10.10 GEAR REQUIREMENTS IN THE FLOUNDER GILL NET FISHERY[1]
Revised

Issue

Evaluation of the 5.5-inch stretched mesh minimum mesh size for large mesh flounder gill nets under a 14-inch minimum size limit, and the effort in the large mesh gill net fishery.

Background

The large mesh gill net fishery is the major commercial fishery targeting southern flounder with annual landings surpassing the flounder pound net fishery since 1995 (see Section 7.1, Status of the Commercial Fishery for more information). This issue was addressed in the 2005 Southern Flounder FMP to investigate gear requirements that minimize the undersized bycatch of southern flounder and to prevent further increases in gill net fishing effort (NCDMF 2005). The management measures implemented by the FMP for this issue were a minimum mesh size of 5.5 inches stretched mesh for large mesh gill nets from April 15 to December 15, a maximum yardage limit of 3,000 yards per operation for gill nets 5 inches stretched mesh and larger in estuarine waters, and the requirement that Recreational Commercial Gear License (RCGL) holders attend their large mesh gill nets at all times from the NC Highway 58 Bridge at Emerald Isle to the South Carolina state line (NCDMF 2005). The minimum mesh size of 5.5 inches stretched mesh for large mesh gill nets was implemented to minimize undersized bycatch of southern flounder resulting from the increase in the minimum size limit from 13 inches to 14 inches. Amendment 1 to the Red Drum FMP implemented full time attendance of gill nets 5 inches stretched mesh and greater that are set less than 10 feet from any point of the shoreline from June through October as a means of reducing red drum bycatch (NCDMF 2008b). Large mesh gill nets from 5 inches to less than 5.5 inches stretched mesh are prohibited in estuarine waters from April 15 to December 15 (15A NCAC 03J .0103 (b)) but are permitted at other times of the year for gill net fisheries targeting American shad, hickory shad, and spotted sea trout.

This issue paper will evaluate the effectiveness of the minimum mesh size under the current southern flounder minimum size limit of 14 inches for the commercial fishery and management measures that limit effort in the commercial gill net fishery. In addition, this issue paper will evaluate the potential impacts on effort and harvest in the southern flounder gill net fishery from Proclamation M-8-2010, which was implemented on May 15, 2010 to minimize interactions with sea turtles in the large mesh gill net fisheries while the NCDMF applies for a coast wide incidental take permit from the National Marine Fisheries Service (NMFS) under Section 10 of the Endangered Species Act. However, these management measures will still be in effect if an incidental take permit is granted. The specific management measures from Proclamation M-8-2010 that will be evaluated are the maximum yardage limit reductions, the maximum gill net length, the minimum distance between gill net sets, and the removal of large mesh gill nets from the water during the day. The impact of prohibiting large mesh gill nets from being set from Friday morning until Monday evening are evaluated in the issue paper “Achieving Sustainable Harvest”.

[1] Emailed to the PDT on 6/2/2010, Presented to the AC on 7/1/2010, NCDMF recommendation 10/19/10, NCMFC preferred recommendations and approved to send to DENR secretary and JLCSA 11/4/10, Revised PDT 7/27/12

Current Authority

G.S. 113-134	RULES
G.S. 113-182	REGULATION OF FISHING AND FISHERIES
G.S. 143B-289.52	MARINE FISHERIES COMMISSION--POWERS AND DUTIES

NC Fisheries Rules for Coastal Waters 2009 (15A NCAC)

03J .0103	GILL NETS, SEINES, IDENTIFICATION, RESTRICTIONS
03M .0503	FLOUNDER

Discussion

Data Sources

The data analysis for this issue paper relied on three different data sources: the NCDMF gill net observer program data, NCDMF fishery dependent fish house sampling of the estuarine gill net fishery, and the NCDMF trip ticket data. The gill net observer program data provided length frequency distributions of southern flounder caught in large mesh gill nets. The length frequencies from the different mesh sizes were compared to determine the differences in the proportion of undersized southern flounder caught and the potential harvest reductions from increasing the minimum mesh size of large mesh gill nets. The fishery dependent fish house sampling of the estuarine gill net fishery was analyzed to determine the proportion of large mesh gill net trips fishing 5.5-inch stretched mesh gill net by area and season, the average large mesh gill net yardage fished per operation by area and year, the proportion of large mesh gill net trips per operation in 500-yard increments by area and year, effort reduction from maximum yardage limit decreases, and the catch per unit effort (CPUE) of southern flounder in the large mesh gill net fishery by area and year. The trip ticket data provided the proportion of large mesh gill net trips landing southern flounder by season and area. This information was used for weighting the harvest reduction estimates from a minimum mesh size increase to 5.75-inch stretched mesh and from maximum yardage decreases by fishing effort.

Minimum Mesh Size

This issue in the 2005 FMP examined fishery independent (Albemarle Sound and Pamlico Sound Independent Gill Net surveys), fishery dependent (NCDMF gill net observer data), and a Fishery Resource Grant (FRG) gill net study conducted in Brunswick County (Beresoff et al. 2001) to determine the size distribution of southern flounder caught in different mesh sizes (NCDMF 2005). At that time, the NCDMF gill net observer program data was limited to the Pamlico Sound Gill Net Restricted Area (PSGNRA), which necessitated the use of fishery independent data and the FRG to cover other times and areas where large mesh gill nets were fished. However, the independent surveys do not use 5.75-inch stretched mesh gill nets, which is a commonly used mesh size by the commercial southern flounder gill net fishery. The NCDMF gill net observer program was expanded spatially and temporally in 2004, which provided observations outside of the location and time period for the PSGNRA. Therefore, the minimum mesh size analysis in this issue paper used length frequency data of southern flounder by mesh size from the NCDMF gill net observer program from 2001 to 2008 to determine the size distribution of southern flounder caught in 5.5-inch, 5.75-inch, and 6-inch stretched mesh gill nets. This data was examined coast wide and by area for the estuaries. The area designations are found in Table 10.20. Samples from Newport River and Bogue

Sound were included in the Southern area for this analysis due to the relatively small number of samples collected from this region. The results of this analysis were also compared to two FRGs that examined gill net selectivity of southern flounder (Kimel et al. 2008; Hassell 2009b).

Table 10.20 Estuarine area designations and their associated water bodies.

Area	Water bodies
Albemarle	Albemarle Sound and its tributaries, including Currituck Sound
Croatan-Roanoke	Croatan and Roanoke sounds
Pamlico	Pamlico Sound and its bays
Rivers	Pamlico, Pungo, Neuse, and Bay rivers
Core-Back	Core and Back sounds, including North River
Southern	Beaufort Inlet to the South Carolina state line

A total of 18,227 southern flounder lengths was available for 5.5-inch stretched mesh gill nets, 8,444 lengths for 5.75-inch stretched mesh gill nets, and 31,941 lengths for 6-inch stretched mesh gill nets coast wide (Table 10.21). The Pamlico area had the most southern flounder length frequencies for all three mesh sizes. Length frequency data from 5.5-inch gill nets were greatest for the other areas. Although the program was expanded spatially and temporally in 2004, most of the sampling effort still came from the PSGNRA. Consequently, the length frequency data is quite limited for some area and mesh size combinations.

Table 10.21 Number of large mesh estuarine gill net trips observed that caught southern flounder and the number of southern flounder lengths by mesh size by area from the NCDMF gill net observer program, 2001-2008 (NCDMF Observer Program).

		Lengths by Mesh size		
Area	Observed trips	5.5-inch	5.75-inch	6-inch
Coast wide	1,867	18,227	8,444	31,941
Albemarle	97	2,200	334	131
Croatan-Roanoke	39	138	53	69
Pamlico	1,315	7,303	6,624	31,047
Rivers	281	5,640	254	133
Core-Back	77	1,447	1,179	560
Southern	58	1,499		

The size distribution of southern flounder from the different mesh sizes showed much overlap, but the 5.5-inch stretched mesh gill nets tended to catch smaller fish (Figure 10.26). Coast wide, the modal length of southern flounder by mesh size was 14 inches for 5.5-inch, 15.5 inches for 5.75-inch, and 15.5 inches for 6-inch stretched mesh. By area, the modal size of southern flounder ranged from 14 to 14.5 inches for 5.5-inch mesh, 14 to 15.5 inches for 5.75-inch mesh, and 15 to 16.5 inches for 6-inch stretched mesh. The disparity of modal fish sizes for the different areas is likely a result of sample size, differences in fish availability for these areas, and possibly a result of different twine sizes of gill nets used in different parts of the estuaries. Southern flounder 18 inches and greater were observed less frequently in the upper

estuaries than in the lower estuaries (Figure 10.26). In general, smaller twine size gill nets are used in the upper portions of the estuaries such as Albemarle Sound and the Rivers (NCDMF, unpublished data). Smaller twine sizes tend to entangle fish rather than gill them (NCDMF 2005). Unfortunately, there were insufficient data available to analyze mesh size selectivity by twine size and by area fished.

Kimel et al. (2008) investigated mesh selectivity of southern flounder for 5.5-inch, 5.75-inch, 6-inch, and 6.25-inch stretched mesh gill nets in the southeastern part of the state between Mason and Topsail inlets. The modal size of southern flounder by mesh size was 14.2-14.6 inches for 5.5-inch, 15 inches for 5.75-inch, 15.4 inches in 6-inch, and 16.9 inches for 6.25-inch stretched mesh. Hassell (2009b) investigated gill net mesh selectivity of southern flounder for 5.5-inch, 5.75-inch, and 6-inch stretched mesh in the upper Pamlico River between Washington and Ragged Point. The modal size of southern flounder by mesh size was 15 inches for 5.5-inch, 15.4 inches for 5.75-inch, and 15.4 inches in 6-inch stretched mesh.

The proportion of southern flounder less than 14 inches decreased as mesh size increased for most areas (Table 10.22). Coast wide, southern flounder less than 14 inches comprised 30% of the fish caught in 5.5-inch stretched mesh gill nets, 16% of the fish caught in 5.75-inch stretched mesh and 7% of the fish caught in 6-inch stretched mesh. By area, the proportion of southern flounder less than 14 inches in 5.5-inch stretched mesh ranged from 23% in Pamlico Sound to 42% in the Rivers. For 5.75-inch and 6-inch stretched mesh sizes, the Albemarle area and the Rivers had the highest proportion of southern flounder less than 14 inches. As was the case with the modal sizes by mesh size, the disparity in the proportion of undersized fish at the different areas is likely a result of differences in the size of the southern flounder available for capture in different areas, a reflection of low sample sizes, and possibly a result of different twine sizes of gill nets used in different parts of the estuaries.

In the southeastern part of the state between Mason and Topsail inlets, undersized southern flounder comprised 23% of the fish caught in 5.5-inch and 5.75-inch stretched mesh gill nets, 21% of the fish caught in the 6-inch stretched mesh, and 7% of the fish caught in 6.25-inch stretched mesh (Kimel et al. 2008). In the upper Pamlico River, undersized southern flounder comprised 17% of the fish caught in 5.5-inch stretched mesh, 6% of the fish caught in 5.75-inch stretched mesh and 1% of the fish caught in 6-inch stretched mesh (Hassell 2009b). The observer data and the FRGs show that the proportion of undersized southern flounder in gill nets can differ for different parts of the estuaries, but the proportion of southern flounder less than 14 inches generally decreases as the mesh size increases.

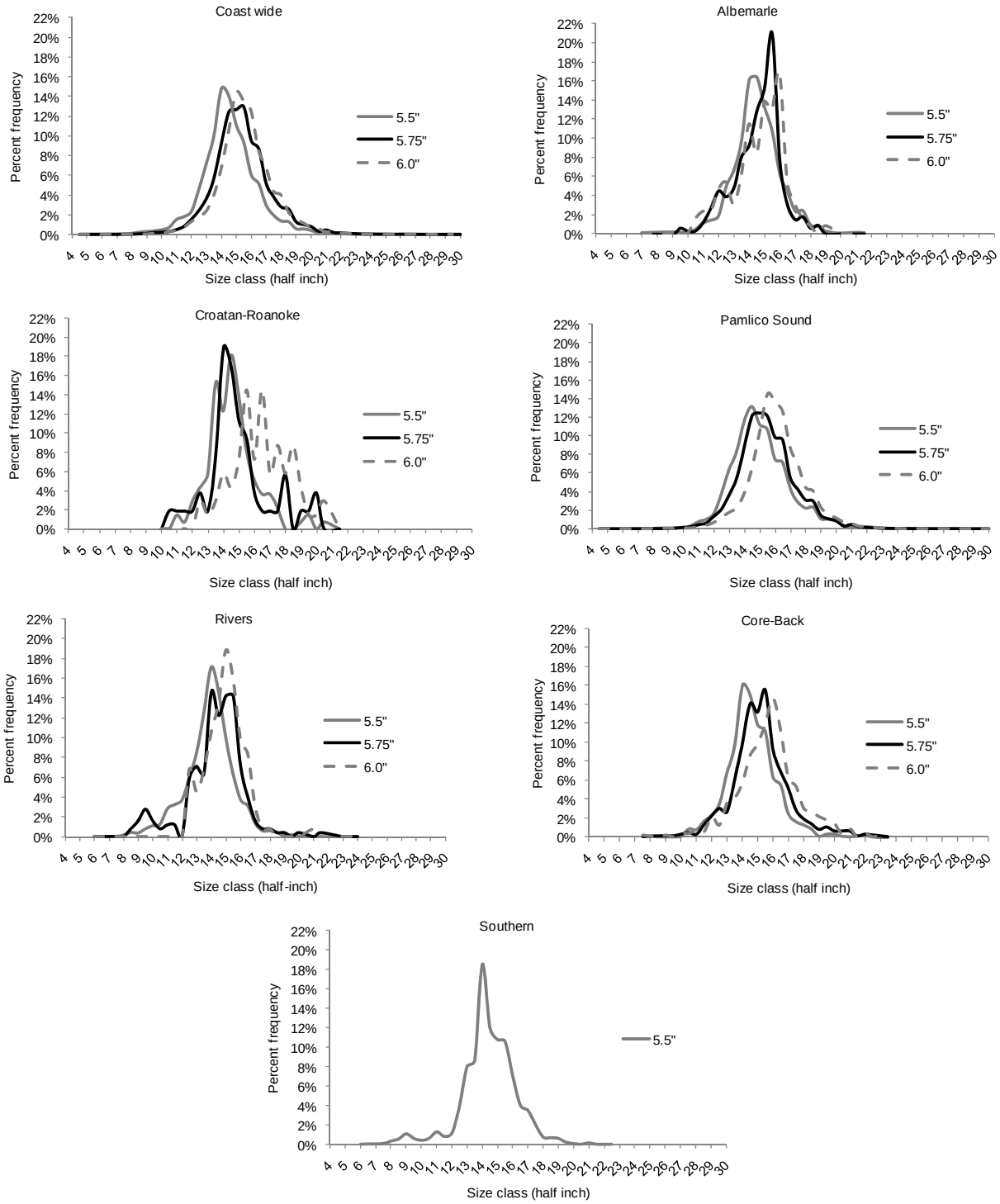

Figure 10.26 Length frequency distributions of southern flounder by mesh size and by area, 2001-2008 (NCDMF Observer Program).

Table 10.22 Proportion of southern flounder less than 14 inches by mesh size and area, 2001-2008 (NCDMF Observer Program).

	Mesh size		
Area	5.5-inch	5.75-inch	6-inch
Coast wide	29.85%	15.53%	7.34%
Albemarle	26.32%	26.35%	19.08%
Croatan-Roanoke	30.43%	20.37%	7.25%
Pamlico	22.85%	14.28%	7.13%
Rivers	41.56%	29.13%	18.05%
Core-Back	26.40%	16.28%	13.39%
Southern	28.29%		

The proportion of southern flounder 14 inches and greater in the 5.5-inch stretched mesh was compared to the 5.75-inch and 6-inch stretched mesh sizes to examine whether any legal sized fish were lost using the larger gill nets (Figure 10.26). Potential harvest reductions were calculated by summing the differences in size class percent frequencies where a greater proportion of fish were caught in the 5.5-inch stretched mesh gill nets than in the 5.75-inch and 6-inch stretched mesh gill nets. This analysis showed that legal sized southern flounder less than 15 inches were lost from 5.75-inch stretched mesh gill nets and legal size southern flounder less than 15.5 inches were lost from 6-inch stretched mesh gill nets compared to what was retained in the 5.5-inch stretched mesh gill nets. The overall estimated reduction in number of fish between 5.5-inch and 5.75-inch gill nets was 7.1%. The overall estimated reduction in number of fish between 5.5-inch and 6-inch gill nets was 18.9%. The area specific estimated reductions in number of fish between 5.5-inch and 5.75-inch stretched mesh gill nets ranged from 3.7% in the Pamlico area to 10.4% in the Albemarle area (Table 10.23). The overall harvest reduction estimate of 7.1% was used for areas where the data was too limited to calculate an area specific reduction.

To determine the potential harvest reduction from increasing the minimum mesh size for large mesh gill nets to 5.75-inch stretched mesh, the proportion of large mesh gill net effort for mesh sizes less than 5.75-inch stretched mesh was examined for different areas and seasons using the fishery dependent fish house sampling of the estuarine gill net fishery. The season designations were winter (January-March), spring (April-May), summer (June-August), and fall (September-December). The proportion of large mesh gill net trips landing southern flounder by area from 2004 to 2007 from the trip ticket program was used to weight the harvest reduction estimates. Gear codes for large mesh (5-inch stretched mesh and greater) and small mesh (less than 5-inch stretched mesh) gill nets were added to the trip ticket program in 2004; examining these trips removed small mesh gill net trips that incidentally landed southern flounder. These reference years for landings were chosen to coincide with the most recent landings (2000-2007) in Section 7.1—Status of the Commercial Fisheries.

The proportion of large mesh gill net effort for gill nets less than 5.75-inch stretched mesh was highest in the spring and decreased through the fall (Table 10.23). Fishermen tended to increase the mesh size used as larger fish became available in the late summer and fall. Large mesh gill net trips increased through the year with peak landings in the fall for most areas. When the area specific reductions (percentage of legal size southern flounder not retained by shifting from a 5.5-inch to a 5.75 inch gill net) are multiplied by the percentage of effort using gill

nets less than 5.75-inch stretched mesh by area and season, the total weighted harvest reduction is 3.1% (Table 10.23). The Albemarle area would experience the largest proportion of this reduction because total large mesh gill net trips and large mesh gill net effort for gill nets less than 5.75-inch stretched mesh are highest in this area. The total weighted harvest reduction is relatively low because large mesh gill net effort from nets less than 5.75-inch mesh is lowest when overall large mesh gill net effort is the highest.

Table 10.23 Harvest reduction estimate in numbers of fish from increasing the minimum mesh size for large mesh gill nets to 5.75-inch stretched mesh from April 15 to December 15 (NCDMF Estuarine Gill Net Fish House Sampling Program).

Area	Season	Percent of total trips	Percent effort using < 5.75-Inch mesh	Mesh size reduction	Season and area reduction
Albemarle	Winter	2.72%	-	-	-
	Spring	2.92%	100.00%	10.39%	0.30%
	Summer	4.89%	16.85%	10.39%	0.09%
	Fall	12.97%	45.13%	10.39%	0.61%
Croatan-Roanoke	Winter	1.05%	-	-	-
	Spring	0.37%	57.06%	7.14%	0.01%
	Summer	1.62%	9.84%	7.14%	0.01%
	Fall	4.91%	15.49%	7.14%	0.05%
Pamlico	Winter	0.45%	-	-	-
	Spring	1.65%	94.52%	3.73%	0.06%
	Summer	8.62%	30.93%	3.73%	0.10%
	Fall	12.57%	10.20%	3.73%	0.05%
Rivers	Winter	2.11%	-	-	-
	Spring	4.89%	93.82%	4.98%	0.23%
	Summer	6.68%	90.06%	4.98%	0.30%
	Fall	7.39%	85.18%	4.98%	0.31%
Core-Back	Winter	0.02%	-	-	-
	Spring	2.06%	90.05%	7.13%	0.13%
	Summer	5.75%	86.84%	7.13%	0.36%
	Fall	4.65%	48.36%	7.13%	0.16%
Newport-Bogue	Winter	0.00%	-	-	-
	Spring	0.16%	60.00%	7.14%	0.01%
	Summer	0.76%	12.96%	7.14%	0.01%
	Fall	1.27%	69.11%	7.14%	0.06%
Southern	Winter	0.25%	-	-	-
	Spring	1.45%	26.13%	7.14%	0.03%
	Summer	3.96%	34.30%	7.14%	0.10%
	Fall	3.89%	57.09%	7.14%	0.16%
				Total harvest reduction	3.13%

This analysis assumes that the season and area specific effort estimates by mesh size from the estuarine gill net fish house sampling is reflective of the fishery in that season and area. The potential harvest reduction would be higher than estimated if the actual large mesh gill net effort for nets less than 5.75-inch mesh is higher than estimated. Conversely, the potential harvest reduction would be lower than estimated if the actual large mesh gill net effort for nets less than 5.75-inch mesh is lower than estimated.

Although increasing the minimum mesh size of large mesh gill nets to 5.75-inch stretched mesh shows a reduction in the number of legal sized southern flounder less than 15 inches, it is possible that this loss could be recouped by larger fish caught in 5.75-inch mesh and larger gill nets. There was no significant difference in the catch per unit effort in numbers of legal southern flounder caught in the three sampled mesh sizes in the upper Pamlico River (Hassell 2009b). Kimel et al. (2008) also found no significant difference in the catch per unit effort (CPUE) in pounds of flounder for the 5.5-inch, 5.75-inch, and 6-inch stretched mesh sizes. Gill net selectivity studies assume that the nets with different mesh sizes have similar fishing power (ASMFC 2000). If southern flounder of a certain size are not as available in a particular season or area, then one mesh size could have lower catch rates than the other mesh size. In the southern flounder fishery, fewer large fish are available in the spring than in the fall, so it is likely that the fishing power of the different mesh sizes is not equal throughout the year. Therefore, the estimated harvest reduction from increasing the minimum mesh size to 5.75-inch stretched mesh assumes appreciable recoupment of larger fish will not occur. If recoupment does occur, then the actual harvest reduction would be less.

Increasing the minimum mesh size of large mesh gill nets to 5.75-inch stretched mesh would reduce the proportion of undersized southern flounder that are caught, which could reduce the number of dead discards from the large mesh gill net fishery. The 2009 Southern Flounder Stock Assessment assumed an annual discard mortality rate of 17.3% from gill nets based on NCDMF gill net observer program data (Takade-Heumacher and Batsavage 2009). Seasonal discard mortality rates were unavailable for this fishery because the number of gill net observer samples by season and area was too variable. Smith and Scharf (2009) investigated post-release survival of undersized southern flounder from the large mesh gill net fishery in New River. The overall survival rate of undersized southern flounder retrieved from the net was 70% (30% mortality). At-net survival was lowest in the summer and highest in the spring and fall. Low dissolved oxygen events occurred regularly throughout the New River during the study, which may have contributed to a higher mortality estimate than what was observed in the NCDMF gill net observer data (Smith and Scharf 2009). However, the seasonal trends in mortality were similar to what was observed in the large mesh gill net samples from the Pamlico Sound Independent Gill Net Survey (spring/fall: 1%; summer: 14%) (Paramore 2009).

The impact of implementing a minimum mesh size increase for large mesh gill nets would be greatest in the spring when gill net effort from nets less than 5.75-inch stretched mesh is greatest and the availability of larger southern flounder is low. This is also during a time when southern flounder gill net mortality is relatively low (Paramore 2009; Smith and Scharf 2009). Instead of implementing the minimum mesh size increase from April 15 to December 15, it could be implemented from June 1 to December 15 to minimize the impact of this management measure on the spring fishery. Removing the spring months from this minimum mesh size increase would result in a total weighted harvest reduction of 2.4% (Table 10.23).

The percentage of undersized southern flounder landed in the gill net fishery increased after the minimum size limit increased to 14 inches. In the two years prior to the size limit increase (2003 and 2004), undersized southern flounder comprised less than 3% of the gill net catch of

southern flounder. In the two full years after the size limit increase (2006 and 2007), undersized southern flounder comprised nearly 7% of the catch. This increase in non-compliance by the fishermen could be the result of an inadequate minimum large mesh gill net mesh size for a 14-inch minimum size limit, strong year class(es) entering the fishery in 2006 and 2007, insufficient enforcement of the 14-inch minimum size limit, or a combination of these factors. Implementing a minimum mesh size of 5.75-inch for large mesh gill nets could help in reducing the percentage of undersized southern flounder landed in the gill net fishery.

Increasing the minimum mesh size for large mesh gill nets could also impact the landings of other marketable species by the southern flounder gill net fishery. Southern flounder account for over 80% of the landings from the southern flounder gill net fishery (NCDMF 2005). However, other species such as black drum, red drum, sheepshead, bluefish and white catfish are also commonly landed. An increased minimum mesh size could reduce the harvest of some species that are not caught as often in large mesh gill nets, but harvest could increase for species that are commonly caught in large mesh gill nets by selecting for larger fish. Gill net selectivity analyses for these species are needed to determine the actual impact on landings.

Maximum Yardage Limit

The intent of the maximum yardage limit of 3,000 yards per operation was to reduce the effort of fishing operations setting more than 3,000 yards and to avoid further expansion of effort in the southern flounder gill net fishery. However, fishery dependent sampling of the estuarine gill net fishery from 2000 to 2009 indicated that the average length of large mesh gill net fished has increased in some parts of the state, and these increases occurred after the FMP was implemented in 2005 (Figure 10.27). The most notable increase in effort was in Core and Back sounds where the average amount of large mesh gill net fished per operation increased from approximately 1,600 yards in 2000 to almost 2,500 yards in 2008. Proclamation M-15-2009, issued on August 6, 2009, decreased the maximum yardage limit for large mesh gill nets to 1,000 yards per operation in Core Sound, Back Sound, Newport River, and the estuarine waters behind Hammocks Beach State Park to minimize sea turtle interactions. This management measure decreased the average amount of large mesh gill net fished per operation to 2,100 yards in Core and Back sounds in 2009. It also contributed to the increased average amount of large mesh gill net fished in Pamlico Sound because this proclamation resulted in fishermen in Core Sound shifting their effort to Pamlico Sound. The average amount of large mesh gill net fished in the Rivers also increased by over 300 yards per trip in 2009. Very low sample sizes in the Albemarle area in 2002 and 2003 precluded investigating the trend in average yards of large mesh gill net fished for the entire time series for this area (Table 10.24). The average yardage fished for this area ranged between 1,650 and 2,150 yards per year. The Southern area of the coast (Bogue Inlet to the South Carolina state line) could not be examined due to small numbers of samples collected prior to 2008; the small number of samples from the Newport River and Bogue sounds for the entire time series also prevented analyzing the mean yardage fished for this area.

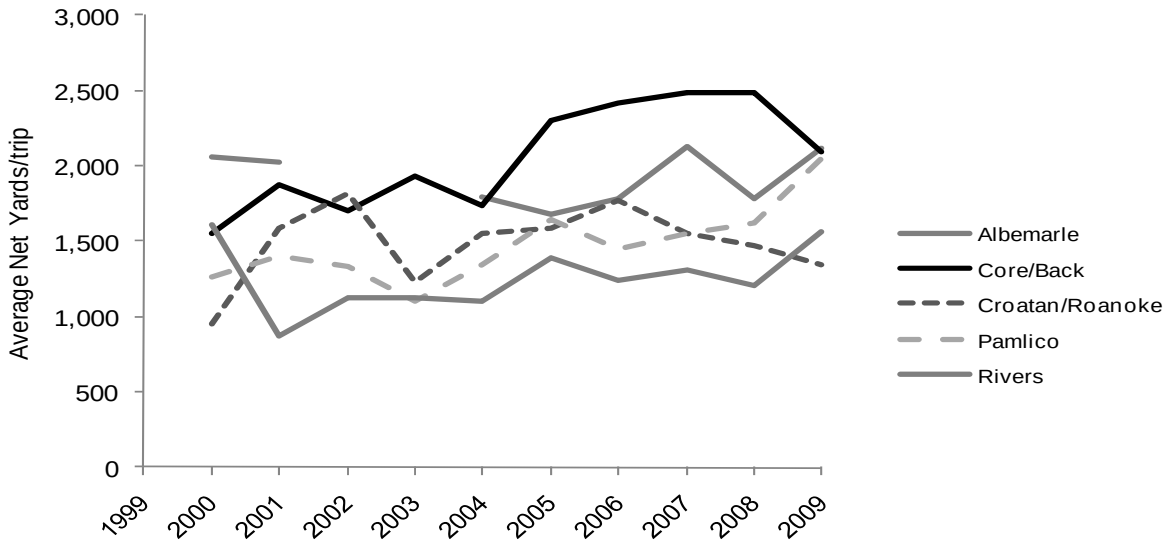

Figure 10.27 Average yardage of large mesh gill net fished per operation by water body, 2000-2009. Note: Insufficient data available for the Albemarle area in 2002 and 2003 due to very low sample sizes (NCDMF Estuarine Gill Net Fish House Sampling Program).

Table 10.24 Number of large mesh gill net samples by area available for maximum gill net yardage limit analysis, 2000-2009 (NCDMF Estuarine Gill Net Fish House Sampling Program).

	Area						
Year	Albemarle	Croatan-Roanoke	Pamlico	Rivers	Core-Back	Newport-Bogue	Southern
2000	35	18	78	70	49	3	2
2001	27	14	51	48	45	0	1
2002	3	15	60	100	55	0	8
2003	9	15	64	69	47	0	7
2004	23	48	72	47	52	3	3
2005	14	38	107	61	71	5	7
2006	18	56	174	70	79	8	2
2007	11	36	162	68	119	15	16
2008	16	41	178	49	168	7	51
2009	19	37	175	57	109	6	46

To further analyze the trends in the amount of large mesh gill net fished per operation, the proportion of large mesh gill net trips (in 500-yard increments) was examined. The majority of large mesh gill net trips in Core and Back sounds before 2005 fished between 1,501 and 2,000 yards per operation (Figure 10.28). The proportion of trips fishing greater than 2,500 yards in Core and Back sounds increased to 71% of the trips sampled in 2008 before decreasing to 54% in 2009. The proportion of trips fishing greater than 2,500 yards of large mesh gill net in Pamlico Sound has increased since 2005 with a substantial increase in 2009. The proportion of trips fishing between 1,501 and 2,000 yards in the Rivers increased in 2009, which likely contributed to the increase in average large mesh net fished here in 2009. Very few trips in

Croatan and Roanoke sounds fished greater than 2,000 yards per trip; most trips fished less than 1,500 yards. The trend in the proportion of large mesh gill nets in Albemarle Sound was not as definitive.

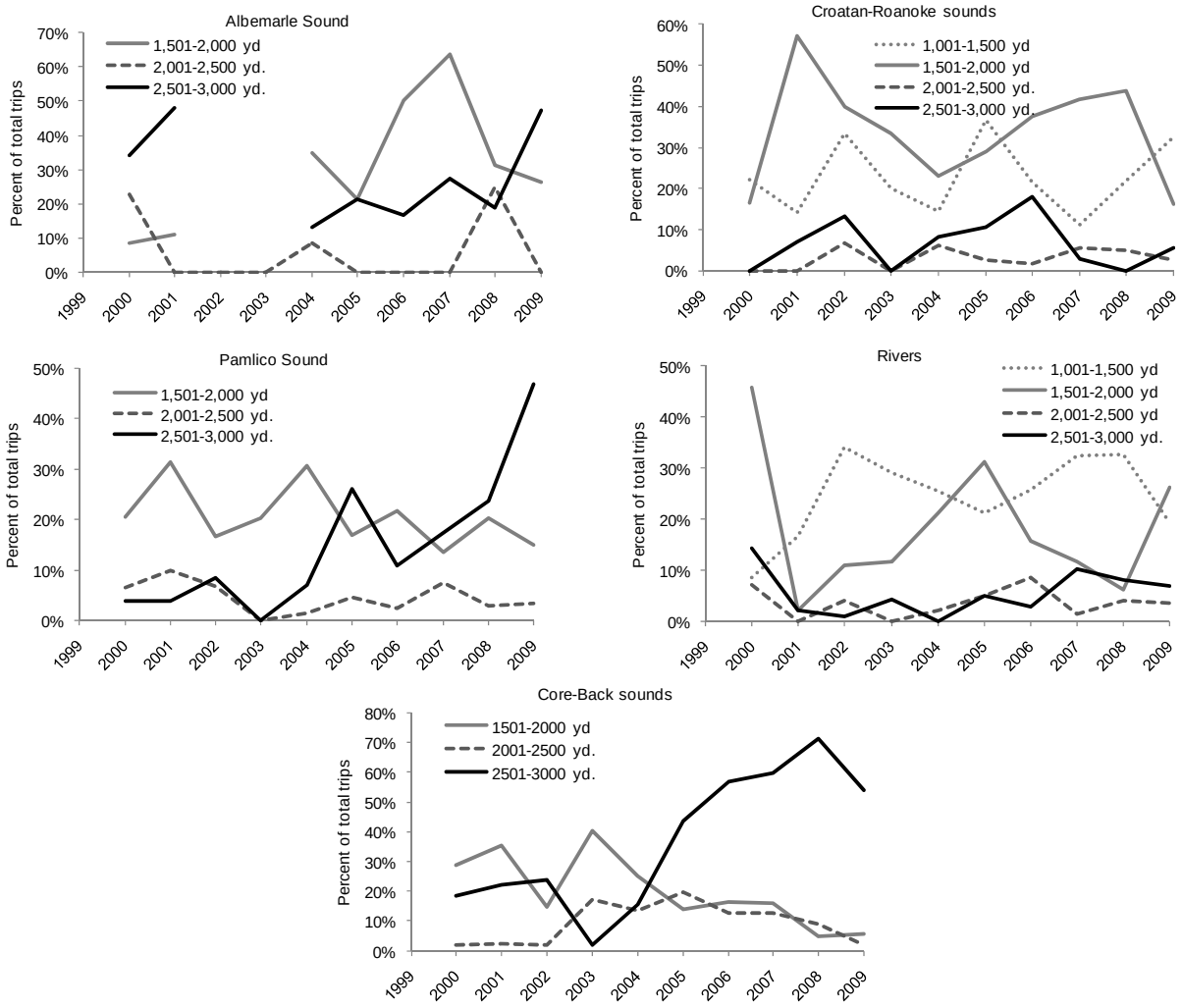

Figure 10.28 Proportion of large mesh gill net trips in 500 yard increments by water body, 2000-2009. Note: Insufficient data available for the Albemarle area in 2002 and 2003 due to very low sample sizes (NCDMF Estuarine Gill Net Fish House Sampling Program).

As the amount of large mesh gill net fished has increased, the CPUE (pounds per trip) of flounder landed has decreased overall and in many parts of the state (Figure 10.29). The minimum size limit increase from 13 inches to 14 inches in 2005 is responsible for some of this decrease, but the CPUE increased in 2007 for Albemarle Sound and in 2009 for Croatan and Roanoke sounds and has steadily decreased for several years after the size limit increase in places like Pamlico Sound and the Rivers. The CPUE tended to decrease in areas where the average yards of large mesh gill net fished per operation increased, which could be an indication that there is more fishing effort in these areas than the southern flounder population can sustain.

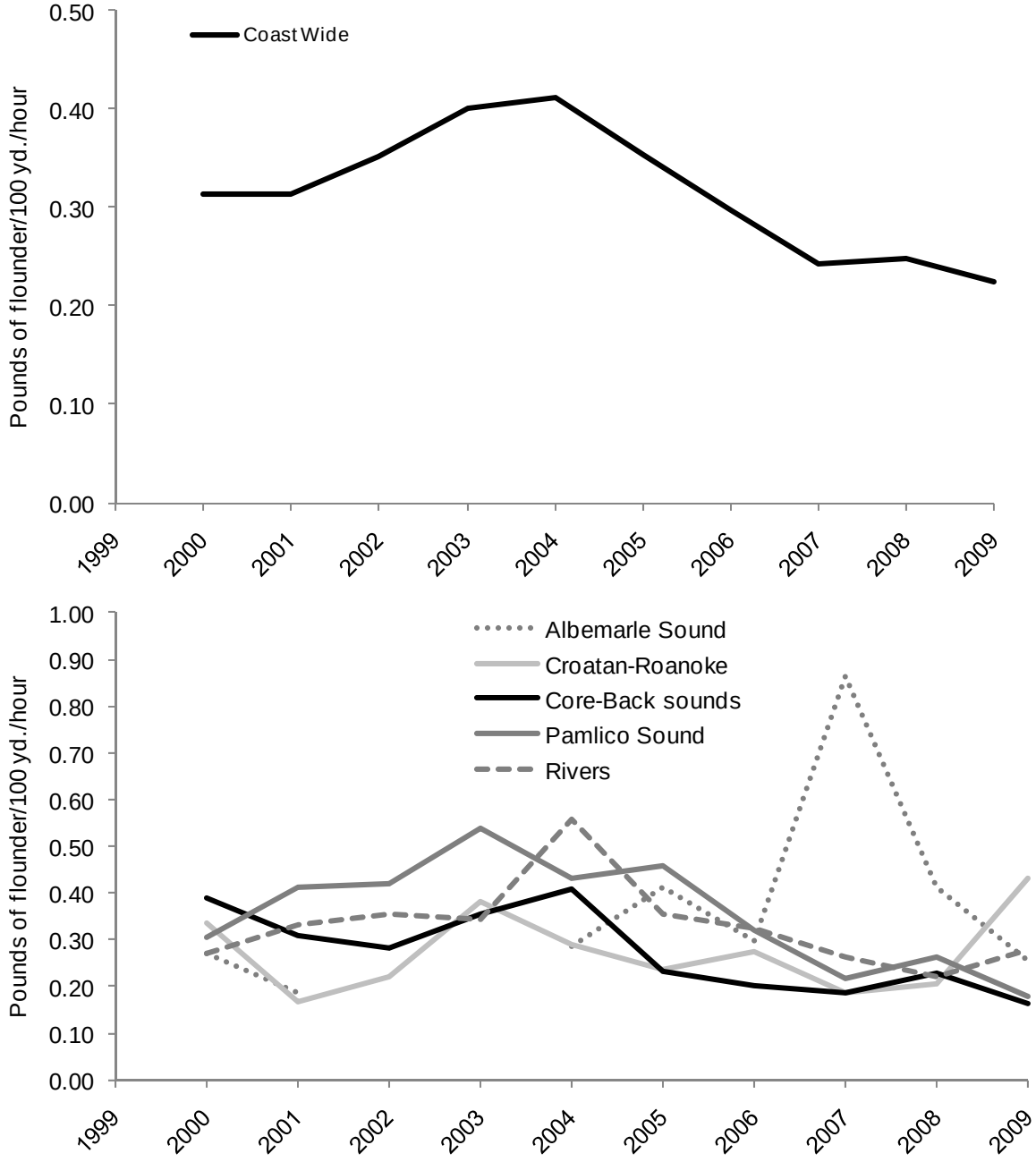

Figure 10.29 Catch per unit effort (CPUE) of flounder in large mesh gill nets coast wide and by water body, 2000-2009. Note: Insufficient data available for the Albemarle area in 2002 and 2003 due to very low sample sizes (NCDMF Estuarine Gill Net Fish House Sampling Program).

A yardage limit reduction could reduce the harvest of southern flounder, which would help end overfishing and rebuild the spawning stock. Management options for three different sets of yardage limits for different areas in the estuarine waters are given. To determine the potential harvest reduction estimate for each option, the reduction in effort was calculated based on the proportion of trips in 500-yard increments by area in 2009; this year was chosen because it

represents the most current distribution of gill net fishing effort for southern flounder in the state. The reduction in effort for trips in 500-yard increments was based on three different sets of yardage limits and the proportion of effort for trips in 500-yard increments by area. These effort reductions were then weighted by the proportion of large mesh gill net trips landing southern flounder by area from 2004 to 2007 from the trip ticket program.

Proclamation M-8-2010 reduced the maximum yardage limit for large mesh gill nets to 2,000 yards from Albemarle Sound east of Alligator River and Currituck Sound south of the US Highway 158 Bridge to western Bogue Sound at the NC Highway 58 Bridge at Emerald Isle; the yardage limit was reduced to 1,000 yards from south of the NC Highway 58 Bridge at Emerald Isle to the South Carolina state line (Figure 10.30). The large mesh gill net yardage limit for flounder gill nets remains at 3,000 yards in Albemarle Sound west of Alligator River and Currituck Sound north of the US Highway 158 Bridge. Under this management, the greatest effort reduction would occur in the Southern area due to the smaller yardage limit and in Pamlico, Core, and Back sounds since these areas had the highest proportion of large mesh gill net effort from trips fishing greater than 2,000 yards (Table 10.25, Figure 10.28). However, the effort reduction estimate for Core and Back sounds might be high because this data included samples collected before the maximum yardage limit was reduced to 1,000 yards by Proclamation M-15-2009 on August 6, 2009. The area specific harvest reduction is greatest for Pamlico Sound due to the proportion of large mesh gill net trips landing southern flounder from this area. The total weighted harvest reduction in numbers of fish is 9.3% (Table 10.25).

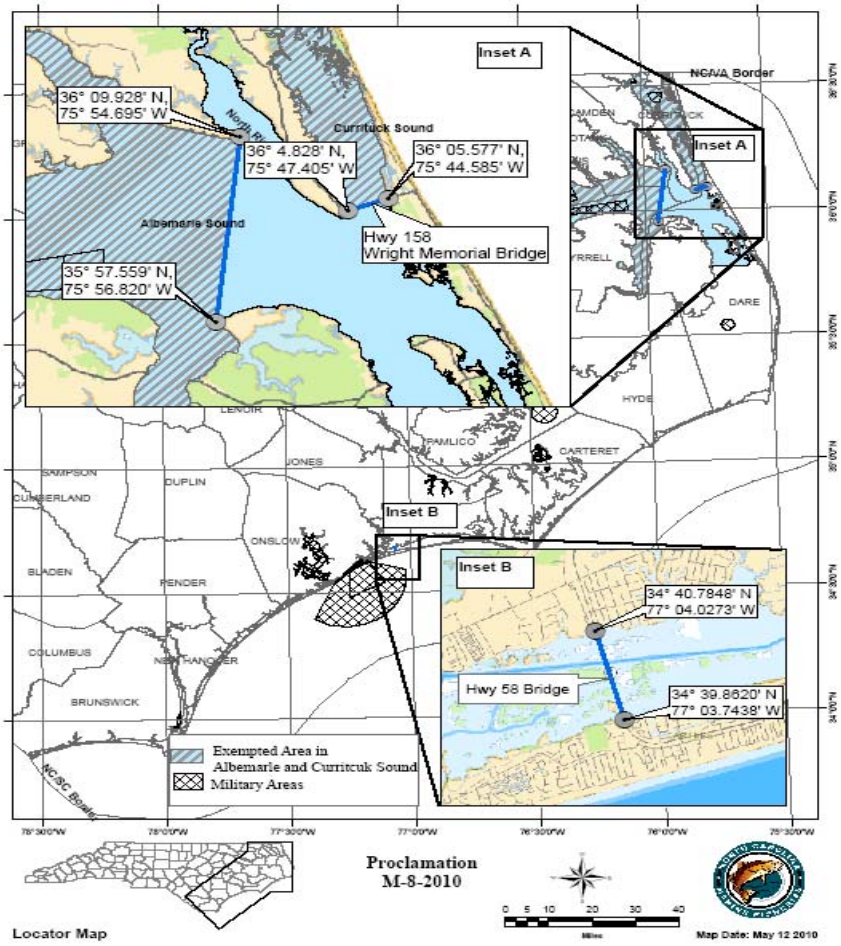

Figure 10.30 Map of the maximum yardage limits for large mesh gill nets implemented by Proclamation M-8-2010.

Table 10.25 Effort reduction and harvest reduction estimates from decreasing the coast wide maximum large mesh gill net yardage limit to 2,000 yards per operation from the Croatan/Roanoke area to Bogue Sound, and 1,000 yards per operation in the Southern area (NCDMF Estuarine Gill Net Fish House Sampling Program and NCDMF Trip Ticket Program).

Area	Effort reduction	Percent of total trips	Area reduction
Albemarle^	0.00%	23.49%	0.00%
Croatan-Roanoke*	2.34%	7.94%	0.19%
Pamlico*	15.59%	23.29%	3.63%
Rivers*	4.87%	21.06%	1.03%
Core-Back*	17.01%	12.48%	2.12%
Newport-Bogue*	0.00%	2.19%	0.00%
Southern#	24.03%	9.55%	2.29%
		Total harvest reduction	9.26%

^ 3,000 yd limit
* 2,000 yd limit
# 1,000 yd limit

Under Proclamation M-8-2010, no reduction in effort would occur in the Albemarle area, which accounts for the majority of southern flounder gill net landings in the state. This could result in effort shifting to this area in order to avoid the management measures implemented by this proclamation. Proclamation M-15-2009 decreased the maximum yardage limit for large mesh gill nets to 1,000 yards per operation in Core Sound, Back Sound, Newport River, and the estuarine waters behind Hammocks Beach State Park to minimize sea turtle interactions, so the 2,000-yard limit from Core Sound to Bogue Sound would actually be an increase in the maximum yardage limit in these waters. In addition, much of the large mesh gill net effort in the Rivers is from trips setting less than 1,500 yards. A 2,000-yard maximum yardage limit would result in minimal effort and harvest reductions for these areas, and it could result in increased effort if fishermen increased their fishing effort to 2,000 yards. An alternative option is to reduce the maximum large mesh yardage limit to 2,000 yards for the entire Albemarle area, 2,000 yards in Croatan, Roanoke, and Pamlico sounds, 1,000 yards per operation for the Rivers and the Southern area and maintain the 1,000 yard limit in Core, Back, and Bogue sounds and the Newport River. The greatest effort reductions under this option would occur in Core and Back sounds followed by the Rivers and Southern area (Table 10.26). However, the effort reduction estimate for Core and Back sounds might be high because this data included samples collected before the maximum yardage limit was reduced to 1,000 yards by Proclamation M-15-2009 on August 6, 2009. The area specific harvest reduction are greatest for the Rivers and Core and Back sounds due to the effort reduction and large proportion of large mesh gill net trips landing southern flounder from these areas. The total weighted harvest reduction in numbers of fish is 20.9% (Table 10.26).

Table 10.26 Effort reduction and harvest reduction estimates from decreasing the coast wide maximum large mesh gill net yardage limit to 2,000 yards per operation in the Albemarle, Croatan/Roanoke, and Pamlico areas and 1,000 yards per operation in the Rivers and from Core Sound to the South Carolina state line (NCDMF Estuarine Gill Net Fish House Sampling Program and NCDMF Trip Ticket Program).

Area	Effort reduction	Percent of total trips	Area reduction
Albemarle*	15.79%	23.49%	3.71%
Croatan-Roanoke*	2.34%	7.94%	0.19%
Pamlico*	15.59%	23.29%	3.63%
Rivers#	28.54%	21.06%	6.01%
Core-Back#	39.19%	12.48%	4.89%
Newport-Bogue#	8.33%	2.19%	0.18%
Southern#	24.03%	9.55%	2.29%
		Total harvest reduction	20.90%

* 2,000 yd limit

\# 1,000 yd limit

Another option would be the yardage limits proposed in the previous option (Table 10.26) except for a 2,000 yard maximum yardage limit for Core and Back sounds. It was quite evident that gill netters in Core and Back sounds shifted their fishing effort to Pamlico Sound after Proclamation M-15-2009 reduced the yardage limit to 1,000 yards (Figures 10.27 and 10.28). Fishermen in this portion of the estuaries typically fish in all three sounds, so a consistent yardage limit for this area would spread fishing effort over a wider area instead of concentrating it in just one area. The greatest effort reductions under this option would occur in the Rivers and Southern area (Table 10.27). The area specific harvest reductions are greatest for the Rivers due to the effort reduction and large proportion of large mesh gill net trips landing southern flounder. The total weighted harvest reduction in numbers of fish is 18.1% (Table 10.27).

Table 10.27 Effort reduction and harvest reduction estimates from decreasing the coast wide maximum large mesh gill net yardage limit to 2,000 yards per operation in the Albemarle, Croatan/Roanoke, Pamlico, and Core/Back areas and 1,000 yards per operation in the Rivers and from the Newport River to the South Carolina state line (NCDMF Estuarine Gill Net Fish House Sampling Program and NCDMF Trip Ticket Program).

Area	Effort reduction	Percent of total trips	Area reduction
Albemarle*	15.79%	23.49%	3.71%
Croatan-Roanoke*	2.34%	7.94%	0.19%
Pamlico*	15.59%	23.29%	3.63%
Rivers#	28.54%	21.06%	6.01%
Core-Back*	17.01%	12.48%	2.12%
Newport-Bogue#	8.33%	2.19%	0.18%
Southern#	24.03%	9.55%	2.29%
		Total harvest reduction	18.14%

* 2,000 yd limit
\# 1,000 yd limit

Harvest reduction estimates from reducing the maximum yardage limit assume that fishermen setting less than the new maximum yardage limit will not increase their fishing effort to the new limit, the gill net CPUEs remain constant, and the proportion of trips fishing more than the new yardage limits is reflective of the actual fishing effort in these areas; violations of any of these assumptions will impact the harvest reduction estimates. Large mesh gill net effort increased in some areas after the 3,000 yard maximum yardage limit was implemented in 2005 (Figures 10.27 and 10.28), and the CPUEs generally decreased in areas where large mesh gill net effort increased (Figure 10.29). Other management measures such as limitations on how and when large mesh gill nets can be set could help prevent effort increases. However, the decreasing CPUEs where large mesh gill net effort increased indicate that southern flounder landings could remain the same with less fishing effort. The uncertainty over whether these assumptions would be violated requires these harvest reduction estimates be viewed cautiously.

Limitations on How and When Large Mesh Gill Nets Can be Set

Management measures that limit the length of any individual large mesh gill net, limit the length of large mesh gill nets that can be set without any breaks or spacing, and to establish a minimum distance between large mesh gill net sets could be implemented to prevent increases in large mesh gill net effort. Proclamation M-18-2009 implemented a maximum gill net length of 200 yards and a minimum space of 25 yards between separate lengths of large mesh gill nets in the PSGNRA to minimize sea turtle interactions in the large mesh gill net fishery; Proclamation M-15-2009 implemented the same maximum gill net length of 200 yards and a minimum space of 25 yards between separate lengths of large mesh gill nets for Core Sound, Back Sound, Newport River, and portions of Bogue Sound to also minimize sea turtle interactions.

Proclamation M-8-2010 implemented a maximum large mesh gill net length of 100 yards and a minimum space of 25 yards between separate lengths of large mesh gill nets for all estuarine waters except for Currituck Sound and Albemarle Sound west of the Alligator River. Enforcing

these management measures could be easier than a large mesh gill net yardage limit because every gill net set by a given operation does not need to be inspected by the Marine Patrol officer. The current maximum yardage limit of 3,000 yards for large mesh gill nets is difficult to enforce. These management measures could require gill net fishermen to purchase more anchors and buoys for their gill nets, which could also limit the amount of gill net an operation could set.

Removing large mesh gill nets from the water during the day, as required by Proclamation M-8-2010, could also prevent increases in large mesh gill net effort. This would result in less time available to fish gill nets, which would make setting additional gill nets impractical. This measure would also be easier to enforce than a maximum yardage limit because it does not require each net to be inspected by the Marine Patrol officer; any large mesh gill net set during the day would be in violation. This management measure could also have a greater impact on fishing effort in southeastern part of the state. The tidal amplitude is higher in this area, which precludes fishing in certain locations when low tide occurs at dusk and dawn.

Management Options

(+ potential positive impact of action)
(- potential negative impact of action)

Minimum Mesh Size

1) Status quo (minimum mesh size of 5.5-inch stretched mesh for large mesh gill nets from April 15 to December 15)

    + No gear changes required
    + No new regulations
    + No increase in lost legal catch of southern flounder
    - Continued retention of a large proportion of undersized southern flounder
    - No reduction in landings to meet management goal
    - No reduction in discard mortality
    - Trend of increased undersized southern flounder in the landings could continue

2) Increase the minimum mesh size of large mesh gill nets to 5.75-inch stretched mesh from April 15 to December 15

    + Reduces the retention of undersized southern flounder
    + Could reverse the trend of increased undersized southern flounder in the landings
    + Reduction in discard mortality
    +/- Estimated 3.1% harvest reduction (in numbers) of southern flounder
    - Gear change required
    - Impact on harvest greatest in the spring when the availability of larger southern flounder is low
    - Harvest reduction greater in the Albemarle area and Rivers than in other areas
    - Could impact landings of other marketable species

3) Increase the minimum mesh size of large mesh gill nets to 5.75-inch stretched mesh from June 1 to December 15

+ Reduces the retention of undersized southern flounder, especially in the summer when mortality is highest
+ Could reverse the trend of increased undersized southern flounder in the landings
+ Reduction in discard mortality
+ Minimizes the impact to harvest in the spring with the availability of larger southern flounder is low
+/- Estimated 2.4% harvest reduction (in numbers) of southern flounder
- Gear change required
- Harvest reduction greater in the Albemarle area and Rivers than in other areas
- Could impact landings of other marketable species

Yardage Limit

1) Status quo (maximum yardage limits implemented by Proclamation M-8-2010)

   + Maximum yardage limit reduced for much of the estuarine waters
   + Reduction in gill net effort could help in achieving sustainable harvest
   - No effort reduction in the Albemarle area, where southern flounder gill net landings are highest
   - Potential for a shift in gill net effort to areas with fewer regulations
   - Maximum yardage limit of 2,000 yards is actually an increase for some areas
   - Potential for gill netters to increase their effort to the new yardage limits
   - Effort reduction higher for some areas more than other areas
   - Difficult to enforce

2) 2,000-yard maximum limit for large mesh gill nets in Albemarle, Croatan, Roanoke, and Pamlico sounds; 1,000-yard maximum limit for large mesh gill nets in the Rivers and from Core Sound to the South Carolina state line.

   + Maximum yardage limit reduced for all of the estuarine waters
   + Effort reduction where southern flounder gill net landings are highest
   + Reduction in gill net effort could help in achieving sustainable harvest
   + Yardage limits better suited to the large mesh gill net fishing effort for the different areas
   - Potential for a shift in gill net effort to areas with higher yardage limits
   - Potential for gill netters to increase their effort to the new yardage limits
   - Effort reduction higher for some areas more than other areas
   - Difficult to enforce

3) 2,000-yard maximum limit for large mesh gill nets in Albemarle, Croatan, Roanoke, Pamlico, Core, and Back sounds; 1,000-yard maximum limit for large mesh gill nets in the Rivers and from the Newport River to the South Carolina state line.

   + Maximum yardage limit reduced for all of the estuarine waters
   + Effort reduction where southern flounder gill net landings are highest
   + Reduction in gill net effort could help in achieving sustainable harvest
   + Yardage limits better suited to the large mesh gill net fishing effort for the different areas
   + Less likely that effort will shift from Core and Back sounds to southeast Pamlico Sound
   - Potential for a shift in gill net effort to areas with higher yardage limits

- Potential for gill netters to increase their effort to the new yardage limits
- Effort reduction higher for some areas more than other areas
- Difficult to enforce

Maximum Net Length

1) Status quo (maximum large mesh gill net length of 100 yards, implemented by Proclamation M-8-2010)

   + Helps control large mesh gill net effort
   + Easier to enforce than a maximum yardage limit
   - Not implemented in the Albemarle area, where southern flounder gill net landings are highest
   - Potential for a shift in gill net effort to areas with fewer regulations
   - Could require gill net fishermen to purchase more anchors and buoys for their gill nets
   - Could impact gill netters more in some areas than in others

2) Coast wide maximum large mesh gill net length of 100 yards

   + Helps control large mesh gill net effort
   + Easier to enforce than a maximum yardage limit
   + Implemented where southern flounder gill net landings are highest
   + Less potential a shift in gill net effort to areas with fewer regulations
   - Could require gill net fishermen to purchase more anchors and buoys for their gill nets
   - Could impact gill netters more in some areas than in others

No Daytime Sets of Large Mesh Gill Nets

1) Status quo (restrictions on daytime sets of large mesh gill nets, implemented by Proclamation M-8-2010)

   + Helps control large mesh gill net effort
   + Easier to enforce than a maximum yardage limit
   - Not implemented in the Albemarle area, where southern flounder gill net landings are highest
   - Potential for a shift in gill net effort to areas with fewer regulations
   - Could impact gill netters more in some areas than in others

2) Coast wide restriction on daytime sets of large mesh gill nets

   + Helps control large mesh gill net effort
   + Easier to enforce than a maximum yardage limit
   + Implemented in the Albemarle area, where southern flounder gill net landings are highest
   + Less potential for a shift in gill net effort to areas with fewer regulations
   - Could impact gill netters more in some areas than in others

Management Recommendations

NCMFC Preferred Management Strategy

- Status quo (maintain minimum mesh size of 5.5-inch stretched mesh for large mesh gill nets from April 15 to December 15 and large mesh gill net management measures implemented by Proclamation M-8-2010). *(Proclamation M-8-2010 no longer valid)

AC - Status quo (maintain minimum mesh size of 5.5-inch stretched mesh for large mesh gill nets from April 15 to December 15 and large mesh gill net management measures implemented by Proclamation M-8-2010). *(Proclamation M-8-2010 no longer valid)

NCDMF*(revised) - Maintain the minimum mesh size of 5.5-inch stretched mesh for large mesh gill nets from April 15 to December 15.

*NOTE: After further analysis of the impact of restrictions enacted due to protected species on southern flounder commercial effort and to set specific gill net measures that are minimum requirements for this Amendment, the NCDMF endorsed the recommendation in Issue paper 10.1 REVISED. Please see that document for further information on the history and recommendations that evolved from the sea turtle settlement agreement.

Research Recommendations

- Continue at-sea observations of the large mesh gill net fishery, especially outside of the PSGNRA, including acquiring biological data on harvest and discards
- Increase the number of large mesh gill catches sampled in areas such as Albemarle sound and the Newport River