the lower sandbar to non-sandbar LCS ratio (*i.e.*, the South Atlantic). For instance, using the 1:4 sandbars to non-sandbar LCS ratio in the Gulf of Mexico to set the retention limit would result in a 32 non-sandbar LCS retention limit with an 8 sandbar shark retention

limit per trip (8 sandbars x 4 = 32 non-sandbar LCS). However, given the 1:1.4 ratio in the South Atlantic, an 8 sandbar shark retention limit/trip would equal a 11 non-sandbar LCS retention limit in the South Atlantic (8 sandbar sharks x 1.4 = 11.2 non-sandbar LCS). Therefore, setting one retention limit based on the Gulf of Mexico's catch ratio would result in excessive sandbar sharks discards. To determine the number of sandbar discards that would occur in the South Atlantic with a Gulf of Mexico's 1:4 ratio, it must first be determined the number of sandbar shark discards that would occur on a South Atlantic trip with a retention limit based on the Gulf of Mexico's catch ratio. This is done by determining the difference in the retention limits for non-sandbar LCS based on the respective ratios in the two regions; setting a non-sandbar LCS retention limit using the South Atlantic ratio would result in no sandbar discards; any non-sandbar LCS retention limit above that threshold would result in sandbar discards, but the number of discards would depend on the difference between the two retention limits divided by sandbar to non-sandbar ratio in the South Atlantic:

- Gulf of Mexico non-sandbar LCS retention limit = 8 sandbars x 4 = 32 non-sandbar LCS
- South Atlantic non-sandbar LCS retention limit = 8 sandbar sharks x 1.4 = 11.2 non-sandbar LCS (or 11 non-sandbar LCS)
- 32 non-sandbar LCS retention limit based on Gulf of Mexico ratio - 11 non-sandbar LCS retention limit based on South Atlantic = 21 non-sandbar LCS;
- 21 non-sandbar LCS/1.4 = 15 sandbar sharks discarded per trip in South Atlantic;
- 15 sandbar sharks x 237 South Atlantic trips = 3,555 sandbar sharks discarded in the South Atlantic; and
- 3,555 sandbar sharks x 40.5 lb dw [average commercial sandbar weight] = 143,977.565.3 lb dw or 65.3 mt dw.

Setting a non-sandbar LCS retention limit in the South Atlantic based on the Gulf of Mexico's catch ratio would therefore result in approximately 65.3 mt dw of sandbar shark discards as fishermen meet their sandbar retention limit and continue to fish for non-sandbar LCS, and discard sandbar sharks, in the South Atlantic.

Therefore, the non-sandbar LCS retention limit was determined by using an average ratio (or 1:2.7) for the two regions. This resulted in a slightly lower non-sandbar LCS retention limit in the Gulf of Mexico compared to its regional ratio (*i.e.*, 21 non-sandbar LCS versus 32 non-sandbar LCS) and a slightly higher non-sandbar LCS retention limit in the South Atlantic compared to its regional ratio (*i.e.*, 21 non-sandbar LCS versus 11 non-sandbar LCS). However, this average ratio balanced the number of sandbar sharks that would be discarded in the South Atlantic with the amount of sandbar quota that would not be harvested in the Gulf of Mexico (Table A.4). Given the lowered non-sandbar LCS retention limit for the Gulf of Mexico region, not all of the 116.6 mt dw of sandbar quota would be harvested under alternative suites 2 and 3 (86.1 mt dw and 105.9 mt dw, respectively). This is to compensate for the discards in the South Atlantic (see Table A.4). In addition, because the non-sandbar LCS retention limit is based on a

ratio approach to limit sandbar discards (*i.e.*, the entire non-sandbar LCS quota was not averaged over the total number of fishing vessels as was done for sandbar sharks), only a portion of the non-sandbar LCS quota would be harvested under alternative suites 2 and 3 (253.6 mt dw and 229.2 mt dw, respectively).

Table A.4 Calculation of non-sandbar LCS retention limits for alternative suites 2 and 3. Note: these limits assume 237 BLL trips in the South Atlantic (SA) region and 553 trips in the Gulf of Mexico (GOM) region for alternative suite 2, and 290 BLL trips in the SA region and 581 trips in the GOM region for alternative suite 3.

Alternative Suite	Sandbar Retention Limit	Regional Ratios of Sandbars to Non-Sandbar LCS Caught	Non-Sandbar LCS Retention Limit Based on Regional ratios	Average Sandbar to Non-Sandbar LCS Ratio ¹	Non-Sandbar LCS retention limit based on average ratio	Sandbar Discards in South Atlantic Region (mt dw) ²	Sandbar quota not caught in the Gulf of Mexico Region (mt dw) ³	Net Sandbar discards ⁴	Resulting Sandbar Quota Harvested (mt dw)	Resulting Non-Sandbar Quota Harvested (mt dw)
2	8	1:4 (GOM)	32	2.7	21	30.5	30.5	0	86.1	253.6
		1:1.4 (SA)	11							
3	4	1:4 (GOM)	16	2.7	10	15.4	10.7	4.7	105.9	229.2
		1:1.4 (SA)	6							

¹The Gulf of Mexico regional ratio of sandbars to non-sandbar LCS caught is 1:4. The South Atlantic regional ratio of sandbars to non-sandbar LCS caught is 1:1.4. The average ratio is $(4 + 1.4)/2 = 2.7$ or a combined 1:2.7 ratio.

²**Alternative suite 2:** A 21 other LCS trip limit would mean that 7 sandbar discards would occur per South Atlantic regional trip (21 other LCS-11 other LCS=9.8 other LCS/1.4 ratio = 7 sandbar sharks discarded). This equates to 30.5 mt dw of sandbar discards over 237 South Atlantic regional trips (7 sandbars x 237 trips = 1,659 sandbars discarded. 1,659 sandbars x 40.5 [average sandbar weight] = 30.5 mt dw).

Alternative suite 3: A 10 other LCS trip limit would mean 2.9 sandbar discards would occur per South Atlantic regional trip (10 other LCS – 6 other LCS = 4 other LCS/1.4 ratio = 2.9 sandbar discarded). This equates 15.4 mt dw of sandbar discards over 290 South Atlantic regional trips (2.9 sandbars x 290 trips = 841 sandbars discarded. 841 sandbars x 40.5 [average sandbar weight] = 15.4 mt dw).

³**Alternative suite 2:** With a 21 non-sandbar LCS trip limit, fishermen in the Gulf of Mexico region would potentially only catch ~5 sandbars per trip. With an 8 sandbar/trip retention limit, this would mean 3 sandbar sharks would not be caught per trip. This equates to approximately 30.5 mt dw of sandbar quota that would not be caught in the Gulf of Mexico region (8 sandbar limit - 5 sandbars caught = 3 sandbars not caught. 3 sandbars not caught x 553 trips = 1,659 total sandbars not caught x 40.5 [average sandbar weight] = 30.5 mt dw of sandbars not caught).

Alternative suite 3: With a 10 non-sandbar LCS retention limit, fishermen in the Gulf of Mexico region would potentially only catch ~3 sandbars per trip. With a 4 sandbar/trip retention limit, this would mean 1 sandbar shark would not be caught per trip. This equates to approximately 10.7 mt dw of sandbar quota that would not be caught in the Gulf of Mexico region (4 sandbar limit - 3 sandbars = 1 sandbar not caught. 1 sandbar not caught x 581 trips = 581 total sandbars not caught x 40.5 [average sandbar weight] = 10.7 mt dw of sandbars not caught)

⁴**Alternative suite 2:** 30.5 mt dw – 30.5 mt dw = 0 mt dw net discards of sandbar sharks

Alternative suite 3: 15.4 mt dw – 10.7 mt dw = 4.7 mt dw net discards of sandbar sharks

Alternative suite 4 would allow vessels outside of a small shark research fishery to retain non-sandbar LCS as well as SCS and pelagic sharks (Table 2.1). However, the available non-sandbar LCS quota and associated retention limit outside the research fishery was based on the amount of non-sandbar LCS quota that could be caught in the research fishery. Based on catch composition in the BLL observer report, NMFS assumed that approximately 92 trips with a 4,000 lb dw trip limit could be taken by a small number of vessels in a shark research fishery to harvest the available sandbar quota of 116.6 mt dw (however, the actual trip limit would be based on the research objectives for a given year). This assumed that the catch composition was 70 percent sandbar sharks and 30 percent non-sandbar LCS (Hale and Carlson, 2007; Table A.2). Based on 92 trips with a catch composition of 30 percent non-sandbar LCS, it is estimated that 50 mt dw of non-sandbar LCS quota would be harvested by vessels within the research fishery (Table A.5). This would leave 491 mt dw of non-sandbar LCS quota available to vessels outside of the research fishery (541.2 mt dw non-sandbar LCS quota – 50 mt dw quota harvested within the research fishery = 491 mt dw quota available outside the research fishery). This quota was averaged over the average annual number of trips that landed non-sandbar LCS by directed and incidental permit holders reported in the Coastal Fisheries logbook and the HMS logbooks. This would result in a 22 non-sandbar LCS retention limit per trip for vessels operating outside of the research fishery (Table A.5). It should be noted that the retention limits for non-sandbar LCS under the preferred alternative suite 4 was updated in the FEIS based on SEFSC's recommendations and public comment. This discussion can be found in Appendix C.

Table A.5 Non-sandbar LCS retention limits for alternative suite 4.

Alternative Suite	Average annual trips taken by directed permit holder that landed sharks in the Coastal Fisheries Logbook	Average annual trips taken by incidental permit holder that landed sharks in the Coastal Fisheries Logbook	Average annual BLL, directed permit holder trips taken in the HMS Logbook landing sharks	Average annual PLL trips, directed permit holder trips in the HMS Logbook landing sharks	Average annual PLL, incidental permit holder trips in the HMS Logbook landing sharks	Total Trips	Non-sandbar LCS quota (mt dw) available outside research fishery 1,200 lb dw non-sandbar LCS/trip x 92 trips = 50.0 mt dw non-sandbar LCS (541.2 mt dw – 50.0 mt dw = 491 mt dw)	Retention Limit (non-sandbar LCS quota / total trips)
4	790	92	80	237.7	255.3	1,455	491	22 sharks/trip outside of research fishery

Appendix A References

- Cortés, E. and J.A. Neer. 2005. Updated catches of Atlantic sharks. LCS05/06-DW-16. NMFS, Southeast Fisheries Science Center, Panama City, Florida. 58 p.
- Hale, L.F. and J.K. Carlson. 2007. Characterization of the Shark Bottom Longline Fishery: 2005-2006. National Oceanic and Atmospheric Administration Technical Memorandum. NMFS-SEFSC-554. 25pp.