A Project to Augment the Data Collection and Development of an Electronic Logbook System Used Within the Gulf of Mexico Shrimp Fishery

NOAA/NMFS Cooperative Agreement Number NA05NMF4540044 (GSAFFI #94)

FINAL REPORT

Gulf & South Atlantic Fisheries Foundation, Inc.

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

December 2008

This final report was prepared by the Gulf & South Atlantic Fisheries Foundation, Inc. under award number NA05NMF4540044 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.

I. Report Title, Author, Organization, Grant Number, Date:

Report Title: A Project to Augment the Data Collection and Development of an Electronic Logbook System Used Within the Gulf of Mexico Shrimp Fishery

Author: Dr. Michael Jepson, Program Director
Judy Jamison, Executive Director

Organization: Gulf & South Atlantic Fisheries Foundation, Inc.
Lincoln Center, Suite 740
5401 West Kennedy Boulevard
Tampa, Florida 33609-2447

Coop. Agree No.: NA05NMF4540044

Date: April 2005 - December 2008

II. Abstract

Through funding from the Cooperative Research Program the Foundation was able to enhance a currently funded LGL Ecological Research Associates program by placing contracted observers onboard vessels with Electronic Logbooks (ELBs) to collect shrimp landings and red snapper bycatch data. Six certified observers were placed on vessels from 7 different ports located in Florida, Alabama, Louisiana, and Texas. There were a total of 17 trips ranging from 4 to 64 sea days onboard 11 different vessels with a total of 691 tows sampled in water depths ranging from nearshore to over 300 feet in 15 different statistical zones. Data collected during this project was used to conduct a formal cohort analysis (VPA) and compute mortality estimates for all Foundation collected red snapper data (both past and present). Results were used to validate ELB landings estimates by region (statistical zone) and to assist fisheries managers in the assessment of the red snapper stock. The analysis suggests that natural mortality for age-0 red snapper may be higher than that previously considered in past stock assessments and therefore may have implications for future management. These results are currently under review in an article submitted to the North American Journal of Fisheries Management and are presently in press, but will appear in Volume No. 28.

III. Executive Summary

The National Marine Fisheries Service (NMFS) classified the red snapper (*Lutjanus campechanus*) stock of the Gulf of Mexico as overfished. Shrimp trawl bycatch of juvenile red snapper is thought to contribute significantly to overall fishing mortality (F) and the adult red snapper stock size. With the requirement beginning in May 1998 that bycatch reduction devices be installed in penaeid shrimp trawl gear in the Gulf of Mexico, parallel changes in observer protocols were also introduced. One change was that all red snapper (*Lutjanus campechanus*) collected would be enumerated and measured where possible. This change yielded catch and length information from the Gulf of Mexico penaeid shrimp fishery. Furthermore, an integrated approach for dealing with age composition, growth and mortality of juvenile red snapper had not

yet been attempted. To remedy this, a program to place observers aboard vessels in the Gulf penaeid shrimp fishery outfitted with Electronic Logbooks was developed by the Foundation to collect the necessary data on fishing effort, red snapper bycatch, and shrimp landings.

Over a three year period observers were placed on 11 vessels from 7 different ports located in Florida, Alabama, Louisiana, and Texas. A total of 17 trips ranging from 4 to 64 sea days were undertaken in water depths ranging from nearshore to over 300 feet in 15 different statistical zones. Observers logged a total of 349 sea days with a total of 691 tows, of which, 285 contained red snapper. These tows containing red snapper comprised forty one percent (41%) of the total tows sampled. All data were entered into the NMFS Galveston Laboratory Shrimp Fishery Observer Database and analyzed by LGL Ecological Associates, Inc.

A length-based, age-structured model was developed using length frequency data collected by observers of the Gulf of Mexico penaeid shrimp fishery from 1999 to 2006. Model results indicate that the age-0 red snapper fraction of the shrimp trawl bycatch in the first and third trimesters exceeds 90% and during the second trimester, the bycatch is more evenly split between age-0 (48%) and age-1 (52%) red snapper. The growth data suggest age-0 and age-1 fish form an opaque annulus in winter which is consistent with results found for older fish. The total mortality estimates for age-0 and age-1 red snapper were about 2.5 and 1.8, respectively. The natural mortality rate for age-0 red snapper based on this study is approximately double the value used in the last red snapper stock assessment. The evidence for the model with density dependence over the model with density independent mortality is overwhelming. Inclusion of our findings in the red snapper stock assessment has the potential to substantially alter management advice.

Finally, the results of the analysis were submitted as an article to the North American Journal of Fisheries Management and currently under review.

IV. Purpose

Detailed Description of Problem

Fish stocks with commercial and recreation value are usually managed via the regulation of fishing mortality to maintain a sustainable harvest (Hilborn and Walters 1992). The National Marine Fisheries Service (NMFS) has classified the red snapper (*Lutjanus campechanus*) stock of the Gulf of Mexico as overfished. Shrimp trawl bycatch of juvenile red snapper is thought to contribute significantly to overall fishing mortality (F) and the adult red snapper stock size. However, there exists some disagreement regarding the magnitude, age composition, and monthly distribution of red snapper bycatch in time and space (Goodyear 1995; Schirripa and Legault 1997, 1999; Gallaway et al. 1998; Gallaway and Cole 1999; Ortiz et al. 2000; NMFS 2004).

Calculations of red snapper bycatch are directly dependent upon estimates of shrimp fishing effort. Historically, state or federally employed port agents collected shrimp landings and value data from dealer records. Fishing effort data were collected by port agents through detailed interviews with fishing vessel captains and/or crew; port interviews are collected on a trip-by-trip

basis. Due to the large number of shrimp fishing trips occurring within the Gulf of Mexico, a comprehensive survey of the shrimp fleet is not feasible, thus subsampling occurs. Monthly, port agents visit all shrimp dealers within their region and collect landings information for individual fishing trips. Port agents then subsample these trips by randomly selecting interviewees to obtain further information regarding effort and catch location (Nance 2004). Both landings and effort data are then allocated to one or more of 231 statistical cells on a monthly basis. When data is unavailable for a statistical zone, a general linear model is used to estimate effort (NMFS 2004).

NMFS does not directly measure shrimp fishing effort, catch, or length-frequency data on commercial shrimp-trawl-caught red snapper. These estimates are derived through indirect approaches or modeling, thus adding to the contention of the red snapper bycatch issue. Inaccuracies in trip interview, time fished, or reported catch data can result in skewed fishing effort calculations (Nance 2004) and biases in the assessment of the red snapper stock (NMFS 2004).

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 fear that the collected data will be used to implement further management regulations. Asking, or mandating, fishermen to collect fishing effort data would be the most inexpensive option, but data is too dependent upon sources that could bias information, thus leading to further inaccuracies. Additional problems could be encountered when trying to solicit industry's involvement; many fishermen believe data collection will lead to increased regulations.

Placing observers on fishing vessels would be the optimal method to collect fishing effort data. Observers are unbiased with regard to effort data collection and could further augment the data collection by recording the abundance and length-frequency of trawl-caught red snapper bycatch. The overwhelming disadvantage to utilizing observers is that a multi-year program, covering a significant proportion of the shrimp fishing fleet, would be extremely expensive (on the order of tens of millions of dollars).

The advantages of implementing an ELB system are that the device is passive, small, and it accurately and autonomously records data. Shortcomings of the ELB system include a lack of ancillary data collection and the price of the device will, most likely, be passed on to fishermen. The most appropriate and effective resolution to estimate fishing effort and bycatch would be to combine all, or part, of these solutions.

In 1998, the US Congress appropriated funds to the Gulf and South Atlantic Fisheries Foundation, Inc. (Foundation) to conduct a three-year research study to enable the fishing industry to evaluate and address fishery management issues including the estimation of shrimp fishing effort and bycatch. A portion of these funds were granted to LGL Ecological Research

Associates, Inc. (LGL) to allow the research and development of an electronic logbook to directly measure shrimp fishing effort thereby reducing the dependence on modeling to provide better estimates of shrimp fishing effort and red snapper bycatch. Over the course of LGL's three year pilot study, ELB systems were randomly 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 (see below) and that individual tows could be identified. Combining the ELB data with paper logbook and observer collected landings data, 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). This analysis indicated that a directional bias exists and that port agent data overestimated effort in midshore regions (areas abundant in juvenile red snapper) while underestimating effort in offshore and nearshore regions (areas lacking juvenile red snapper). These studies proved that an ELB system was accurate at recording shrimp-trawl fishing effort and estimating and allocating landings data (Gallaway 2001, 2003a, and 2003b).

Based upon the results derived from the abovementioned studies and recommendations made by the SEDAR-7 Shrimp Fleet Bycatch Working Group (NMFS 2004), LGL was granted money by the NMFS to further expand the ELB program within the shrimp fishery in the Gulf of Mexico. The project, entitled "Estimation of Shrimp Fishing Effort in the Gulf of Mexico: Phase 1 Implementation", was designed to capture accurate estimates of shrimp-trawl fishing effort from the construction and installation of 50 ELB (and 100memory units) on a random and representative sample of the shrimp fishing fleet operating in the Northern Gulf of Mexico. Although the data collected during this study will be invaluable to fishermen and fisheries managers in resolving effort-related questions, red snapper bycatch and shrimp landings data will not be collected. Through funding from the Cooperative Research Program the Foundation was able to enhance the LGL Ecological Research Associates program by placing contracted observers onboard vessels with Electronic Logbooks (ELBs) to collect shrimp landings and red snapper bycatch data.

Objectives of Project

1) Complement the current ELB study with onboard observers to collect data on fishing effort, red snapper bycatch, and shrimp landings;

2) Analyze all observer collected data to further ensure that ELB landings estimates are accurate and defensible;

3) Determine the spatiotemporal abundance of juvenile red snapper, compute a total mortality (Z) estimate for shrimp-trawl red snapper bycatch, and conduct a formal cohort analysis (VAP) on all observer collected red snapper data; and

4) Further develop the ELB system to make the device more robust and accommodating to commercial fishermen.

V. Approach

The Foundation convened a planning meeting on November 8-9, 2005 to discuss performance of this project. Present at the meeting were the Foundation Executive Director, Foundation Program Specialist, Foundation Program Director, Dr. Benny Gallaway (LGL Ecological Research Associates), Mr. John Mitchell (NMFS-Pascagoula Laboratory), Dr. Jim Nance (NMFS-Galveston Laboratory), Mr. Russell O'Brien (Foundation Observer/Vessel Coordinator), Mr. Gary Graham (Gulf of Mexico Regional Coordinator), Mr. Lindsey Parker (South Atlantic Regional Coordinator), Mr. Sal Versaggi (FL Industry), Mr. John Williams (FL Industry), Ms. Wilma Anderson (TX Industry), and Dr. Mike Travis (NMFS-SERO Economist).

The Foundation Program Director opened the meeting with an overview of the project and the proposed objectives. Dr. Gallaway then presented information related to increasing industry's support in the random selection of fishing vessels. This included field efforts within the Gulf States with assistance from the Foundation's Gulf of Mexico Regional Coordinator, Mr. Gary Graham. The group then discussed the spatiotemporal coverage of fishery observers, the random selection of fishing vessels, opportunistic data collection, the collection and retention of all trawl-caught red snapper bycatch from Florida waters, and the need for a no-cost extension for the full completion of project objectives.

Observer Training and Deployment

Regional Coordinator, Gary Graham and Russell O'Brien, Vessel/Observer Coordinator, reviewed all observer applications and recommended individuals for contracting. Observers contracted by the Foundation received a NMFS certificate of training prior to being deployed onboard a fishing vessel. The training detailed the gear specifications, sampling protocols, data collection and documentation required by each onboard observer. Training allowed for data consistency and standardization between Foundation and NMFS datasets and expedited data analysis by interested parties (i.e., Foundation contracted Data Analyst and stock assessment scientists). Mr. O'Brien trained all observers over a span of two years and coordinated their placement on vessels for data collection. During the course of this research five observers were contracted, trained and deployed aboard vessels for data collection.

Observers recorded the weight (heads-on or heads-off) of all Penaeid shrimp regardless of the quantity harvested. Once the total weight was recorded, harvested shrimp were homogenized and a representative sub-sample was measured to estimate the size composition of landed shrimp. All incidentally harvested red snapper were counted, weighed, and measured to produce accurate abundance and size-frequency estimates. Efforts were taken to sort, weigh, size, and record all red snapper from individual nets. In the event that individual net sorting became impractical, observers sorted, weighed, and sized red snapper taken from all nets combined (i.e., catch from all fished nets were combined and red snapper separated). Any and all sea turtles incidentally taken during experimental tows were handled, measured, and tagged

according to established NMFS protocols. Observers also noted the degree to which trawl nets were tuned and checked for proper gear installation.

Data Collection

Over a three year period observers were placed on 11 vessels from 7 different ports located in Florida, Alabama, Louisiana, and Texas. A total of 17 trips ranging from 4 to 64 sea days were undertaken in water depths ranging from nearshore to over 300 feet in 15 different statistical zones. Observers logged a total of 349 sea days with a total of 691 tows, of which, 285 contained red snapper. These tows containing red snapper comprised forty one percent (41%) of the total tows sampled. All data were entered into the NMFS Galveston Laboratory Shrimp Fishery Observer Database and analyzed by LGL Ecological Associates, Inc. Summary statistics for red snapper data collected are as follows:

Table 1. Number of red snapper collected by size range.

Total Red Snapper	Red Snapper <= 100mm	Red Snapper >100mm	Red Snapper =>130mm
11736	1908	9755	5159

Table 1 indicates that of the total number of red snapper captured, 16% were less than or equal to 100 mm in length; 83% were greater than 100 mm with 44% of the total of all of the snapper being greater than or equal to 130 mm. In other words 44% of the snapper would be considered Year Class I or over and 56% would be classified as Year Class 0. The average length of the snapper was 150.1 mm and the average water depth in which red snapper were captured is 128.1 feet.

Table 2. The Catch per Unit Effort (CPUE) for all tows by size range.

Total Red Snapper	Red Snapper <=100mm	Red Snapper >100mm	Red Snapper >130mm
17/tow	2.8/tow	14.1/tow	7.4/tow

The shrimp catch per unit effort (CPUE) averaged 25.4 kg/hr with the CPUE beginning to increase in late April, peaking in July and August, and slowly declining over remaining year in Texas and Louisiana waters. The dominate species caught in these waters was brown shrimp. In Southern Florida the data indicate that the shrimp CPUE is greatest during January and February with a slow decline occurring in March, the predominate species being pink shrimp, however, there were no other tows recorded in other months in this area.

Table 3. The CPUE per hour of towing by red snapper size range.

Total Red Snapper	Red Snapper <= 100mm	Red Snapper >100mm	Red Snapper >130mm
3.2/hr	0.5 /hr	12.6/hr	1.4/hr

The EEZ Statistical Zones that were sampled over the duration of this project ranged from just west of Ft. Meyers, Florida to Brownsville, Texas. A breakdown of these zones and the number of tows sampled per zone are in Table 4.

Table 4. Number of Tows per Statistical Zone.

Stat Zone	Near Shore	Offshore
4	74	20
6	5	0
7	41	1
8	55	84
9	0	3
11	1	3
13	35	3
14	44	0
15	39	3
16	33	3
17	5	2
18	0	81
19	0	45
20	0	40
21	0	71
Total	332	359

The data indicate that 98% of the red snapper were captured in EEZ zones 18, 19, 20, and 21. These are all in Texas and there were 11,473 of the total 11,736 snapper caught in these zones, however, only 34% of the total tows for the project were represented in the data set from these zones.

Table 5. Number of Tows with Red Snapper per Statistical Zone.

Stat Zone	Near Shore	Offshore
4	5	10
6	0	0
7	0	0
8	8	20
9	0	1
11	1	2
13	0	3
14	0	0
15	0	2
16	0	3
17	0	2
18	0	81
19	0	42
20	0	39
21	0	66
Total	14	271

The majority of these tows were conducted from mid-July through mid-August during the Texas Opening. Numbers of captured snapper appear to gradually increase from mid-July until late September, peaking in early October. The number of snapper enumerated by statistical zone is presented in Table 6.

Table 6. Number of Red Snapper by Statistical Zone.

Stat Zone	Near Shore	Offshore
4	5	14
6	0	0
7	0	0
8	13	55
9	0	1
11	32	58
13	0	14
14	0	0
15	0	8
16	0	10
17	0	36
18	0	5869
19	0	1399
20	0	1156
21	0	3049
Total	50	11686

Data Analysis

To better estimate the impact that the commercial shrimp fishing industry has on the red snapper population, a virtual population analysis (VPA; e.g., "cohort analysis") was conducted on all observer collected red snapper bycatch data. Age-0 and age-1fish comprise the bulk (~99%) of red snapper shrimp trawl bycatch. To better define red snapper cohorts, all fish below 100 mm were considered age-0 fish and all fish less than 300 mm that are not age-0 were counted as age-1. Due to the continuous fishing practices (in time and space; with some time/area exceptions) of the shrimp fleet, the VPA must rely on natural mortality and population estimates for both age-0 and -1 fish. As such, mortality and population estimates derived from the most recent SEDAR-7 (Red Snapper) Assessment/Review Workshop were utilized. This ensured the robustness of the estimates used for, and results derived from, the analyses (i.e., all estimates have undergone extensive peer review prior to analysis).

To compute a total mortality (Z) estimate for age-0 and age-1 red snapper, catch-per-unit-effort (CPUE) by length and month data enabled the relative abundance of year classes over time to be computed. CPUE was converted to the number of fish caught per net per 10,000 hours. Effort was multiplied by the CPUE values to approximate bycatch by age, month, and region (e.g., statistical zone). From these data, survival was estimated and total mortality (Z) calculated using a Z estimate from all Foundation datasets, both past and present.

Project Management

Principal Investigator:

Ms. Judy L. Jamison	Executive Director

Foundation Staff:

Dr. Michael Jepson	Program Director
Ms. Gwen P. Hughes	Program Specialist
Ms. Charlotte L. Irsch	Grants Specialist Administrative Assistant

Regional and Field Coordinators:

Mr. Gary Graham	Gulf of Mexico Regional Coordinator Texas A&M University Sea Grant
Mr. Russell O'Brien	Field Coordinator (Observers and Vessels)

Data Management and Analysis:

Mr. Phil Diller	Data Manager
Dr. Benny Gallaway	Data Analyst

Fishery Observers:

Mr. Robert Timmeney
Mr. Konstantin Kopylov
Mr. Justin Arnold
Mr. Michael Gordon
Mr. J.L. Wiswell

Quality control and quality assurance responsibilities for the overall project administration and coordination were assumed by Judy Jamison and Dr. Michael Jepson out of the Foundation's office in Tampa, Florida. The Foundation's Executive Director has ultimate responsibility for all administrative and programmatic Foundation 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 consistent with NOAA/NMFS requirements. The Program Director had overall responsibility of the technical aspects of all Foundation projects, coordinated performance activities of all project personnel, including contractors. He also coordinated all analytical efforts and prepared all progress reports concerning project performance.

It is the responsibility of the Principal Investigator and Program Director to ensure that quality control and quality assurance were maintained for all aspects of this program. They regularly communicated with Observers and Coordinators concerning fieldwork and contacts with commercial fishermen to ensure that the proposed number of sampling days was met. They also reviewed the incoming data for completeness and accuracy. The Program Director monitored data management procedures to ensure that the analyses met the specified objectives outlined in the proposal.

The Grant/Contracts Specialist is 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 fiscal auditors in their reviews. She conducts/documents internal and program (single and desk) audits, prepares backup documentation for fiscal audits, and drafts award extension requests (if applicable). She provides the Executive and Program Directors with projected budgets concerning program performance and ensures that these budgets adhere to the proposed budget. Finally, she prepares the annual administrative budget, NOAA Financial Reports, and confirms compliance of all activities with NOAA/NMFS and OMB guidelines.

The Program Specialist, Ms. Gwen Hughes, is responsible for tracking programmatic activities, securing federal and state collection and experimental permits required for experimental testing, and individual scientific collection permits for contracted observers. She is also responsible for generating supporting documentation to assist in any and all programmatic audits. Ms. Hughes is responsible for the coordination of all program related workshops and auditing and paying program related invoices. She processes requests for reimbursement to conform with federal guidelines and prepares and maintains all subcontracts and amendments. Additionally, she is responsible for maintaining vessel insurance and verifies that all cooperators are maintaining worker's compensation coverage on their employees, if applicable.

The Administrative Assistant is responsible for receptionist/clerical duties, word processing, filing correspondence, dissemination of materials to industry (final reports, press releases, newsletter). She is also responsible for creating and organizing meeting files, processing invoices and maintaining cooperative program files.

The contracted personnel for this project have been associated with other, similar Foundation research projects and programs. Their continued involvement provided stability and allowed for a smooth progression into this project from both a management and performance perspective. Through years of experience, the Foundation has found that working with local Sea Grant Marine Extension Service Personnel is an efficient and rapid method to achieve communication and cooperation with local fishermen. The Regional Coordinators (1) acted as liaison between the Foundation and vessel owners, relaying information about project goals and securing vessel participation; (2) reviewed, with the Data Manager, Field Coordinator and Program Director, incoming data for completeness and accuracy; and (3) monitored observer and TED performance.

The Field Coordinator assisted the Program Director and Regional Coordinators with observer and vessel activities, including the recruitment, training and coordination of Fishery Observers in

the field. He also contacted and established a superior working relationship with the various cooperating vessel owners/captains that assisted in this project. The Field Coordinator also provided any and all assistance needed by the Fishery Observers. The quality of the data collected, and the procedures used to collect data, was assured through the use of highly qualified and knowledgeable Observers who had extensive experience in this line of study.

The Data Manager was responsible for checking and transferring all the collected raw data into a manageable computer database for analysis and archival at the Foundation and at NMFS Galveston Laboratory. Once the data were entered and archived, it was forwarded to the Data Analyst. The Data Analyst, with oversight by the Program Director and Coordinators, conducted all statistical analyses of observer-collected data. The observers were responsible for collecting accurate data according to established protocols.

Both internal and external monitors also supervised the performance of this project. As staff of the Foundation, the Board of Trustees, representing various commercial fishing and seafood interests throughout the southeastern United States, monitored the Principal Investigator's activities and performance. Just as importantly, the NMFS Program Office of the Southeast Regional Office, NOAA Grants Management, and a NMFS Technical Monitor, assigned by the NMFS Program Office, monitored the timely completion and achievement of planned project activities and objectives. Interim and final progress and financial reports were submitted by the Foundation to NOAA/NMFS. These reports allowed NMFS agency monitors to examine and track the successful completion of this project.

IV. Findings

A. Actual accomplishments and findings:

Following the collection and entering of observer data into the NMFS Observer data base, LGL conducted their analysis. A length-based, age-structured model was developed using length frequency data collected from the observer data in the Gulf of Mexico penaeid shrimp fishery from 1999 to 2006. Model results indicate that the age-0 red snapper fraction of the shrimp trawl bycatch in the first and third trimesters exceeds 90% and during the second trimester, the bycatch is more evenly split between age-0 (48%) and age-1 (52%) red snapper. The growth data suggest age-0 and age-1 fish form an opaque annulus in winter which is consistent with results found for older fish. The total mortality estimates for age-0 and age-1 red snapper were about 2.5 and 1.8, respectively. The natural mortality rate for age-0 red snapper based on this study is approximately double the value used in the last red snapper stock assessment. The evidence for the model with density dependence over the model with density independent mortality is overwhelming. Inclusion of these findings in the red snapper stock assessment has the potential to substantially alter management advice. The result of the analysis was submitted to the North American Journal of Fisheries Management in article form and is currently under review.

B. Problems Encountered

During late summer/early Fall 2005, the Gulf Coast of the Southeastern United States was severely impacted by hurricanes Katrina and Rita. These storms dramatically affected shrimp

fishing efforts within the Gulf of Mexico, thereby limiting the number of areas experimental treatments could be tested and the data collected by fishery observers. The devastation created by the hurricanes affected the entire seafood industry within the Gulf of Mexico, but especially the shrimp fisheries of Alabama, Louisiana, Mississippi, and Texas. Many vessels were washed onto land, sunk, or were unable to fish because of storm debris, loss of infrastructure and increased fuel prices. This affected the behavior of fishermen (avoidance of areas, and effort, vessels cannot leave the dock) and fishing effort in the Gulf. This natural disaster, in addition to the economic disaster (rising imports, lower prices and higher fuel prices) that had afflicted the industry prior to the hurricanes, added to an already bleak economic future. The impact of both disasters will have long term implications for the industry.

VII. Evaluation

A. Extent to which project goals were attained:

All project goals and objectives were met over the duration of this research, although there were delays as a result of the hurricane season of 2005. Through continuous monitoring and contact, observers were placed on board shrimp fishing vessels in the Gulf of Mexico and the necessary data were collected for the analysis. The final analysis show significant changes may be necessary for upcoming red snapper assessments and therefore may have a major impact on future assessments. Important findings include: 1) the shrimp trawl bycatch during the first and third trimesters is dominated (about 90%) by age-0 fish; 2) growth patterns of age-0 and age-1 fish suggests they form an opaque annulus in winter months; 3) natural mortality of age-0 fish appears to be about double the value used in the last stock assessment; and 4) density dependent juvenile mortality appears highly likely. Inclusion of these findings in the red snapper stock assessment has the potential to substantially alter management advice. Through industry involvement in placing ELBs and observers on board their vessels, fishermen have been able to participate in important research that may provide insight into new assessment modeling which may provide solutions to problems that plague the shrimp industry.

B. Dissemination of Project results:

Cooperating fishing vessels will be forwarded a copy of the Foundation's project Final Report. Copies will also be distributed to various federal and state fishery agencies and permitting offices, university extension/Sea Grant offices, and industry associations. Summary reports of the project's findings were published as part of the "Foundation Project Update" sections of the "Gulf and South Atlantic News", the quarterly publication of the Gulf & South Atlantic Fisheries Foundation, Inc. This newsletter, along with an updated listing of available Final Reports, is disseminated to over 500 organizations and individuals throughout the region. An electronic version (PDF) of the newsletter is also included in the regular updates to the Foundation's website (www.gulfsouthfoundation.org). In addition, an electronic copy of the final report will also be placed on the Foundation's website under Foundation Research.

The results of the analysis were submitted in article form to the North American Journal of Fisheries Management and are presently in press, but will appear in Volume No. 28.

Literature Cited

Gallaway, B.J., M. Longnecker, J.G. Cole, and R.M. Meyer. 1998. Estimates of shrimp trawl bycatch of red snapper (*Lutjanus campechanus*) in the Gulf of Mexico. Pages 817-839 in F. Funk, T.J. Quinn II, J. Heifetz, J.N. Ianelli, J.E. Powers, J.F. Schweigert, P.J. Sullivan, and C.I. Hang (Eds), Fishery Stock Assessment Models. Alaska Sea Grant College Program, Fairbanks, Alaska.

Gallaway, B.J. and J.G. Cole. 1999. Reduction of juvenile red snapper bycatch in the U.S. Gulf of Mexico shrimp trawl fishery. North American Journal of Fisheries Management. 19: 342-355.

Goodyear, C.P. 1995. Red snapper in the U.S. waters of the Gulf of Mexico. Southeast Fisheries Science Center, Miami Laboratory, Coastal Resources Division, Miami, Florida. Contribution: MIA-97/98-05. 171p.

Ortiz, M., C.M. Legault, and N.M. Ehrhardt. 2000. An alternative method for estimating bycatch from the U.S. shrimp trawl fishery in the Gulf of Mexico, 1972-1995. Fishery Bulletin 98(3): 583-599.

Nance, J.M. 2004. Estimation of effort in the offshore shrimp trawl fishery of the Gulf of Mexico. Report to red snapper SEDAR 7. SEDAR7-DW-24. 41p.

National Marine Fisheries Service. 2004. Red snapper data workshop report. SEDAR 7: Gulf of Mexico Red Snapper Technical Report, June, 17 2004, New Orleans, Louisiana. 88p.

Schirripa, M.J. and C.M. Legault. 1997. Status of the red snapper in the U.S. waters of the Gulf of Mexico. National Marine Fisheries Service, Southeast Fisheries Science Center, MIA-97/98-05, Miami.

Schirripa, M.J. and C.M. Legault. 1999. Status of the red snapper in U.S. waters of the Gulf of Mexico updated through 1998. National Marine Fisheries Serivce, Southeast Fisheries Science Center, SFD-99/00-75, Miami.

Appendices

Appendix A

94-01
LGL Final Report

Age Composition, Growth and Density-Dependent Mortality in Juvenile Red Snapper Estimated from Observer Data from the Gulf of Mexico Penaeid Shrimp Fishery

W.J. Gazey, B.J. Gallaway, J.G. Cole, and D.A. Fournier
LGL Ecological Research Associates, Inc.
Contract 94-01-59350/0

23April 2007

FINAL REPORT

I. REPORT TITLE, Etc:

Ia. Title: Age Composition, Growth and Density-Dependent Mortality in Juvenile Red Snapper Estimated from Observer Data from the Gulf of Mexico Penaeid Shrimp Fishery

Ib. Authors:	W.J. Gazey, B.J. Gallaway, J.G. Cole, and D.A. Fournier
Ic. Organizations:	LGL Ecological Research Associates. Inc.
	W.J. Gazey Research
	Otter Research Limited

Id. Grant Number:	GSAFF 94-01-59350/0

II. ABSTRACT:

Bycatch reduction devices were required to be installed in penaeid shrimp trawl gear in the Gulf of Mexico beginning in May 1998. Changes in observer protocols were introduced and one change was that all red snapper *Lutjanus campechanus* collected would be enumerated and measured where possible. This change has yielded catch and length information from the Gulf of Mexico penaeid shrimp fishery. An integrated approach for dealing with age composition, growth and mortality of juvenile red snapper has not yet been attempted. We constructed a length-based, age-structured model to objectively estimate growth and mortality parameters, and age composition of the shrimp trawl bycatch of red snapper in the western Gulf of Mexico from 81 monthly length-frequency data sets (a total of 239,521 fish were measured) over July 1999 to February 2007. Our specific objectives in modeling these data were to 1) estimate the age composition of the bycatch by year and trimester; 2) describe monthly or seasonal growth deviations from the mean trend; 3) estimate total apparent mortality; and, 4) evaluate the inferential evidence for density dependent mortality. Our model strategy was to make simple and straightforward representations of growth deviations, partial recruitment, density dependent mortality and population dynamics. Bayesian parameter estimation was accomplished through calculating the mode of the posterior distribution (maximum likelihood estimation). Important findings include: 1) the shrimp trawl bycatch during the first and third trimesters is dominated (about 90%) by age-0 fish; 2) growth patterns of age-0 and age-1 fish suggests they form an

opaque annulus in winter months; 3) natural mortality of age-0 fish appears to be about double the value used in the last stock assessment; and 4) density dependent juvenile mortality appears highly likely. Inclusion of these findings in the red snapper stock assessment has the potential to substantially alter management advice.

III. EXECUTIVE SUMMARY:

A length-based, age-structured model was developed using length frequency data collected by observers of the Gulf of Mexico penaeid shrimp fishery from 1999 to 2006. Model results indicate that the age-0 red snapper fraction of the shrimp trawl bycatch in the first and third trimesters exceeds 90% and during the second trimester, the bycatch is more evenly split between age-0 (48%) and age-1 (52%) red snapper. The growth data suggest age-0 and age-1 fish form an opaque annulus in winter which is consistent with results found for older fish. The total mortality estimates for age-0 and age-1 red snapper were about 2.5 and 1.8, respectively. The natural mortality rate for age-0 red snapper based on this study is approximately double the value used in the last red snapper stock assessment. The evidence for the model with density dependence over the model with density independent mortality is overwhelming. Inclusion of our findings in the red snapper stock assessment has the potential to substantially alter management advice.

IV. PURPOSE:

IVa. The Problem: Monthly catch rates and size information for red snapper taken as bycatch in the Gulf of Mexico penaeid shrimp fishery were not available for the SEDAR7 red snapper stock assessment. The Gulf and South Atlantic Fisheries Foundation, Inc. (GSAFF) conducted an observer program for the fishery to help gather such information. LGL Ecological Research Associates, Inc. (LGL) was contracted to conduct an analysis of all available observer data taken after 1998.

IVb. Objectives: The specific objectives were to: 1) estimate the age composition of the bycatch by year and trimester; 2) describe monthly or seasonal growth deviations from the mean trend; 3) estimate total apparent mortality; and, 4) evaluate the inferential evidence for density dependent mortality.

V. APPROACH:

Va. Description of Work: See manuscript in NAJFM.

Vb. Project Management:

Benny J. Gallaway (LGL): Managed overall project, responsible for overall design and interpretation.

John G. Cole (LGL): Database Manager.

William J. Gazey: Responsible for model analysis and interpretation.

VI. FINDINGS:

VIa. Actual Accomplishments and Findings: See manuscript in NAJFM.

VIb. Significant Problems: None.

VIc. Description of Need for Additional Work: It is critical to continue and expand the observer program for the Gulf of Mexico penaeid shrimp fishery.

VII. EVALUATION:

VIIa.1. Goals and objectives were obtained.

VIIa.2. No modifications of the original goals and objectives were made.

VIIa.3. Dissemination of Project Results: Results have been submitted to the North American Journal of Fisheries Management for publication.