Regulatory Amendment 11:
Warsaw Grouper and Speckled Hind Catches in the U.S. South Atlantic
NOAA Fisheries Service
Southeast Regional Office
June 1, 2011

INTRODUCTION

In 1992, the sale of speckled hind (*Epinephelus drummondhayi*) and warsaw grouper (*E. nigritus*) was prohibited in the South Atlantic EEZ. Due to continuing concerns regarding the overfished status of these stocks, Amendment 17B to the South Atlantic Fishery Management Council's Snapper-Grouper Fishery Management Plan (S-G FMP) established annual catch limits (ACLs) of 0 pounds for speckled hind and warsaw grouper in January 2011. Due to concerns about bycatch of these species, Amendment 17B also prohibited harvest beyond a depth of 240 ft for snowy grouper, blueline tilefish, yellowedge grouper, misty grouper, queen snapper, and silk snapper in the U.S. South Atlantic. Regulatory Amendment 11 (Reg-11) to the S-G FMP proposes adjustments to the regulations imposed by Amendment 17B to alleviate social and economic impacts while maintaining protections for speckled hind and warsaw grouper. For example, some alternatives in Reg-11 consider modifying the closure to allow harvest of blueline tilefish or snowy grouper north of Cape Hatteras, NC, or south of Cape Canaveral, Florida. This analysis seeks to identify: (1) What data are available for speckled hind and warsaw grouper, (2) Where speckled hind and warsaw grouper are caught, and (3) What species are caught with speckled hind and warsaw grouper.

METHODS

Data Sources

Data from the Southeast Fisheries Science Center's (SEFSC) commercial logbook program, SEFSC's supplemental discard commercial logbook program, SEFSC's headboat survey (HBS), reef fish observer program (RFOP), Marine Resources Monitoring Assessment and Prediction (MARMAP) program, accumulated landings system (ALS), and Florida, Georgia, South Carolina, and North Carolina trip tickets (TT) were evaluated to determine locations of warsaw grouper and speckled hind encounters and co-occurrence with other species. Locations of catch were provided to the highest possible resolution.

The SEFSC's commercial logbook program (accessed 9 Mar 2011) consisted of self-reported landings on a trip level from commercial fishermen. This dataset provided species-specific landings (in lbs), primary gear used, primary area and depth of capture. The SEFSC's supplemental discard commercial logbook program began in 2001 and came from a random sample of 20% of commercial vessels. Commercial logbook and supplemental discard logbook data were merged into a combined CLB dataset for the years 2001-2009. All trip records with a recorded landing or discard of warsaw grouper or speckled hind were retained. Area fished was based on reported 1° longitude by 1° latitude commercial logbook statistical areas. A single depth of fishing was reported in the commercial logbooks for each species per trip from 2005 onward, although they may be encountered at numerous depths during multiple sets. Very little

depth of capture information was available prior to 2005, and no harvest information was available prior to the harvest prohibition in 1992.

In July 2006, NOAA Fisheries Service began a voluntary reef fish observer program (RFOP) to characterize fishery landings and bycatch in the southern U.S. Atlantic Ocean. This voluntary program suffers from spatial and sampling biases; however, it does provide accurate species identification and depth of capture at the gear set-level for species encountered using bottom longline, electric (bandit) reel, and hand lines. Depth fished was reported for each set.

The recreational headboat sector of the snapper-grouper fishery was evaluated using HBS logbook data (accessed 2 Feb 2011) reported by headboat operators. Headboats are large, for-hire vessels that typically accommodate 20 or more anglers on half- or full-day trips. HBS records are arranged similar to commercial logbook records, and contain trip-level information on number of anglers, trip duration, date, area fished, landings (number of fish), and releases (number of fish) of each species. Headboat encounters (landings plus releases) were summarized by species, year, month, and area fished for the years 1973-2009. Reporting of area fished has improved through time, with resolution ranging from state level to 0.17° by 0.17° grids. For cluster analysis, area fished was aggregated at the most common reporting level (1° latitude by 1° longitude). As with the commercial fishery data, area fished is self-reported and this could have introduced error into the analysis. Additionally, vessels fishing in multiple areas during a trip would be constrained by the current data form to select one area fished for the trip, which limits the spatial precision of the analysis. Depth fished was not reported.

For over thirty years, the Marine Resources Research Institute at the South Carolina Department of Natural Resources, through the MARMAP program, has conducted fisheries-independent research within the region between Cape Lookout, North Carolina, and Ft. Pierce, Florida. The overall mission of the program is to determine distribution, relative abundance, and critical habitat of economically and ecologically important fishes of the southeastern U.S., and to relate these features to environmental factors and exploitation activities. MARMAP survey work has provided a monitoring program that allowed standardized sampling of fish populations over time and development of a historical base for future comparisons of long-term trends. The gears (e.g., chevron trap, bottom longlines) and methodologies used have been consistent over the years to allow for long term analysis and comparisons. Historically, sampling effort for snapper-grouper has been concentrated off South Carolina using various trap gears. MARMAP samples accurately identify fish to species and also collect valuable information on undersized fish. MARMAP data for the years 1977-2009 were aggregated by individual gear (i.e., a single trap, or a single line), at the set level. Depth fished was reported for each set.

Information on the quantity and value of seafood products caught by fishermen and sold to established seafood dealers or brokers are reported to the fisheries agency in each state. The accumulated landings system (ALS) is a general canvass landings data encompassing all landings statistics for the Southeast Region. The data was filtered so only landings from states in the south Atlantic region remained (Florida, Georgia, South Carolina, and North Carolina), and only landings from the Atlantic side of Florida were included. The database began in 1962 but Florida was the only south Atlantic state that had records during this early period. ALS data was

available in Georgia starting in 1979, South Carolina in 1980, and North Carolina in 1981. Catch location data did not begin until after 1992.

Each state of the south Atlantic region has their own commercial trip ticket database. These databases provide information on catch (i.e. date, pounds and price) of fish species landed. This program began in Florida in 1986, followed by South Carolina in 1989, North Carolina in 1994, and then Georgia in 2004. In later years the states recorded general catch locations in one degree squares. Florida began providing general catch locations in 1992. Georgia recorded general catch locations for only 5% of the landings for all years of available data (2004-2009). South Carolina started reporting general catch locations in 2004, and North Carolina always recorded general locations of the catch since the beginning (1994).

Cluster Analysis

Dimension reduction and hierarchical cluster analyses were used to evaluate associations of speckled hind and warsaw grouper with other species in the catch. These analyses were performed upon fishery datasets containing 'area-fished' information (i.e., CLB, RFOP, HBS, and MARMAP). Each data set was formatted as a matrix, with columns representing species (i) and rows representing aggregation bins (j). Aggregation bins represented the highest resolution of data available for the dataset. Fishermen will typically make multiple sets on a trip, sometimes in geographically distant areas, targeting different species. Aggregating landings at the highest resolution reduced the probability of grouping species caught during the same time period that would likely not co-occur during any given set due to disparate geographic distributions. For CLB, aggregation bins were *year-month-area* combinations. For the RFOP, aggregation bins were *set-level*. For HBS, aggregation bins were *year-month-area (1° latitude by 1° longitude)* combinations. For MARMAP, aggregation bins were *set-level*. Within each element of the matrix (c_{ij}) the presence or absence of a species (i) landed in a specific bin (j), was assigned a '1' when there was an encounter and assigned a '0' when there were no encounters. Whenever possible, discards were included in the aggregated catch, as they provide valuable information when determining species associations.

By restricting the analysis to only bins where speckled hind or warsaw grouper were observed, we ensured that the resultant clusters would be representative of the co-occurrence of other species with these two species of concern. Because the fishing effort that generates the landings data does not represent a consistent sampling program, reported landings data might not be quantitatively comparable between collections. Additionally, due to the restrictions on harvest since 1992, for most of the data sources examined, the catch of warsaw grouper and speckled hind is incidental. Boesch (1977) suggested a binary index (e.g., 'presence-absence') may be a more appropriate measure of similarity for data collected with an inconsistent sampling framework (e.g., fishery-dependent data). A binary index applied to each fish record also reduces distortions caused by using fish weights which are influenced by super-abundant and heavier species.

Dimension reduction was conducted using PROC VARCLUS in SAS V9.2 (SAS Institute Inc., Cary, NC). PROC VARCLUS is a dimension reduction tool that clusters variables with the greatest correlation and minimized correlations with other clusters. The algorithm used by

PROC VARCLUS is binary and divisive - all variables start in one cluster. A cluster is chosen and split into two clusters by performing an orthoblique rotation on the first two principal components. Each variable is assigned to the rotated component with which it has the higher squared correlation. The procedure is nonhierarchical; variables are iteratively reassigned to clusters to maximize the variance accounted for by the cluster components. Clusters are split until all variance is explained (i.e., 'proportion=1').

Hierarchical cluster analysis of species presence-absence data used average linkage between groups with a Sørenson measure of dissimilarity:

$$D_{ih} = \sum_{j=1}^{J} \frac{\left|c_{ij}^{'} - c_{hj}^{'}\right|}{\left|c_{ij}^{'} - c_{hj}^{'}\right|} \quad (1)$$

where D_{ih} is the distance between species i and h, and j is the number of rows (bins). The Sørenson (e.g. 'Dice', 'Bray-Curtis', 'Czekanowski') measure is an index in which joint absences are excluded from consideration, and matches are double weighted. The Sørenson measure has been found to be more robust in ecological studies (Beals 1973, Field et al. 1982, Faith et al. 1987), and is commonly used in studies of fish assemblages (e.g., Mueter & Norcross 2000, Gomes et al. 2001, Williams and Ralston 2002, Shertzer & Williams 2008, Shertzer et al. 2009).

The average linkage clustering function specifies the distance between two clusters as the average distance between objects from the first cluster and objects from the second cluster. Averaging is performed over all pairs (x, y) of objects, where x is an object from the first cluster and y is an object from the second cluster. The average linkage function is expressed as follows:

$$D(X,Y) = \frac{1}{N_X * N_Y} \sum_{i=1}^{N_X} \sum_{j=1}^{N_Y} d(x_i, y_i); \quad x_i \in X, y_i \in Y \quad (2)$$

where $d(x, y)$ is the distance between objects $x \in X$ and $y \in Y$; X and Y are two sets of objects (clusters), and N_X and N_Y are the numbers of objects in clusters X and Y, respectively. Average-link clustering is less sensitive to outliers than complete-link clustering, and less likely to form long chains than single-link clustering. This method is also known as the 'unweighted pair-group method using arithmetic averages' (UPGMA), and is widely used in ecology (see Boesch 1977, McGarigal et al. 2000). This method is a space-conserving strategy that introduces little distortion to the relationships expressed in the similarity matrix (Boesch 1977).

Dendrograms were generated for each cluster, based upon the agglomeration schedule. The dendrogram is read from left to right, with vertical lines indicating joined clusters. The position of the line on the scale indicates the distance at which clusters are joined. In SPSS, observed distances are rescaled to fall into the range of 1 to 25; the ratio of the rescaled distances within the dendrogram is the same as the ratio of the original distances. In SAS, Proc TREE was used to plot the dimension reductions with the proportion of variability explained as the height variable. Species joined closer to the left of the dendrogram would be considered more associated.

RESULTS

Gear

- In all datasets except MARMAP, the primary gears catching warsaw grouper, speckled hind, and blueline tilefish were vertical line and bandit gears, followed by longlines. Traps were the primary gear catching warsaw grouper and speckled hind during MARMAP sampling.

Commercial Logbook and Supplemental Discard Logbook (2001-2009)

- 42 records for warsaw grouper were reported, with most encounters off St. Augustine, FL and South Carolina.
- 255 records for speckled hind were reported, with most encounters off Charleston, SC, Wilmington, N.C. and Cape Hatteras, N.C.

Headboat Logbook (1973-2009)

- 3,203 records for warsaw grouper were reported, with most encounters off Charleston, SC, St. Augustine, FL, and Cape Canaveral, FL (**Figure 1**).
- 26,650 records for speckled hind were reported, with most encounters off Charleston, SC (**Figure 1**).

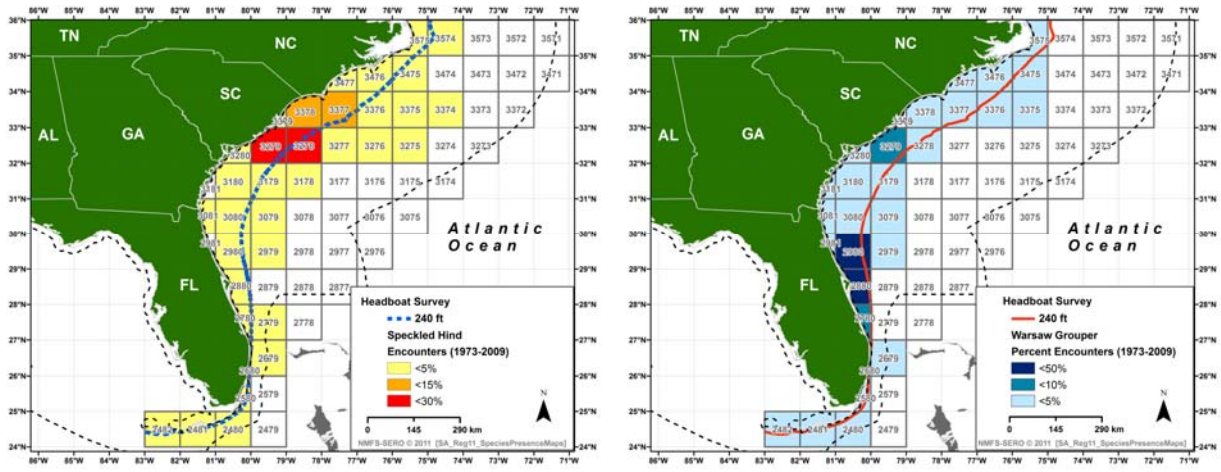

Figure 1.- Headboat survey encounters (1973-2009) of speckled hind (n=26,650) and warsaw grouper (n=3,203).

Reef Fish Observer Program (2006-2009)

- 13 records for warsaw grouper were reported, with encounters off SC and GA (**Figure 2**).
- 318 records for speckled hind were reported, with encounters ranging from NC to mid-FL (**Figure 2**).

MARMAP (1977-2009)

- 9 records for warsaw grouper, with most encounters off SC (**Figure 2**).
- 30 records for speckled hind, with most encounters off SC (**Figure 2**).

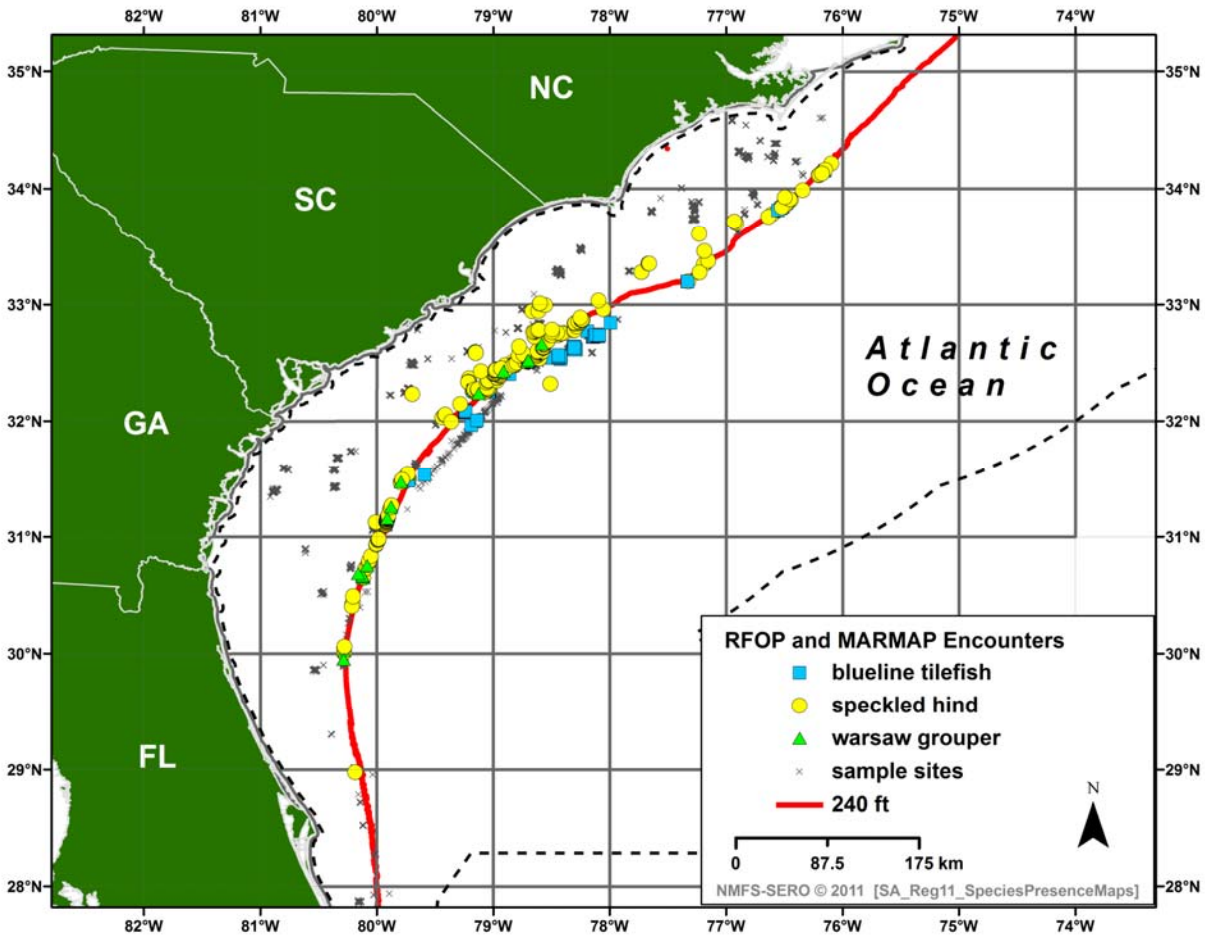

Figure 2.- Reef fish observer program (2006-2009) and MARMAP (1977-2009) encounters of blueline tilefish (n=103), speckled hind (n=348), and warsaw grouper (n=22). 'Sample sites' indicate MARMAP sets using gears that could have caught the species of interest. Data were aggregated and RFOP 'sample sites' are not shown to protect confidentiality.

ALS (1962-2010)

- No specific catch location data were available for either species prior to 1992. Instead, the catch location was listed as southeast US.
- 2,309 records for warsaw grouper were reported. After 1992, the majority of the warsaw grouper catch was reported in the Florida Keys (**Table 1**).
- 2,145 records for speckled hind were reported. After 1992, the majority of the speckled hind catch was reported in the Florida Keys (**Table 1**).

FL Trip Ticket (1986-1992)

- Only general locations of the catch were available before 1992.
- 1,731 records for warsaw grouper. After 1992, the majority of the catches came from offshore waters of Cape Canaveral and Jacksonville (**Table 1**).
- 205 records for speckled hind. After 1992, the majority of catches with recorded locations came from offshore waters of Jacksonville (**Table 1**).

Table 1.- Percentage of catch where specific Florida trip ticket (FTT) location data and accumulated landing system (ALS) data were available. Catch is in pounds gutted weight.

Warsaw				Region			
% of landings	Time Period	Not Recorded	Jacksonville	Canaveral	West Palm	Miami	Keys
ALS	1992-2009	0.0	2.6	7.9	1.9	23.6	**64.1**
FTT	1986-1992	20.1	28.7	**32.1**	8.9	3.2	7.1
Speckled Hind				Region			
% of landings	Time Period	Not Recorded	Jacksonville	Canaveral	West Palm	Miami	Keys
ALS	1992-2009	0.0	3.8	11.9	4.9	7.8	**71.7**
FTT	1986-1992	**79.4**	18.2	0.0	0.5	1.9	0.0

SC Trip Ticket (1989-2009)

- No location data was available for reported catches of warsaw grouper. The majority of speckled hind records (96%) also had no location information. When location information was available, it was not possible to determine the depth of the catch due to the coarse spatial resolution of the reported location.
- For warsaw grouper, there were 48 records from 1989-1992, and 47 records from 1993-1996. There were no warsaw grouper records after 1996. No location data were available for any of these records.
- For speckled hind, there were 213 records from 1989-1992, and 137 records from 1993-2008. The 2004 to 2008 records had location grids off of Myrtle Beach and Charleston. It is not possible to determine the depth where these fish were caught because these two location codes include South Carolina's shoreline.

GA Trip Ticket (2004-2009)

- There were no records reported for warsaw grouper.
- Only one speckled hind record was reported in 2004 with no location data.

NC Trip Ticket (1994-2010)

- Landings locations were separated into state or federal waters and north or south of Cape Hatteras.
- 5 records of warsaw grouper were available from the years 1994, 2001, and 2010. One record was reported in North Carolina state waters (within 3 miles from shore). Another record was reported in federal waters south of Cape Hatteras. The final three records were reported from federal waters (>3 miles from shore, water zone 25) with no detail on whether the fish were caught north or south of Cape Hatteras.
- 38 records of speckled hind were available from the years 1994-1998. The locations of the catches were in three different areas. Two of the records were from federal waters north of Cape Hatteras. Five records were in federal waters south of Cape Hatteras. Thirty-one of the records were in federal waters (>3 miles from shore, water zone 25) with no detail on whether the fish were caught north or south of Cape Hatteras.

- 11,817 blueline tilefish records were available. Most of the records (46%) were in federal waters. These catches were mostly south of Cape Hatteras (45%), followed by north of Cape Hatteras (37%), and the remaining federal waters catches did not have location information (18%) (**Table 2**). There were a small number of blueline tilefish reportedly caught in state waters (<1%, n=89). Given the depth distribution of the species, these observations may have been misreported.

Table 2.- Location of blueline tilefish records.

Water Code	n	Location
20	67	North Carolina state waters north of Cape Hatteras
21	22	North Carolina state waters south of Cape Hatteras
22	4,322	Federal waters north of Cape Hatteras
23	5,385	Federal waters south of Cape Hatteras
24	17	North Carolina state waters
25	2,004	Federal waters, no other location information
Total	11,817	

Depth

- All data sources (i.e., Commercial Logbook, Discard Logbook, Reef Fish Observer Program, and MARMAP) were heavily biased towards fishing inshore of 240 ft depth (**Figure 3**). Coupled with the harvest prohibition and the rarity of speckled hind and warsaw grouper, this implies most speckled hind and warsaw grouper encounters would occur inshore of 240 ft. Chi-square tests and Fisher Exact tests suggested that although most encounters occurred inshore of 240 ft, the odds of encountering speckled hind and warsaw grouper are higher outside of 240 ft.
- The limited depth information available suggested limited encounters of speckled hind and warsaw grouper in waters >240 ft depth North of Cape Hatteras and South of Cape Canaveral. Few encounters were reported in waters >500 ft depth throughout the EEZ (**Table 3**). By contrast, the majority of commercial logbook reported landings of snowy grouper (67% across SAFMC; 76% in waters South of Cape Canaveral) and yellowedge grouper (50% across SAFMC; 77% in waters South of Cape Canaveral) were >500 ft depth.

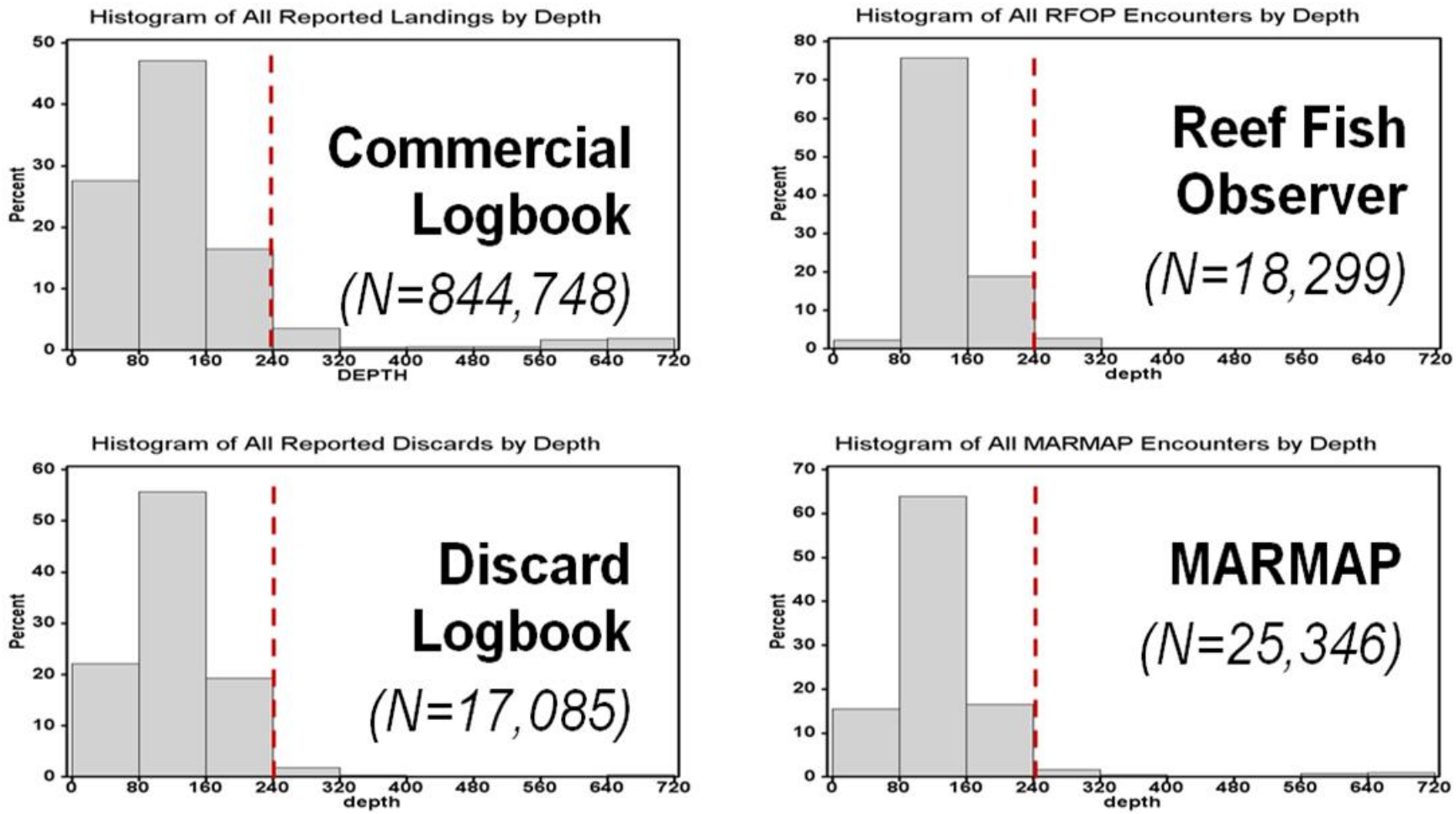

Figure 3. 'Sampling' distributions for all records (all species), by depth, for Commercial Logbook, Discard Logbook, Reef Fish Observer, and MARMAP datasets.

Table 3.- Percent of observations by depth and area.

	Speckled Hind				Warsaw Grouper			
Range	**Comm LB***	**Discard LB**	**RFOP**	**MARMAP**	**Comm LB***	**Discard LB**	**RFOP**	**MARMAP**
>240 ft North of 35°00	4%	0%	0%	0%	0%	0%	0%	0%
>240 ft South of 27°00	2%	0%	0%	0%	0%	0%	0%	0%
>500 ft Entire EEZ	4%	0%	0%	0%	0%	0%	0%	0%

*Ratio of lbs landed.

Encounters South of Cape Canaveral, FL or North of Cape Hatteras, NC

- The limited data available suggested that catches of warsaw grouper and speckled hind do occur south of Cape Canaveral (**Table 4**).
- The limited data available suggested that few catches of warsaw grouper and speckled hind do occur north of Cape Hatteras, NC (**Table 4**).

Table 4. – Percent of warsaw grouper and speckled hind records north of Cape Hatteras, NC or south of Cape Canaveral, FL.

	North of Cape Hatteras		South of Cape Canaveral	
Dataset	**Warsaw Grouper**	**Speckled Hind**	**Warsaw Grouper**	**Speckled Hind**
ALS	0%	0%	4%	12%
Trip Ticket	n/a	1%	24%	1%
Headboat Survey	0%	1%	5%	3%
MARMAP	0%	0%	0%	0%
RFOP	0%	0%	0%	0%
CLB	0%	2%	0%	5%

Species Associations

- In general, speckled hind and warsaw grouper rarely co-occurred with snowy grouper, blueline tilefish, yellowedge grouper, misty grouper, queen snapper, or silk snapper (**Table 5**).
- Hierarchal cluster analyses of commercial logbook data indicated relatively low levels of association between warsaw grouper, speckled hind and other deep-water species (**Figure 4**). Warsaw grouper was most closely associated with shallow-water groupers and speckled hind was most closely associated with vermilion snapper, red porgy, and scamp.
- Dimension reduction analyses of commercial logbook data showed warsaw grouper was closely associated with misty grouper and lightly associated with snowy grouper, but not other deep-water species. Speckled hind was closely associated with red grouper, scamp, and red porgy, but not other deep water species (**Figure 5**).
- Hierarchal cluster analyses of headboat data indicated warsaw grouper most closely associated with shallow-water snappers and speckled hind were most closely associated with porgies and grunts (**Figure 6**).

- Dimension reduction analyses of headboat data showed warsaw grouper and speckled hind were closely associated with each other. These species were also associated with grunts and porgies. Blueline tilefish was most closely associated with snowy grouper and yellowedge grouper (**Figure 7**).
- Dimension reduction analyses of reef fish observer data showed warsaw grouper and speckled hind were closely associated with each other. Blueline tilefish, snowy grouper, and yellowedge grouper were on separate branches of the dendogram and distinctly separated from speckled hind and warsaw grouper (**Figure 8**).

Table 5.- Top co-occurring species with warsaw grouper and speckled hind for the merged commercial logbooks (CLB) and headboat survey (HBS) datasets. Amendment 17B 'deep-water' species are in bold.

	With Speckled Hind		With Warsaw Grouper	
Rank	**Commercial**	**Headboat**	**Commercial**	**Headboat**
1	red porgy	vermilion snapper	red porgy	gray triggerfish
2	scamp	gray triggerfish	scamp	black sea bass
3	vermilion snapper	scamp	vermilion snapper	red snapper
4	greater amberjack	red porgy	greater amberjack	gag
5	red snapper	tomtate	**speckled hind**	gray snapper
6	gag	white grunt	red snapper	lane snapper
7	red grouper	knobbed porgy	gag	vermilion snapper
8	gray triggerfish	greater amberjack	gray triggerfish	tomtate
9	**warsaw grouper**	gag	red grouper	scamp
10	rock sea bass	red snapper	red hind	whitebone porgy
11	**snowy grouper**	black sea bass		greater amberjack
12	yellowtail snapper	whitebone porgy		red porgy
13	black grouper	almaco jack		red grouper
14	blue runner	bank sea bass		white grunt
15	crevalle jack	graysby		almaco jack
16	almaco jack	queen triggerfish		knobbed porgy
⋮	⋮	⋮	⋮	⋮
	blueline tilefish (#22)	***blueline tilefish (#32)***	***no blueline tilefish***	***blueline tilefish (#39)***

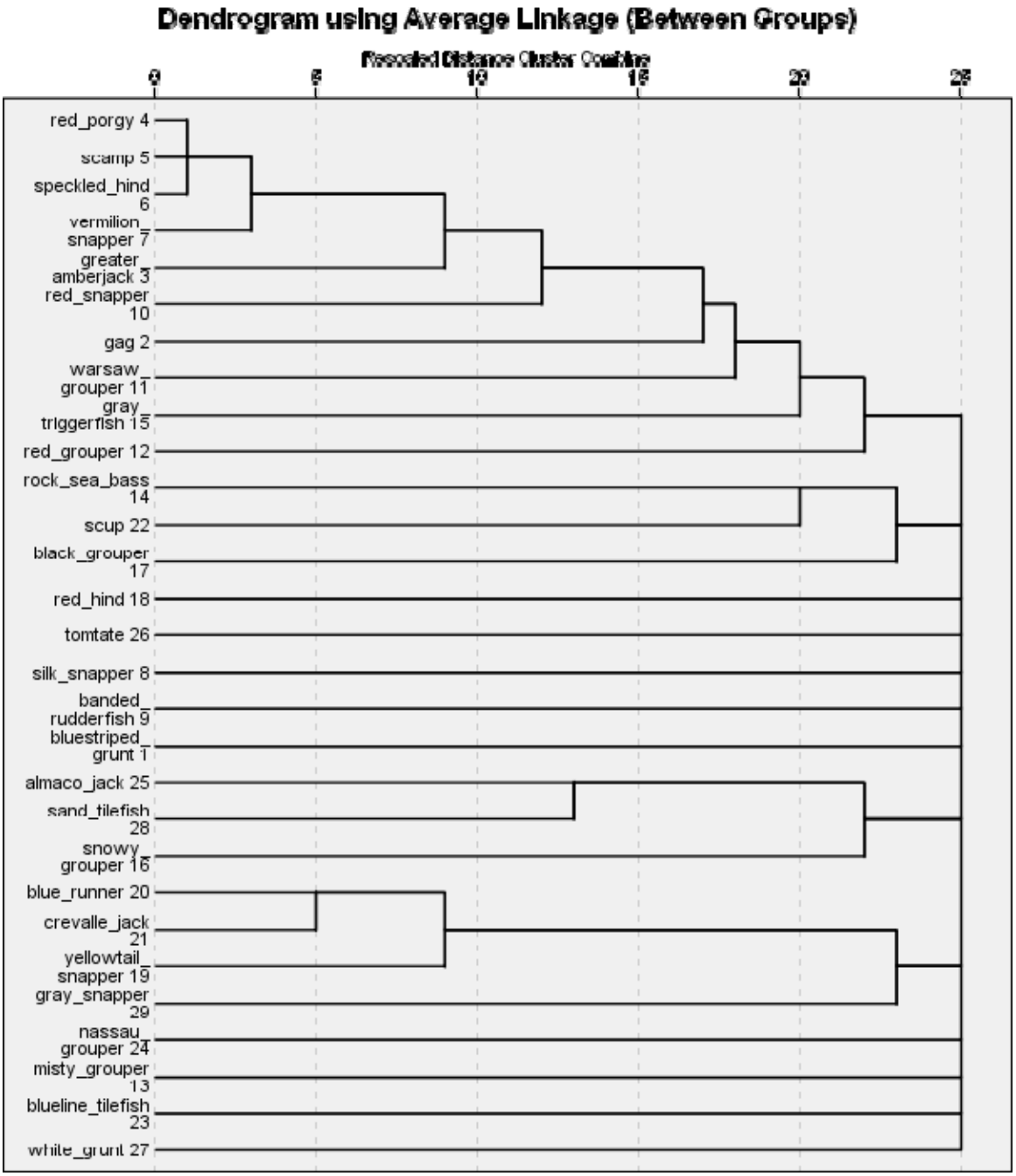

Figure 4.- Hierarchical cluster analyses results for the commercial logbook dataset from 2001 to 2009 (warsaw grouper n=42; speckled hind n=255). Only includes trips where a warsaw grouper or speckled hind was caught. Average linkage method was used with Sorenson similarity measure and binary transformation.

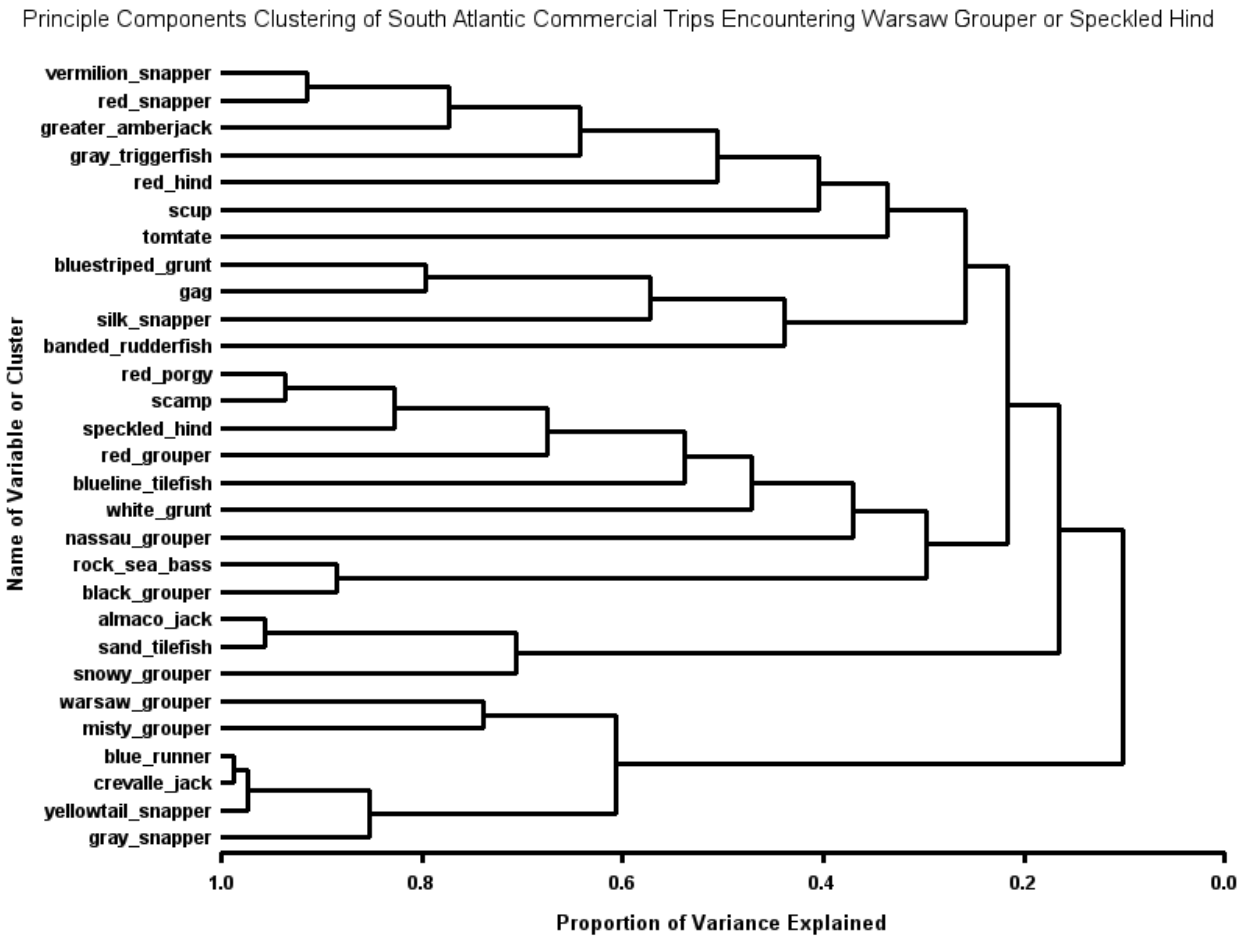

Figure 5.- Dimension reduction analysis results for the commercial logbook dataset from 2001 to 2009 (warsaw grouper n=42; speckled hind n=255).

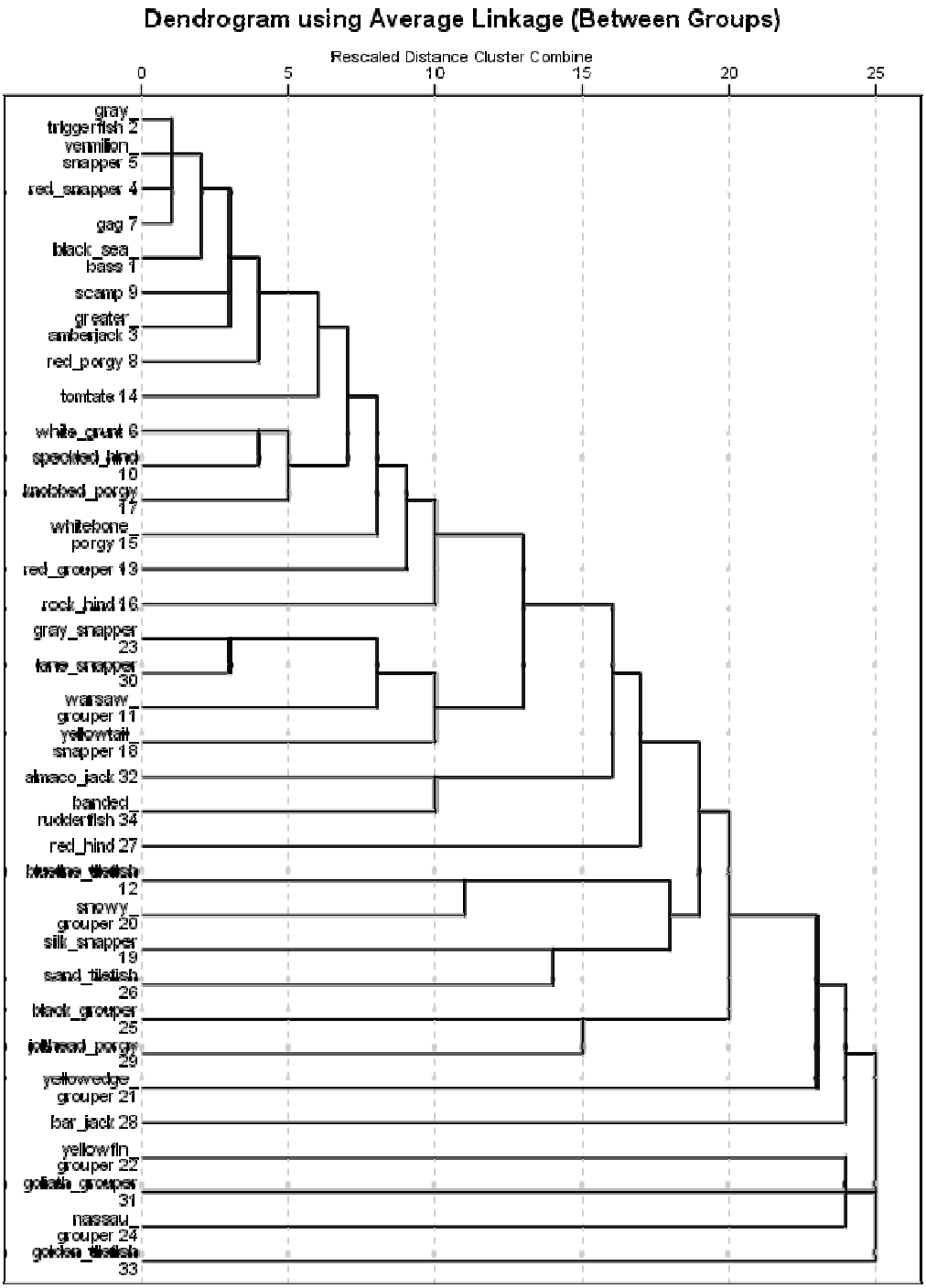

Figure 6.- Hierarchical cluster analyses results for the headboat logbook dataset from 1973 to 2009 (warsaw grouper n=3,203; speckled hind n=26,650). Only includes trips where a warsaw grouper or speckled hind was caught. Average linkage method was used with Sorenson similarity measure and binary transformation.

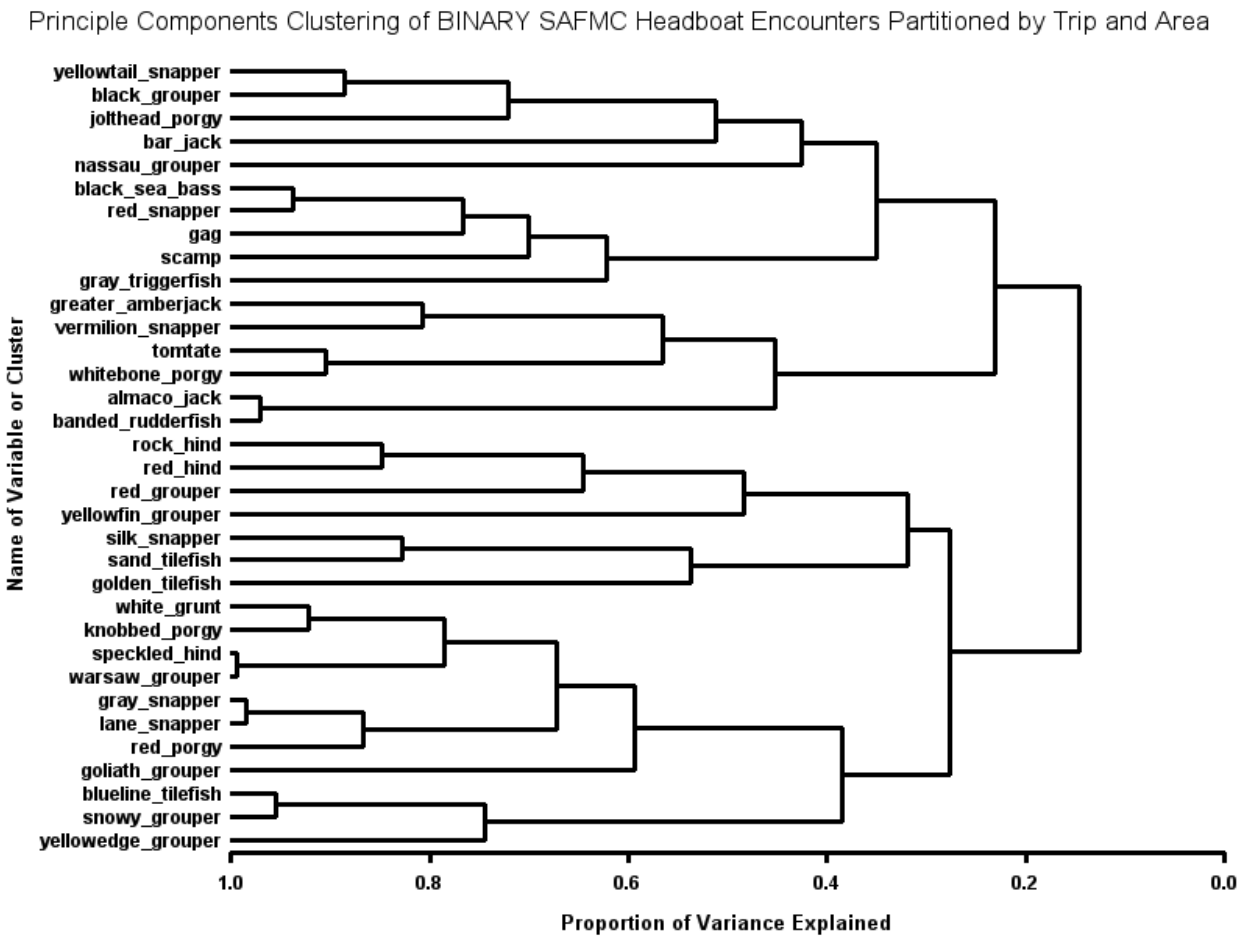

Figure 7.- Dimension reduction analysis results for the headboat logbook dataset from 1973 to 2009 (warsaw grouper n=3,203; speckled hind n=26,650).

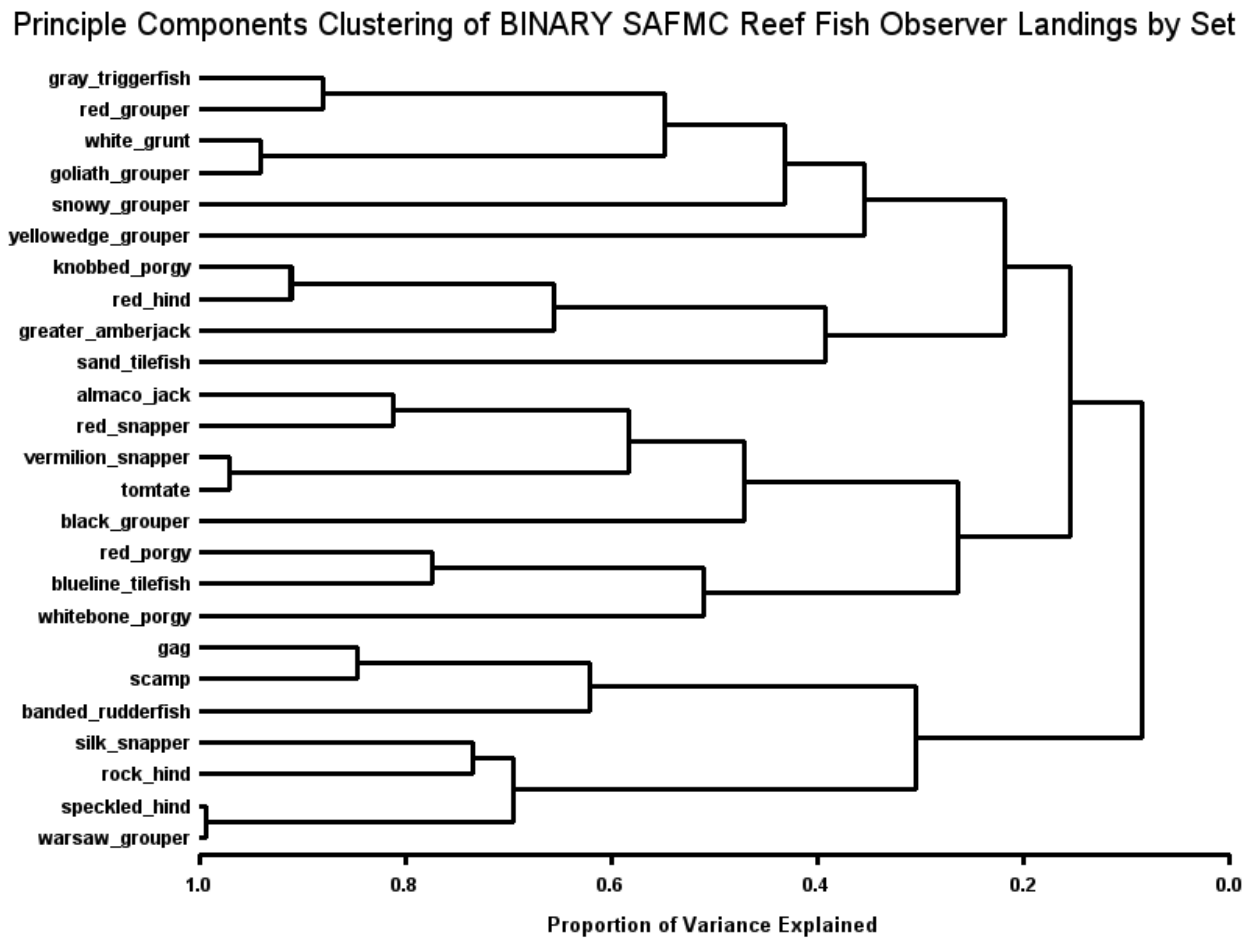

Figure 8.- Dimension reduction analysis results for the reef fish observer dataset from 1973 to 2009 (warsaw grouper n=13; speckled hind n=182).

CONCLUSIONS

- Overall there were a relatively small number of warsaw grouper and speckled hind records. When data were available there was limited information on the catch location. **Table 6** provides a summary of the records for each dataset.
- Very few data were available prior to the 1992 harvest prohibition on speckled hind and warsaw grouper. Of those data that were available, location was seldom available and never highly resolved. Depth was unavailable for most datasets. As such, all conclusions that might be drawn about the distribution of the stock from post-1992 data suffer from biases for under-representation due to the disincentive to retain the fish, and incentives to misidentify the fish if kept and sold.
- For most data sources, depth information was entirely unavailable, rendering it impossible to control for this bias. For data sources with depth, samples were most frequently from depths beyond 160 ft.
- The RFOP and MARMAP datasets indicated catches of warsaw grouper and speckled hind more inshore of the blueline tilefish (**Figure 2**). However, these two datasets have potentially biased results because they had limited sampling beyond 240 feet.

- FL Trip Ticket (1986-1992) and ALS data (1992-2009) indicate substantial landings of warsaw grouper and speckled hind south of Cape Canaveral (**Table 1**).
- Available data suggested encounters with warsaw grouper and speckled hind are uncommon north of Cape Hatteras (**Table 4**). The North Carolina trip ticket and commercial logbook datasets are subject to bias since no commercial sale was allowed for the duration of available data. Additionally, the North Carolina trip ticket data reported a large amount of blueline tilefish records (37%, n= 4,322) north of Cape Hatteras.

Table 6- Summary of warsaw and speckled hind catches for all south Atlantic datasets. Values in parentheses are sample size.

Data	Years	Location of Majority of Catch (# Records)		Discard Info	Depth Info
		Warsaw Grouper	Speckled Hind		
Commercial Logbooks	2001-2009	St. Augustine, Offshore South Carolina (42)	Charleston SC, Wilmington NC, Cape Hatteras (255)	20% of Records	2005-present
Headboat Survey	1973-2009	Charleston SC, St. Augustine FL, Cape Canaveral FL (3,203)	Charleston SC (26,650)	2004-Present	None
RFOP	2006-2009	South Carolina and Georgia (13)	South Carolina (317)	Yes	Yes
MARMAP	1977-2009	South Carolina and Georgia (9)	South Carolina (30)	Yes	Yes
ALS	1962-2010	Florida Keys (2,309)	Florida Keys (2,145)	No	None
Georgia Trip Ticket	2004-2009	No Records	No location information	No	None
Florida Trip Ticket	1986-1992	Cape Canaveral (59,609)	Jacksonville (2,427)	No	None
South Carolina Trip Ticket	1989-2009	No location information	No location information	No	None
North Carolina Trip Ticket	1994-2010	Federal Waters (5)	Federal Waters (38)	No	None

- The cluster analyses displayed low association between warsaw grouper and speckled hind with blueline tilefish and snowy grouper. The low levels of association with blueline tilefish may be explained by the different habitat preferences of the species. Warsaw grouper inhabit steep cliffs, notches, and rocky ledges of the continental shelf break (Manooch and Mason 1987), and speckled hind inhabit high and low profile hard bottom (Huntsman and Dixon 1976). Blueline tilefish inhabit irregular bottoms comprised of troughs and terraces inter-mingled with sand, mud, or shell hash bottom where they live in burrows (Parker and Ross 1986; Parker and Mays 1998). Snowy grouper inhabit the upper continental slope, between 240 and 330 ft of depth, in habitats characterized by rocky ledges and swift currents (Matheson and Huntsman 1984). Although snowy grouper appear to occupy similar habitats to warsaw grouper and speckled hind, cluster analyses suggested co-occurrence of these species are rare.
- The cluster analysis results could have been biased because relatively little data was available beyond 240 feet. Warsaw grouper and speckled hind undergo an ontogenetic migration; as they mature, they move into deeper waters (Heemstra and Randall 1993;

Brule et al. 2000). Thus, the mature portion of the stock, which would suffer from higher release mortality due to deeper depth-at-encounter, is under-represented in the available data. The mature portion of the stock may also be under-represented relative to unfished conditions, as overfishing typically preferentially removes larger (e.g., older) individuals.

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