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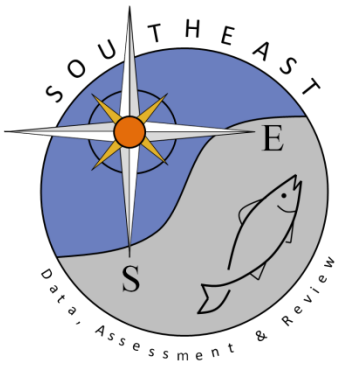

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Red Snapper *Lutjanus campechanus* in Gulf of Mexico versus southeast US Atlantic Ocean waters: gaps in knowledge and implications for management

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Abstract

Red Snapper (*Lutjanus campechanus*) populations support (or have supported) important commercial and recreational fisheries in Gulf of Mexico and southeastern US Atlantic Ocean waters. Stock assessment results and resulting regulatory actions are contentious in both regions. We assessed the relative availability of information to support Red Snapper assessment and management between the two regions by comparing the number of region-specific, Red Snapper-focused peer-reviewed publications, 94% (103 of 110) of which were regionally focused in Gulf of Mexico waters. We then assessed available information on juvenile (≤ 150 mm total length) Red Snapper. Twenty-eight peer-reviewed publications focused entirely or partially on juvenile Red Snapper in Gulf of Mexico waters. No publications or reports documenting the occurrence of juvenile Red Snapper in southeastern US Atlantic Ocean waters were identified. While more than 50,000 records of juvenile Red Snapper were identified in a single Gulf of Mexico trawl survey database, a comprehensive search of fishery-independent survey databases (totaling >75,000 individual gear deployments) and institutional collections identified only 132 records of juvenile Red Snapper from southeastern US Atlantic Ocean waters, despite the surveys occurring across the range of habitats, depths and seasons in which juvenile Red Snapper have been collected in GOM waters. These results highlight the need for additional information on Red Snapper in southeastern US Atlantic Ocean waters, and on connectivity between Gulf of Mexico and southeastern US Atlantic Ocean Red Snapper populations, to support Red Snapper population assessment and fishery management.

Keywords: Red Snapper, Fisheries management, Recruitment, Migration, Sustainability

1 Introduction

Red Snapper *Lutjanus campechanus* (Poey 1860) are highly valued reef fish found throughout coastal and nearshore areas of the Gulf of Mexico (GOM) and southeastern US Atlantic (hereafter SEUS; Bortone, 1986). Stock assessment results and resulting regulatory actions are contentious in both regions. In the GOM, Red Snapper contribute to a multibillion-dollar recreational fishing industry and support an important commercial fishery (commercially, in 2011, >3.6 million pounds landed with ~$11.6 million ex-vessel landings value; NOAA, 2014). In SEUS waters, where the Red Snapper fishery has historically been one of the most important fisheries in terms of landings and ex-vessel landings value, the fishery has been predominantly closed since 2010 as part of a population rebuilding plan (Department of Commerce 2010). Both GOM and SEUS populations are classified as overfished but not undergoing overfishing (SEDAR 24, 2010, SEDAR 31, 2013), and it is anticipated that both populations are rebuilding (e.g., NMFS, 2012; SEDAR 31, 2013), with populations in the eastern GOM extending as far south as the Dry Tortugas (Fig. 1; Brown-Peterson et al., 2009; Burns et al., 2006). Genetic research indicates homogeneity between GOM and SEUS populations (Garber et al., 2004; Gold and Richardson, 1998).

A wealth of information exists on Red Snapper biology, ecology, behavior, population structure, fisheries interactions, stock assessment and management from GOM waters (see references in this text and Appendix 1). For example, juvenile habitats have been identified in the northern (Szedlmayer and Conti, 1999) and western (Rooker et al., 2004) GOM. Settlement-stage fish seek habitat such as sandy/shell bottom (Gallaway et al., 2009; Rooker et al., 2004; Szedlmayer and Howe, 1997), and subsequently make ontogenetic shifts to other structured habitats such as low-relief hard-bottom and artificial reef habitat (Workman et al., 2002). In

contrast to the GOM, and with the exception of publications or reports documenting age-growth patterns (Manooch and Potts, 1997; Nelson and Manooch,1982; White and Palmer, 2004), reproductive characteristics (including potential spawning areas off South Carolina, Georgia and Florida: Brown-Peterson et al., 2009; Burns et al., 2006; Sedberry et al., 2006; White and Palmer, 2004), and stock assessments (Manooch et al., 1998; SEDAR 15, 2008; SEDAR 24, 2010), there is an apparent paucity of information available on Red Snapper from SEUS waters.

We compared the number of peer-reviewed publications focused on Red Snapper in GOM versus SEUS waters to make inferences about the relative availability of information on Red Snapper in both regions. As a specific example, we also assessed and compared available information on Red Snapper juveniles in both regions. Based on these comparisons, we propose future research to further the understanding of Red Snapper life history, abundance, and distribution in SEUS waters, with an ultimate goal of facilitating Red Snapper fishery management.

2. Methods

2.1. Red Snapper-related Literature Search and Comparison

A literature search was conducted utilizing Thomson Reuters Web of Knowledge (WOK; http://wokinfo.com/) and ProQuest Aquatic Sciences and Fisheries Abstracts (ASFA; http://www.csa.com/factsheets/aquclust-set-c.php) databases[1], and by referencing literature cited sections of peer-reviewed publications and stock assessment documentation retained by the Gulf of Mexico Fishery Management Council (i.e., Reef Fish Stock Assessment Panel and Southeast Data, Assessment, and Review [SEDAR] documents). For database searches, a single search

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was performed (completed in February 2014) in WOK and ASFA for peer-reviewed publications containing the terms "Red Snapper" or "*Lutjanus campechanus*" in the title. Publications were then categorized according to their region of focus (GOM and/or SEUS), and to one of two "research focus" categories corresponding to Red Snapper: (1) biology, ecology, behavior or population structure and (2) fisheries interactions (including gear effects, release mortality, and bycatch issues), stock assessment and management. Publications focusing on aquaculture, physiology, fishery economics and the evaluation of research methodologies (e.g., assessing and comparing tagging or otolith preparation methods) were excluded from consideration.

2.2. Assessment and comparison of information on Red Snapper juveniles

First, from the Red Snapper-related publications identified during the literature search described above, the number of publications focusing at least partially on juveniles was assessed and compared between regions. Second, the number of records of Red Snapper juveniles in GOM and SEUS waters was assessed and compared between regions by querying fishery-independent survey data (GOM and SEUS) and institutional collections (SEUS only). We conservatively defined Red Snapper juveniles as individuals $\leq$ 150 mm total length (TL) based on results from White and Palmer (2004), in which the smallest mature individual was 200 mm TL and the L_{50} (defined by White and Palmer to be the median length at maturity) was 223 mm TL for males and 378 mm TL for females. We considered a single GOM survey database which we knew, prior to analysis, contained a large number of records of juvenile red snapper. We considered all SEUS-focused surveys of which we were aware. Each SEUS survey database was also queried for records of non-Red Snapper finfish species < 150 mm TL, standard length (SL) or fork length (FL) (see below) to provide context as to whether the gears used in each survey

would likely be capable of capturing juvenile Red Snapper (i.e., if a survey collected few non-Red Snapper individuals ≤ 150 mm TL, one would not expect the survey to effectively capture Red Snapper ≤ 150 mm TL). In some SEUS surveys, SL or FL measurements were recorded while TL measurements were not. Because of the lack of available SL-or-FL-to-TL conversion equations for many of the surveyed species, we used 150 mm TL, SL or FL as the cut-off for similar-sized non-red-snapper species, depending on which length format was recorded for each survey, recognizing that individuals with SL or FL measurements approaching 150 mm would have TL measurements slightly larger than 150 mm. Taxonomic identification of finfish from the GOM and SEUS surveys was not independently verified by the authors; however, the validity of those identifications is assumed to be accurate based on the expertise of those responsible for collecting the samples.

2.2.1. Gulf of Mexico Spring, Summer and Fall Groundfish Surveys

The ongoing GOM Southeast Area Monitoring and Assessment Program (SEAMAP) Groundfish Surveys, initiated in 1982, target non-structured habitats in coastal waters from FL to TX (88° W to 97° W), during spring, summer and fall seasons at depths ranging from < 5 m to 200 m, with occasional exploratory samples to > 500 m (Eldrige, 1988; J. Rester, Gulf States Marine Fisheries Commission, pers. comm.). The trawl survey utilizes two Western Jib trawls constructed of 47 mm (1-7/8 inch) sapphire webbing. Head rope lengths were 15.24 m and each was spread by 2.4 m x 1.0 m wooden doors. All available records (n = 29,746; 1982-2013) were surveyed for Red Snapper catches (Fig. 2).

2.2.2. SEAMAP – South Atlantic (SA) Coastal Trawl Survey

The ongoing SEAMAP–SA Coastal Trawl Survey, initiated in 1989, targets non-structured habitats in coastal waters from Cape Hatteras, North Carolina, to Cape Canaveral, Florida, during spring, summer and fall seasons at depths ranging from 4.6 to 9.1 m (15 to 30 feet), and historically to 13.7 m (45 feet) (see SCDNR 2014). The trawl survey utilizes paired 22.9 m (75-foot) mongoose-type, Falcon trawl nets. The body of the trawl is constructed of 47.6 mm (1.875-in) stretch mesh, while the cod end is constructed of 41.3 mm (1.625-in) stretch mesh. All available records (n = 6,758; 1989-2011) were surveyed for Red Snapper catches (Fig. 3).

2.2.3. Marine Resources Monitoring, Assessment, and Prediction (MARMAP) Program Trawl Survey

The MARMAP trawl survey, which sampled both unstructured and hard-bottom habitats, occurred annually from 1973 to 1980 in SEUS waters (depths ~ 20 - 200 m). The seasonality of sampling varied across years, including sampling during winter months in some years, and for sampling during late summer and/or early fall in all years. The trawl was composed of 1.3 cm stretched mesh nylon liner, a 16.5 m footrope sweep, #500 New England otter trawl doors, and 11 aluminum floats (20.3 cm diameter) spaced equally along the 11.9 m headrope. The footrope was equipped with 9 cm rollers. The net had the following stretched mesh dimensions: 11.4 cm in the wings, 10.2 cm then to 8.9 cm in the body, 5.1 cm in the cod end, and 1.3 cm in the cod end liner. All available records (n = 1,196; 1973-1980) were surveyed for Red Snapper catches (Fig. 4).

2.2.4. Southeast Reef Fish Survey - Chevron Trap Survey

This ongoing survey was initiated by MARMAP in 1988, with supplemental funding from SEAMAP-SA beginning in 2009. Beginning in 2010 MARMAP / SEAMAP-SA survey efforts were supplemented by the National Marine Fisheries Service's Southeast Fishery-Independent Survey (SEFIS) program. The chevron trap survey occurs from ~ April – September annually and targets hard-bottom habitats in depths of ~ 15 m to 100 m (historically to ~ 215 m) in SEUS continental shelf, shelf-break and upper slope waters. Traps are arrowhead-shaped and are constructed using 35 mm x 35 mm square mesh plastic-coated wire, with a total interior volume of 0.91 m^3 (Collins et al., 2001). Traps possess a single entrance funnel ("horse neck") and release panel to remove catch (Collins et al., 2001), and are baited with Clupeids (typically Atlantic Menhaden *Brevoortia tyrannus*). All available records (n = 11,941; 1987-2011) were surveyed for Red Snapper catches (Fig. 5).

2.2.5. Northeast Fisheries Science Center (NEFSC) Trawl Survey

This ongoing survey, initiated in 1963, is focused in waters between Massachusetts and Cape Hatteras, North Carolina; see NOAA, 1988 for survey description), but at times surveys are performed south of Cape Hatteras in SEUS waters. The survey, which occurs in the spring and fall, targets unstructured habitats but may also partially occur over hard-bottom habitats. The survey utilizes a Yankee trawl equipped with a 1.25 cm (0.5 in) stretched mesh liner in the cod end and upper belly of the net. All available records (n = 2,441; 1967-2011) were surveyed for Red Snapper catches (Fig. 6).

2.2.5. Other SEUS Institutional Queries

State agencies responsible for fisheries management in North Carolina, South Carolina, Georgia and Florida were queried regarding potential juvenile Red Snapper occurrences in state-specific estuarine survey programs. For North Carolina, databases from two ongoing North Carolina Division of Marine Fisheries trawl surveys, initiated in 1979 and 1987 (see Taylor et al., 2009 for description), were queried (n > 3,000 and 1,250, respectively). For South Carolina, a database associated with an ongoing trammel net (183 m x 2.1 m; 63.5 mm mesh) survey, initiated in 1987, was queried (n = 19,756). For Georgia, databases from ongoing Georgia Department of Natural Resources large (12 m flat) trawl (initiated in 2003; n = 2,560), small (6 m otter) trawl (1979-1985; 2006-present; n = 895), gill net (initiated in 2003; n =1,299) and trammel net (initiated in 2003; n = 950) surveys were queried. For Florida (Atlantic coast), databases from ongoing Florida Fish and Wildlife Conservation Commission small (21.3 m) seine (initiated in 1997; n = 10,983), large (183 m) seine (initiated in 1997; n = 8,178) and 6.1 m trawl (initiated in 1997; n = 6,618) surveys were queried.

An extensive search of state, academic, and private ichthyology collections was also conducted for records of juvenile Red Snapper, and is presented in Table 2. Juvenile Red Snapper identified in ichthyology collections held by the Florida Museum of Natural History at the University of Florida were measured by Rindone, and those identified in ichthyology collections held by the North Carolina Museum of Natural Sciences were measured by museum staff.

3. Results

3.1. Red Snapper-related Literature Search and Comparison

One hundred and ten peer-reviewed publications focusing on Red Snapper biology, ecology, behavior, population structure, fisheries interactions, stock assessment and management were identified from literature database searches (Appendix 1). Four publications (3.6% of the total) addressed issues in both GOM and SEUS waters (Burns and Froeschke, 2012; Cowan, 2011; Garber et al., 2004; Nelson and Manooch, 1982). Three publications (2.7% of the total; one age-growth, one age-growth and reproduction, and one stock assessment) were regionally focused in the SEUS (Manooch and Potts, 1997; Manooch et al., 1998; White and Palmer, 2004). The remaining 103 publications (93.6% of the total) were regionally focused in the GOM. Of those 103 publications, 75 focused on biology, ecology, behavior or population structure, and 28 focused on fisheries interactions (including gear effects, release mortality, and bycatch issues), stock assessment and management.

3.2. Assessment and comparison of information on Red Snapper juveniles

Twenty-eight publications, all regionally pertaining to the GOM, focused entirely or partially on Red Snapper juveniles (Appendix 1). No publications were identified that included information on Red Snapper juveniles in SEUS waters.

A total of 50,378 juvenile red snapper records were identified in the GOM SEAMAP Spring, Summer and Fall Groundfish Survey databases (Fig. 7). Capture locations ranged from < 4 m to 97 m depth (Fig. 8). A total of 132 juvenile Red Snapper records were identified for SEUS waters: 97 from fishery-independent survey databases (Table 1) and 35 from institutional collections (Table 2). SEUS fishery-independent survey databases contained records of more than 2.5 million individuals of similar-sized non-Red Snapper finfish species (Table 1). The locations of SEUS juvenile collections are shown in Fig. 9.

4. Discussion

Relative to the GOM region, there appeared to be a dearth of information on Red Snapper biology, ecology, life history and fisheries interactions in SEUS waters. While the number of peer-reviewed publications is an imperfect proxy for available information (e.g., important information is contained in gray literature), the finding that $\leq$ 3% of Red Snapper-focused peer-reviewed publications were regionally focused in SEUS waters clearly indicates that the geographical focus of Red Snapper research has been concentrated in GOM waters. This disparity is likely a result of a combination of historical factors including the greater economic value of the GOM Red Snapper fishery and, consequently, greater management focus and research funding availability.

In terms of Red Snapper juveniles, the lack of information for SEUS waters is particularly apparent. Twenty-eight of the 103 GOM-focused publications in the literature review focused or included information on Red Snapper juveniles (Appendix 1). Those publications include information on juvenile Red Snapper behavior, diet, growth rates, habitat utilization, site fidelity, ontogenic shifts, spatiotemporal distribution and genetic connectivity. Juveniles are regularly captured in the GOM shrimp trawl fishery, and trawl-associated juvenile mortality has been a contentious issue in GOM Red Snapper stock assessments and fishery management (Gallaway and Cole 1999; GMFMC 1991, 1998, 2004, 2008; Gutherz and Pellegrin, 1988; SEDAR 7, 2005; SEDAR 7 Update, 2009; SEDAR 31, 2013). Juveniles appear to be widely distributed and have been collected across a broad range of depths in the GOM (see Figures 7 and 8).

In contrast, in the SEUS, no publications included information on Red Snapper juveniles, nor is there documentation of Red Snapper bycatch in shrimp trawl fisheries (K. Brown, NCDMF, pers. comm.; L. Delaney, SCDNR, pers. comm.; Brown, 2009; Schmied and Nance, 1995). Additionally, we are unaware of any reports or other gray literature documenting the occurrence of juvenile Red Snapper in SEUS waters. The comprehensive search of fishery-independent survey databases and institutional collections identified only 132 records of juvenile Red Snapper. Fishery-independent survey databases (totaling > 75,000 individual gear deployments in and beyond the range of depths in which juvenile Red Snapper predominantly occur in GOM waters, and during and beyond the summer and early-fall period in which Red Snapper juveniles would be expected to be most abundant based on documented spawning patterns and catches from the GOM Groundfish Surveys) contained records of more than 2.5 million individuals of other similarly sized finfish species (Table 1), indicating their potential for collecting Red Snapper juveniles had they been present in the survey area. Given the historical importance of the Red Snapper fishery in SEUS waters (e.g., landings in the 1960s and 1970s of 275,000 kg to > 450,000 kg annually; SEDAR 24, 2010) and the abundant Red Snapper required to support that fishery, the near lack of documentation of Red Snapper juveniles in SEUS waters is intriguing and, from a fishery standpoint, potentially concerning. The 132 records of juvenile Red Snapper in SEUS waters were distributed throughout the region (Fig. 9), providing no evidence for (nor precluding) the existence of geographical "hotspots" of juvenile production.

4.1. What do we need to know, and why?

Improved information on Red Snapper biology, ecology, life history and fisheries interactions, particularly in SEUS waters, would aid Red Snapper population assessment and

management. For example, improved information on Red Snapper ontogenic and life-stage-specific spatiotemporal distribution patterns in SEUS waters could inform the choice of fishing sector-specific size- and age-selectivity patterns utilized in Red Snapper stock assessments for SEUS waters, a controversial topic in previous stock assessments (see Cowan, 2011). Knowledge of the occurrence and distribution of Red Snapper juveniles in SEUS waters would facilitate the establishment of surveys to assess annual juvenile year-class strength, which could be used to develop a recruitment index for use in stock assessments, as has occurred in the GOM (Karnauskas et al., 2013). As such, research and targeted surveys to identify juvenile habitats, guided by results from the surveys documented herein, is recommended. Research is also needed on Red Snapper fishery interactions, particularly in terms of assessing regulatory discard rates, discard mortality, and the effects of venting and recompression on discard mortality rates. Results from similar research in the GOM (see, for example, Campbell et al., 2010; Diamond and Campbell, 2009; Nieland et al., 2007; Render and Wilson, 1994; Rummer, 2007) have supported management decisions (GMFMC 2008, 2013) and likely improved the precision of stock assessments (SEDAR 31 2013) by providing the basis for release mortality estimates.

From a regional perspective, efforts are needed to assess hypotheses regarding connectivity between GOM and SEUS waters: are Red Snapper in SEUS waters (i) self-recruited from the SEUS stock, (ii) supported via larval supply, juvenile migration, or adult migration from the eastern GOM stock, or (iii) some combination thereof? Progress in assessing these hypotheses would facilitate the development of improved stock-recruitment relationships for use in Red Snapper stock assessments, and the determination of appropriate spatial scales for Red Snapper-focused fishery management actions. We are not aware of any studies which have documented or suggested considerable recruitment of larval Red Snapper from the GOM to the

SEUS. In contrast, a study describing a year of intensive surface and depth-interval ichthyoplankton sampling in the Florida Current (strong current flowing through the Straits of Florida; precursor to the Gulf Stream; Fig. 1) documented only two larval Red Snapper (D'Alessandro et al., 2010). Furthermore, Johnson et al. (2011) suggested that the Mississippi River Delta, the DeSoto Canyon, and the Apalachicola Peninsula act as geographic barriers to alongshore larval transport of Red Snapper spawned in the northern GOM, with the most influential barrier being the Apalachicola Peninsula (SEDAR 31 2013). While Red Snapper spawned from the Campeche Banks (Johnson et al., 2013) or the Dry Tortugas (Brown-Peterson et al., 2009) regions could theoretically be transported to SEUS habitats (Domeier, 2004; Johnson et al., 2013; Hare and Walsh, 2007), there is currently no evidence to indicate that Red Snapper from the GOM or Dry Tortugas provide measurably relevant larval contributions to the SEUS. Recruitment of juvenile Red Snapper to SEUS waters via juvenile migration from Gulf waters is unlikely, as studies documenting movements of juvenile Red Snapper have largely demonstrated high site fidelity of post-settlement juveniles to settlement habitat, with limited movement between habitat gradients (Diamond et al., 2007; Gallaway et al., 2009; Workman and Foster, 1994; Workman et al., 2002). Recruitment of adult Red Snapper from the GOM appears to be infrequent (Burns et al., 2006, unpub. data) and unlikely to result in significant contributions to the SEUS spawning stock. Research efforts to address GOM-SEUS connectivity hypotheses, via, for example, larval dispersal modeling and otolith chemistry analysis (e.g., to determine areas of juvenile production), are recommended.

5. Conclusions

There is a relative dearth of information on Red Snapper biology, ecology, life history and fisheries interactions in SEUS waters. In particular, there is limited information on the occurrence of juvenile Red Snapper in SEUS waters, despite fishery independent surveys having occurred in SEUS waters across the seasons, depths and habitats in which juvenile Red Snapper have been collected in the Gulf of Mexico. Research to identify juvenile Red Snapper habitats in SEUS waters and, more broadly, to fill other Red Snapper-related information gaps may increase the precision of stock assessments, improve fishery management capability, and support sustainable Red Snapper fisheries.

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Figure captions

Figure 1: Map showing the eastern Gulf of Mexico, the eastern Floridian coastline, and associated topographical and oceanographic features. Current locations are approximations, with arrows delineating general flow direction. Arrows do not reference current velocity. Map Credit: Gulf of Mexico Fishery Management Council.

Figure 2. Gulf of Mexico Spring, Summer and Fall Groundfish Surveys sampling locations for 1982-2013.

Figure 3. SEAMAP Coastal Trawl Survey sampling locations for 1989-2011.

Figure 4. MARMAP Trawl Survey sampling locations for 1973-1980.

Figure 5. Southeastern US Chevron Trap Survey sampling locations for 1987-2011.

Figure 6. NEFSC Trawl Survey sampling locations for 1967-2011.

Figure 7. Collection locations of Red Snapper $\leq$ 150 mm TL from the Gulf of Mexico Spring, Summer and Fall Groundfish Surveys. Multiple individuals were collected at some locations. Data accessed from Gulf States Marine Fisheries Commission, June 2014.

Figure 8. Individual records of Red Snapper $\leq$ 150 mm total length collected in the Gulf of Mexico SEAMAP Spring, Summer or Fall Groundfish Surveys, by depth of collection.

Figure 9. Collection locations of Red Snapper $\leq$ 150 mm TL from fishery-independent surveys or institutional collections in southeast US Atlantic Ocean waters. Multiple individuals were collected at some locations. Smaller filled circles represent Red Snapper < 50 mm TL; larger filled circles represent Red Snapper 50 – 150 mm TL. N = 112 (20 of the 132 records in Table 1 did not have corresponding collection location information).

FIGURES

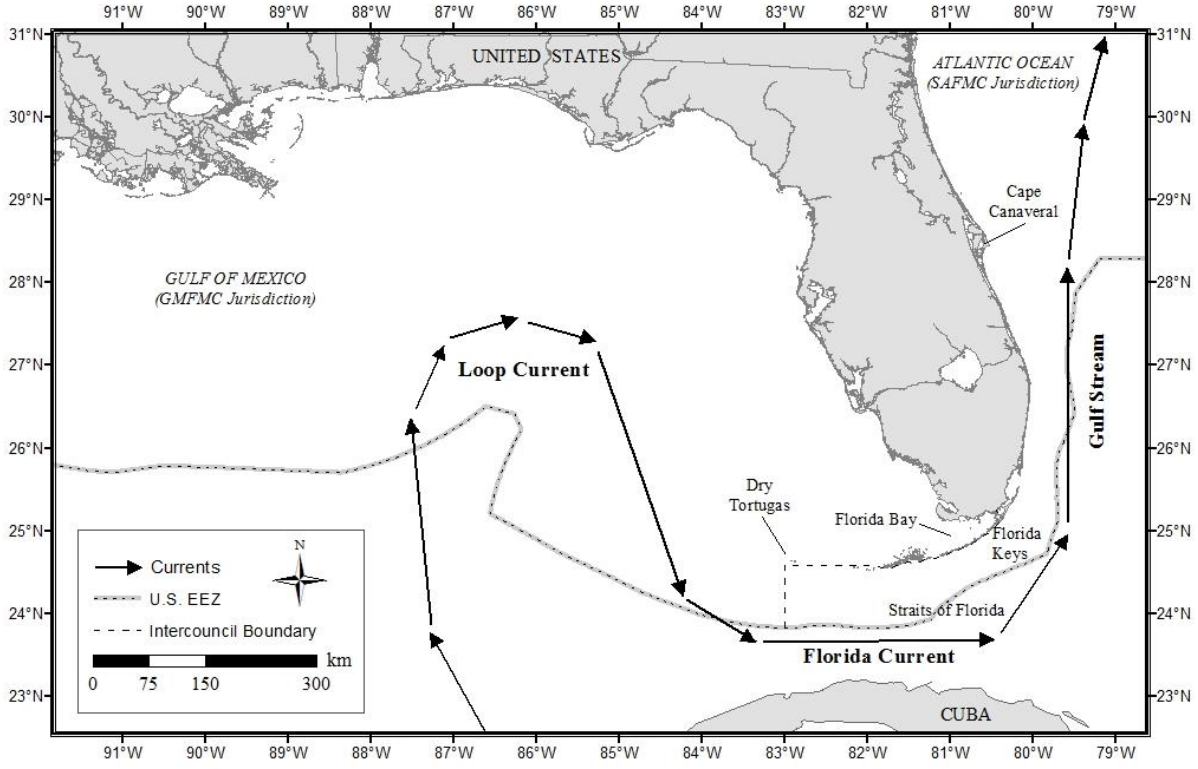

Figure 1.

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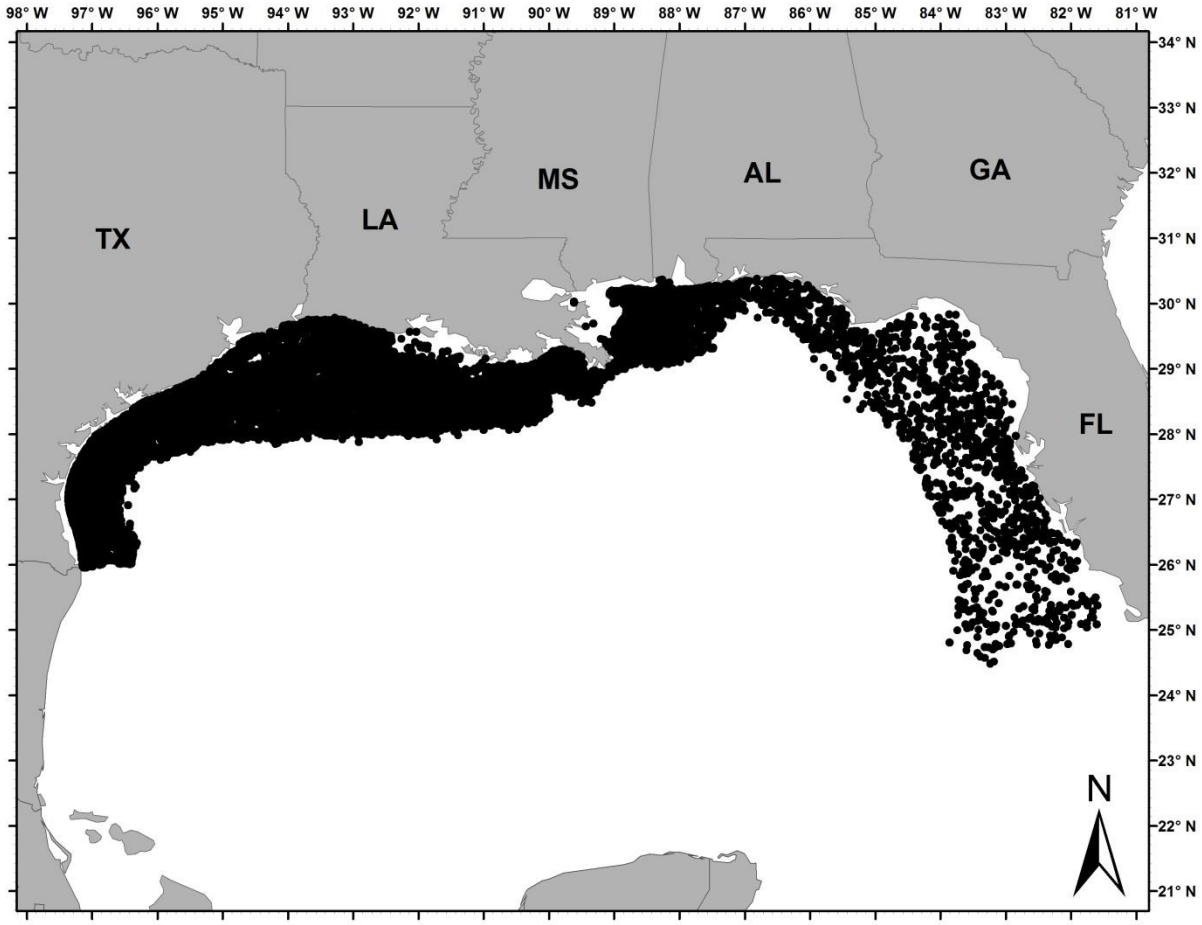

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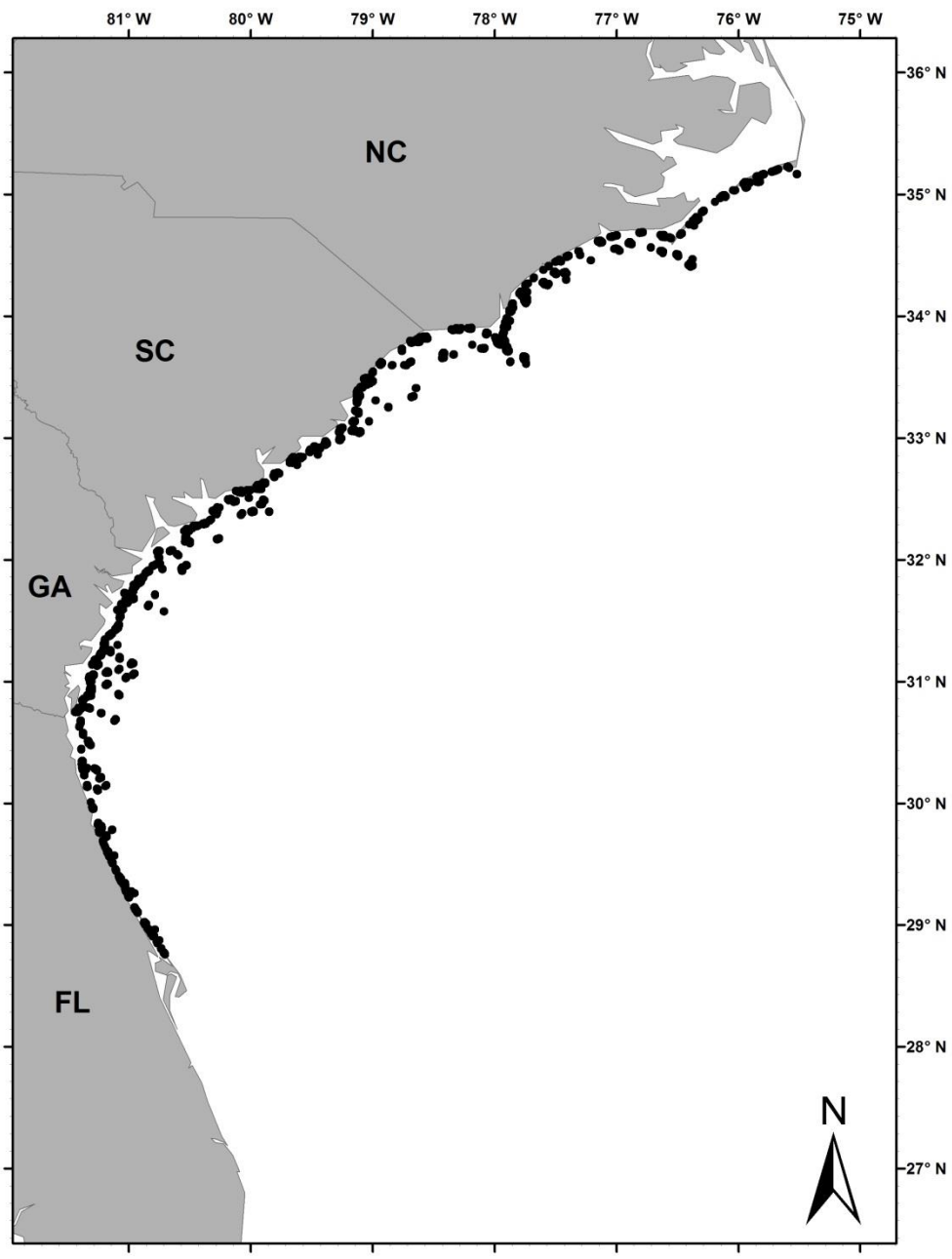

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4 Figure 3.
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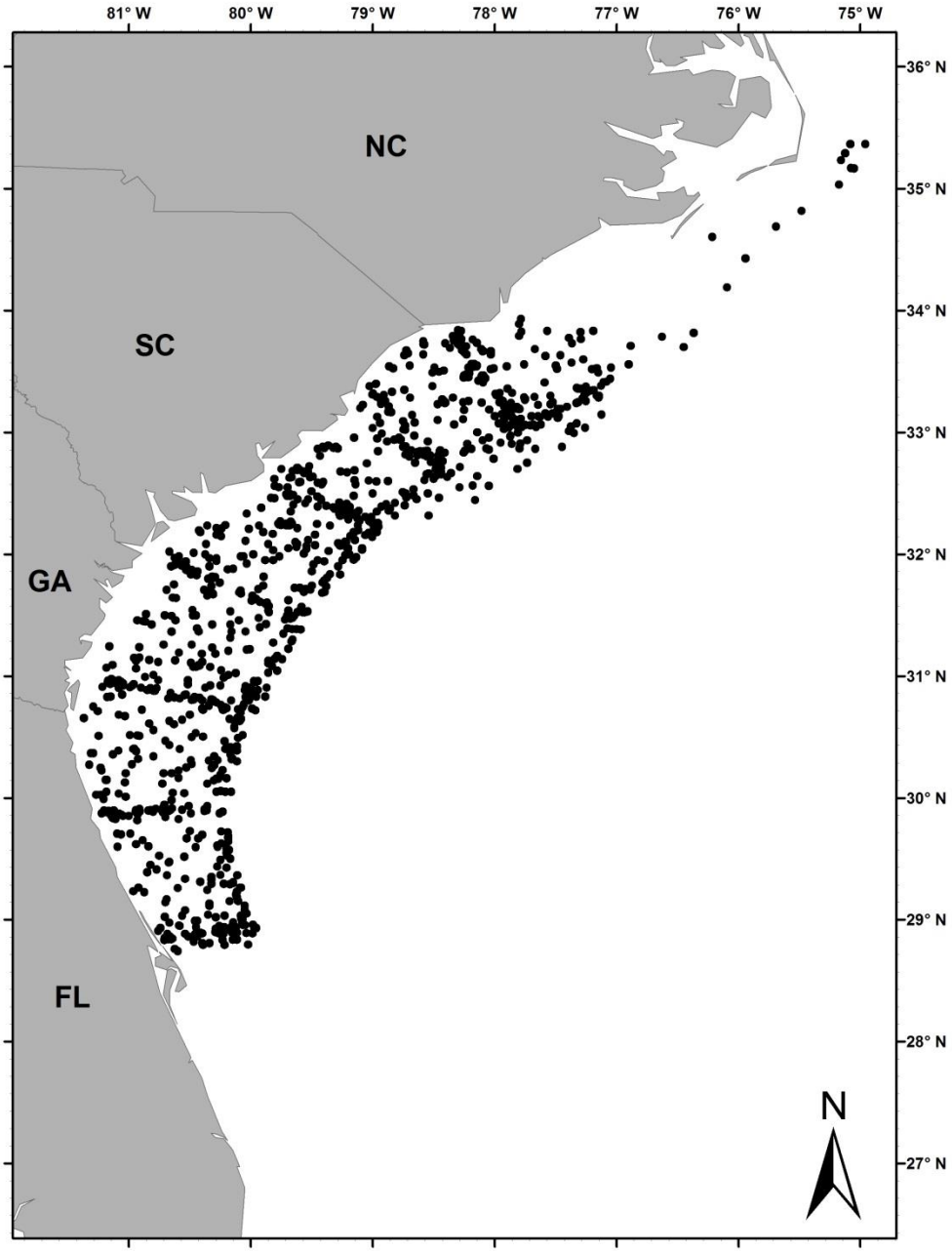
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78° W
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76° W
75° W
36° N
35° N
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27° N
NC
SC
GA
FL
N

Figure 4.

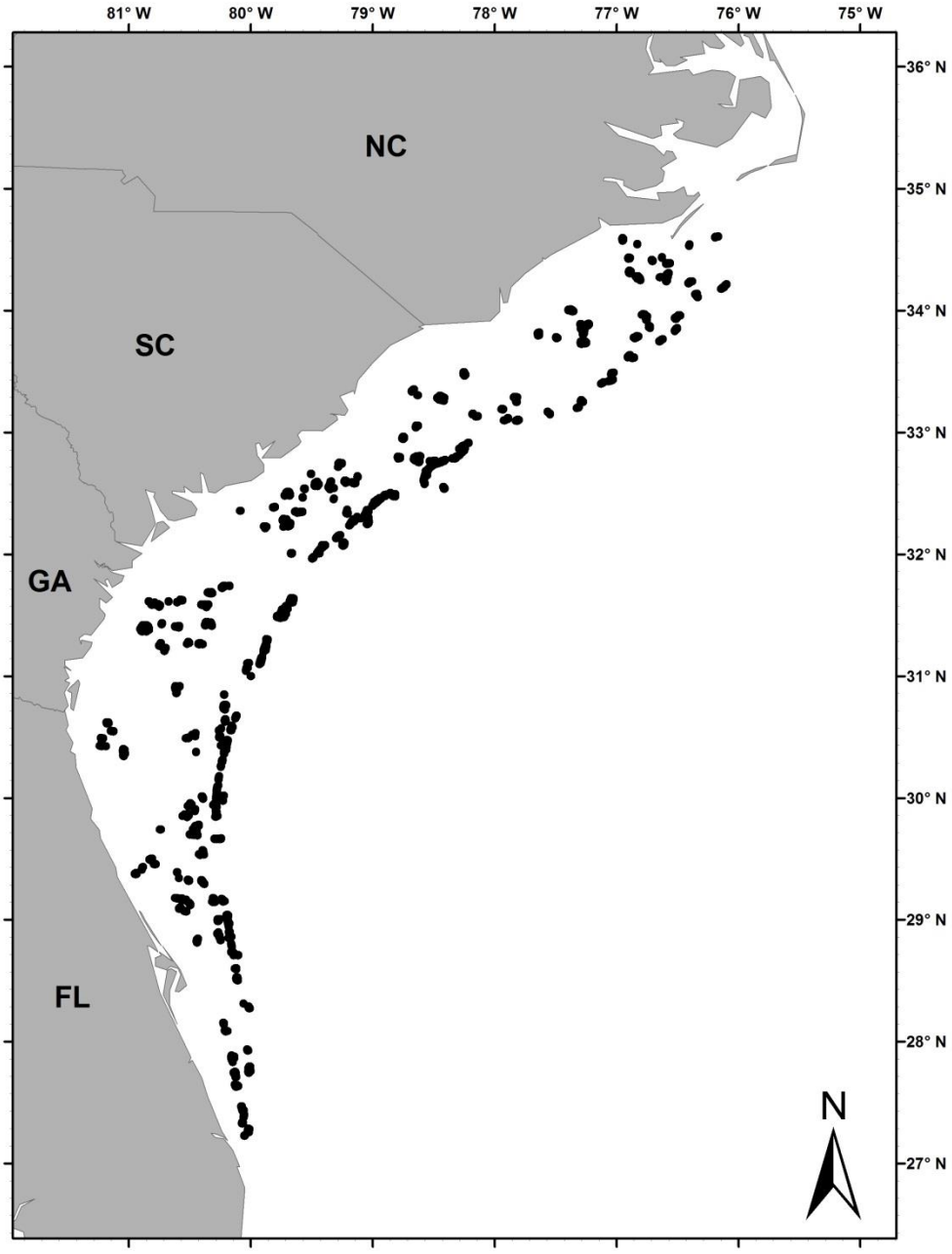
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Figure 5.

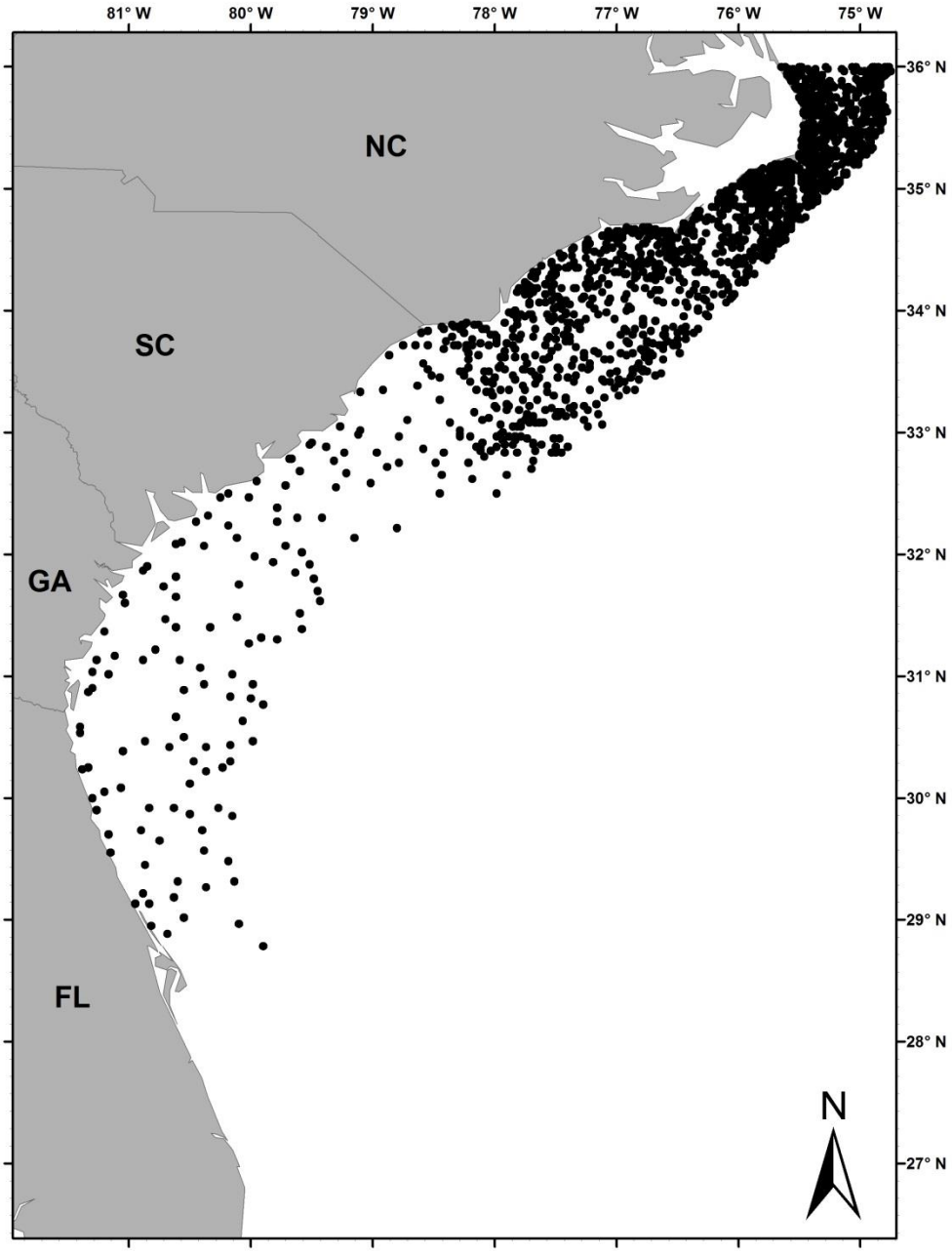
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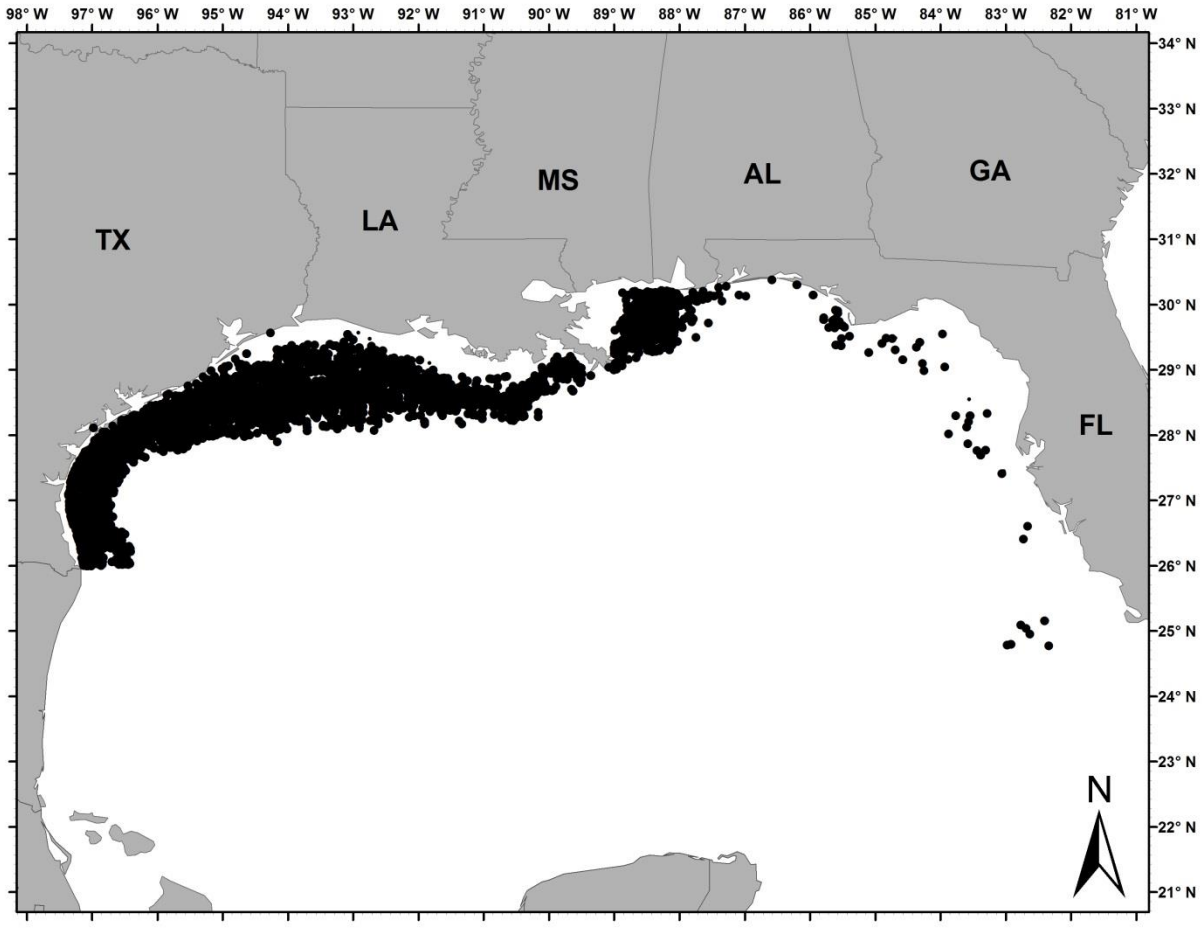
Figure 6.

1



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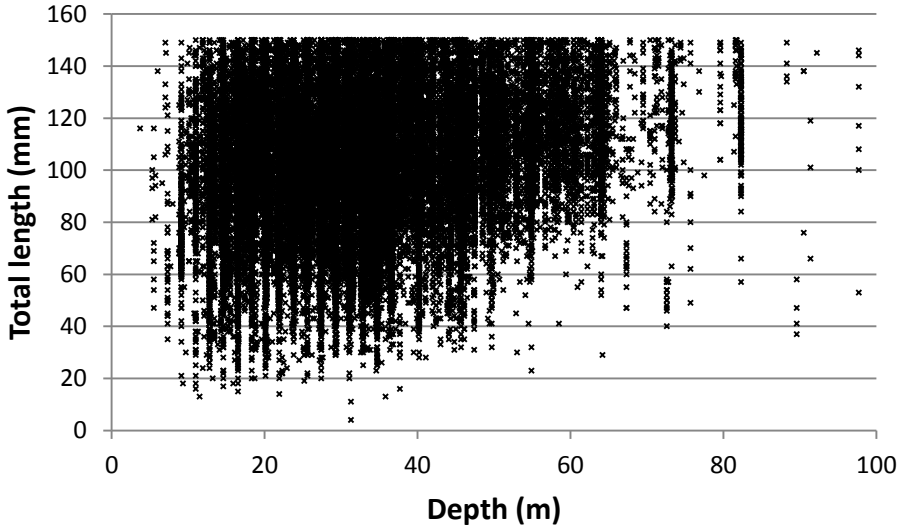
3 Figure 7

4


Total length (mm)
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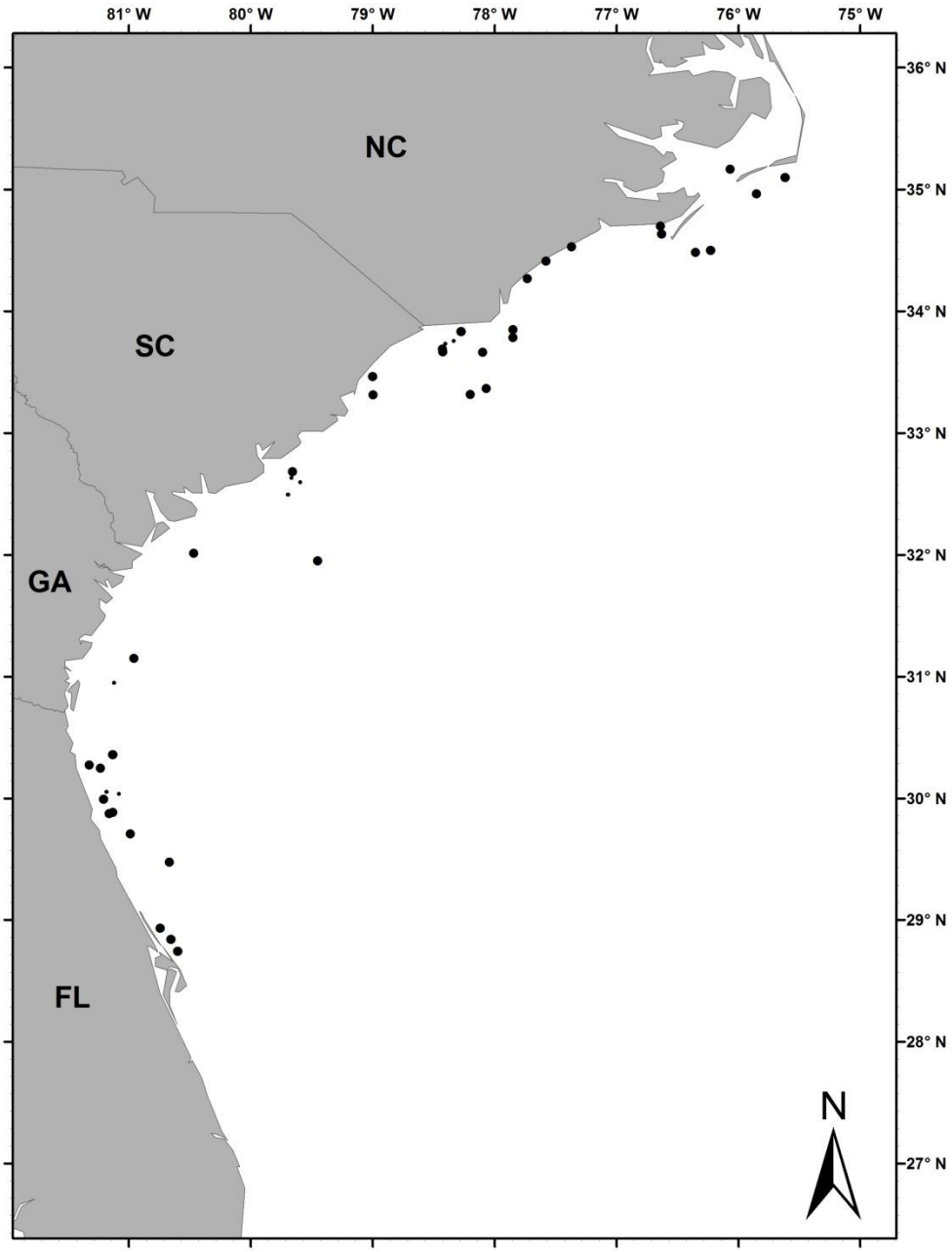
120
100
80
60
40
20
0
0
20
40
60
80
100
Depth (m)

Figure 8

1



2
3 Figure 9
4

TABLES

Table 1: Number of records of Red Snapper ≤ 150 mm TL and of similar-sized individuals of non-red snapper species in fishery-independent survey conducted in Atlantic waters from North Carolina to Florida.

Source	Survey depth range (m)	Survey temporal coverage	Red Snapper ≤ 150 mm TL	Other species ≤ 150 mm TL, SL or FL
SEAMAP-SA coastal trawl survey	~ 5-9 (historically to 14)	Spring, summer, fall	5	33,501 (TL)
MARMAP trawl survey	~ 20-200	Summer, fall, early winter	82	529,439 (TL)
SEUS chevron trap survey	~15-100	Spring, summer, early fall	0	48,169 (TL)
NEFSC trawl survey	~ 5-500	Spring and fall	6	71,429 (TL)
NC estuarine surveys	< 10	Spring, summer, early fall	4	?[1]
SC estuarine surveys	< 10	Spring, summer, fall, winter	0	18,558 (SL)
GA estuarine surveys	< 10	Spring, summer, fall	0	876,110 (TL)
FL estuarine surveys	< 10	Spring, summer, fall, winter	0	1,019,046 (SL)
Total	-	-	97	2,596,252

[1] Data unavailable to authors

Table 2: Number of records of SEUS juvenile Red Snapper in institutional collections.

Institution	Red Snapper ≤ 150mm TL
California Academy of Science	0
Campbell Museum at Clemson	0
Cornell University	0
Field Museum of Natural History, Zoology Dept., Chicago IL	0
FL Fish & Wildlife Cons. Comm., FWRI	0
Florida Aquarium	0
Florida Museum of Natural History	21
GA Museum of Natural History	0
Georgia Aquarium	0
Georgia College and State University	0
Grice Marine Laboratory	0
Harvard University Museum of Comparative Zoology	0
Los Angeles County Natural History Museum	0
Louisiana Museum of Natural History	0
Miami Seaquarium	0
Michigan State University Museum	0
Mississippi Museum of Natural Science	0
Nat. Mus. Nat. Hist., Smithsonian, Dept. Vert. Zool.	0
North Carolina Aquarium System	0
North Carolina Museum of Natural Sciences	14
Royal Ontario Museum	0
SC Aquarium at Charleston	0
SC Museum of Natural Resources	0
Texas Cooperative Wildlife Collection	0
Tulane Museum of Natural History	0
TX Nat. Hist. Coll., TX Nat. Sci. Cen., TX Mem. Mus.	0
University of Kansas Natural History Museum	0
University of Louisiana-Monroe	0
University of Michigan Museum of Zoology	0
University of Tennessee Department of Zoology	0
Virginia Institute of Marine Science	0
Yale Peabody Museum	0
Total	**35**

Appendix 1: Citations categorized by region and topic of focus. Superscripts denote the following: [1] relates to Gulf of Mexico; [2] relates to South Atlantic; [3] relates to both Gulf of Mexico and South Atlantic; [a] relates to biology, ecology, behavior or population structure; [b] relates to fisheries interactions (including gear effects, release mortality, and bycatch issues), stock assessment or management; [c] focuses fully or partially on red snapper juveniles.

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