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MANAGEMENT BRIEF

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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 U.S. Atlantic Ocean waters. Stock assessment results and related 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 performing a literature review and comparing the number of region-specific, Red Snapper–focused peer-reviewed publications. One hundred and ten publications (over the period 1982–2013) were identified in this search, with 94% focused on Gulf of Mexico waters. We then assessed the 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. None documented the occurrence of juvenile Red Snapper in southeastern U.S. Atlantic Ocean waters. For the Gulf of Mexico, more than 50,000 records of juvenile Red Snapper were identified in a single trawl survey database. For southeastern U.S. Atlantic Ocean waters, a comprehensive search of fishery-independent survey databases (totaling >75,000 individual gear deployments and occurring across the range of habitats, depths, and seasons in which juvenile Red Snapper were collected in the Gulf of Mexico trawl survey) and institutional collections identified only 132 records of juvenile Red Snapper. These results highlight the need for additional information on Red Snapper in southeastern U.S. Atlantic Ocean waters and on the connectivity between Gulf of Mexico and southeastern U.S. Atlantic Ocean Red Snapper populations to support Red Snapper population assessment and fishery management.

Red Snapper *Lutjanus campechanus* (Poey 1860) are highly valued reef fish found throughout coastal and nearshore areas of Gulf of Mexico (GOM) and southeastern U.S. Atlantic Ocean (SEUS; Bortone 1986) waters. Stock assessment findings and the resulting regulatory actions are contentious in both regions (Cowan 2011). In the GOM, Red Snapper contribute to a multibillion-dollar recreational fishing industry and support an important commercial fishery. In SEUS waters, where the Red Snapper fishery has historically been one of the most important in terms of landings and exvessel value, the fishery has mainly been closed since the end of 2010 as part of a population rebuilding plan, with limited commercial and recreational fishery openings from 2012 to 2014. Though Red Snapper are clearly important to both regions, the economic impact of the commercial fishery in the Gulf of Mexico is markedly higher than that of the fishery for all commercially harvested snappers in the SEUS (NMFS 2014; Figure 1). Both the GOM and SEUS populations are classified as overfished but not undergoing overfishing (SEDAR 24 2010; SEDAR 31 2013), and it is thought 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 (Burns et al. 2006; Brown-Peterson et al. 2009; Figure 2). Genetic research indicates homogeneity between the GOM and SEUS populations (Gold and Richardson 1998; Garber et al. 2004).

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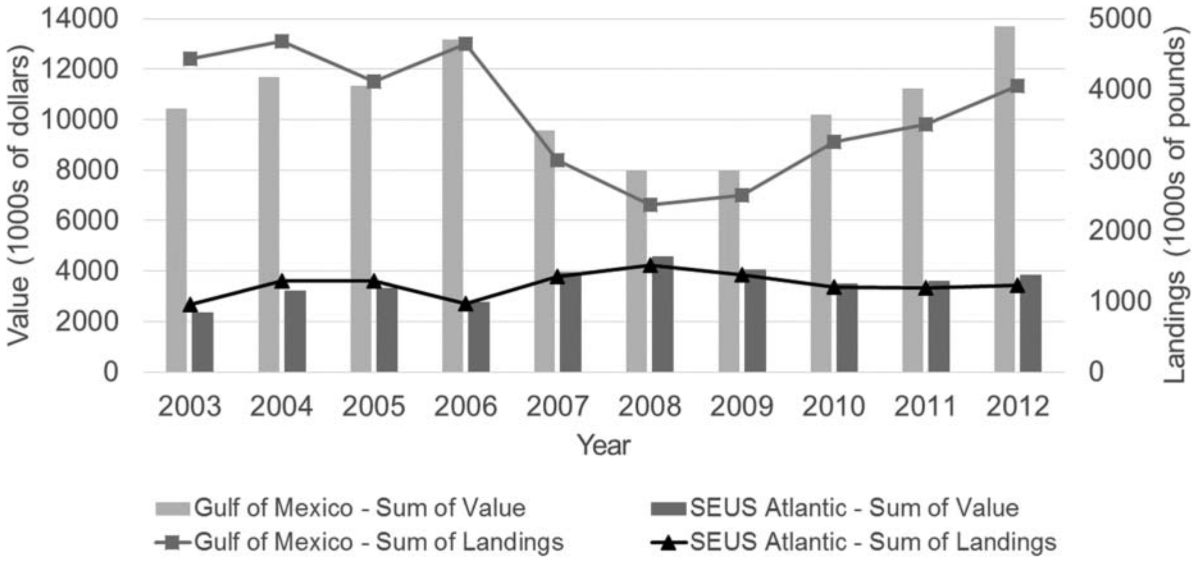

FIGURE 1. Economic value and landings (whole weight) of Red Snapper in the Gulf of Mexico and the snapper species complex in the southeastern U.S. Atlantic Ocean, which includes Red Snapper and other snapper species. Source: NMFS (2014).

There is a wealth of information on the biology, ecology, behavior, population structure, fisheries interactions, stock assessment, and management of Red Snapper from GOM waters (see the references in the reference list and the appendix). 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 or shell bottom (Szedlmayer and Howe 1997;

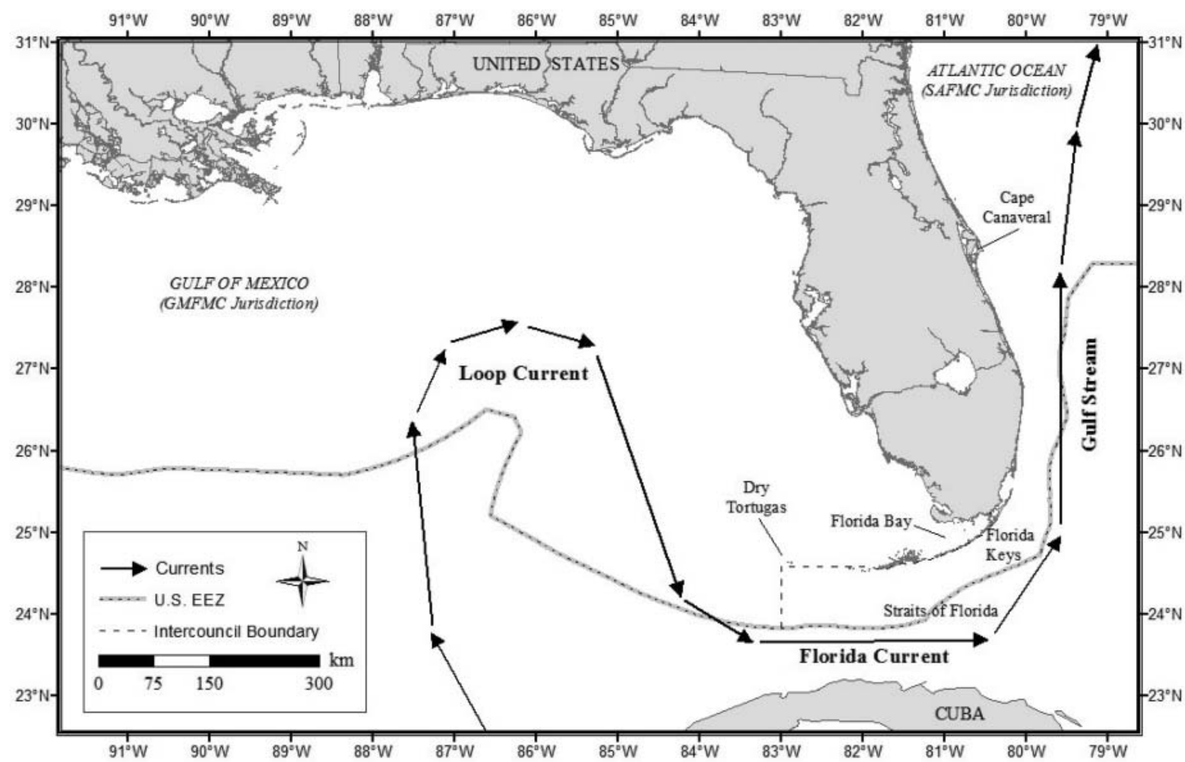

FIGURE 2. Map showing the eastern Gulf of Mexico, the eastern coast of Florida, and associated topographical and oceanographic features. Current locations are approximations; the arrows delineate the general directions of flow but not current velocities. Abbreviations are as follows: GMFMC = Gulf of Mexico Fishery Management Council; SAFMC = South Atlantic Fishery Management Council. Source: GMFMC.

Rooker et al. 2004; Gallaway et al. 2009) and subsequently make ontogenic shifts to other structured habitats such as low-relief, hard-bottom and artificial reef habitat (Workman et al. 2002). There is an apparent paucity of information on Red Snapper from SEUS waters, generally limited to age–growth patterns (Nelson and Manooch 1982; Manooch and Potts 1997; White and Palmer 2004), reproductive characteristics (White and Palmer 2004; Burns et al. 2006; Sedberry et al. 2006; Brown-Peterson et al. 2009), and stock assessments (Manooch et al. 1998; SEDAR 15 2008; SEDAR 24 2010).

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

METHODS

Red Snapper–related literature search and comparison.—A literature search was conducted using the 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, and the literature-cited sections of peer-reviewed publications and stock assessment documentation held by the Gulf of Mexico Fishery Management Council (i.e., Reef Fish Stock Assessment Panel and Southeast Data, Assessment, and Review [SEDAR] documents). The searches were not constrained by year of publication. For database searches, a single search 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, the latter to provide insight into the distribution of publications (and therefore available information) across two broad areas of research: (1) biology, ecology, behavior, and 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.

Assessment and comparison of information on Red Snapper juveniles.—First, the number of publications focusing at least partially on juveniles was assessed and compared between regions from the Red Snapper–related publications identified during the literature search described above. 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 ≤150 mm total length (TL) based on White and Palmer (2004), in which the smallest mature individual was 200 mm TL and the L50 (defined by White and Palmer to be the median length at maturity) was 223 mm for males and 378 mm for females. We considered a single GOM survey database that we knew (prior to the analysis) contained a large number of records of juvenile Red Snapper. We considered all SEUS-focused surveys of which we were aware. Database queries were performed by data managers associated with each data set utilized or by a National Marine Fisheries Service (Beaufort, North Carolina) data manager in cases in which there was direct access to the data sets. For each database, a single query was run to identify all records of Red Snapper ≤150 mm TL. Queries were not constrained by any factors (e.g., date or depth), as our interest was in identifying all records of Red Snapper ≤150 mm. For the SEUS databases, a second query was run to identify all records of non–Red Snapper finfish species ≤150 mm TL (or standard length [SL] or fork length [FL] if TL data were not available], with the objective of providing context as to whether the gears used in each survey would be capable of capturing juvenile Red Snapper [i.e., if a survey collected few non–Red Snapper individuals ≤150 mm, one would not expect the survey to effectively capture Red Snapper of that size). We included SEUS estuarine surveys in our analyses since juvenile Red Snapper are infrequently collected in Gulf of Mexico estuarine waters (T. Switzer and M. Murphy, Florida Fish and Wildlife Conservation Commission; S. Powers, University of South Alabama; J. Mareska, Alabama Marine Resources Division; M. Fischer, Louisiana Department of Wildlife and Fisheries; M. Fisher, Texas Parks and Wildlife Department; personal communications). 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.

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 unstructured habitats in coastal waters from Florida to Texas (88°W to 97°W) during spring, summer, and fall at depths ranging from <5 m to 200 m, with occasional exploratory samples from depths >500 m (Eldridge 1988; J. Rester, Gulf States Marine Fisheries Commission, personal communication). The trawl survey utilizes two Western Jib trawls constructed of 47-mm sapphire webbing. The length of the head ropes was 15.24 m, and each was spread by 2.4-m × 1.0-m wooden doors. The database is managed by the Gulf States Marine Fisheries Commission and is accessible online at http://seamap.gsmfc.org/. All available records (n = 29,746

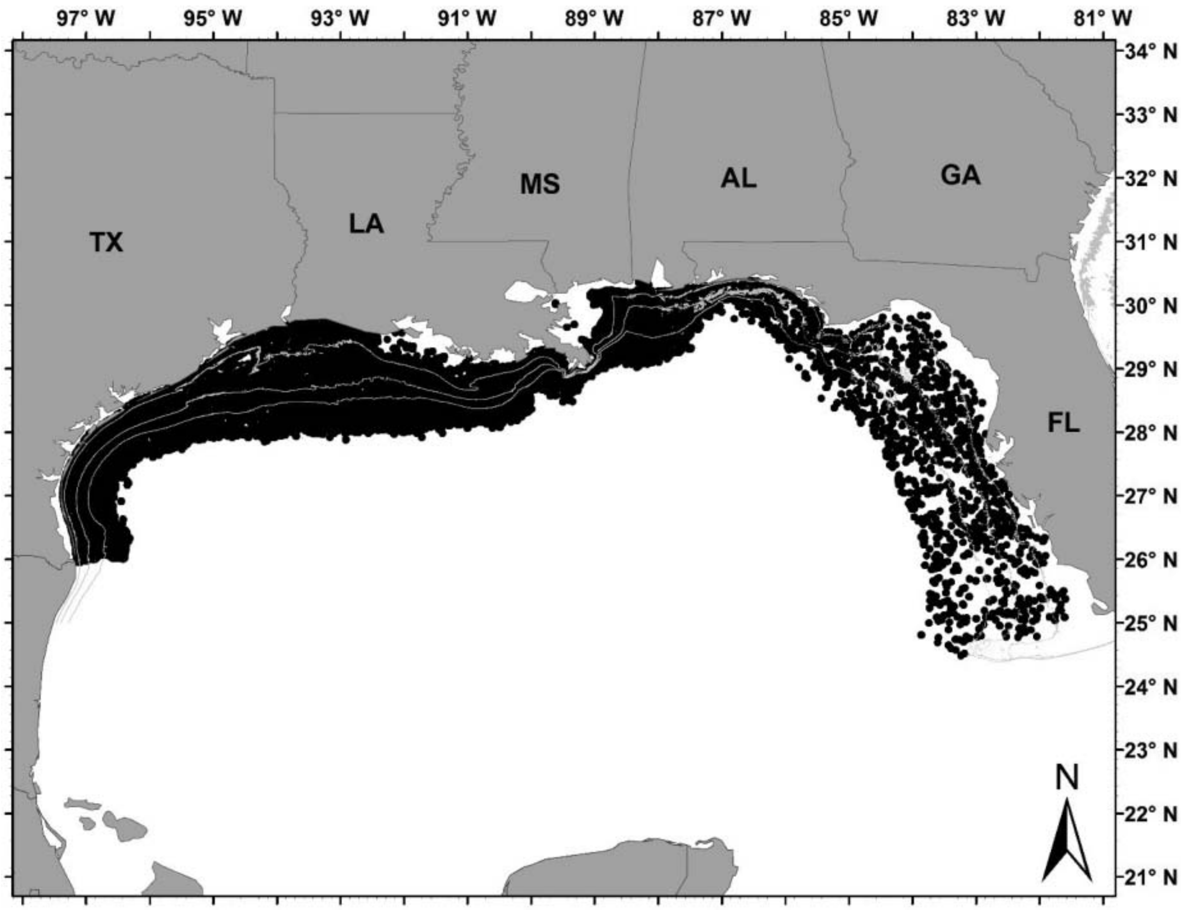

FIGURE 3. Sampling locations for Gulf of Mexico spring, summer, and fall groundfish surveys in 1982–2013. The bathymetric lines represent the 15-, 30-, and 45-m depth contours.

trawl sets; 1982–2013) were queried for Red Snapper catches (Figure 3).

SEAMAP South Atlantic (SA) coastal trawl survey.—The ongoing SEAMAP South Atlantic coastal trawl survey, initiated in 1989, targets unstructured habitats in coastal waters from Cape Hatteras, North Carolina, to Cape Canaveral, Florida, during spring, summer, and fall at depths ranging from 4.6 to 9.1 m and historically to 13.7 m (see SCDNR 2014). The survey utilizes paired 22.9-m mongoose-type Falcon trawl nets. The body of the trawl is constructed of 47.6-mm stretch mesh, while the cod end is constructed of 41.3-mm stretch mesh. The database is managed by the South Carolina Department of Natural Resources. All available records ($n = 6{,}758$ trawl sets; 1989–2011) were queried for Red Snapper catches (Figure 4A).

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 during late summer and/or early fall in all years. The trawl was composed of a 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 in 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 tapering to 8.9 cm in the body, 5.1 cm in the cod end, and 1.3 cm in the cod end liner. The database is managed by the South Carolina Department of Natural Resources. All available records ($n = 1{,}196$ trawl sets; 1973–1980) were queried for Red Snapper catches (Figure 4B).

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, the MARMAP–SEAMAP-SA survey efforts were supplemented by the National Marine Fisheries Service's Southeast Fishery-Independent Survey (SEFIS) program. The combined MARMAP–SEAMAP-SA–SEFIS survey efforts are now referred to as the Southeast Reef Fish Survey (SERFS). The SERFS chevron trap survey occurs from approximately April to September annually and targets hard-bottom habitats in depths of 15 to 100 m (historically to 215 m) in SEUS

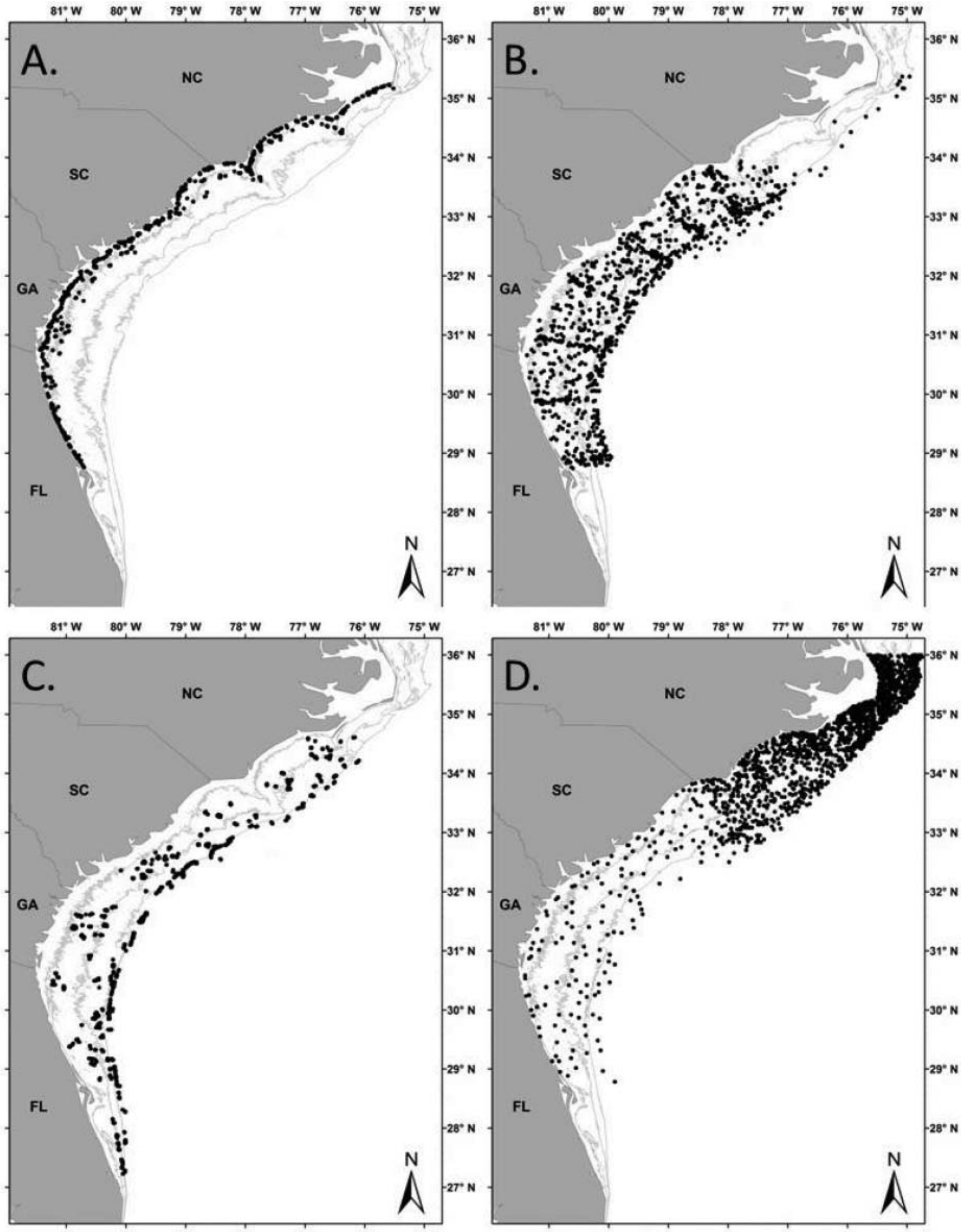

FIGURE 4. Sampling locations for **(A)** the SEAMAP coastal trawl survey in 1989–2011, **(B)** the MARMAP trawl survey in 1973–1980, **(C)** the SERFS chevron trap survey in 1987–2011, and **(D)** the NEFSC trawl survey in 1967–2011; see text for details. The bathymetric lines represent the 15-, 30-, and 45-m depth contours.

continental shelf, shelf-break, and upper-slope waters. The traps are arrowhead-shaped and are constructed using 35-mm × 35-mm square mesh plastic-coated wire, with a total interior volume of 0.91 m^3 (Collins et al. 2001). They possess a single entrance funnel and release panel to remove the catch (Collins et al. 2001) and are baited with clupeids (typically Atlantic Menhaden *Brevoortia tyrannus*). The database is managed by the South Carolina Department of Natural Resources. All available records ($n = 11{,}941$ chevron trap sets; 1987–2011) were queried for Red Snapper catches (Figure 4C).

Northeast Fisheries Science Center trawl survey.—This ongoing survey, initiated in 1963, focuses on the waters between Massachusetts and Cape Hatteras, North Carolina (see NOAA 1988 for a 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 stretched mesh liner in the cod end and upper belly of the net. The database is managed by the NMFS Northeast Fisheries Science Center. All available records ($n = 2{,}441$ trawl sets; 1967–2011) were queried for Red Snapper catches (Figure 4D).

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 descriptions), were queried ($n > 3{,}000$ and 1,250 trawls sets, respectively). For South Carolina, a database associated with an ongoing South Carolina Department of Natural Resources trammel net (183 × 2.1 m; 63.5-mm mesh) survey, initiated in 1987, was queried ($n = 19{,}756$ trammel net sets). For Georgia, databases from ongoing Georgia Department of Natural Resources large (12-m flat) trawl (initiated in 2003; $n = 2{,}560$ trawl sets), small (6-m otter) trawl (1979–1985; 2006–present; $n = 895$ trawl sets), gill net (initiated in 2003; $n = 1{,}299$ net sets), and trammel net (initiated in 2003; $n = 950$ trammel net sets) surveys were queried. For Florida (Atlantic coast), databases from ongoing Florida Fish and Wildlife Conservation Commission small (21.3 m) seine (initiated in 1997; $n = 10{,}983$ net sets), large (183 m) seine (initiated in 1997; $n = 8{,}178$ net sets), and 6.1-m trawl (initiated in 1997; $n = 6{,}618$ trawl sets) surveys were queried.

An extensive search of state, academic, and private ichthyology collections was also conducted for records of juvenile Red Snapper. We measured the juvenile Red Snapper identified in ichthyology collections held by the Florida Museum of Natural History at the University of Florida; North Carolina Museum of Natural Sciences staff measured the specimens identified in that museum's ichthyology collection.

RESULTS

Red Snapper–Related Literature Search and Comparison

A total of 110 peer-reviewed publications focusing on Red Snapper biology, ecology, behavior, population structure, fisheries interactions, stock assessment, and management were identified (Table 1; Appendix). The year of publication ranged from 1982 to 2013. Four publications (3.6% of the total) addressed issues in both GOM and SEUS waters (Nelson and Manooch 1982; Garber et al. 2004; Cowan 2011; Burns and Froeschke 2012). Three publications (2.7% of the total) were focused on the SEUS (Manooch and Potts 1997; Manooch et al. 1998; White and Palmer 2004). The remaining 103 publications (93.6% of the total) were focused on the GOM.

Assessment and Comparison of Information on Red Snapper Juveniles

Twenty-eight publications pertaining to the GOM focused entirely or partially on Red Snapper juveniles (Table 1; Appendix). 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 (Figure 5A). Capture locations ranged from <4 m to 97 m in depth (Figure 6). We identified 132 juvenile Red Snapper records for SEUS waters: 97 from fishery-independent survey databases (Table 2) and 35 from institutional collections. The SEUS fishery-independent survey databases contained records of more than 2.5 million individuals of similar-sized non–Red Snapper finfish (Table 2). The locations of SEUS juvenile collections are shown in Figure 5B.

TABLE 1. Results of peer-reviewed literature search pertaining to Red Snapper. Shown are the number of publications by subject and area (GOM = Gulf of Mexico, SEUS = southeastern U.S. Atlantic Ocean); publication dates range from 1982 to 2013.

Subject	GOM	SEUS	GOM and SEUS
All publications	103	3	4
Biology, ecology, behavior, and population structure	75	2	2
Fisheries interactions, stock assessment, and management	28	1	2
Red Snapper juveniles	28	0	0

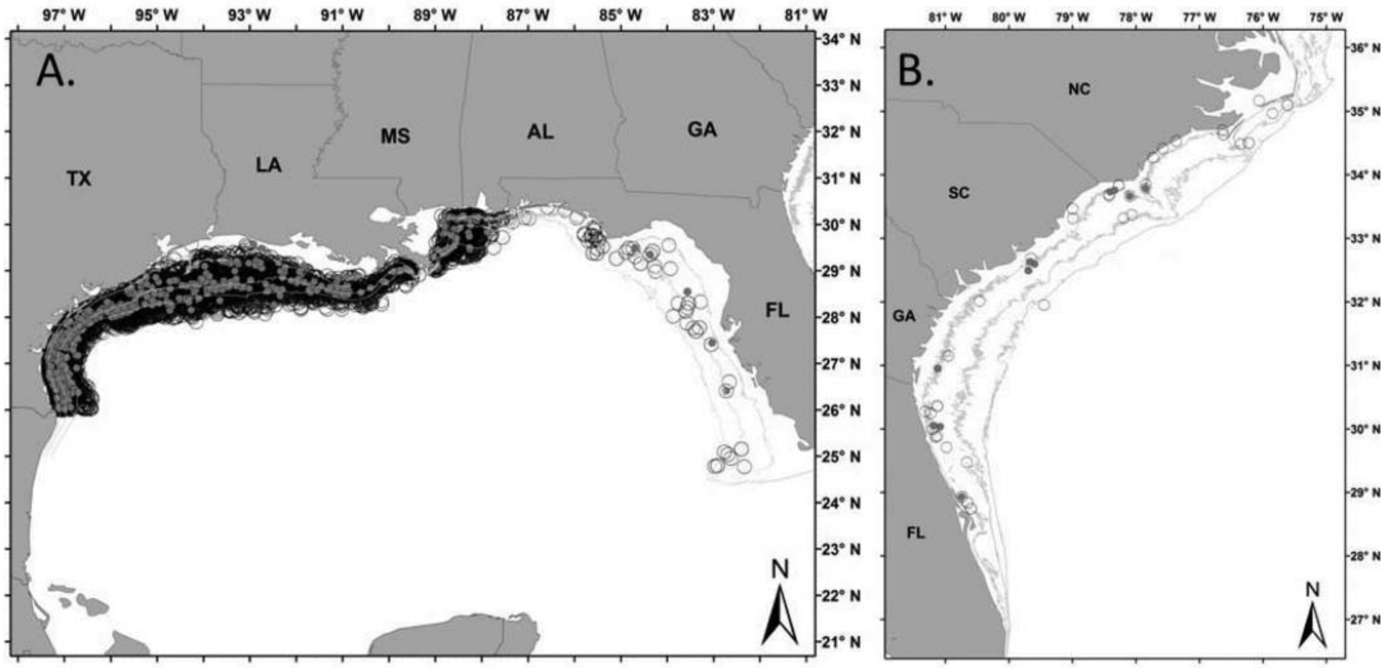

FIGURE 5. Panel (**A**) shows the collection locations of Red Snapper ≤150 mm TL in the Gulf of Mexico spring, summer, and fall groundfish surveys. Multiple individuals were collected at some locations. Data are from the Gulf States Marine Fisheries Commission (June 2014). Panel (**B**) shows the collection locations of Red Snapper ≤150 mm TL from fishery-independent surveys or institutional collections in southeast U.S. Atlantic Ocean (SEUS) waters; $N = 112$ (20 of the 132 SEUS records did not have collection location information). Multiple individuals were collected at some locations. In both panels, the bathymetric lines represent the 15-, 30-, and 45-m depth contours; the smaller, filled circles represent Red Snapper ≤50 mm TL; and the larger, open circles represent Red Snapper 50–150 mm TL.

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 the available information (important information is contained in the gray literature), the finding that <3% of Red Snapper–focused peer-reviewed publications focused on SEUS waters clearly indicates that Red Snapper research has concentrated on GOM waters. This disparity is likely the result of a combination of historical factors, including the greater economic value of the GOM Red Snapper fishery (Figure 1) and consequently greater management focus on and research funding for that fishery.

TABLE 2. Number of records of Red Snapper ≤150 mm TL and similar-sized individuals of other species from fishery-independent surveys conducted in Atlantic waters from North Carolina to Florida.

Source	Survey depth (m)	Survey times	Red Snapper ≤150 mm TL	Other species ≤150 mm[a]
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
North Carolina estuarine surveys	<10	Spring, summer, early fall	4	[b]
South Carolina estuarine surveys	<10	Spring, summer, fall, winter	0	18,558 SL
Georgia estuarine surveys	<10	Spring, summer, fall	0	876,110 TL
Florida estuarine surveys	<10	Spring, summer, fall, winter	0	1,019,046 SL
Total			97	2,596,252

[a]Total or standard length, depending on availability.
[b]Unavailable to authors.

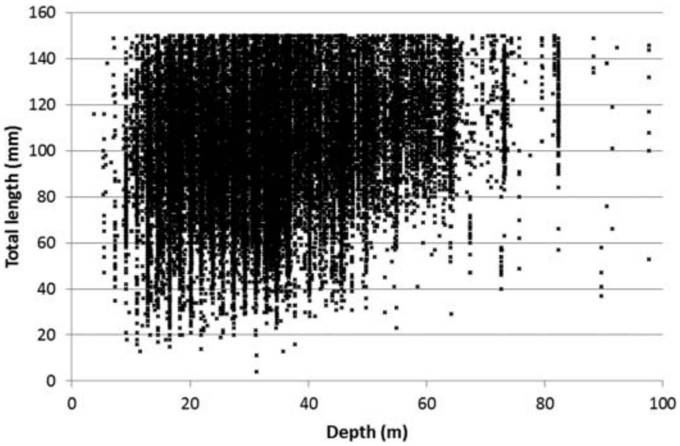

FIGURE 6. Individual records of Red Snapper ≤150 mm TL collected in the Gulf of Mexico SEAMAP spring, summer, and fall groundfish surveys, by depth of collection.

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 on or included information on Red Snapper juveniles (Appendix). Those publications include information on juvenile Red Snapper behavior, diet, growth rates, habitat utilization, site fidelity, ontogenetic shifts, spatiotemporal distribution, and genetic connectivity. In addition, millions of juveniles are captured annually in the GOM shrimp trawl fishery (SEDAR 31 2013), and trawl-associated juvenile mortality has been a contentious issue in GOM Red Snapper stock assessments and fishery management (Gutherz and Pellegrin 1988; GMFMC 1991, 1998, 2004, 2008; Gallaway and Cole 1999; 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 (Figures 5A; 6).

In contrast, no publications about the SEUS included information on Red Snapper juveniles, nor is there documentation of Red Snapper bycatch in shrimp trawl fisheries (Schmied and Nance 1995; Brown 2009; K. Brown, North Carolina Division of Marine Fisheries, personal communication; L. Delaney, South Carolina Department of Natural Resources, personal communication). 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 spatial and temporal range in which juvenile Red Snapper predominantly occur in GOM waters) contained records of more than 2.5 million individuals of other similarly sized finfish species (Table 2), 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 1970 of 275,000 to more than 450,000 kg annually; SEDAR 24 2010) and the abundance of Red Snapper required to support that fishery, the nearly complete 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 (Figure 5B), providing no evidence for (or precluding) the existence of geographical "hot spots" of juvenile production.

What Do We Need to Know, and Why?

Improved information on Red Snapper biology, ecology, and life history, 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). Fortunately, advances on this topic have occurred during the preparation of this manuscript (Mitchell et al. 2014). 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). For this reason, research and targeted surveys to identify juvenile habitats, guided by the results from the surveys documented herein, is recommended. We acknowledge that each of the SEUS fishery-independent surveys described in this article included substantial effort during the summer and early fall seasons (when early juvenile Red Snapper would most likely be abundant) and targeted both structured (reef or hard bottom; sampled by the South East Reef Fish Survey chevron trap survey) and unstructured (sand or mud; sampled by the trawl surveys) habitats across the range of depths in which juvenile Red Snapper are collected in the GOM. However, it is possible and perhaps likely that the dearth of records of early juvenile Red Snapper in SEUS waters is due to the absence to date of an optimally designed survey (i.e., a survey with a gear type and temporal coverage optimized for the collection of Red Snapper juveniles). In essence, we are not suggesting that early juvenile Red Snapper do not abundant in SEUS waters—only that it is intriguing that so few early juveniles have been collected given the breadth of historical survey efforts.

Research is also needed on Red Snapper–fishery interactions, particularly assessments of regulatory discard rates, discard mortality, and the effects of venting and recompression on discard mortality rates. Results from similar research in the GOM (e.g., Render and Wilson 1994; Nieland et al. 2007; Rummer 2007; Diamond and Campbell 2009; Campbell et al.

2010) have supported management decisions (GMFMC 2008, 2013) and likely improved the precision of stock assessments (SEDAR 31 2013) by providing a basis for estimates of release mortality.

From a regional perspective, efforts are needed to assess hypotheses regarding connectivity between GOM and SEUS waters. Specifically, are the Red Snapper in SEUS waters (1) self-recruited from the SEUS stock, (2) supported via larval supply, juvenile migration, or adult migration from the eastern GOM stock, or (3) the result of some combination these two factors? Progress in assessing these hypotheses may facilitate the development of improved stock–recruitment relationships for use in Red Snapper stock assessments as well as the determination of appropriate spatial scales for Red Snapper–focused fishery management actions. While presumably low levels of population mixing could maintain the genetic homogeneity observed between the GOM and SEUS populations (Gold and Richardson 1998; Garber et al. 2004), we are not aware of any studies that document measurably relevant mixing between the GOM and the SEUS. At the larval stage, Red Snapper spawned from the Campeche Banks (Johnson et al. 2013), northern GOM, or Dry Tortugas (Brown-Peterson et al. 2009) regions could theoretically be transported to SEUS habitats (Domeier 2004; Hare and Walsh 2007; Johnson et al. 2013). However, a study describing a year of intensive surface and depth-interval ichthyoplankton sampling in the Florida Current (a strong current flowing through the Straits of Florida that is a precursor to the Gulf Stream; Figure 2) documented only two larval Red Snapper (D'Alessandro et al. 2010). Furthermore, Johnson et al. (2009) 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). The recruitment of juvenile Red Snapper to SEUS waters via juvenile migration from Gulf waters is unlikely, as studies documenting the movements of juvenile Red Snapper have largely demonstrated high site fidelity by postsettlement juveniles to their settlement habitat, with limited movement between habitat gradients (Workman and Foster 1994; Workman et al. 2002; Diamond et al. 2007; Gallaway et al. 2009). The recruitment of adult Red Snapper from the GOM appears to be infrequent (Burns et al. 2006) 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.

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 those waters, despite fishery-independent surveys having occurred across the seasons, depths, and habitats in which juvenile Red Snapper have been collected in the GOM. Research to identify juvenile Red Snapper habitats in SEUS waters and 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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APPENDIX: RESULTS OF LITERATURE SEARCH

In the references below, the superscripted numbers denote water bodies (1 = the Gulf of Mexico; 2 = the South Atlantic Ocean; and 3 = both the Gulf of Mexico and the South Atlantic Ocean) and the superscripted letters denote subject areas (a = biology, ecology, behavior, or population structure; b = fisheries interactions [including gear effects, release mortality, and bycatch issues], stock assessment, or management; and c = Red Snapper juveniles).

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