Pilot study to characterize fishing effort of the South Atlantic penaeid shrimp trawl fishery through the use of electronic logbooks

Gulf and South Atlantic Fisheries Foundation

SEDAR-PW6-RD10

29 April 2014

Pilot Study to Characterize Fishing Effort of the South Atlantic Penaeid Shrimp Trawl Fishery through the use of Electronic Logbooks

NOAA/NMFS Award Number NA11NMF4540115 (GSAFF #119)

FINAL REPORT

www.southeasternphotography.com

Gulf & South Atlantic Fisheries Foundation, Inc.

Lincoln Center, Suite 740
5401 West Kennedy Blvd.
Tampa, Florida 33609-2447

November 2013

This Final Report was prepared by the Gulf & South Atlantic Fisheries Foundation, Inc. under award number NA11NMF4540115 from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of the National Oceanic and Atmospheric Administration or the Department of Commerce.

Title: Pilot Study to Characterize Fishing Effort of the South Atlantic Penaeid Shrimp Trawl Fishery through the use of Electronic Logbooks

Authors: Frank C. Helies, Program Director
Dr. Scott Raborn, LGL
Lindsey Parker, South Atlantic Coordinator
Judy L. Jamison, Executive Director

Gulf & South Atlantic Fisheries Foundation, Inc.
Lincoln Center, Suite 740
5401 W. Kennedy Blvd.
Tampa, Florida 33609-2447

Award No: NA11NMF4540115 (Foundation #119)

Project Period: September 1, 2011 – August 31, 2013 (amended)

I. Abstract

Catch and effort data for the South Atlantic (SA) penaeid shrimp fishery are collected through trip tickets that generally lack detailed specificity in relation to effort. Due to the tens of thousands of trips that are made every year, many chances exist for error to occur in location assignment of catch and effort. The goal of this work was to combine the use of electronic logbooks (ELBs) with observer data collection to determine the feasibility of instituting an ELB program in the SA. We used the knowledge garnered from the successful ELB project conducted in the Gulf of Mexico and instituted the same methodology and protocols in the SA. ELBs were installed on 20 vessels from Georgia ports. Data collected from the ELBs were augmented by observer validated at-sea collections which accounted for 30 sea days and 67 tows. Given this was a pilot study, we sought to spot check the accuracy and precision of ELB effort estimates for a subset of observations. This study was successful in proving that ELBs are an affordable approach to accurately quantify effort of the expanded fishery across space and time.

II. Executive Summary

The South Atlantic (SA) penaeid shrimp fishery spans the eastern U.S. coast from Pamlico Sound and Ocracoke Inlet, North Carolina, across South Carolina and Georgia, to Fort Pierce, Florida. Throughout the SA, most shrimp trawling occurs within three miles of shore. Catch and effort data for the shrimp fishery are minimum requirements of the Atlantic Coastal Cooperative Statistics Program (ACCSP) and all the SA states are compliant. However, these data are lacking detailed specificity and though total catch is often tractable, stratifying this catch and linking it to the estimates of effort that produced it is problematic (Gallaway *et al*., 2003b). There are no longer National Marine Fisheries Service (NMFS) port agent interviews in the SA, and catch and effort data are collected via trip tickets. Due to the tens of thousands of trips that are made every year, many chances exist for error to occur in location assignment of catch and effort.

At least three possible solutions exist to resolve the current inaccuracies inherent with shrimp fishing effort data: 1) Have the fishing vessel captain maintain a tow-by-tow paper logbook; 2) Place observers on fishing vessels to maintain paper logbooks; or 3) Utilize electronic logbooks (ELB) to record the time, date, and location of fishing activities. Each of these three solutions has associated advantages and disadvantages. Tow-by-tow logbooks are tedious for captains to fill out while fishing and observers are unbiased with regard to effort data collection, but observer programs are expensive to implement. The advantages of implementing an ELB system are that the device is passive, small, and accurately and autonomously records data. The most appropriate and effective resolution to estimate fishing effort and bycatch would be to combine some of these solutions.

The ELB system employed in the Gulf of Mexico was developed by LGL Research Associates to directly measure shrimp fishing effort and provide better estimates of effort and red snapper bycatch. There was considerable buy-in to the program by the captains and crews, because the fishermen viewed it as their program being conducted by scientists they have used and trusted over the last decade. Results from this study indicated that the ELB system accurately estimated the fishing practices of a vessel on a per trip basis meaning that individual tows could be identified with accurate estimates of effort and catch. This project used the knowledge garnered from the successful ELB project conducted in the Gulf and instituted the same methodology and protocols in the SA penaeid shrimp trawl fishery.

ELBs were constructed and installed on 20 participating boats docked in coastal Georgia. Focusing on a smaller group of ports facilitated a better characterization of a single area versus a broader, yet more ambiguous, picture of the entire fishery. Data were downloaded from the ELB only after trips were completed; thus, real-time information from the ELB on the vessel's location and activity were not available. Catch and effort data were collected by a Foundation contracted observer placed onboard selected participating commercial shrimp fishing vessels that had an ELB installed. Contracted observers recorded the weight (heads-on or heads-off) of all penaeid shrimp regardless of the quantity harvested (e.g., no sub-samples were taken). All small coastal sharks were identified, measured, and weighed, from each net. Five observer data collection trips were made during the project. The trips varied from one day to 18 days in length and consisted of one to 30 tows per trip. Data were collected for 30 sea days and 67 tows.

The data gathered by an ELB consisted of date, time, and location of the vessel collected in one minute intervals. These data were used to develop algorithms that described the duration and locations of individual tows made during each trip, i.e., effort (Gallaway *et al*., 2001). Given this was a pilot study, we sought to spot check the accuracy and precision of ELB effort estimates for a subset of observations. Effort recorded by observers essentially represented truth (or as close as anyone could come to it), recording errors notwithstanding. ELB effort could be compared to this truth on a tow-by-tow basis. Because of this hindrance and because fisheries management uses effort on a per trip basis, we pooled effort across tows within each trip before the validation analysis similar to Gallaway *et al.* (2001). Pooling by trip eliminated the need to match exact towing times; moreover, subtle errors in ELB effort estimates across tows tended to cancel each other when pooled yielding more efficient estimates at this broader resolution.

Landings effort and catches were paired to the ELB estimates by vessel identifier, county of landing, year, and month. Each record in the landings database represented pounds of catch by species and landing type (e.g., heads on, tails, whole, etc…) nested within the trip record number. These data were correctly summarized first to the trip record level, then to each county-vessel-year-month combination, then to each county-year-month for comparison to the ELB data.

In all, at least three ELBs per month were used to monitor shrimping effort from April 2012 through July 2013 resulting in 191 usable vessel-months or 25,029 tow hours out of the recorded 28,820 tow hours. The ELBs recorded each vessel's coordinates every one minute throughout the study period. From these data vessel speed was estimated. Towing activity was assigned to all ELBs using reference values that defined towing speeds. The accuracy for estimated fishing effort with this method was validated with observers that recorded start and end times for each tow during their coverage. ELB estimated effort was summed for each observed trip-month-latitude bin combination and compared to observed effort. Just based on our limited observer coverage, the accuracy of shrimping effort estimating with ELBs in the South Atlantic was still convincing. We suspect that, though our observer coverage was minimal, full validation (an observer watching every tow for numerous trips) in this pilot study was unnecessary.

The primary goal of any pilot study is to serve as a proof of concept. Even though ELBs from this pilot study were concentrated in a smaller section of coastline for the South Atlantic shrimp fishery, the results presented were based on a handful of vessels and should be viewed as first approximations. This study was successful in proving that ELBs are an affordable approach to accurately quantify effort of the expanded fishery across space and time.

Given the ELBs accurately reflected fishing effort for the participating vessels, the number of vessels requiring ELBs to adequately estimate effort for the expanded South Atlantic fishery remains a quintessential consideration. The level of coverage depends on the spatial distribution of catch/bycatch, as well as the number of participating vessels and their spatial distribution; on average, Babcock and Pikitch (2003) recommend covering 20% of the fishing fleet to estimate CPUE of common species. Currently, there are 515 permit holders in the South Atlantic penaeid shrimp fishery. Twenty percent comes to 103 vessels equipped with ELBs parsed across ports based on relative magnitude of catch; likewise, random assignment to vessels within each port would be proportionate to their relative catches. The total cost of an expanded project would be a function of outfitting 103 vessels (assuming 20% coverage is the target), the number of ports that must be accessed, which has bearing on the corresponding personnel time for servicing the ELBs, and the time to manage the project, analyze the data, and report the results. The Gulf ELB program is transitioning to new technology and some of the costs are being offset by NMFS, but some of the costs are being placed on industry. It is imperative that the Gulf program is thoroughly tested prior to establishing a program in the SA.

III. Purpose

Description of Problem:

The South Atlantic (SA) penaeid shrimp fishery spans the eastern U.S. coast from Pamlico Sound and Ocracoke Inlet, North Carolina, across South Carolina and Georgia, to Fort Pierce, Florida. Throughout the SA, most shrimp trawling occurs within three miles of shore. In 1996, there were approximately 1,400 large and 1,000 small vessels harvesting 30 million pounds of predominately penaeid shrimp including white (*Penaeus setiferus*), brown (*P. aztecus*), and pink (*P. duorarum*) (SAFMC, 1996). By 2002, annual harvest was estimated at 33 million pounds from 1,731 vessels, of which 488 operated exclusively in inshore waters. On average, about 20% of the harvest is taken in the federal exclusive economic zone (EEZ) (SAFMC, 2004). Since 2002, the downturn in the economy and the rise in fuel price have reduced fishing effort in this fishery.

Catch and effort data for the shrimp fishery are minimum requirements of the Atlantic Coastal Cooperative Statistics Program (ACCSP) and all the SA states are compliant (Jim Nance, National Marine Fisheries Service [NMFS], pers. comm.). However, these data are lacking detailed specificity and though total catch is often tractable, stratifying this catch and linking it to the estimates of effort that produced it is more problematic (Gallaway *et al*., 2003b). There are no longer NMFS port agent interviews in the SA, and catch and effort data are collected via trip tickets. Because the fishing trip is the basic sampling unit, the fundamental principle of the data collection is to record both catch and effort data on a trip-by-trip basis. However, because the reported number of fishing trips that occur in the shrimp fishery is on the order of tens of thousands, not every trip has information on fishing effort and location. The dealer must assign a catch and effort location for the landings from each trip, and uses information obtained from informal interviews or historical knowledge of the fleet's activity to perform this assignment. Thus, many chances exist for error to occur in location assignment of catch and effort (Gallaway *et al*., 2003b).

At least three possible solutions exist to resolve the current inaccuracies inherent with shrimp fishing effort data: 1) Have the fishing vessel captain maintain a tow-by-tow paper logbook; 2) Place observers on fishing vessels to maintain paper logbooks; or 3) Utilize electronic logbooks (ELB) to record the time, date, and location of fishing activities. Each of these three solutions has associated advantages and disadvantages. Commercial fishermen are typically wary of collecting data for use by fisheries managers and are sometimes concerned that the information will be used against them to implement further management regulations. Asking, or mandating, fishermen to collect fishing effort data may be difficult, necessitating the use of other data collection methods. Paper log books can be an expensive solution because the information must be keyed into a digital database before it is useable. The forms are often difficult to decipher as they are filled out at sea. Errors tend to go one direction as well; no one ever records a tow they did not make, but it is easy to miss a tow they did make.

Observers are unbiased with regard to effort data collection and can further augment data by recording the abundance and length-frequency of bycatch. The main disadvantage to utilizing an observer program is the cost of covering the necessary portion of the shrimp fishing fleet to provide the requisite accuracy and precision in the effort estimates (several millions of dollars).

The advantages of implementing an ELB system are that the device is passive, small, and accurately and autonomously records data (Gallaway *et al*., 2003a). Shortcomings of the ELB system include a lack of ancillary data collection. The most appropriate and effective resolution to estimate fishing effort and bycatch would be to combine some of these solutions. The Gulf and South Atlantic Fisheries Foundation (Foundation) has worked with LGL Ecological Research Associates, Inc. (LGL) on several studies that augmented the collection of ELB data through the use of observers in the Gulf of Mexico (Gulf) shrimp fishery (Award No. NA05NMF4540044 / NA09NMF4540135 / NA11NMF4540118). The goal of this work was to enable the fishing industry to evaluate and address fishery management issues, including the estimation of shrimp fishing effort and bycatch.

The ELB was developed by LGL to directly measure shrimp fishing effort and provide better estimates of effort and red snapper bycatch in the Gulf. It should be noted that the ELB studies that were successfully implemented in the Gulf were conceived and initiated by shrimp fishing industry leaders and their consultants, namely LGL. There was considerable buy-in to the program by the captains and crews, because the fishermen viewed it as their program being conducted by scientists they have used and trusted over the last decade. Over the course of LGL's 3 year pilot study, ELB systems were placed onboard commercial shrimp fishing vessels to collect fishing effort data. To augment the data collection, both paper logbooks and observers were utilized to collect shrimp landings and red snapper bycatch data on a tow-by-tow basis. Results from this study indicated that the ELB system accurately estimated the fishing practices of a vessel on a per trip basis meaning that individual tows could be identified with accurate estimates of effort and catch (Gallaway *et al*., 2003a). Nevertheless, observers are still required to estimate bycatch.

Through the combination of the ELB data with paper logbooks and observer collected landings, it was demonstrated that total vessel landings (on a per trip basis) could be divided accurately on a tow-by-tow basis and allocated to specific statistical zones. Of the 135 trips where ELBs recorded effort data, port agents collected data on 62 of these trips. A comparison of the ELB and port agent data allowed for a direct comparison of fishing effort estimation methodologies (i.e. NMFS/State port agent data vs. ELB data). The Gallaway report indicated that a directional bias existed and that port agent data overestimated effort in midshore regions (areas abundant in juvenile red snapper; between 10-30 fathoms) while underestimating effort in offshore and nearshore regions (areas where juvenile red snapper abundance is low; 30+ fathoms and 0-10 fathoms, respectively). These studies proved that an ELB system was accurate at recording shrimp-trawl fishing effort and estimating and allocating landings data (Gallaway, 2001; 2003a; 2003b). This project used the knowledge garnered from the successful ELB project conducted in the Gulf and instituted the same methodology and protocols in the SA penaeid shrimp trawl fishery.

Objectives:

1) As a pilot study, use electronic log books (ELBs) to characterize the spatial and temporal distribution of penaeid shrimp fishing effort for a subset of vessels operating in the South Atlantic;

2) Estimate catch-per-unit-effort (CPUE) of penaeid shrimp for the monitored fishing vessels;

3) Through allotted observer coverage, estimate bycatch of sea turtles and blacknose shark, *Carcharhinus acronotus* and other important bycatch species;

4) Determine the feasibility of a South Atlantic-wide ELB program for the estimation of shrimp fishing effort; and

5) If an expanded program proves feasible, organize port meetings to explain the benefits of the program to shrimp fishermen, answer their questions, and address their concerns.

IV. Approach

Statement of Work:

<u>ELB Description</u>

Hardware

The LGL Electronic Logbook (ELB) is a small, inexpensive GPS position logging device for commercial shrimping vessels, which has undergone four major revisions. Each major version change provided additional functionality. Detailed description of this device can be found in Gallaway *et al*. (2001, 2003a).

Software

The original software consisted of programs written in PBASIC which were loaded into the ELB, and programs written in C++ which were used to analyze the data collected (see Gallaway *et al*. [2001] for more detail). The current version of the ELB (v5.1) runs on a full function miniature computer (FFMC) running a customized version of the Linux operating system. The system uses built-in timers to activate the system periodically and record the current time and location by reading the data transmitted by the incorporated GPS unit. The position and time data are recorded into a temporary location in memory. Every hour the system wakes again to write the data from temporary memory onto a 128MB internal Multimedia Card (MMC). The MMC is formatted with a journaling file system to protect against disk corruption, and programmed with a unique card identifier number. The data collection system runs continuously when the vessel has power. In the event of a loss of power or activation of a reset circuit, the program resumes where it left off, with loss of recorded data between 0 and 5 observations. Periodically, the MMC card is retrieved and replaced with a newly initialized version. After the MMC card has been retrieved, it is sent back to the LGL offices for downloading and processing.

<u>ELB Construction and Installation Training</u>

Foundation Contractor LGL Ecological Research Associates, Inc. (LGL) constructed 20 electronic logbook (ELB) units.

Foundation South Atlantic Coordinator Captain Lindsey Parker traveled to Galveston/College Station, TX for training in the installation and maintenance of the ELB units by LGL in February 2012. Captain Parker was responsible for installing the ELB units on cooperating fishing vessels and retrieving the data as necessary.

A cooperating captain informed Captain Parker of a lightning strike to his vessel in mid to late August 2012. On Sept 11, 2012, Captain Parker visited the dock, troubleshot the ELB, and pronounced it dead. First indication was to go without further data on the vessel, but we later determined to fix the ELB. Repairs were completed and the ELB was back operational on Oct 12, 2012.

<u>Participating Vessels and ELB Installation</u>

Voluntary participation was requested for this project. The Regional Coordinators and Industry Cooperators were responsible for securing vessels from the list to participate in the program. Captain Parker compiled a tentative list of vessels and 20 vessels were selected to participate. Once the 20 participating boats were identified, Captain Parker installed and serviced the devices for the life of the project.

Due to the pilot nature of the project, all of the participating vessels were docked in coastal Georgia. Focusing on a smaller group of ports facilitated a better characterization of a single area versus a broader, yet more ambiguous, picture of the entire fishery. The location breakdown of participating vessels is as follows: seven from Brunswick, seven from McIntosh County, five from Savannah, and one from St. Mary's, Georgia.

<u>ELB Collection</u>

Data were downloaded from the ELB only after trips were completed; thus, real-time information from the ELB on the vessel's location and activity were not available. Captain Parker retrieved all ELBs and data chips from the 20 cooperating vessels and delivered them to Mr. John Cole in July 2013 for data reduction and QNQC.

A consent request letter for specific trip ticket landings data was composed and distributed to cooperating vessels. Completed consent letters were collected by Ms. Julie Califf, Georgia Department of Natural Resources Statistics (Appendix A).

<u>Validation with Observers</u>

Observer Protocol

Catch and effort data were collected by a Foundation contracted observer placed onboard selected participating commercial shrimp fishing vessels that had an ELB installed. Observers contracted by the Foundation received a NMFS certificate of training prior to being deployed aboard a fishing vessel. All Federal and state scientific collecting permits and exempted fishing permits were acquired prior to observer deployment and data collection.

Contracted observers recorded the weight (heads-on or heads-off) of all penaeid shrimp regardless of the quantity harvested (e.g., no sub-samples were taken). All small coastal sharks were identified, measured, and weighed, from each net.

Five observer data collection trips were made during the project. The trips varied from one day to 18 days in length and consisted of one to 30 tows per trip. Data were collected for 30 sea days and 67 tows. All data sets were entered into the NMFS Galveston Database upon deliverance to the Foundation.

Comparing ELB Effort to Observer Records

The data gathered by an ELB consisted of date, time, and location of the vessel collected in one minute intervals. These data were used to develop algorithms that described the duration and locations of individual tows made during each trip, i.e., effort (Gallaway *et al*., 2001). Thorough validation of an ELB program in the Gulf was provided by Gallaway *et al*. (2003a), which required a full observer program. Given this was a pilot study, we sought to spot check the accuracy and precision of ELB effort estimates for a subset of observations.

Effort recorded by observers essentially represented truth (or as close as anyone could come to it), recording errors notwithstanding. ELB effort could be compared to this truth on a tow-by-tow basis. Differences between start/stop times recorded by the observers versus those estimated by the ELBs obfuscated the matching of corresponding tows. Because of this hindrance and because fisheries management uses effort on a per trip basis, we pooled effort across tows within each trip before the validation analysis similar to Gallaway *et al.* (2001). Pooling by trip eliminated the need to match exact towing times; moreover, subtle errors in ELB effort estimates across tows tended to cancel each other when pooled yielding more efficient estimates at this broader resolution.

Four of the observer trips occurred during December 2012 and January 2013, and one in May 2013. Spatially, these trips occurred across latitude bins truncated to 29°, 30°, and 31°. To capture greater contrast during the validation analysis, increase sample size, and yet maintain the error correcting benefits of pooling, we combined tows by the month-latitude bin combinations covered by the five trips. This strategy resulted in eight pairs of effort estimates for comparison.

<u>Characterizing Effort for a Local Penaeid Shrimp Fishery</u>

As mentioned, we chose to focus this pilot study on a few ports close together in lieu of trying to cover the entire South Atlantic penaeid shrimp fishery with the limited number of ELBs. Data from this study helped to characterize the seasonal Georgia penaeid shrimp fishery. Individual records (points) were geo-referenced with coordinates for the starting point of each tow; tows were separated from points recorded during traveling or being anchored using boat speed (trawling conveniently occurs at telltale speeds). The time-area strata used to depict effort were chosen *post hoc* based on seasonal and spatial trends in magnitude. Within each stratum, hot spot analyses (ESRI 2013 ArcInfo 10.1 Hotspot Analysis Tool. Redlands, California) were used to depict levels of shrimping effort based on ELB tow hours across coastal waters.

The Hot Spot Analysis Tool facilitates identification of spatial clustering that was not likely due to random chance. First, predicted values were determined with inverse distance weighting, then the global mean of these predictions was used as a reference value. Next, the standard deviation across all points represented the average difference between a given point and the global mean. Lastly, the intensity in towing effort was scaled as the number of standard deviations, or z-scores, these differences represented. The clustering of points with greater absolute z-values (hotspots = positive values; coldspots = negative values) was interpreted as being less likely due to random chance. Z-scores +/- 2.58 represented 99% confidence that clustering for those points was non-random; 95% confidence corresponded to +/- 1.96.

Estimating CPUE and Comparison of ELBs with Landings Effort

Landings data are comprised of the information recorded from each boat onto the "Landings Reporting Forms" upon the completion of each trip (an example form is provided in Appendix B). Data pertaining to the number of hours fished, trip start and end times/dates, county of landing, number of nets fished, species, and pounds landed among other data fields. By way of consent from each participating vessel, Ms. Julie Califf from Georgia DNR provided this information corresponding to the times and vessel identification numbers (note: these identifiers have been changed as per our confidentiality agreement). Effort and catch data were recorded for each trip; however, we were too uncertain about matching start and end dates with the ELB estimates. Landings effort and catches were paired to the ELB estimates by vessel identifier, county of landing, year, and month. Each record in the landings database represented pounds of catch by species and landing type (e.g., heads on, tails, whole, etc.) nested within the trip record number. These data were correctly summarized first to the trip record level, then to each county-vessel-year-month combination, then to each county-year-month for comparison the ELB data.

Project Management:

Principal Investigator:

Ms. Judy L. Jamison	Executive Director

Foundation Staff:

Mr. Frank C. Helies	Program Director
Ms. Gwen Hughes	Program Specialist
Ms. Charlotte Irsch	Grants/Contracts Specialist
	Administrative Assistant

Overall project quality control and assurance was assumed by the Gulf & South Atlantic Fisheries Foundation, Inc. through its office in Tampa, FL. The Foundation's Executive Director had ultimate responsibility for all Foundation administrative and programmatic activities, with oversight by the Foundation's Board of Trustees. She ensured timely progress of activities to meet project objectives and confirmed compliance of all activities with NOAA/NMFS. The Foundation's Program Director had overall responsibility for all technical aspects of Foundation projects and coordinated performance activities of all project personnel, including contractors. The Program Director prepared all progress reports concerning project performance.

It was the responsibility of the Foundation's Executive and Program Director to ensure quality control and assurance were maintained for all aspects of this program. This was accomplished through regular phone and email communications with project Contractors.

The Grant/Contracts Specialist was responsible for maintaining general financial accounting of all Foundation funds including all Cooperative Agreements and contracts, as well as communicating with NOAA Grants Management personnel, and assisting auditors in their reviews. She conducted/documented internal and program (single and desk) audits, prepared backup documentation for fiscal audits, and drafted award extension requests (if applicable). She provided the Executive and Program Directors with projected budgets concerning program performance and ensured that these budgets adhered to the proposed project budget. Finally, she prepared the annual administrative budget, NOAA Financial Reports, and confirmed compliance of all activities with NOAA/NMFS and OMB guidelines.

The Program Specialist was responsible for tracking programmatic activities, monitoring funding and distribution of funds. She processed requests for reimbursement to conform with federal guidelines and prepared and maintained all contracts, subcontracts, agreements and amendments.

While the Foundation took the lead in project management, this project required the cooperation and active participation of many organizations and individuals. The essential personnel we would like to thank for their participation and hard work are:

Mr. Lindsey Parker, South Atlantic Regional Coordinator (UGA Marine Extension)
Mr. Gary Graham, Gulf of Mexico Regional Coordinator (Texas Sea Grant)
Mr. Daniel Parshley, Observer Coordinator
LGL Ecological Research Associates, Inc., Data Analysts
- Dr. Scott Raborn, Fisheries Scientist
- Dr. Benny Gallaway, Senior Fisheries Scientist
- Mr. John Cole, Gulf ELB Coordinator and Analyst
- Mr. Robert Nguyen, Gulf ELB Technician

Fishery Observers
- Mr. Matt Gaylord
- Mr. William McClain

Industry and NOAA Fisheries Cooperators:
- Mr. Bob Jones, Executive Director, Southeastern Fisheries Association, Inc.
- Mr. John Williams, Executive Director, Southern Shrimp Alliance
- Dr. Jim Nance, Chief Scientist, NOAA Fisheries Galveston Laboratory

All data were gathered through the cooperation and direct participation of the commercial shrimp fishing industry of the South Atlantic region. Without the cooperation of industry, this project would not have been possible.

V. Findings

Results:

Summary of ELB Data

Twenty boats volunteered to have ELBs installed in 2012—one ELB was installed in March, eleven in April, three in May, three in June, and two in July. All ELBs were removed in July 2013. One vessel was dropped from the study because it participated in other fisheries at various times throughout the study period; also, some months from other vessels not used because of known participation in other fisheries or because the ELB was operational during only a small portion of the month (Table 1). Vessels C, D, E, J, and K took part in the cannonball jellyfish *Stomolopohus meleagris* fishery. In all, at least three ELBs per month were used to monitor shrimping effort from April 2012 through July 2013 resulting in 191 usable vessel-months or 25,029 tow hours out of the recorded 28,820 tow hours.

Detected Fishing Effort Validated with Observers

The ELBs recorded each vessel's coordinates every one minute throughout the study period. From these data vessel speed was estimated. In Figure 1 we provide an example of vessel speeds recorded every minute for a single vessel from April 3, 2012 to September 25, 2012. The frequency distribution of these speeds during this time period is given in Figure 2. Three vessel activities corresponding with the three modal frequencies can be discerned from this plot. The first mode at a speed of zero knots shows how often the vessel was on anchor. The second mode at about 2.5 knots represents the most frequent towing speed; the range of towing speeds was narrow (≈1.5-3.5 knots) and greatly facilitated assignment of times/speeds to fishing effort. The third modal speed was about 7.8 knots, which indicates traveling. All speeds in between were transitional among the three activities.

Towing activity was assigned to all ELBs using reference values that defined towing speeds. The accuracy for estimated fishing effort with this method was validated with observers that recorded start and end times for each tow during their coverage. ELB estimated effort was summed for each observed trip-month-latitude bin combination and compared to observed effort (Figure 3). If the two sets of effort values were identical, then all points would fall exactly on the 1:1 line (i.e., the dashed line at 45°). Two reasons for them not to fall on this line would be random sampling error (random departures on either side of the line) and/or systematic bias (consistent departures in a prevailing direction). A least squares regression line fit to these data resulted in an r^2 = 0.99 for the eight data points. This means that variation in observer effort was the same as variation in the ELB data 99% of the time and that random error was not substantial. Nominal bias was reflected by all points consistently falling on or very near the 1:1 line.

Table 1: Tow hours per month for each vessel participating in the ELB pilot study. Outlined values were not used in the study (dashed outlines=the entire month was not covered; solid outlines=the vessel participated in other fisheries besides penaeid shrimp.

	County of	2012										2013						
Vessel	landing	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Total
A	Glynn		94	94	10	96	129		111	168	47				46	129	170		1092
B	Glynn		81	143	140	140	138	111	119	112	64				18	99			1165
C	McIntosh			259	108	170	191	173	181	145	108	154	172	145	50	129	218	1	2203
D	McIntosh	37	201	233	42	68	95	223	164	107	240	144	368	446					2370
E	McIntosh		68	267	78	116			71	70	147	139	165	115	29	160	156	9	1587
F	McIntosh				113	138	152	233	156	172	157	151				169	235	43	1720
G	McIntosh							136	151		53								341
H	Glynn				43	132	187	158									45		565
	McIntosh								149	29	31				53	59			320
I	Chatham			87	188	112	95	132	175	95	1						205		1091
	Glynn														59	155			214
J	McIntosh				97	195	175	207	91	132	83		101	105		239	129		1556
K	Camden					21				5	19	44	32	7	13	57	41		240
L	Chatham		113	241	141		82	194	148	112	99	52				194	181	141	1699
M	Glynn		94	146	142	141	124	131	103	38				1	34	114	50		1118
N	Chatham		75	137	126	117	124	141	63	5						90	140	1	1019
O	McIntosh			187	168	116	172	163	166	117	66	21			40	194	176	4	1590
P	Glynn		93	128	109	47	129	79	143	127						134	168		1158
Q	Glynn		22	240	154	174	196	229	244	147	276	227			9	227	218	126	2489
R	Glynn		120	157	24	168	309	201	195	209	125	199	38		76	229	286		2335
S	Chatham		37	129	101	43	101	153	67	97	9					83	146		966
T	Chatham		181	289	153		132	239	132	26	60	21			79	235	283	155	1984
Number of useable ELBs			5	14	17	16	17	17	18	18	16	6			11	17	16	3	
Monthly mean (useable only)			92	177	101	116	141	161	131	100	92	96			41	147	165	106	119

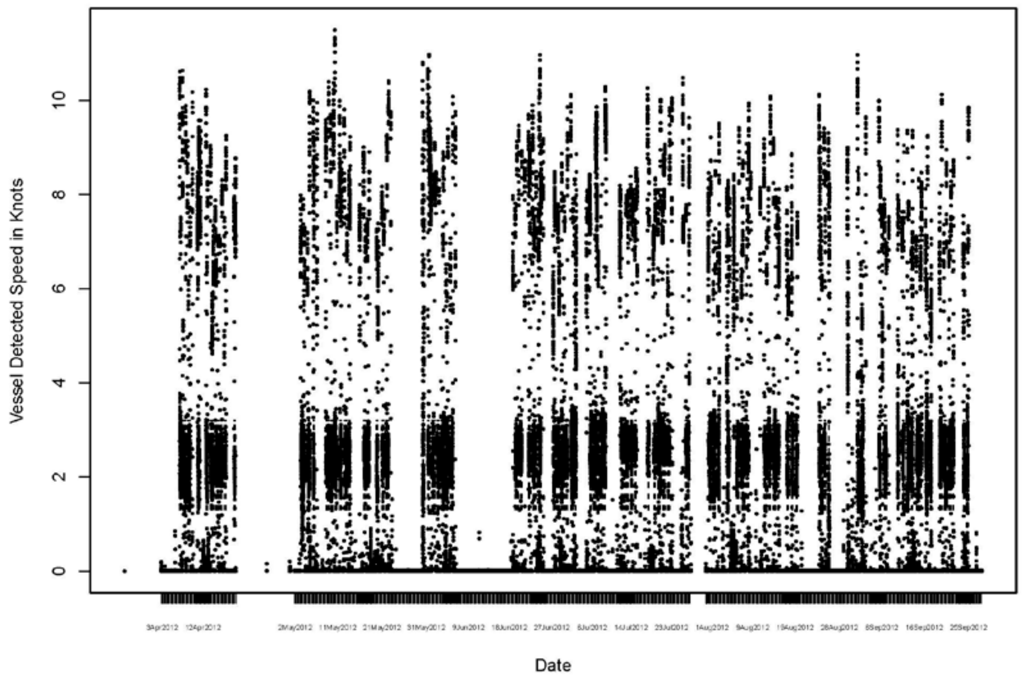

Figure 1: Vessel speeds recorded every minute by an ELB used in the pilot study from April to September 2012.

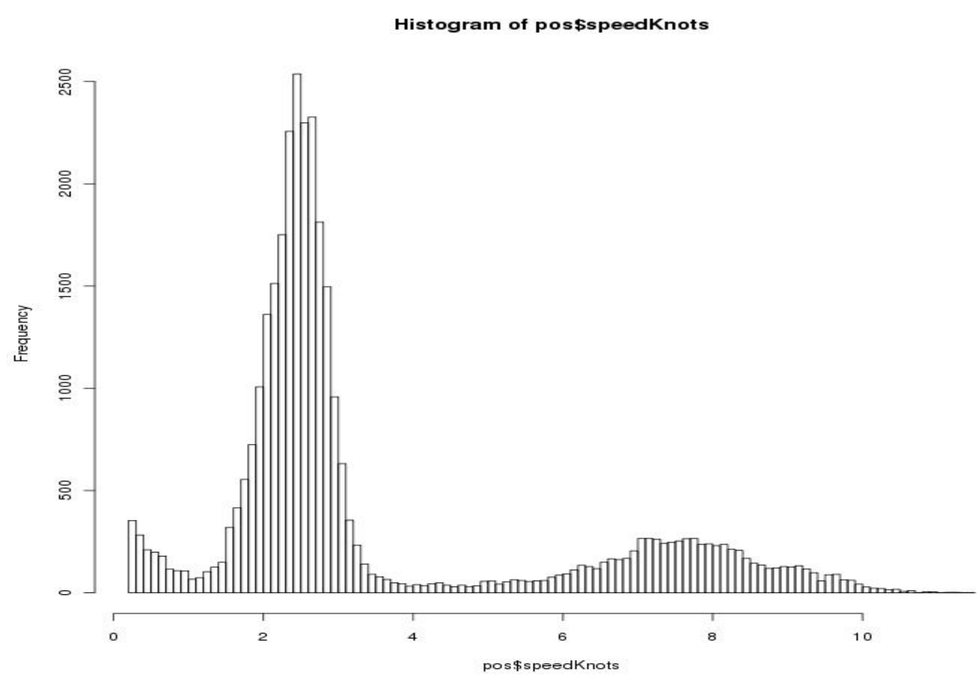

Figure 2: Length frequency histogram of vessel speeds summarized for the scatter plot in Figure 1.

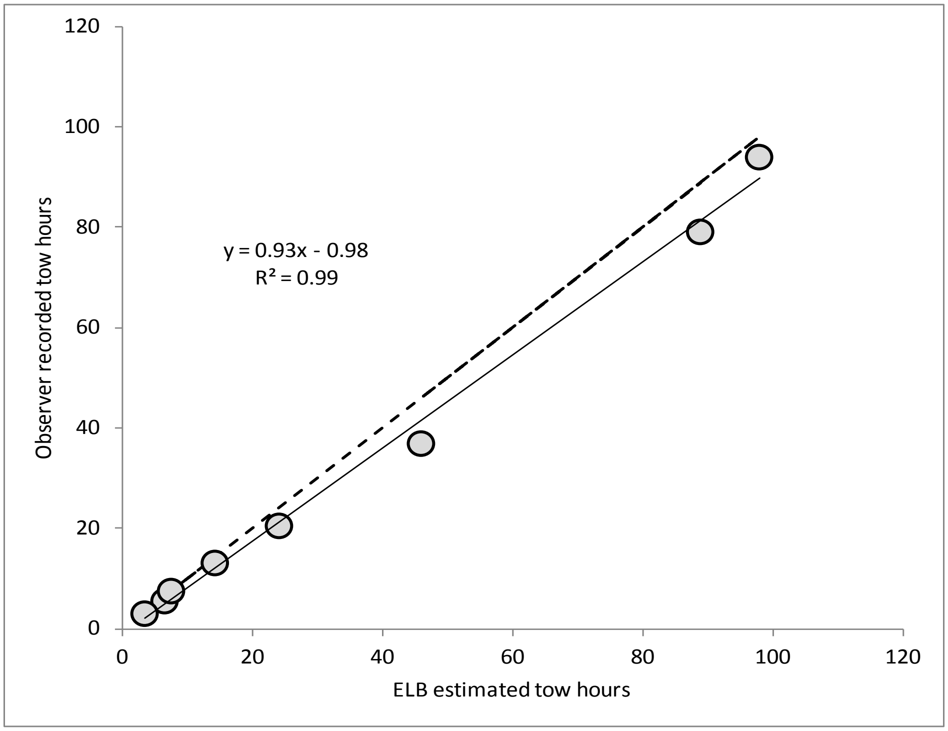

Figure 3: Comparison of tow hours recorded by observers versus those estimated with ELBs. Each point reflects tow hours summarized for each observer trip-month-latitude bin combination. The dashed line indicates when x-y values are identical.

Just based on this limited observer coverage, the accuracy of shrimping effort estimating with ELBs in the South Atlantic was still convincing. Moreover, the accuracy of ELB effort allocations across spatial and temporal strata was thoroughly validated with observers and paper logbooks in the Gulf (Gallaway *et al.*, 2003a). The logbooks used in the Gallaway *et al*. (2003a) study were dedicated to the Gulf ELB pilot study; as such, special attention was given to their accuracy so that they did not reflect the poorer quality data typically obtained from fishery-wide logbook programs. Regressing ELB effort estimates against logbook effort estimates yielded an R^2_{adj} of 0.97 with a slope of one and intercept near zero; regressing ELB catch against observer catch yielded R^2_{adj} of 0.92, slope=1, intercept=0. Thus, we suspect that, though our observer coverage was minimal, full validation (an observer watching every tow for numerous trips) in this pilot study was unnecessary.

Temporal-Spatial Trends in Shrimping Effort

The primary goal of any pilot study is to serve as a proof of concept. Even though ELBs from this pilot study were concentrated in a smaller section of coastline for the South Atlantic shrimp fishery, the results presented were based on a handful of vessels and should be viewed as first approximations. This study was successful in proving that ELBs are an affordable approach to accurately quantify effort of the expanded fishery across space and time.

Effort across all vessels was stratified by county of landing in an attempt to homogenize fishing patterns (only two vessels landed in more than one county). During the study period, three counties demonstrated similar trends in average effort per vessel per month (Figure 4). For all three counties, fishing effort increased from April to peak in May-June followed by a lull in July before peaking again in August-September tapering again in November-January. An exception to this pattern was a spike in January for Glynn County. Using this figure, seasonal strata were assigned as follows: *Spring* = February-April, *Early Summer* = May-June, *Mid-summer* = July, *Late summer/Fall* = August-October, and *Winter* = November-January.

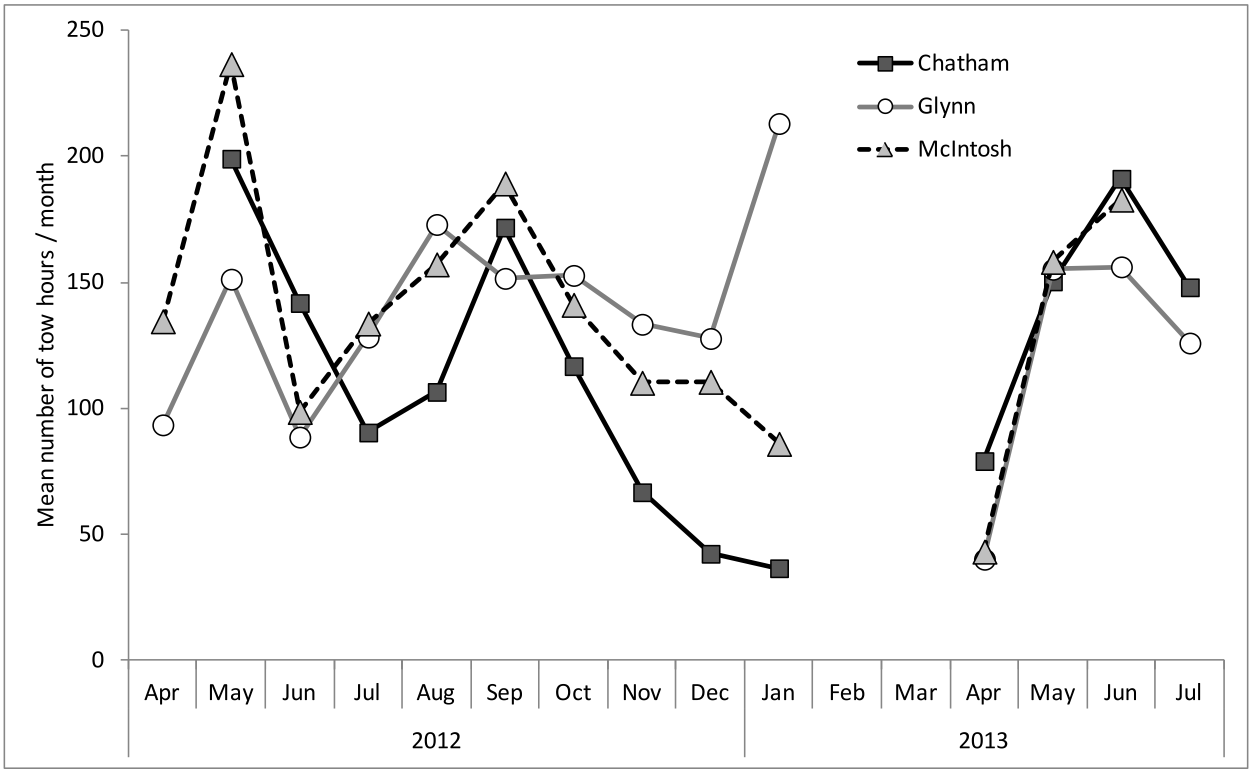

Figure 4: Mean monthly tow hours across vessels within each county-year-month combination.

Hot spot analyses of the spatially referenced effort estimates were performed within each season, county and county-peak season combinations. Across seasons, hotspots/coldspots for early and late summer were similar with respect to tow frequency and duration; more variable in this regard were the seasons of lower fishing intensity—spring, mid-summer, and winter (Figure 5). When vessels were grouped by count of landing, spatial differences were evident—more northern for Chatham County, southern for Glynn County, and in between for McIntosh County (Figure 6). These trends were consistent when separated into the peak fishing seasons as well (Figure 7).

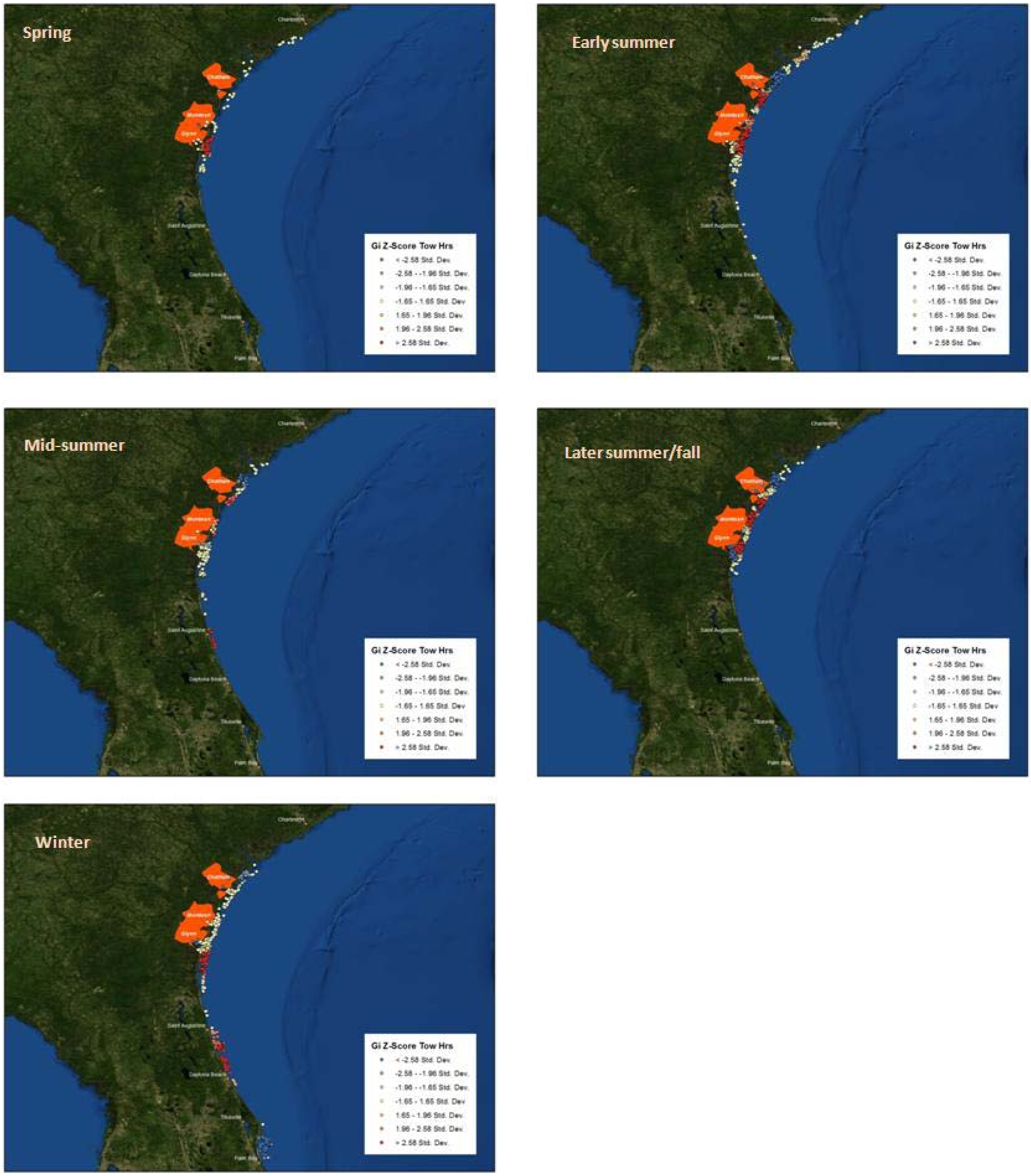

Figure 5: All tow locations for ELB monitored vessels pooled within each season. Shading of points was determined with hotspot analyses (see Methods). Red points reflect more towing time, blue less time, and white intermediate between the two.

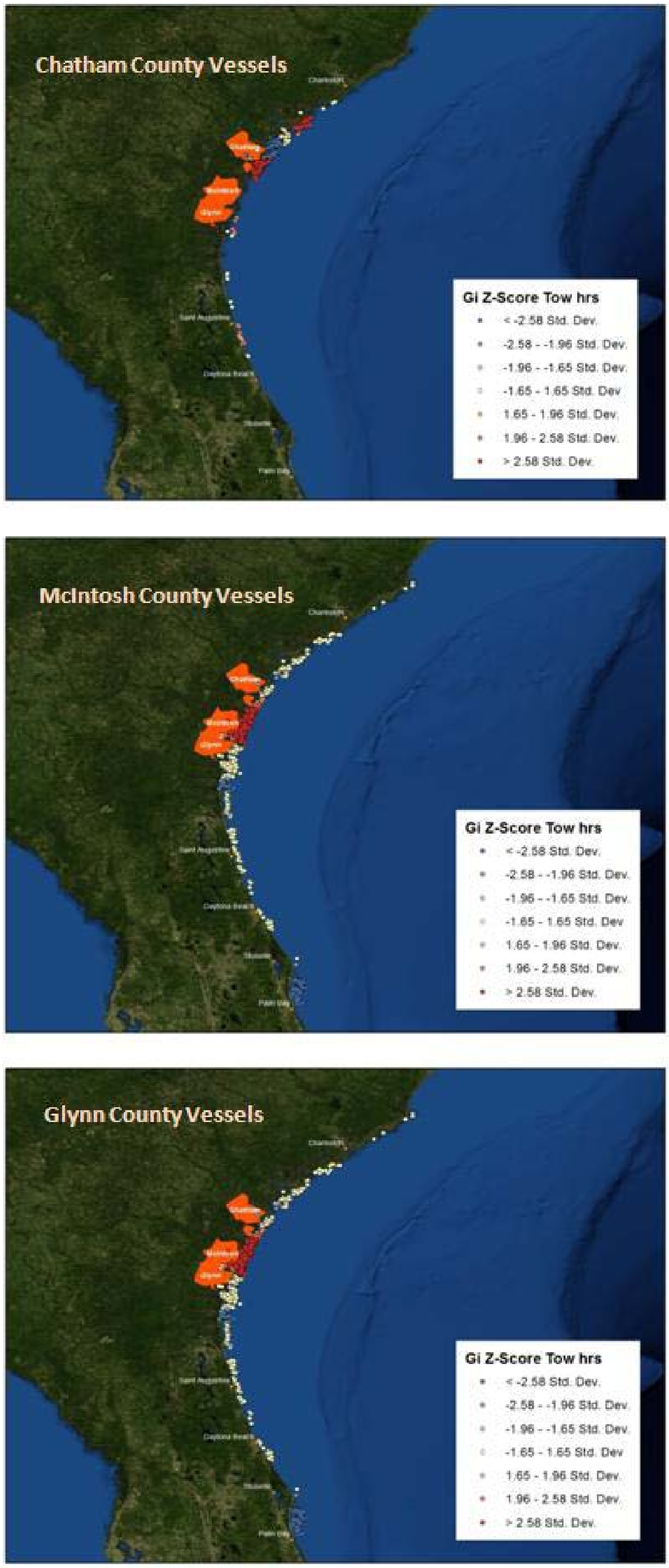

Figure 6: All tow locations for ELB monitored vessels pooled within each season. Shading of points was determined with hotspot analyses (see Methods). Red points reflect more towing time, blue less time, and white intermediate between the two.

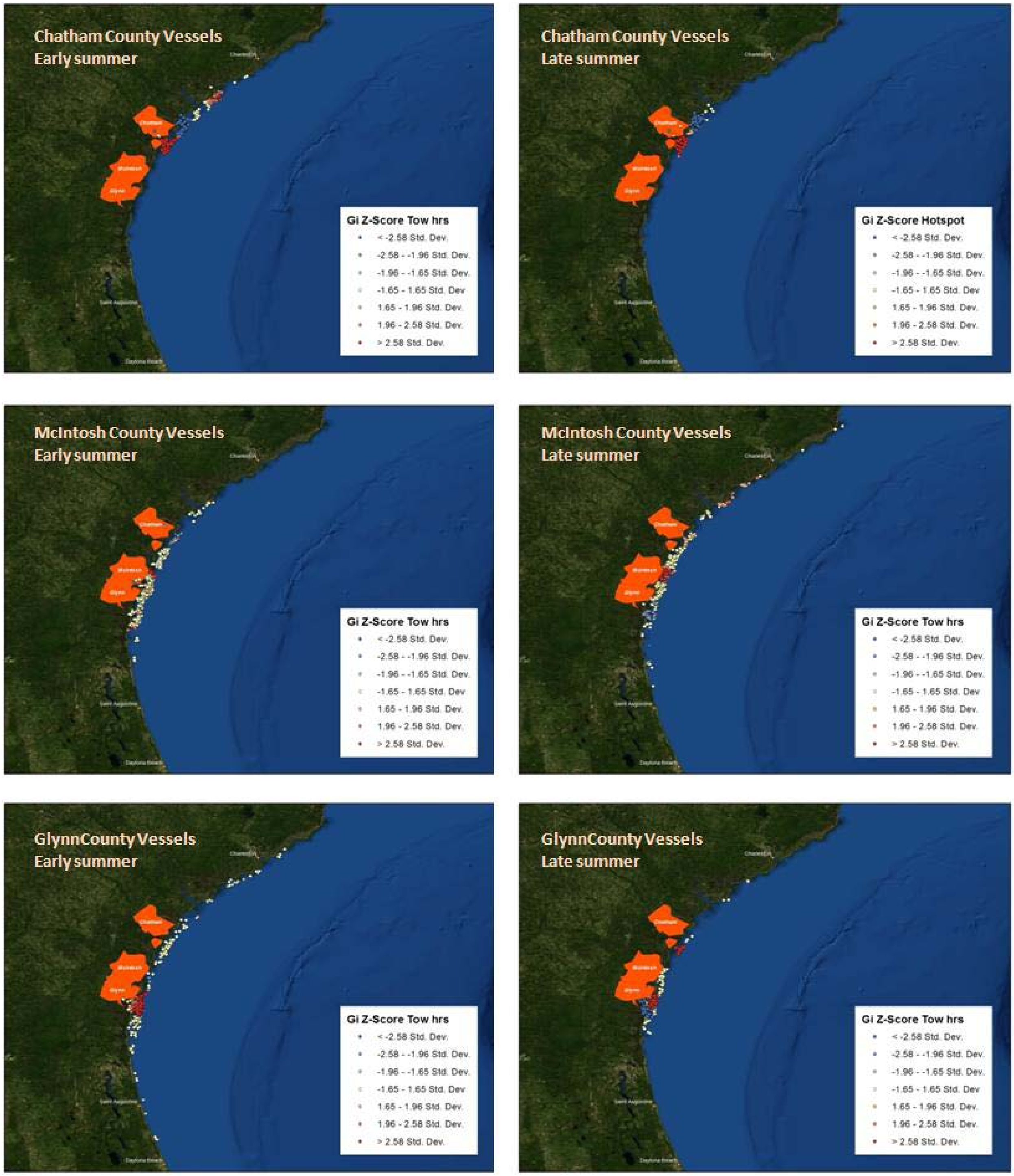

Figure 7: All tow locations for ELB monitored vessels pooled within each season. Shading of points was determined with hotspot analyses (see Methods). Red points reflect more towing time, blue less time, and white intermediate between the two.

CPUE Estimates and Comparison of ELBs with Landings Effort

The information compiled from landings reporting forms was variable with respect to both catch and effort data. This information was linked to the ELB data for each common vessel-county-year-month combination. Clearly some effort was unreported on the landings forms during the study period (Figure 8). Comparing catch to the two effort estimates shows further discrepancies (Figure 9). The top graph includes catches for which effort on landings reports went unreported, while the bottom graph includes effort for which catches went unreported. Removing month helped to improve the relationships by allowing errors to cancel each other when pooled (Figure 10). Further, the relationship between ELBs and catch was improved more. This is because some ELB trips crossed months, but catches paired to these trips were assigned only to the month in which the catch was landed. CPUE estimated for each county-year-month combination was more variable across counties than ELB effort; however, like ELB effort, CPUE increased during May-June (Figure 11).

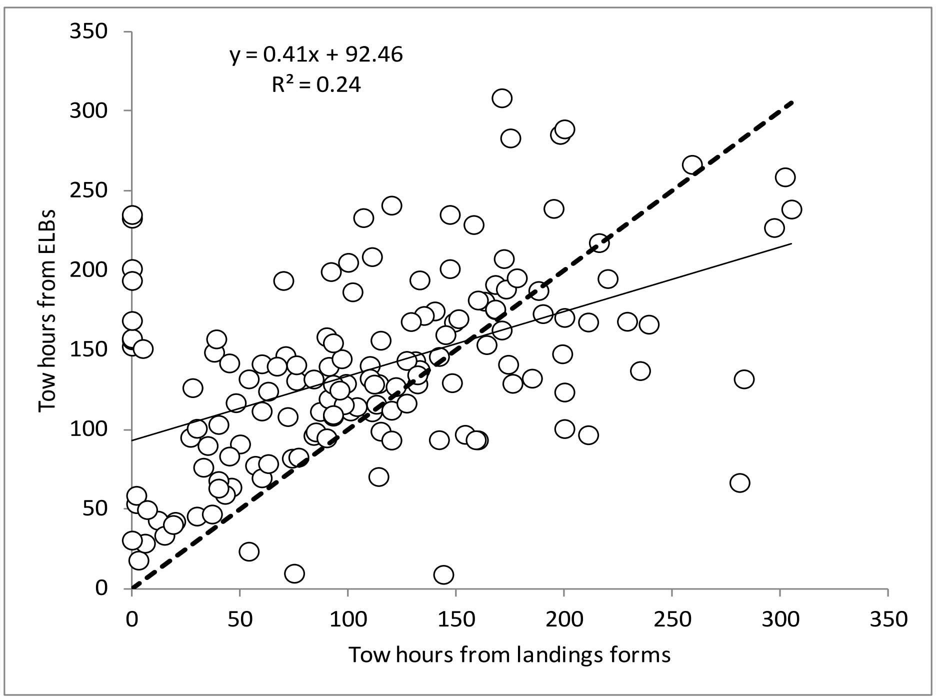

Figure 8: Comparison of tow hours estimated with ELBs versus those reported on landings reporting forms. Each point reflects tow hours summarized for each observer vessel-year-month combination. The dashed line indicates when x-y values are identical.

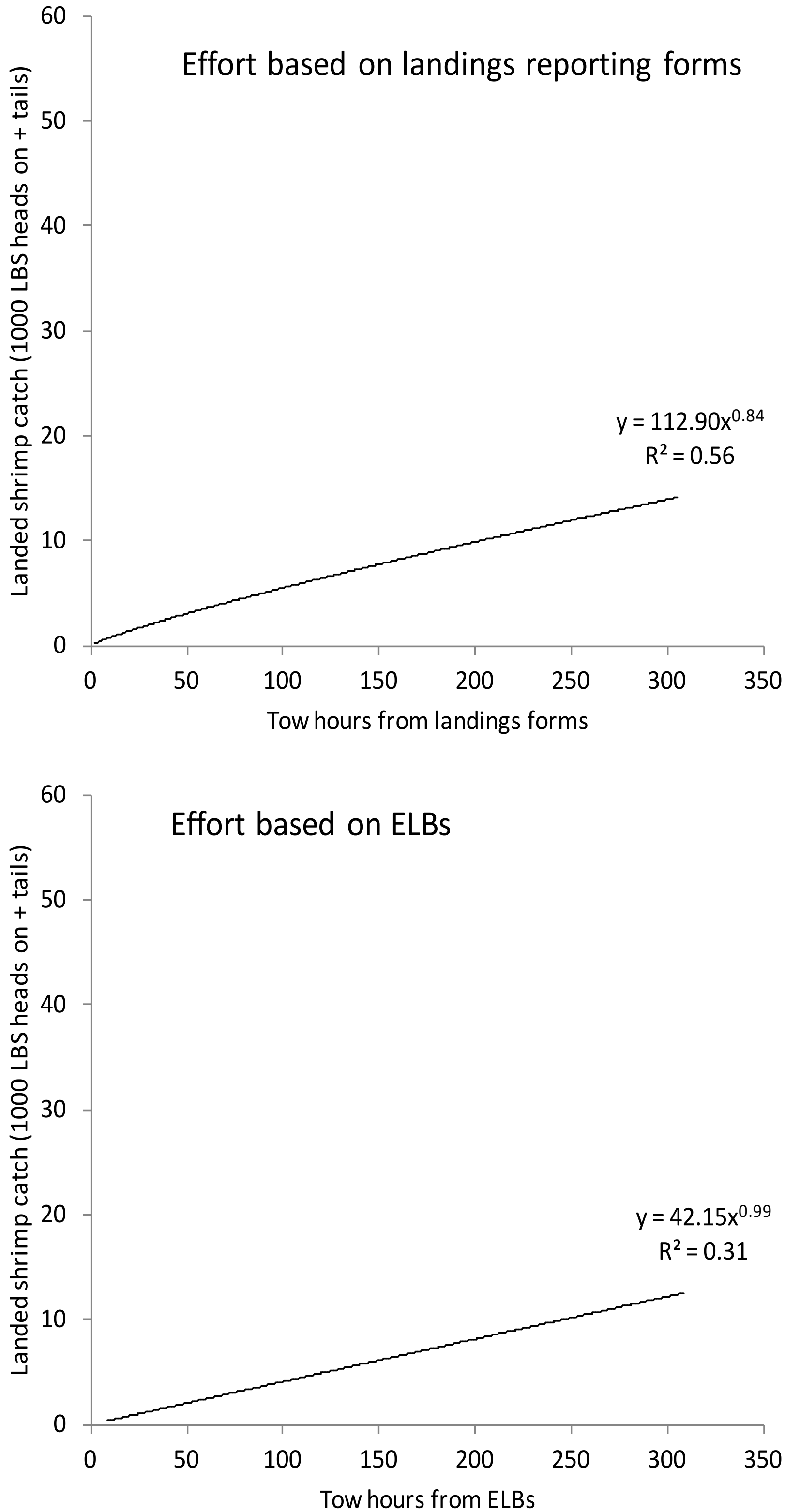

Figure 9: Landed shrimp catch as a function of tow hours. Each point reflects catch and tow hours summarized for each vessel-year-month combination.

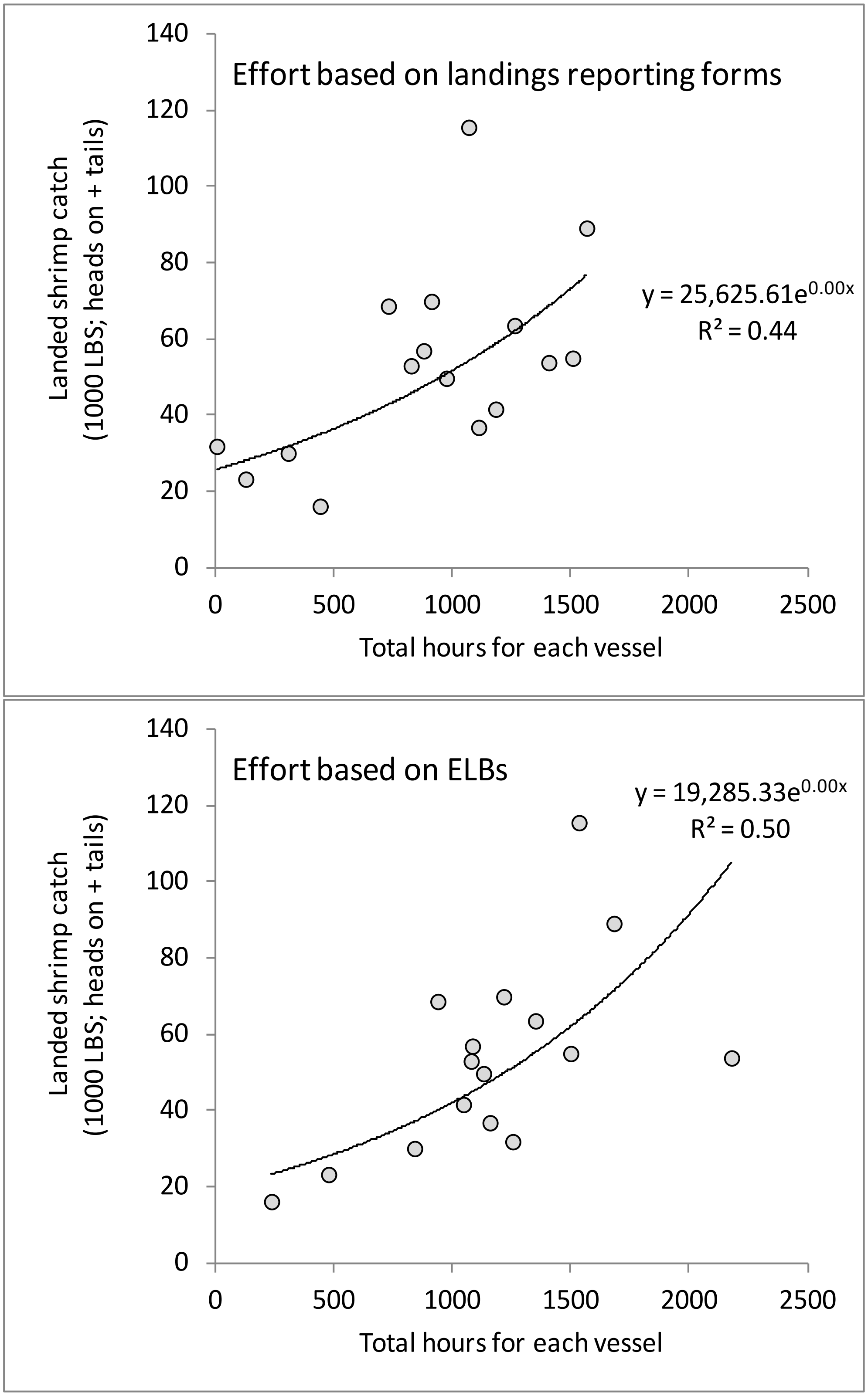

Figure 10: Landed shrimp catch as a function of tow hours. Each point reflects catch and tow hours summarized for each vessel.

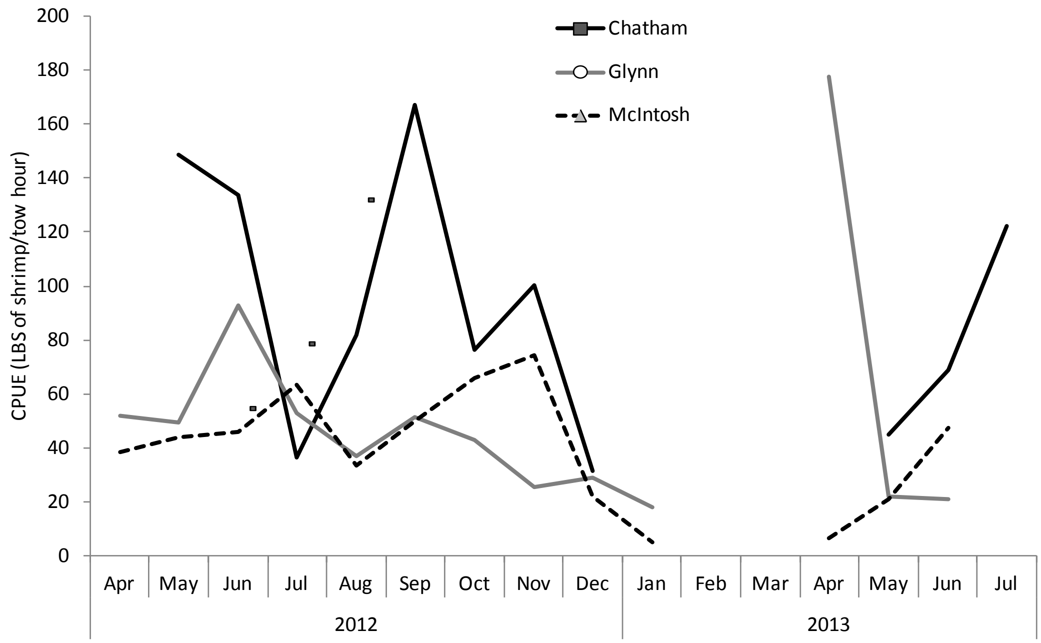

Figure 11: Mean catch-per-unit-effort (CPUE) across vessels by county.

<u>Estimating Bycatch for Species of Interest</u>

With respect to bycatch, observers were to enumerate all species of interest and record the towing time from each observed tow. These data would generate bycatch CPUEs, which could be used from an expanded program to render fishery-wide bycatch estimates. During the limited coverage afforded by this pilot study, some small coastal sharks were caught as bycatch however no sea turtles were encountered.

Table 2: Small coastal shark bycatch.

	Total	**Avg Length**
Atlantic sharpnose	54	34 cm
Bonnethead	12	52 cm
Scalloped Hammerhead	4	44 cm
Smooth Dogfish	87	46 cm

<u>Determining Feasibility of a South Atlantic ELB Program</u>

Given the ELBs accurately reflected fishing effort for the participating vessels, the number of vessels requiring ELBs to adequately estimate effort for the expanded South Atlantic fishery remains a quintessential consideration. From a sampling design perspective, ELBs can be treated similar to observers, and therefore draw upon the body of literature pertaining to the same consideration for observer programs. The level of coverage depends on the spatial distribution of catch/bycatch, as well as the number of participating vessels and their spatial distribution; on average, Babcock and Pikitch (2003) recommend covering 20% of the fishing fleet to estimate CPUE of common species. This approximation was based on simulation results and a literature review. Currently, there are 515 permit holders in the South Atlantic penaeid shrimp fishery (http://sero.nmfs.noaa.gov/operations_management_information_services/constituency_services_branch/freedom_of_information_act/common_foia/SPA.htm; accessed on November 25, 2013). Twenty percent comes to 103 vessels equipped with ELBs parsed across ports based on relative magnitude of catch; likewise, random assignment to vessels within each port would be proportionate to their relative catches. The total cost of an expanded project would be a function of outfitting 103 vessels (assuming 20% coverage is the target), the number of ports that must be accessed, which has bearing on the corresponding personnel time for servicing the ELBs, and the time to manage the project, analyze the data, and report the results. A ballpark estimate would be about $500,000 per year.

In place of holding formal port meetings when the project was completed, Captain Parker requested comments on the program from the participating captains. Responses among fishermen were positive. Due to the success of the Gulf ELB program, South Atlantic fishermen viewed this study as a welcome change from current management protocols for estimating bycatch in their fishery.

Problems Encountered:

No significant problems were encountered during project performance.

A cooperating captain informed Captain Parker of a lightning strike to his vessel in mid to late August 2012. On Sept 11, 2012, Captain Parker visited the dock, troubleshot the ELB, and pronounced it dead. First indication was to go without further data on the vessel, but we later determined to fix the ELB. Repairs were completed and the ELB was back operational on Oct 12, 2012.

Additional Work Needed:

Increasingly, marine habitats are being parceled for use by various stakeholder groups. Inherent in this delineation is the recognition of traditional fishing grounds. Without established documentation of relative effort in the areas of interest, claims of utilization are more tenuous. ELB data removes all doubt concerning where and when shrimping occurred. In Texas and Louisiana the established ELB program in the Gulf helped artificial reef committees to place new reefs in areas that were not important to the shrimp fishery (S. Raborn, pers. comm.). ELB data were also used by the Gulf of Mexico Fisheries Management Council (GMFMC) when citing proposed aquaculture areas (J. Cole, LGL, pers. comm.).

Federal regulations currently require a vessel monitoring system (VMS) on all shrimping vessels trawling for rock shrimp (*Sicyonia brevirostris*) in the SA. Currently, there is no VMS requirement for the penaeid shrimp fishery, but the tendency for this type of regulation to be enacted in similar fisheries is common. The cost of an average VMS is around $3,500 for installation and a $500 annual service fee, both of which are at the expense of the vessel owner. The cost of an ELB is only $500, which will be paid through the government funded ELB program. Both VMS and ELB have hidden cost with respect to data processing and analysis, but these costs should be about the same for each. Both devices provide the exact location of the vessel, but only VMS data are real time, which is not necessary for accurate effort estimation and fishery management and is disconcerting to commercial fishermen. VMS data are used primarily for enforcement and are not usually appropriate or available for effort estimation as they are not programmed to record positions frequently enough to estimate effort.

The Gulf ELB program is transitioning to new technology and some of the costs are being offset by NOAA Fisheries, but some of the costs are being placed on industry. It is imperative that the Gulf program is thoroughly tested prior to establishing a program in the SA.

VI. Evaluation

Achievement of Goals and Objectives:

The goals and objectives of this project were successfully completed:

- As a pilot study, this project proved that the use of ELBs to characterize the spatial and temporal distribution of penaeid shrimp fishing effort for a subset of vessels operating in the South Atlantic was possible.

- Through previously designed algorithms, we were able to estimate the CPUE of penaeid shrimp for the monitored fishing vessels.

- We were able to gather some data through allotted observer coverage on small coastal shark bycatch. However, observers did not collect any blacknose shark during fishing operations and the sample size for the other species was not large enough to complete an accurate estimation.

- If the funding is available, it would be possible to design and implement a South Atlantic-wide ELB program for the estimation of shrimp fishing effort.

- Responses among fishermen encountered during the course of this project were positive. Due to the success of the Gulf ELB program, South Atlantic fishermen viewed this study as a welcome change from current management protocols for estimating bycatch in their fishery.

Dissemination of Results:

Summary reports of the project's findings were also published as part of the "Foundation Project Update" section of the "Gulf and South Atlantic News", a publication of the Gulf & South Atlantic Fisheries Foundation, Inc. This newsletter is distributed to over 700 organizations and individuals throughout the region. An electronic version of this newsletter (PDF) is also included in the regular updates to the Foundation's website (www.gulfsouthfoundation.org).

Copies of this project's Final Report will be published and distributed to various federal and state fishery agencies, university extension/Sea Grant offices, and Industry associations. In addition, PDF copies of the Final Report will be made available for download from the Foundation's website.

VII. Literature Cited

Babcock E.A. and Pikitch E.K. 2003. How much observer coverage is enough to adequately estimate bycatch? Unpublished report, 35 pp.

Gallaway, B.J., J.G. Cole, and L.R. Martin. 2001. Development of direct measures of Gulf of Mexico shrimp fishing effort as a means to evaluate existing measures of effort and juvenile red snapper bycatch. Final Report to the Gulf & South Atlantic Fisheries Foundation, Inc., Tampa, Florida. 119p.

Gallaway, B.J., J.G. Cole, L.R. Martin, J.M. Nance, and M. Longnecker. 2003a. Description of a simple Electronic Logbook (ELB) designed to measure effort in the Gulf of Mexico shrimp fishery. North American Journal of Fisheries Management. 23: 581-589.

Gallaway, B.J., J.G. Cole, L.R. Martin, J.M. Nance, and M. Longnecker. 2003b. An evaluation of an Electronic Logbook (ELB) as a more accurate method of estimating spatial patterns of trawling effort and bycatch in the Gulf of Mexico shrimp fishery. North American Journal of Fisheries Management. 23: 787-809.

South Atlantic Fisheries Management Council (SAFMC). 1996. Final amendment 2 (bycatch reduction) to the fishery management plan for the shrimp fishery of the South Atlantic region including a final supplemental environmental impact statement, regulatory impact review, and social impact assessment. South Atlantic Fisheries Management Council, Charleston, South Carolina.

South Atlantic Fisheries Management Council (SAFMC). 2004. Final amendment 6 to the fishery management plan for the shrimp fishery of the South Atlantic region including a final supplemental environmental impact statement, initial regulatory flexibility analysis, regulatory impact statement review, social impact assessment/fishery impact statement and biological assessment. South Atlantic Fisheries Management Council, Charleston, South Carolina.

Appendices

Appendix A

Sample Consent Request Letter

December 2, 2013

Ms. Julie Califf
One Conservation Way
Brunswick, GA 31520

Re:Gulf & South Atlantic Fisheries Foundation, Inc. NOAA Award #NA11NMF4540115 (#119)

Dear Ms. Califf:

I am a participant in the Gulf and South Atlantic Fisheries Foundation Inc.'s, (GSAFFI) Pilot Study with Electronic Log Books (ELBs), in the South Atlantic. On behalf of the GSAFFI, I request that you provide to them my landings data from trip tickets for the duration of this study. GSAFFI ensures that this data will be kept confidential.

Dr. Scott Raborn with LGL Ecological Research Associates, Inc. will be conducting the data analysis on behalf of the GSAFFI. Funding for this project is provided by NOAA Award #NA11NMF4540115 (#119).

Thank you in advance for your cooperation in this project.

Sincerely,

Appendix B

Georgia Department of Natural Resources Shrimp Landings Reporting Form

203320

ALL ITEMS ARE MANDATORY!

SHRIMP LANDINGS REPORTING FORM — **GEORGIA DEPARTMENT OF NATURAL RESOURCES** Coastal Resources Division
One Conservation Way Brunswick, Georgia 31520 (912) 264-7218

Fisherman Name		Commercial Fishing License Number (Not required if card is presented)	**TRAWL GEAR - complete this section** Rig type (circle one) Single Double Twin Number of Tows 1 Fishing Time 1 hr. (total hours the nets were in the water)
Trip Start Date	Number of Crew (include captain) 3	Area Fished Sapelo	
Unloading Date		County of Landing McIntosh	
Dealer Name Shrimp Dock		Boat Registration # or Documentation # Dealer code (DNR use only)	**CASTNET GEAR - complete this section** Fishing Time (total amount of time actually spent fishing)

PLEASE SPECIFY IS SHRIMP IS HEADS-ON OR TAILS

COUNT	1/15	16/20	21/25	26/30	31/35	36/40	41/50	51/60	61/70	71/80	Over 80
POUNDS			100				7				
PRICE			6.50				4.25				
POUNDS											
PRICE											

SPECIES	POUNDS	PRICE	SPECIES	POUNDS	PRICE
MIXED FISH			WHELK		
WHITING			OTHER SPECIES (name)		
FLOUNDER			OTHER SPECIES (name)		
BLUE CRABS			OTHER SPECIES (name)		

RECEIVED AUG 13 2013

WHITE COPY - Dealer YELLOW COPY - Harvester PINK AND GOLD - DNR