Observer Coverage of the US Gulf of Mexico and Southeastern Atlantic Shrimp Fishery, February 1992 – December 2013 - Methods

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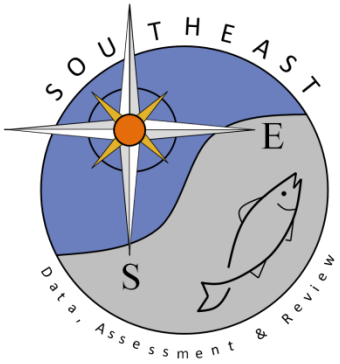

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Introduction

In 1992, in response to Congressional directives, NOAA's National Marine Fisheries Service (NMFS), Southeast Fisheries Science Center (SEFSC), in cooperation with the Gulf and South Atlantic Fisheries Foundation, Inc. (Foundation), implemented a voluntary shrimp trawl bycatch observer program to 1) characterize and estimate catch rates of trawl caught bycatch, and 2) identify, develop, and evaluate gear options to reduce bycatch in the Gulf of Mexico and South Atlantic shrimp fisheries (NMFS, 1991; Hoar et al., 1992; Foster and Scott-Denton, 2004; Scott-Denton, 2007). To improve the statistical validity of data from the voluntary observer program, the Gulf of Mexico Fishery Management Council, through Amendment 13 to the Shrimp Fishery Management Plan (FMP), mandated observer coverage of Federally-permitted shrimp vessels. In 2007, the SEFSC implemented a mandatory observer program for the commercial shrimp fishery operating in the U.S. Gulf of Mexico (Scott-Denton et al., 2012). In June 2008, observer coverage expanded to include the South Atlantic penaeid and rock shrimp fisheries through Amendment 6 to the Shrimp FMP for the South Atlantic Region.

Since the program's implementation, more than 150 bycatch reduction device and turtle excluder device (TED) combinations have been evaluated. Since 1992, data from more than 56,533 tows (Figure 1) have been collected during 3,101 trips (29,262 sea days).

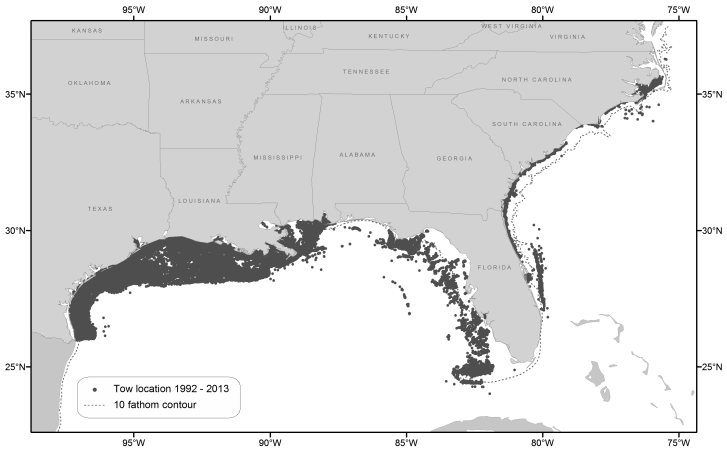

Figure 1. Distribution of sampling effort (tows) based on observer coverage the US Gulf of Mexico and southeastern Atlantic shrimp fishery from 1992 through 2013.

Several organizations identified below contributed to the Southeast Regional shrimp trawl database. The resulting database is housed and managed at SEFSC

Galveston Laboratory. Early-year analyses files are housed at SEFSC Miami Laboratory. Collectively, these data are used extensively by SEFSC and the Southeast Fisheries Regional Office (SERO) for stock assessment (e.g. SEDAR), and as a foundation for many fishery management decisions.

The primary focus of this updated report (former report SEDAR7-DW-38) addresses program data collection methods for bycatch characterization and BRD evaluation and certification efforts in the US Gulf of Mexico and southeastern Atlantic shrimp fishery, and more recently (i.e., mid-2007) mandatory observer coverage.

Background: A full history of the Shrimp Observer Program is documented (NMFS 1991; NMFS 1998; Foster and Scott-Denton, 2004; Scott-Denton, 2007; Scott-Denton et al., 2012). For early years of the multi-year research program, observers were deployed on commercial shrimp vessels through voluntary methods through a cooperative effort between SEFSC and the Foundation. In February 1992, observers began collecting fishery-specific catch and BRD evaluation data. From 1992 through 1996, sixteen BRD designs were evaluated during commercial shrimp operations (Watson, et al., 1999). BRD designs currently certified (or provisionally certified) for use in Federal waters of the Gulf of Mexico and South Atlantic include: composite panel, extended funnel, fisheye, Jones-Davis, and modified Jones-Davis (Fed. Regist. 2008a). An additional design, the expanded mesh BRD, is certified for use in the South Atlantic only. Potential BRD designs are certified based on criteria set forth in the revised and consolidated BRD testing manuals and certification requirements for the Gulf and South Atlantic shrimp fisheries (Fed. Regist. 2008b). Once certified, observer data are used periodically to reassess the continued effectiveness of BRD designs (Foster and Scott-Denton, 2004; NMFS, 2006; Helies and Jamison, 2009).

The Gulf of Mexico Fishery Management Council implemented a FMP for the shrimp fishery in May 1981 in an effort to increase shrimp yield and value through measures designed to allow for optimal shrimp production. Since 1981, the shrimp FMP has been amended fourteen times with several regulatory mandates enacted in the Gulf of Mexico shrimp fishery. Following a red snapper quantitative assessment in 1988, NMFS concluded that the directed fisheries for red snapper (both commercial and recreational) as well as incidental take of juvenile red snapper by shrimp trawlers were responsible for annual declines in red snapper stock (Goodyear, 1988; Goodyear and Phares, 1990). This led to a multi-year effort to develop and evaluate bycatch reduction devices (BRDs).

The Gulf fisheye and Jones-Davis BRD designs were certified by interim rule on May 19, 1998, for the western Gulf of Mexico. These regulations followed the 1997 Congressionally-mandated independent red snapper peer review panel's recommendations pertaining to data collection and stock assessment methods for red snapper in the Gulf of Mexico. The panel concluded that observers were needed on all vessels involved with the fishery to quantify catch and associated bycatch, and release mortality of red snapper (MRAG Americas, 1997).

In May 1998, the NOAA Fisheries component of the regional observer program intensified coverage of the shrimp fishery operating in the western Gulf of Mexico. Through legislative measures in May 1998, mandatory BRDs (Amendment 9 to Gulf shrimp FMP), observers, logbooks and vessel monitoring systems (VMS) units were required for the western Gulf of Mexico shrimp fishery. Ultimately, the mandatory observer program became a voluntary charter program. The mandatory BRD

requirement remained in effect, and later became permanent with the final rule for the Gulf BRD protocol in 1999.

Based on the number of operating units, the commercial shrimp industry is the largest and most valuable fishery in the US southeast region, and until 2002, one of only a few commercial fisheries not required to have a federal permit. Amendment 11 to the Gulf shrimp FMP required all commercial shrimp vessels operating in federal waters of the Gulf of Mexico to obtain a renewable federal permit. The permit requirement became effective December 5, 2002.

Methods

Observers: Through a cooperative effort among several organizations, standardized observer training, sampling protocols and data forms were established in 1992. Initially, all observers were trained at SEFSC Galveston Laboratory. Since the program's implementation, 205 observers have been trained and deployed from February 1992 through December 2013.

The majority of observers hold a Bachelor's degree in marine science or closely related field, and had previous at-sea experience. NMFS contracted observers primarily through five contracting companies over the Program's history. Foundation observers contracted directly with the Foundation.

Organizations: SEFSC and the Foundation deployed the greatest number of observers. Other organizations, including Texas Shrimp Association, North Carolina Division of Marine Fisheries, and Georgia Department of Natural Resources, placed observers at some times during the study period.

Organization Codes:
G = NMFS SEFSC Galveston
F = Foundation, Gulf of Mexico
S = Foundation, South Atlantic
T = Texas Shrimp Association
D = Georgia DNR
N = North Carolina Sea Grant/State Resource Agency

Projects: While the major emphasis from February 1992 through July 2007, was bycatch characterization and BRD evaluation aboard shrimp vessels operating in the US Gulf of Mexico and southeastern Atlantic shrimp fishery, several other projects evolved including, but not limited to: TED evaluations, BRD certifications, rock shrimp characterization, and BRD evaluations in the rock shrimp fishery. Mandatory coverage began in 2007 for the Gulf and in 2008 for the South Atlantic. Projects contained in the data set are coded as follows:

A = South Atlantic Mandatory Penaeid Shrimp
B = BRD Evaluation
C = Bycatch Characterization
D = Deep Water Royal Red
E = Effort (Foundation Project)
F = Flynet

G = BRD Certification, Gulf of Mexico
H = North Carolina Blue Crab
I = Skimmer Trawl Mandatory
L = Skimmer Trawl (Experimental)
M = Modified Bycatch Characterization
N = Naked Net (TED alternative)
P = Electronic Monitoring Pink Shrimp (Sawfish)
R = Red Snapper Initiative/Gulf Mandatory Penaeid Shrimp
S = BRD Certification, South Atlantic
T = TED Evaluation
W = Mandatory Rock Shrimp
X = Rock Shrimp Characterization
Y = Rock Shrimp BRD Evaluation
Z = Soft TED Evaluation

Both the data and the methods of collection varied among projects. BRD evaluations (B) recorded catch data for shrimp and selected finfish from nets equipped with BRD/TED (experimental) versus nets with the same type of TED (control). BRDs used in these evaluation trials were non-certified; the majority of trials were prior to 1998. Bycatch characterization (C) identified all species in a subsample (approximately 20% of the total catch) from one randomly-selected net during a tow. During Effort (E) trips all shrimp and red snapper weights were recorded from all nets during a tow. BRD Certification, Gulf of Mexico (G) trips which occurred after 1998, were similar to BRD evaluations relative to data collection methods, and designed to provide data to certify new BRDs based on specified criterion. Modified Bycatch Characterization (M) trips, similar to bycatch characterization, selected 20 species (or taxa) of finfish with the remaining organisms from the subsample grouped. Naked Net or Alternative to TED (N) obtained sea turtle catch data from TED-equipped nets versus non-TED equipped nets; limited tow time restrictions applied for nearshore waters. Red Snapper Initiative (R) compared data from nets equipped with certified BRDs/TED (experimental) versus nets equipped with a TED (control); all trials were conducted in the Gulf of Mexico. (R) post mid-2007 denotes mandatory observer coverage in the Gulf of Mexico. BRD Certification, South Atlantic (S) evaluations trials were the same as described for (G), but occurred off the southeastern Atlantic. TED Evaluation (T) were designed to evaluate new or modified TED designs; TED equipped nets versus modified or non-TED equipped nets were tested. Rock Shrimp Characterization (X) trips occurred primarily off the east coast and were similar to project (C), with rock shrimp the target species. Soft TED Evaluation (Z) trips were the same as described for project (T), and involved catch comparisons from nets equipped with soft TEDs versus modified or non-TED equipped nets. All mandatory trips recorded catch data for shrimp and selected finfish or species groupings from nets equipped with BRD/TED (if applicable) generally from the two outboard nets. No direction was given by the Program relative to location or duration of shrimping activities other than for limited tow time restrictions for non-TED equipped nets.

Voluntary Vessel Selection: SEFSC-approved observers were placed year round on cooperating shrimp vessels. From February 1992 through May 1998 vessels were selected on a voluntary basis. In May 1998, the NOAA Fisheries component of the program became mandatory following federal requirements for mandatory observer coverage, BRDs and VMS units in the Gulf of Mexico. Federal regulations in June 17, 1998, required vessels to have a current US Coast Guard (USCG) Safety Decal prior to taking an observer.

In 1998, efforts to place observers randomly, through mandatory measures, were met with a high rate of refusal from industry. Observer safety, inadequate sleeping facilities, liability insurance concerns, combined with the lack of an enforcement mechanism for a non-permitted fishery, ultimately resulted in the program becoming a voluntary charter program in June 1998.

Beginning in July 2001, vessels selected to participate in BRD evaluations were required to obtain a LOA from SERO. Prior to the federal shrimp permit requirement (effective December 5, 2002), port agents, when possible, obtained the contact information (e.g., owner phone numbers) for selected vessels; the Internet was also used.

From 1992 through July 2007, the majority of vessel operators in the study volunteered to participate, so vessel selection, for the most part, was non-random. Vessel owners (or operators) were compensated a flat rate for the observer's food and lodging while aboard the vessel, and for potential shrimp loss when gear modifications occurred. Compensation rates varied among organizations and projects, and were dependent on annual funding levels. Effective October 2003, vessel owner/operators participating in the NOAA Fisheries component of the program were required to complete vendor profiles, register online with the Central Contractor Registration (CCR), and obtain a D-U-N-S number in order to be compensated by the federal government.

Mandatory Vessel Selection: A detailed description is given in Scott-Denton et al, 2012. SEFSC-approved observers were placed on randomly selected shrimp vessels targeting either penaeid or rock shrimp. For the Gulf of Mexico, under the mandatory selection process, Federally permitted vessels were randomly selected based on the previous year of effort stratified by area, depth, and season. Shrimp effort data were not available for all areas in South Atlantic; therefore, only landings data were used to proportionally allocate sampling effort. Once selected, permit holders were notified by certified mail at least 1 month prior to the selection period. Seasonal selection periods were as follows: January through April, May through August, and September through December.

A minimum sea day requirement by permit type was established to prevent potential early trip termination due to having an observer on board. Gulf of Mexico Federal penaeid permit holders are required to carry an observer for a minimum of 18 days during a selection period, with 11 and 6 days for South Atlantic rock and penaeid shrimp, respectively. Moreover, permit holders are required to carry an observer if selected, regardless of area fished or target species. No exemptions have been granted; however, a small percentage of vessel substitutions have been allowed (i.e., same owner, different vessel, same area).

At-Sea Data Collection Methods: A detailed description of at-sea collection methods and data requirements are presented in the NMFS Galveston Laboratory's observer manual entitled "Characterization of the U.S. Gulf of Mexico and Southeastern Atlantic Otter Trawl and Bottom Reef Fish Fisheries" (NMFS, 2014).

Biological measurements (weight and length) were recorded in metric units. Vessel, gear, and depth measurements followed current standards for the fisheries (U.S. system equivalents) as related to relevant regulatory mandates.

Protected species were documented and reported to SERO and SEFSC, generally within 24 h of capture. Sighting or capture of sea turtles were recorded in accordance with SEFSC protocol (NMFS, 2008).

Data from all sampled nets, regardless of operational problems (e.g., torn webbing, hangs, clogging), were recorded and are listed in Table 1.

Table 1. Operational codes (Op Code) observed in the shrimp fishery based on observer coverage the US Gulf of Mexico and South Atlantic shrimp fishery from 1992 through 2013.

A - Nets not spread; typically doors are flipped or doors hung together so net could not spread.
B - Gear bogged; the net has picked up a large quantity of sand, clay, mud, or debris in the tail bag possibly affecting trawl performance.
C - Bag obstructed; the catch in the net is prevented from getting into the bag by something (i.e. grass, sticks, turtle, tires, metal/plastic containers etc.) or constriction of net (i.e. twisting of the lazy-line around net).
D - Gear not digging; the net is fishing off the bottom due to insufficient weight or not enough cable let out (etc.).
E - Twisted warp or line; the cables composing the bridle get twisted (from passing over blocks which occasionally must be removed before continuing to fish). Use this code if catch was affected.
F - Gear fouled; the gear has become entangled in itself or with another net. Typically this involves the webbing and some object like a float or chains or lazy line (etc.).
G -Bag untied; bag of net not tied when dragging net.
H - Rough weather. Bags mixed due to rough seas (too dangerous to separate); if the weather is so bad fishing is stopped, then the previous tow should receive this code if the rough conditions affected the catch.
I - Torn, damaged, or lost net; usually results from hanging the net and tearing it loose. The net comes back with large tears etc. if at all. Do not use this code if there are only a few broken meshes. Continue using this code until net is repaired or replaced
J - Dumped catch; tow was made but catch was discarded, perhaps because of too mud. Give reason in comments.
K - Catch not emptied on deck; nets brought to surface, boat changes location, nets redeployed. (explain in comments)
L - Hung up; untimely termination of a tow by a hang. Specify trawl(s) which were hung and caused lost time in Comments.
M - Bags dumped together, catches could not be kept separate.
N - Net did not fish; no apparent cause. Describe reasoning in comments.
O - Gear fouled on submerged object but tow was not terminated. Performance of tow could be affected. Give specifics in Comments.
P - No measurement taken of shrimp and/or total catch.
Q - Main cable breaks and entire rigging lost. Describe in Comments.
R - Net caught in wheel.
S - Tickler chain heavily fouled, tangled, or broken.
T - Other problems. Describe in comments.
U - Turtle excluder gear intentionally disabled.
V – Unknown operation code.
W - Damaged (i.e., bent or broken) excluder gear.
X - BRD intentionally disabled or non-functional. (Damaged) Describe in comments.
Y - Net trailing behind try net.
Z - Successful tow.

Vessel and Gear Characteristics: For all projects specific data relative to vessel and gear characteristics were recorded. Vessel length, hull construction material, gross tonnage, engine horsepower and crew size information were obtained for each vessel. Characteristics related to BRD, TED, net type and other associated gear were recorded at the start of each trip, or when changes were made. For each tow, bottom time, vessel speed and operational aspects relative to each net were documented.

Location and Depth: For the Gulf of Mexico, shrimp statistical zones (Patella, 1975) were used to delineate area designations. Conventionally, statistical areas 1–9 represent areas off the west coast of Florida, 10–12 delineate Alabama/Mississippi, 13–17 depict Louisiana, and 18–21 denote Texas.

Depth strata seaward of the beach, or International Regulations for Preventing Collisions at Sea 1972 (COLREGS) line, were classified as nearshore (≤ 10 fm) or offshore (> 10 fm). Similarly, for the Atlantic, lat. 24°00'N–30°42.5'N denote the east coast of Florida, > lat. 30°42.5'N–32°00'N depict Georgia, > lat. 32°00'N–33°51.6'N represent South Carolina, and > lat. 33°51.6'N delineate North Carolina.

Bycatch Characterization: Onboard data collection for the purpose of bycatch characterization consisted of sampling trawl catches taken from commercial shrimp vessels operating in the US Gulf of Mexico and southeastern Atlantic. The first characterization trips occurred in April 1992 in the Gulf of Mexico, and in June 1992 off the east coast. Fishery-specific data were collected from one randomly-selected net for each tow. Nets trailing behind the try net were not selected for sampling (Op Code Y - Table 1). The catch from the selected net was placed into a partitioned area (e.g., separated from the catch from the remaining nets). The catch was then mixed to ensure randomness, shoveled into baskets, and a total weight obtained. A subsample (approximately 20% of the total catch weight) was processed for species composition. Species weight and number were obtained from the subsample. Length frequencies for 30 specimens were recorded for selected species.

Bycatch characterization efforts involved identifying all species in the subsample to species level. During modified characterization trips, 20 selected species (or taxa) of finfish were processed with the remaining subsample grouped into one of the following categories: non-shrimp crustaceans, fish, other non-crustacean invertebrates, or debris (e.g., rocks, logs, trash).

BRD Evaluation, Red Snapper Initiative and BRD Certification: BRD evaluations began in the Gulf of Mexico in February 1992 and off the east coast in July 1992. Observers collected data for the evaluation of specific BRD designs. Comparisons of catch data for nets equipped with BRD/TED gear combinations (experimental) versus nets with the same type of TED (control) were conducted. Experimental and control nets were alternated, typically mid-trip, from starboard to port outboard nets to reduce net and side biases. Generally, only the two outboard nets were sampled. The total catch and shrimp weights were obtained from the experimental and control nets. A subsample of approximately 32 kg (70 pounds) from each net (experimental and control) was processed for a modified bycatch characterization. When time permitted, all red snapper from the subsamples were counted and weighed.

Following the certification of the Gulf fisheye and Jones-Davis designs in 1998, an intensive effort was made to evaluate the effectiveness of these BRD designs under

commercial operation in the western Gulf of Mexico. This project, identified as the red snapper initiative, involved the use of certified BRDs (i.e., Gulf fisheye and Jones-Davis). Evaluation efforts followed the guidelines set forth in to the bycatch reduction criterion proposed for the Gulf of Mexico as presented in the Federal Register, July 2, 1997. The onboard sampling methods were similar to the BRD evaluation described above, with minor exceptions. The control net had a closed BRD; the experimental net was equipped with the Gulf fisheye or Jones-Davis BRD design. The gear was alternated every third day. Total shrimp weights and red snapper counts and weights were obtained from each net (experimental and control), with all red snapper measured. If time permitted, a subsample was processed for a modified bycatch characterization.

BRD pre-certification and certification procedures are described at length in the 1999 document entitled "Gulf of Mexico Bycatch Reduction Device Testing Protocol Manual". Onboard data collection procedures are similar to those described above. A minimum of 30 successful tows, a specific number of red snapper caught, and consistent tow times are among some of the testing requirements required for BRD certification.

Mandatory Gulf and South Atlantic Penaeid and Rock Shrimp: Fishery-specific data were collected for each tow from the two outboard nets from vessels equipped with four nets, and one net for vessels equipped with two nets. Total catch, total shrimp, and red snapper weights were recorded for each net sampled. A subsample (one basket per net; approximately 32 kg) was processed from each net for bycatch composition by sorting for species, family, or species groupings. Penaeid shrimp (and/or rock shrimp depending on the target), nonpenaeid crustaceans (crustaceans), noncrustacean invertebrates (invertebrates), and debris (e.g., rocks, logs, trash) were recorded from the subsample.

In the Gulf of Mexico, 14 other species of commercial, recreational and ecological importance were recorded. These included: Atlantic croaker, *Micropogonias undulates*; black drum, *Pogonias cromis*; cobia, *Rachycentron canadum*; king mackerel, *Scomberomorus cavalla*; lane snapper, *Lutjanus synagris*; longspine porgy, *Stenotomus caprinus*; red drum, *Sciaenops ocellatus*; seatrout, *Cynoscion* spp.; other snapper, *Lutjanus* spp.; grouped sharks, Order Selachii; southern flounder, *Paralichthys lethostigma*; spotted seatrout, *Cynoscion nebulosus*; Spanish mackerel, *Scomberomorus maculatus*; and vermilion snapper, *Rhomboplites aurorubens*. The remaining finfish species were grouped into a finfish other category. From 2007 through 2008, all shark species were grouped. Beginning January 2009, identification of some shark species (as well as other species) was implemented; similar selection lists and methods were developed for the South Atlantic penaeid and rock shrimp fisheries.

Results

Trips and Sea Days: A total of 3,101 trips was completed in the US Gulf of Mexico and southeastern Atlantic from February 1992 through December 2013 during 29,262 sea days of observations. More than 262,000 hours of trawling were observed.

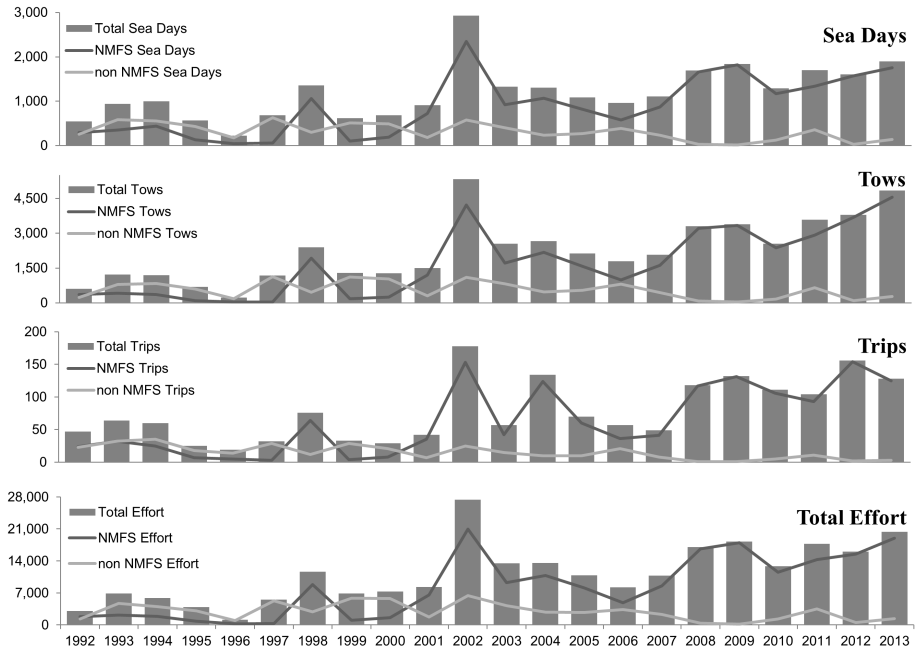

Figure 2. Distribution of sea days, sampling effort (tows), trips and total observed effort based on observer coverage the US Gulf of Mexico shrimp fishery from 1992 through 2013.

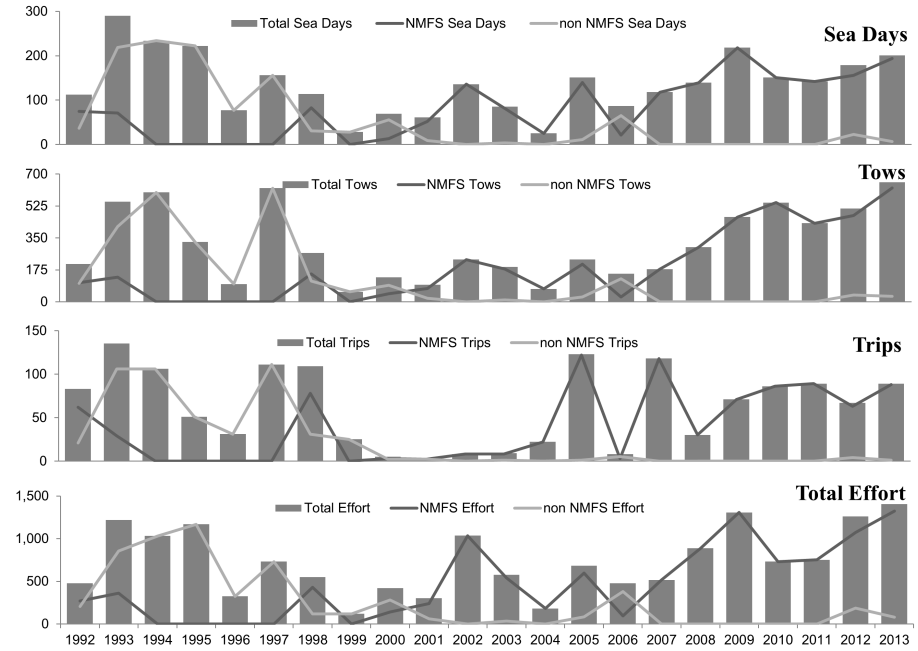

Figure 3. Distribution of sea days, sampling effort (tows), trips and total observed effort based on observer coverage the US South Atlantic shrimp fishery from 1992 through 2013.

Caveats: From 1992 through mid-2007, vessel selection, for the most part, was opportunistic, and may not be representative of the commercial shrimp fleet as a whole. Data collected throughout the study period have been entered into three different databases. Early-year analyses files are available from SEFSC Miami Laboratory. Data contributors were responsible for editing and proofing their own data and for providing hard copies of the source data. Archived data on the server were not changed or altered (e.g., keystroke errors or outliers) unless written permission was granted by the contributing organization.

Acknowledgments

We commend the outstanding efforts given by the fishery observers involved in this research effort and the commercial fishing industry for their continued participation.

Literature Cited

Federal Register. 2008a. Fisheries of the Caribbean, Gulf of Mexico, and South Atlantic; Shrimp fishery of the Gulf of Mexico; Revisions to the allowable bycatch reduction devices. Fed. Regist. 73 FR 68355 (avail. at http://www.gpo.gov/fdsys/pkg/FR-2008-11-18/pdf/E8-27351.pdf).

Federal Register. 2008b. Fisheries of the Caribbean, Gulf of Mexico, and South Atlantic; Shrimp fishery of the Gulf of Mexico; Revisions to bycatch reduction devices and testing protocols. Fed. Regist. 73 FR 8219 (avail. at http://www.gpo.gov/fdsys/pkg/FR-2008-02-13/pdf/E8-2679.pdf).

Foster, D. G., and E. Scott-Denton. 2004. Status of bycatch reduction device performance and research in north-central and western Gulf of Mexico. Southeast Data Assessment and Review, South Atl. Fish. Manage. Counc., Charleston, S.C., SEDAR 7-DW-38, 50 p. (avail. at http://www.sefsc.noaa.gov/sedar/).

Goodyear, C. P. 1988. Recent trends in the red snapper fishery of the Gulf of Mexico. National Marine Fisheries Service, Southeast Fisheries Center, Miami Laboratory, Contribution CRD-87/88-16, 125 p.

Goodyear, C. P., and P. Phares. 1990. Status of red snapper stocks of the Gulf of Mexico - Report for 1990. National Marine Fisheries Service, Southeast Fisheries Science Center, Miami Laboratory, Miami, FL. Laboratory Report, Contribution CRD 89/90-05, 72 p.

Helies, F., and J. Jamison. 2009. Reduction rates, species composition, and effort: assessing bycatch within the Gulf of Mexico shrimp trawl fishery. Gulf & South Atlantic Fisheries Foundation, Inc., Suite 740, Lincoln Center, 5401 W. Kennedy Blvd. Tampa, Fla., 182 p. (avail. at http://www.gulfsouthfoundation.org/uploads/reports/101_final4.pdf).

Hoar, P., J. Hoey, J. Nance, and C. Nelson. 1992. A research plan addressing finfish bycatch in the Gulf of Mexico and South Atlantic shrimp fisheries. Gulf & South Atlantic Fisheries Foundation, Inc., Suite 740, Lincoln Center, 5401 W. Kennedy Blvd. Tampa, Fla., 128 p. (avail. at http://www.gulfsouthfoundation.org/uploads/reports/45 Part 2_20091022111207.pdf).

MRAG Americas. 1997. Consolidated report on the peer review of red snapper (*Lutjanus campechanus*) research and management in the Gulf of Mexico. Prepared by MRAG Americas Inc. for the Office of Science and Technology, National Marine Fisheries Service, 86 p, plus annexes.

NMFS . 1991. Shrimp trawl bycatch research requirements. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Southeast Fish. Sci. Cent., Miami, Fla., and NMFS Southeast Reg. Off., St. Petersburg, Fla., 66 p.

NMFS. 1998. Report to Congress: southeastern United States shrimp trawl bycatch program. Natl. Mar. Fish. Serv., NOAA, Southeast Fish. Sci. Cent., Galveston Laboratory, Galveston, Tex., 155 p. (avail. at http://galveston.ssp.nmfs.gov/publications/pdf/235.pdf).

NMFS. 2006. Report to Congress: Gulf of Mexico shrimp trawl bycatch reduction. NMFS, Southeast Fish. Sci. Cent., Miami, Fla., 126 p.

NMFS. 2008. Sea turtle research techniques manual. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SEFSC-579, 92 p. [updated 1/2009].

NMFS. 2014. Characterization of the U.S. Gulf of Mexico and southeastern Atlantic otter trawl and bottom reef fish fisheries. Observer Training Manual. NMFS, Southeast Fish. Sci. Cent., Galveston Laboratory, Galveston, Tex. (avail. at http://galveston.ssp.nmfs.gov/research/fisherymanagement).

Patella, F. 1975. Water surface area within statistical subareas used in reporting Gulf Coast shrimp data. Mar. Fish. Rev. 37(12):22-24.

Scott-Denton, E. 2007. U.S. southeastern shrimp and reef fish resources and their management. Ph.D. Dissert., Texas A&M Univ., Coll. Stat., Tex. 400 p.

Scott-Denton, E., P. F. Cryer, J. P. Gocke, M. R. Harrelson, D. L. Kinsella, J. M. Nance, J. R. Pulver, R. C. Smith, and J. A. Williams. 2012. Characterization of the U.S. Gulf of Mexico and South Atlantic penaeid and rock shrimp fisheries based on observer data. Marine Fisheries Review 74(4): 1-26.

Watson, J., D. Foster, A. Shah, E. Scott-Denton, S. Nichols and J. Nance. 1999. The development of bycatch reduction technology in the southeastern United States shrimp fishery. Marine Technology Society Journal 33(2): 51-56.