MARINE FISHERIES INITIATIVE

MARFIN

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ST PETERSBURG, FL
Marine Fisheries Initiative Program

(MARFIN)

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National Marine Fisheries Service
State/Federal Liaison Branch
263 13th Avenue South
Southeast Regional Office
St. Petersburg, Florida 33701
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Cover Photo by Dax Ruiz
The Marine Fisheries Initiative (MARFIN) Program received its initial impetus from a 1983 discussion paper entitled: "Research Needs For Information Leading To Full and Wise Use of Fishery Resources In The Gulf of Mexico," by Dr. Thomas D. McIlwain of the Gulf Coast Research Laboratory while he was in the office of then Representative Trent Lott. This paper, sometimes referred to as the Lott-McIlwain paper, proposed an additional investment in fisheries research and development in the Gulf of Mexico to increase the economic contribution of marine fisheries, develop more valuable products from existing fisheries, develop export markets, forecast variation in yields, and conserve and maintain presently exploited resources.

The next step in the evolution of MARFIN was the preparation and publication of the Marine Fisheries Initiative - Gulf of Mexico Phase. This publication, developed by a joint industry, federal, state, and academic task force, detailed the research and development efforts necessary to enhance, restore, and maintain fisheries in the Gulf of Mexico. The program focused on funding projects that had the greatest probability of maintaining and improving existing fisheries, increasing revenues for the domestic industry, increasing yields from fisheries, and generating increased recreational opportunity and harvest potential. Projects were to be selected for funding on their likelihood of achieving these benefits through both short-term and long-term research with consideration of the magnitude of the eventual benefit that might be realized. Both short-term projects yielding immediate benefits and long-term projects were to receive high-priority emphasis. Planning emphasis was placed upon attaining priority goals either through a single project or a series of projects necessary to attain that goal.

In 1992, the MARFIN program was expanded to include a South Atlantic component (North Carolina, South Carolina, Georgia, and the Atlantic coast of Florida). The goals and objectives of the South Atlantic Phase of MARFIN are described in Special Report No. 13 of the Atlantic States Marine Fisheries Commission, Marine Fisheries Initiative (MARFIN) South Atlantic Phase.

The Lott-McIlwain paper and the Marine Fisheries Initiative publication were instrumental in gaining public support for the MARFIN program. On December 4, 1985, the conference report of the House and Senate that appropriated funds for the Departments of Commerce, Justice, State, the judiciary, and related agencies for the fiscal year (FY) ending September 30, 1986, allocated $2,850,000 for the MARFIN Program.

The following list represents funding for each year from the start of the MARFIN program until the current year:

* Fiscal Year 1986 - $2,850,000
* Fiscal Year 1987 - $3,500,000
* Fiscal Year 1988 - $3,500,000
* Fiscal Year 1989 - $3,000,000
* Fiscal Year 1990 - $3,000,000
* Fiscal Year 1991 - $2,986,000
* Fiscal Year 1992 - $4,000,000 (This includes $500,000 of the South Atlantic MARFIN and $1,300,000 for shrimp trawl bycatch studies.)

* Fiscal Year 1993 - $3,540,000

* Fiscal Year 1994 - $3,542,000

* Fiscal Year 1995 - $3,540,000

* Fiscal Year 1996 - $2,760,000 (No new projects were accepted during FY 1996 due to a reduction in congressional allocation, and because of the large number of active multi-year projects selected during previous funding cycles.)

* Fiscal Year 1997 - $3,000,000

* Fiscal Year 1998 - $3,000,000

* Fiscal Year 1999 - $3,000,000 (This includes $500,000 for the Northeast Region.)

* Fiscal Year 2000 - $2,750,000 (No new projects were accepted during FY 2000 due to a reduction in congressional allocation, and because of the large number of active multi-year projects selected during previous funding cycles.)

* Fiscal Year 2001 - $3,500,000 (This includes $250,000 for the Northeast Region and $750,000 for red snapper research.)

* Fiscal Year 2002 - $3,500,000 (This includes $250,000 for the Northeast Region and $750,000 for red snapper research.)

* Fiscal Year 2003 - $3,250,000 (This includes $250,000 for the Northeast Region and $500,000 for red snapper research.)

* Fiscal Year 2004 - $2,500,000

* Fiscal Year 2005 - $3,400,000 (This includes $250,000 for the Northeast Region and $750,000 for red snapper research.)

* Fiscal Year 2006 - $2,400,000

* Fiscal Year 2007 - $2,898,000 (This includes $750,000 for red snapper research.)

* Fiscal Year 2008 - $2,898,000 (This includes $750,000 for red snapper research.)

* Fiscal Year 2009 - $3,000,000 (This includes $750,000 for red snapper research.)

* Fiscal Year 2010 - $3,000,000 (This includes $750,000 for red snapper research.)

MARFIN promotes and endorses programs that seek to optimize economic and social benefits from marine fishery resources through cooperative efforts that evoke the best research and management talents of the Southeast Region. The intent of the MARFIN program is to focus projects on key fisheries issues in the southeast United States.

1Office of Representative Trent Lott, Washington, DC; Dr. Thomas D. McIlwain; May 1983

2Gulf States Marine Fisheries Commission, P.O. Box 426, Ocean Springs, MS 39564; J.Y. Christman, D.J. Etzold, T.D. McIlwain, L.B.Simpson, Eds. January 1985

Tuesday, April 6, 2010

8:00 am  Registration

8:30 am  Welcome & Conference Objectives

Mr. Buck Sutter  
Deputy Regional Administrator  
NOAA Fisheries, Southeast Region

Ms. Ellie F. Roche  
Chief, State/Federal Liaison Branch  
NOAA Fisheries, Southeast Region

SESSION I - Red Snapper: Session Chair - Mr. Mark Robson

8:45-9:05 am  Grant# NA05NMF4331070  
PI: Dr. Glenn Parsons  
Recipient: University of Mississippi  
Title: The effect of light and hydraulic regime on the behavior and swimming ability of dark adapted red snapper, Lutjanus campechanus: Its application to bycatch reduction

9:10-9:30 am  Grant# NA05NMF4331082  
PI: Dr. Donald Johnson  
Recipient: University of Southern Mississippi  
Title: Determination of the limiting effect of currents on distribution of red snapper populations in the Gulf of Mexico

9:35-9:55 am  Grant# NA06NMF4330054  
PI: Dr. Steve Szedlmayer  
Recipient: Auburn University  
Title: The use of ultrasonic telemetry to estimate natural and fishing mortality of red snapper, Lutjanus campechanus

9:55-10:25 am  Break
SESSION II - Reef Fish:  Session Chair - Mr. Larry Simpson

10:25-10:45 am  Grant# NA06NMF4330052
  PI: Dr. David Olsen
  Recipient: St. Thomas Fishermen's Association

  Title: Bycatch studies of reef fish in support of Caribbean Fishery Management Council preferred options for fishery management in St. Thomas, U.S. Virgin Islands

10:50-11:10 am  Grant# NA04NMF4330071
  PI: Ms. NoemI Peña
  Recipient: Puerto Rico Department of Natural and Environmental Resources

  Title: Bycatch study of the Puerto Rico's marine commercial fisheries

11:15-11:35 am  Grant# NA05NMF4331073
  PI: Mr. Jeffrey Rester
  Recipient: Gulf States Marine Fisheries Commission

  Title: Distribution of bottom habitat information in the Gulf of Mexico

11:40-12:00 pm  Grant# NA05NMF4331076
  PI: Dr. Mike Tringali
  Recipient: Florida Fish and Wildlife Conservation Commission

  Title: Using microsatellite DNA analysis to identify sources of recruitment for Florida's spiny lobster (Panulirus argus) stock

12:00 pm-1:30 pm  Lunch Break

1:30-1:50 pm  Grant# NA04NMF4330075
  PI: Dr. Bill Lindberg
  Recipient: University of Florida

  Title: Habitat selection and the performance of gag grouper across a range of hard bottom habitat in the northeastern Gulf of Mexico

1:55-2:15 pm  Grant# NA05NMF4331071
  PI: Dr. Debra Murie
  Recipient: University of Florida

  Title: Age, growth, and sexual maturity of greater amberjack in the Gulf of Mexico
2:20-2:40 pm  Grant# 07MFIH007  
PI: Ms. Linda Lombardi-Carlson  
Recipient: NOAA Fisheries, Panama City Laboratory  
Title: Validation of longevity, growth and production in reef fish and deep-water tilefish

2:45-3:05 pm  Grant# 08MFIH007  
PI: Ms. Loraine Hale  
Recipient: NOAA Fisheries, Panama City Laboratory  
Title: Essential data collection of tilefish and deepwater grouper using on-board observers for age-based estimates of mortality and reproductive potential

3:05 pm-3:20 pm  Break

3:20-3:40 pm  Grant# 08MFIH002  
PI: Ms. Jennifer Potts  
Recipient: NOAA Fisheries, Panama City Laboratory  
Title: Age and growth of SEDAR priority species of the snapper-grouper complex of the U.S. South Atlantic

3:40 pm  Wrap-up for Day 1 Presentations

Wednesday, April 7, 2010 - Continuation of the Reef Fish Session

8:00 am  Registration

8:30-8:50 am  Grant# NA06NMF4330050  
PI: Dr. Sean Powers  
Recipient: Dauphin Island Sea Lab  
Title: Evaluating species interactions in reef fish communities: The potential impact of red snapper (Lutjanus campechanus) on recruitment of vermillion snapper (Romboplites aurorubens)

8:55-9:15 am  Grant# NA06NMF4330056  
PI: Dr. Michelle Davis  
Recipient: Virginia Polytechnic Institute and State University  
Title: Incorporating protogyny into stock assessment models
9:20-9:55 am
Grant# NA05NMF4331075
PI: Dr. John Gold
Recipient: Texas A & M Research Foundation
Title: Development of DNA microsatellites for genetic applications in greater amberjack (*Seriola dumerili*) and other amberjacks of genus *Seriola*

Grant# NA04NMF4330074
PI: Dr. John Gold
Recipient: Texas A & M Research Foundation
Title: Population structure and genetic demography of red snapper in the Gulf of Mexico and development of genetic tools for population-genetic studies of lane, grey, mutton, and vermillion snappers

10:00-10:20 am
Grant# NA04NMF4330078
PI: Dr. Stephen Geiger
Recipient: Florida Fish and Wildlife Conservation Commission
Title: Is habitat availability limiting recruitment of calico scallops (*Argopecten gibbus*)?

**SESSION III - Essential Fish Habitat:** Session Chair - *Mr. James Franks*

10:25-10:45 am
Grant# NA05NMF4331078
PI: Dr. Ted Switzer
Recipient: Florida Fish and Wildlife Conservation Commission
Title: Size and age structure and catch and release mortality estimates of sub-adult and adult red drum in the Tampa Bay estuary and nearshore Gulf of Mexico waters

10:45 – 11:05 am
Break

11:05-11:25 am
Grant# NA05NMF4331080
PI: Dr. Bruce Comyns
Recipient: University of Southern Mississippi
Title: Studies on dolphin (*Coryphaena hippurus*) and greater amberjack (*Seriola dumerili*) in the northcentral Gulf of Mexico: early life history and recruitment of larvae and young juveniles to pelagic sargassum habitat
11:30-11:50 am  Grant# O8MFIH004  
*PI*: *Dr. Doug Devries*  
Recipient: NOAA Fisheries, Panama City Laboratory  
Title: A trap and stationary video survey of inner shelf hard bottom habitat in the NE Gulfof Mexico

**SESSION IV – Other:** Session Chair - *Mr. James Franks*

11:55 am -12:15 pm  Grant# NA07NMF4330125  
*PI*: *Ms. Judy Jamison*  
*Dr. Benny Galloway will be presenting*  
Recipient: Gulf and South Atlantic Fisheries Foundation, Inc.  
Title: Reduction rates, species composition, and effort: assessing bycatch within the Gulf of Mexico shrimp trawl fishery

12:15 pm-1:45 pm  **Lunch Break**

1:45-2:05 pm  Grant# 07MFIH011  
*PI*: *Mr. Dominy Hataway*  
Recipient: NOAA Fisheries, Pascagoula Laboratory  
Title: Investigating the potential for modified circle hooks with wire appendages to reduce hook ingestion rates in incidentally captured sea turtles

2:10-2:30 pm  Grant# NA05NMF4331079  
*PI*: *Dr. Manoj Shivlani*  
Recipient: University of Miami  
Title: Examination of non-fishery factors on the welfare of fishing communities in the Florida Keys: A focus on the cumulative effects of trade, economic, energy, and aid policies, macroeconomic (county and regional) conditions, and coastal development on the Monroe County commercial fishing industry

2:30-2:50 pm  **Summary and Conclusions - Mr. James Franks**

Adjourn the Eighteenth Annual MARFIN Conference
SESSION I – Red Snapper

Session Chair: Mr. Mark Robson
Study Objective: We examined and recorded the behavioral and swimming responses of red snapper, *Lutjanus campechanus* to a number of environmental stimuli (i.e. illumination, flow quality, moving pattern, sound, magnetic fields, etc.). The most promising behavioral responses were used in designing bycatch reduction devices that were tested in the Gulf of Mexico shrimp fishery.

Methods and Materials: Red snapper juveniles, ranging in size from about 30 to 250 mm SL were trawl collected from the northern Gulf of Mexico shrimp grounds and transported to the laboratory at the University of Mississippi. Using the optomotor response, snapper were found to be sensitive to light levels as low as 0.00797 foot candles and displayed an optomotor response at levels as low as 0.551 foot candles. Snapper were found to respond to an angled surface by moving to the lowest point in the test tank. In studies on the effect of illumination on snapper's ability to exit a laboratory test chamber, fish were found to exit more quickly with greater illumination and the greatest percentage of fish that successfully exited was observed at the highest level of illumination. Additionally, we observed that the best position for placement of illumination in the test tank, was downstream of the escape opening. In studies to examine the effect of changing flow quality, snapper were found to exit a test chamber in greater numbers when flow was interrupted by a curved interruptor (as opposed to a flat one). Snapper did not respond in any consistent or observable way when subjected to sounds of 10 Hz to 20kHz nor did they respond to dolphin vocalizations. Likewise, there was no obvious response to magnetic fields. Considering the above observations we incorporated alteration in flow quality and illumination into a bycatch reduction device and tested this device on board a Gulf of Mexico shrimp trawler. The nested cylinder bycatch reduction device (NCBRD, Figure 1) excluded total finfish at rates of from 37 to 54%, excluded snapper at rates of about 21% and retained about 81 to 94% of shrimp. We found that extending the inner cylinder further into the cod end increased shrimp retention but also resulted in poorer bycatch reduction. Illuminating the device did not provide significantly increased total fish bycatch reduction. However, an illuminated NCBRD reduced snapper bycatch at a rate of about 42% whereas an un-illuminated device reduced snapper at a rate of about 13%.

Conclusions and Recommendations: The NCBRD is effective at overall bycatch reduction (40 to 50% reduction) but illumination does not seem to improve over-all bycatch reduction. Illumination does improve red snapper bycatch reduction. Use of the NCBRD will result in reduced mortality of trawl captured fin fish including red snapper. It is possible that illumination of BRD's already in service in the shrimp fishery may significantly reduce red snapper bycatch.
The application of illumination to reduce red snapper bycatch in BRD's already in service in the Gulf shrimp fishery, is an area of investigation that may result in significant dividends.

Figure 1. The Nested Cylinder Bycatch Reduction Device. A continuous escape opening is created by nesting the end of the trawl inside of the cod end. Flow blocking plates create a "flow shadow" ahead of the escape opening and attract fish toward the exit.
Study Objective: To determine the patterns of dispersal of red snapper (*Lutjanus campechanus* Poey) larvae in the Gulf of Mexico and to evaluate the potential for reestablishment of populations in depleted areas by planktonic transport processes.

Methods and Materials: Near-surface current observations from a large number of programs in the northern Gulf of Mexico (nGOM) were collected and synthesized into a gridded field of currents that extended southward to 26°N. The currents were temporally and spatially smoothed to daily currents based on year day. Archived model currents were also obtained from a data assimilative operational nowcast/forecast model and synthesized into gaps in the gridded observational data field.

From the SEAMAP Ichthyoplankton Data Base, dates and locations of red snapper larval capture were extracted along with larval size statistics. Using the field of currents, computer propagules were tracked from the year day and locations of the captures for a planktonic larval duration of 31 days. In addition to this base level of dispersion, a number of computer experiments were done to establish the potential for larval transport across alongshore topographic impediments (Mississippi Delta, DeSoto Canyon, and Apalachicola Peninsula). Additional experiments were done in collaboration with the Naval Research Laboratory-Stennis to examine the effect of hurricanes on dispersal. A program using a computer model to determine red snapper larval dispersion from Campeche Banks is in the final stages.

Conclusions and Recommendations: Dispersal from the SEAMAP capture locations showed a broad larval dispersion, especially west of the DeSoto Canyon. Average distance traveled was 125 km with a maximum displacement of 486 km. However, east of DeSoto Canyon and especially east of the Apalachicola Peninsula, there was little flux of larvae from the more abundant western stocks.
Since the capture data in SEAMAP were neither seasonally nor geographically uniform, additional experiments were conducted to determine if sampling biases influenced dispersion and if there was a potential for topographic impediments to isolate basins. Launching propagules from the SEAMAP locations every 3 days for the entire spawning season (May-Oct), showed larger flux into the basin formed by the DeSoto Canyon and the Apalachicola Peninsula, otherwise, the results were similar to the base experiment. From topographic experiments, it was found that flow past the Mississippi Delta occurred in both directions, but not symmetrically. Westward flow occurred during non-summer spawning months (Sep/Oct), following a path close in to the Mississippi River outflow and ending in suitable habitat on the Texas/Louisiana shelf. However, eastward flow into the Mississippi Bight occurred during summer months (Jun-Aug), following a path along the upper continental slope and ending in deep water along the western wall of the DeSoto Canyon, away from suitable juvenile habitat. Larval flux across the head of the DeSoto Canyon was not impeded in either direction. Flux across the Apalachicola Peninsula was also strongly asymmetric. Under non-summer winds, westward flux was readily accomplished, however under summer winds, eastward flow was deflected southward along the outer shelf of peninsular Florida (into the 'Green River'). This left the Big Bend area from Tampa Bay to the Apalachicola isolated from influx of larvae from the abundant western stocks.

Joining with the Naval Research Laboratory – Stennis Space Center, the effect of large storms on larval dispersion was also examined. The archived results from an operational nowcast/forecast model run during the time of hurricanes Ivan (2004), Katrina (2005) and Rita (2005) were applied to propagules starting at the SEAMAP capture locations and run from 3 days before the hurricane to 3 days afterward. Unexpectedly, in all three cases, there was a counter-clockwise displacement around the continental shelves of the nGOM. The average displacement was 112.5 km. A flux of larvae occurred from the Mississippi Bight onto the Texas/Louisiana shelf. Larvae in the Big Bend area were displaced into the Mississippi Bight. The Big Bend area received larvae from the Tampa Bay area. Instead of an eastward flux from the more abundant western stocks, large storms had the opposite effect.

Although not part of our original proposal, a study was made of red snapper dispersion from the Campeche Banks using eight years of archived results from an operational nowcast/forecast model. Good retention was seen over the Banks, with spreading along the narrow western shelf to the west Texas shelf during summer. Relatively good success, measured by arrival into shelf waters shallower than 200 m, was also seen in dispersion to the southern end of peninsular Florida (South of Saratoga) via the Loop Current. Spreading into the northeastern GOM occurred rarely and appeared to be tied to special events: hurricanes and flattened Loop Current.

Our conclusions are:

1. There is gene mixing over the entire Gulf.
2. Larval flux from abundant western stocks (or from Campeche Banks) to eastern stocks is highly limited.
3. The red snapper population from Apalachicola to Tampa Bay is most likely recruitment limited.
The Use of Ultrasonic Telemetry to Estimate Natural and Fishing Mortality of Red Snapper, *Lutjanus campechanus*

MARFIN Grant No. NA06NMF4330054

Funding Amount: $301,136 Federal ($61,985 non-Federal)

Stephen T. Szedlmayer and *Darin Topping*

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**Study Objectives:** The main objective of this study was to use ultrasonic telemetry to estimate the mortality rates (fishing and natural) of red snapper, *Lutjanus campechanus*, in the northeastern Gulf of Mexico. Also, we estimated long-term (remote automated monitoring) and fine-scale (manual tracking) residency, site fidelity, seasonal movements, diel movements, and home range of red snapper associated with natural and artificial reef habitats.

**Methods and Materials:** Telemetry methods were used to estimate mortality rates for large (500 – 860 mm TL) red snapper (*N* = 87) from December 2005 to October 2009 in the northeastern Gulf of Mexico. At five separate sites (one natural and four artificial reefs) an array of five receivers was deployed with one receiver at the center (near the reef) and four receivers placed 1100 m north, south, east, and west of the reef site. These arrays enabled the direct estimation of fishing mortality, natural mortality, and emigration of red snapper fitted with ultrasonic transmitters. Kaplan-Meier (K-M) event analysis was used to estimate survival from fishing and natural mortality events. Survival was then converted to instantaneous mortality rates: mortality = -ln(survival over 365 days).

Event analysis was also used to estimate site fidelity and residence to the reef sites, based on right censoring fishing and natural mortality. Right censoring is simply the removal of fish from calculations due to emigrations and mortalities. Patterns of seasonal movements were determined from long-term detections of fish at each site. Fine-scale diel movements and home range estimates were based on the continuous 24-h manual tracking of fish at study sites from a surface vessel, with fish locations recorded every 30 min.

**Conclusions and Recommendations:** Telemetry methods were successful in identifying mortality and emigration at all study sites. Of the 87 fish released: 70 remained at the site through a 7-d post-release recovery period, 19 were caught, 10 died naturally, and 28 emigrated from the 12.6 km² study sites. Estimates of total mortality (*Z*) ranged from 0.43 to 0.50, fishing mortality (*F*) from 0.30 to 0.38, and natural mortality (*M*) from 0.12 to 0.22. Annual fishing mortality estimates reflected changes in fishing regulations, i.e., mortality decreased with shorter
fishing periods and lower bag limits: $F = 0.80$ (2006), $F = 0.25$ (2007), $F = 0.14$ (2008), and $F = 0.14$ (2009). The overall mortality rates were similar to past estimates and provide the first direct estimates of mortality rates for red snapper.

Telemetry methods were also successful at estimating site fidelity and movements of red snapper at reef sites. Site fidelity and residence times of red snapper in the present study were greater than any previous study. Median residence time was 588 d, ranging from 1 to 1020 d, with 76% of all marked fish resident for at least one year at particular sites. Several fish ($N = 9$) that emigrated from marking sites returned to their original sites after periods of absence up to 7 months. Two fish showed quick (< 5 h) directed movement to other telemetry sites 6-8 km away and established long term residence (weeks to months) at the new sites, and one of these repeated this pattern four times between its original tagging site and another telemetry site.

Red snapper ($N = 9$; 550 - 745 mm TL) were also manually tracked at artificial reefs over continuous 24-h periods. Most fish stayed near (< 80 m) the artificial reef over these 24-h periods with 80% of locations within 30 m of the structure, but fish were significantly further from the reef at night (mean = 26.0 m) compared to daylight periods (mean = 16.1 m). Also, significant positive relations were detected between fish size and home range size, and between fish size and mean distance from the reef. The close proximity of these fish to the reef over 24 h and the long-term residency estimates provide evidence that these artificial reef structures are important habitat for red snapper.

The telemetry methods used in this study clearly provided a fishery independent method of estimating movement and mortality that is much more accurate than traditional tagging methods. We recommend that telemetry methods continue to be used to estimate critical mortality and movement rates for red snapper and other ecologically and economically important reef fish species.
SESSION II – Reef Fish

Session Chair: Mr. Larry Simpson
Study Objectives: The project goal was to design and test an effective approach for collecting bycatch information from St. Thomas' commercial fishermen. The effort was intended to supply needed data to guide management planning by the USVI Territorial government and the Caribbean Fishery Management Council (CFMC).

Project objectives included quantifying bycatch species, determining reasons for discard, and estimating bycatch mortality rates for the primary St. Thomas commercial fisheries. The project built upon findings from an earlier port-sampling study with a significant increase in sample size. An additional objective was assessing seasonality for the various bycatch species as a means to judge whether recent CFMC seasonal closures resulted in increased regulatory discards during the closed seasons.

Methods and Materials: Fishermen were provided with “trip ticket” forms in which they recorded bycatch species and numbers as well as details regarding their fishing activities, i.e., gear, landings, locations/depths. Participating fishermen were paid for their involvement to compensate for the additional time required for detailed reporting. The data were input into a database and the results compared to prior port-sampling based studies and to mandatory monthly trip reports submitted to USVI Dept. of Fish and Wildlife/NMFS. Geographic aspects of the data set were analyzed using GIS techniques.

Conclusions and Recommendations: The study exceeded expectations; total expected sample sizes were exceeded by 50% and fishermen accepted reduced payments in order to continue participation throughout the full annual cycle. Study participants made 46% of all St. Thomas reported fish and lobster trap trips, 27% of the hand-line trips and 48% of the seine trips. The results, therefore, are considered representative of the St. Thomas commercial fisheries.

Based on a total sample of 1854 fishing trips and 306,666 lbs landed, the study participants reported a total of 144,461 bycatch individuals from a total of 95 taxa. Number of bycatch species varied by fishery: 72 species in the fish trap bycatch, while the lobster trap fishery reported 12 species and the hand-line fishery reported 14 species and the seine net fishery reported 32 species. Reasons for discards also varied somewhat by fishery although the possibility of Ciguatera poisoning from certain species was common for all.
The **fish trap** fishery reported a total of 104,827 fish (72.6% of all fisheries’ bycatch) from 73 different taxa as bycatch; a bycatch rate of 1.74 fish per trap haul. Nine species accounted for 93.8% of the bycatch with 38% made up of small boxfish and 23% by small surgeonfish. Species posing a risk of Ciguatera poisoning (*L. apodus* and *C. ruber*) constituted 12% of the discards. Non-commercial species (*D. holocanthus*, *C. striatus*, and *S. plumieri*) made up 10.5% and spiny lobsters and small commercial species the remainder.

A total of 24,440 individuals from 48 taxa were reported as **lobster trap** bycatch; 9 species made up 94.6%. The species mix was similar to that seen in fish traps although regulatory discards of spiny lobsters (under size and females with eggs) dominated the mix with 53% of the total. The bycatch per trap haul (0.59 individuals/trap haul) was about 36% that of fish traps.

A total of 3,736 individuals were reported as **hand line** bycatch: bycatch rate of 9.1 fish per trip, 53 taxa, 89.5% made up of 17 species. Many fish were discarded because of risk of Ciguatera poisoning including *C. latus*, *L. apodus*, *C. ruber*, *M. niger*, *S. barracuda*, *C. lugubris*. Mortality rate was high. A total of 11,297 individuals were reported as **seine net** bycatch: 46.5 fish per trip, thirty two taxa, 96.1% from 11 species.

Species-specific mortality rates in fish traps ranged from zero to eighty percent. Alternative means to reduce mortality of species like *Chaetodon* spp. and *Acanthurus* spp such as trap escape vents are being investigated in cooperative research between NMFS and STFA.

Other findings included delineation of the fishing zones and depth ranges for the various commercial fisheries, documentation of regulatory discards, assessment of the accuracy of reporting on Territorial catch reports, and validation of direct reporting by fishermen as a valid and useful tool in local fisheries management. More direct collaborative involvement by fishermen in data collection design is warranted for improving management of their fisheries. This study has replaced conjecture regarding bycatch rates, species, and mortalities with actual data. The successful completion of the study has led STFA members to their own discussions of trap reduction and increased research participation.
Bycatch Study of the Puerto Rico's Marine Commercial Fisheries

MARFIN Grant No. NA04NMF4330071

Funding Amount: Federal $77,811 (Non-Federal $27,932)

By

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Study Objective: The objective of this project is to describe the Puerto Rico’s commercial fishery bycatch in their biological, economical and social aspects. The commercial fishing gears don’t discriminate between target species and those that live in close association with it. Puerto Rico did not have any study of the bycatch, thus this study it is needed urgently. The goals of this project are: determine the magnitude of bycatch, obtain information about most used fishing gears in Puerto Rico where bycatch occurs at any scale, commercial fishers will participate directly in this project, for bycatch fisheries species biostatistics data will collected, determine the catch mortality by gear of any fishery resource in the bycatch, evaluate all different fishing gears in order to reduce the impacts of bycatch and recommend conservation and management measures to minimize bycatch.

Methods and Materials: Select commercial fishers of different type of fishing gears (fish traps, trammel nets, beach seine and hand lines) to be contracted to collaborate with the project and work with the DNER. Personnel of the project will travel 30 trips per gear to collect independent data. This includes identifying fishing bycatch by species level, obtain length (fork length in mm) and weight (g) and account the bycatch number by species caught. Collect the biostatistics data from the commercial total landing by species and by weight. For every trip collect the following fishing gear information: size of the gear, soak time, fishing time, depth and CPUE. All data will be entered using Microsoft Access and data analysis will include bycatch composition by gear in order to make recommendations to reduce or eliminate bycatch.

Conclusions and Recommendations: The data collected shows that every gear has their own bycatch characteristics. A total of 10 shellfish species and 95 fish species were considered bycatch, including illegal size and no target species. Fish traps that target spiny lobsters and trunkfishes shows approximately 33% of their total catch weight was bycatch. However, 21 of 48 bycatch species reported (44%) were commercial and easily marketed. The others bycatch individuals were used as bait to attract lobsters. On the other hand, trammel nets that targeted
lobsters and trunkfishes, approximately 50% of the total catch were bycatch. A total of 30 species composed the bycatch for this gear, 40% of the mentioned species were commercial and easily marketed. Beach seine reported only 17% of the total weight caught as bycatch. A total of 35 species were reported and 20 species were commercial, although were too small to be marketed. Hand lines reported that only 20 percent of the total catch was considered bycatch and 100% of the catch was easily marketed and/or use as bait. The bycatch in Puerto Rico could be considered low in species and number of individuals, also is important to consider the geographic area when marketing the fish. However due to the overfished resource is important to reduce current bycatch. The recommendation made will improve the fishery resource resulting in better socioeconomics conditions to commercial fishers and will help to recover fish stocks. The following recommendations are given: The DNER and NMFS should educate all commercial fishers to return alive juveniles to the sea when possible, DNER should eliminate the use of the beach seine to reduce the juveniles fishing mortality, reduce the time soak (12 hours) for the trammel net, for trap fishers educate them to use only dead fishes as bait or attractors and the implementations of new regulations (DNER Fishing Regulations 6768) like closed season and minimum legal size and the law enforcement for this regulations. Finally is important to continue bycatch data collection.
Distribution of Bottom Habitat Information in the Gulf of Mexico

MARFIN Grant No. NA05NMF4331073

Funding Amount: $210,621

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Study Objectives: Objectives of the study were to develop a user friendly interactive system that identifies, describes, and displays resources characterizing the seabed habitat of the Gulf of Mexico.

Materials and Methods: In order to accomplish the goals of the project as well as provide technical expertise, a fourteen member committee was formed with expert representatives from the academic community and federal and state agencies. They were tasked with defining the different habitat types that should be considered for the project, the appropriate types of datasets to be evaluated, the protocols to be used to evaluate data obtained from each gear type, and helping monitor and review the work of the contractor. The database was created from the recovery, interpretation, and integration of existing data for the Gulf of Mexico. The project created a geodatabase of bottom habitats on the continental shelf and slope of the Gulf of Mexico. The project built upon the U.S. Geological Survey's usSEABED project in that it contains a compilation of published and previously unpublished sediment texture and other geologic data about the seabed from diverse sources. The project is based upon using the dbSEABED processing system developed by Dr. Chris Jenkins of the University of Colorado. The dbSEABED system is able to produce a unified mappable database from the multitude of data dealing with the seabed. The purpose of the dbSEABED system is to produce integrated data on the seabed that can be mapped, analyzed, and visualized. Data can be incorporated from a variety of sources with various sampling techniques. Data from grabs, cores, probes, photographs, videos, geophysics, and soundings can be incorporated across common themes. These data may be numeric based textural, acoustic, geochemical, and geophysical data or verbal descriptions of grabs, cores, or photographs. Data also may be a combination of any of these techniques.

The dbSEABED system holds the data in their original values and produces standardized output data. One feature of dbSEABED is its ability to use word based descriptive data such as "fine sand with shells; seagrass with pebbles; whiff of hydrogen sulfide". The ability to handle word based data greatly extends the power of the system to map the seabed, because on a global average, approximately 85% or more of data characterizing the seabed are word based. The
outputs of dbSEABED are fuzzy memberships of parameters such as mud, grain size, carbonate, organic carbon, grain type, sedimentary features, rock and weed coverage, and engineering strengths.

Dr. Jenkins was hired as a contractor to collect and input data for project. He began the data gathering process with a trip around the Gulf of Mexico to meet with researchers. The meetings helped identify existing and potential data sources. If data were immediately available, he obtained copies of the data while on site. Additional data sources were also identified and researchers were contacted about including their data. He also performed literature searches to identify pertinent data. After data were collected, they were imported into dbSEABED. The results were then combined into a geodatabase.

Conclusions and Recommendations: Two different point sample datasets are contained within the database. The first is the WWD dataset which holds the numeric integrated results from the original data sources. The WWD dataset is the most mappable and comprehensive form of GIS-ready output from dbSEABED. It represents all the samples with values which have passed quality controls. This is the primary data product of the project. Parameters in the WWD data include such things as gravel, sand, mud, and clay content, grain size, Folk code, percentage carbonate, Munsell code, shear strength, and porosity. The CMP dataset includes a table of integrated data on grain components and features of the substrates. Geologists and others frequently describe the presence and abundance of components in a sediment, like shell debris, quartz, heavy minerals, etc. They do this by grain counts or in their descriptions. The dbSEABED processing system assesses the abundances of these components and outputs them in the CMP file. Many of the parameters in the CMP dataset have significance in habitat mapping. For example, the CMP dataset list things such as biogenic rhodoliths, Halimeda, shell or coral debris, the minerals glauconite, phosphate and hydrate, and features such as ripples, seagrass and hydrogen sulfide. The values within these attribute fields range between 0 and 100.

As a result of this study, there are approximately 230,000 seabed observations in the WWD dataset and approximately 47,000 observations in the CMP dataset. The geodatabase is comprised of feature datasets, raster datasets, tables, and metadata documents for the project. The WWD and CMP datasets represent the seabed sampling locations and their substrate attributes. Also delivered were cut down versions of the files with null values removed for certain parameters such as clay, gravel, sand, and mud. These datasets were created to allow for proper grids to be produced for these parameters quickly and easily. The contractor also developed grids computed from the point feature datasets for the most useful attributes such as gravel, mud, sand, and rock. These can be used to estimate seabed characteristics at locations between the actual sampling point data.
Study Objectives: The primary goal of the project was to acquire information on the stock structure and sources of recruitment for the Florida spiny lobster (Panulirus argus) stock using microsatellite DNA analysis. Our specific objectives were as follows: (1) Using microsatellite DNA analysis, identify the source(s) of recruitment of the Florida P. argus stock by examining the genetic structure of P. argus adults and postlarvae collected from Florida and throughout the Caribbean basin; (2) Using microsatellite DNA analysis, compare the genetic structure of postlarval P. argus recruiting to the Florida Keys to adults to examine whether or not there are genetically-based differences in post-settlement survival; (3) Using microsatellite DNA analysis, evaluate whether or not the source(s) of recruitment of the Florida stock vary temporally by examining the genetic structure of the monthly cohorts of P. argus postlarvae recruiting to nearshore Florida waters.

Methods and Materials: In a genetic survey of population connectivity in the spiny lobster, 14 microsatellite DNA loci (including 10 de novo markers) were used to genotype specimens from 21 locations throughout U.S. and Caribbean waters. Approximately 2,000 post-larvae specimens were obtained in monthly collections from two FL Keys locations and genotyped at these markers.

Conclusions and Recommendations: In the adult survey, significant differences in sample allele frequencies were observed between 57 of the 210 tested pairs. Strong departures from HWE were observed in seven of the 14 loci. Although the overall value of $\theta$ (0.00018) did not differ significantly from zero, relatively high $\theta$ values were observed between some sample pairs. There was also evidence of spatial structure among these populations in factorial correspondence analyses and in a Bayesian analysis of population genetic metrics. In a survey of postlarval specimens from Big Munson and Long Key, FL, significant temporal variation was observed between specimens collected monthly from these locations, suggesting that they are an admixture of multiple recruitment sources. Although, the recruitment sources could not be identified, the data were inconsistent with high levels of local or self-recruitment. That is, the postlarval cohort could not be genetically assigned to the sample of adult lobster collected simultaneously from those locations. Estimates of effective population size for the postlarval
cohort, based on linkage disequilibrium over multiple loci, were high. Overall, our results indicate that spiny lobster populations are highly interconnected in terms of gene flow in locations along the coastal United States and throughout the Caribbean. However, significant allele-frequency differences, fixation-index trends, and spatial clustering of genotypes among some samples provide evidence for partial-self recruitment at some locations. Regional monitoring and assessment, as well as cooperative management over the range of the species are needed.
Habitat Selection and the Performance of Gag Grouper
Across a Range of Hard Bottom Habitat in the Northeastern Gulf of Mexico

MARFIN Grant No. NA04NMF4330075

Funding Amount: $290,160 Federal ($246,784 non-Federal)

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Study Objective: To characterize hard-bottom habitat features on the shallow continental shelf of the northeastern Gulf of Mexico, and examine the generality of previous experimental results for pre-reproductive gag (Mycteroperca microlepis). Two hypotheses were examined: (1) Gag abundance depends on habitat quality that is a function of physical reef architecture, and (2) Gag performance (condition and growth) versus reef architecture is a density-dependent function in which maximum performance occurs at intermediate reef architectures.

Methods and Materials: Seafloor surveys with high resolution 600 kHz side-scan sonar covered almost 13,000 hectares and identified a range of physical habitat complexities. This involved in situ ground-truthing by scientific divers and photo-interpretation of side-scan imagery. Imagery from ~25% of the surveyed area, deemed most complex, yielded 255 hard-bottom features classed as low and high complexity on relative 5-point scales (L1-L5 and H1-H5). Forty sampling sites were selected across that range. Landscape metrics were rugosity ratios from in situ measurements, and feature perimeters, areas and perimeter-to-area ratios from imagery digitized in ArcGIS 9.2. Gag abundance by size class was counted by underwater visual census along 10m x 80m strip transects, followed by collections for measures of metabolic rate by ETS assay, marginal increments from otoliths, and relative weight, Wn, from lengths and weights.

Conclusions and Recommendations: Gag abundances among sampling sites were generally much lower than expected, and precluded statistically fitting the hypothesized functions with the sample sizes attainable (N=15 and 20 sites over two consecutive years, with only 135 and 129 gag censused, respectively). Instead, a logistic regression model predicted the presence of gag
with rugosity increasing and feature area decreasing (i.e. smaller complex features). Trends in metabolic rates and relative weights were also consistent with what would be expected for sites under persistent direct fishing pressure. Metabolic rates tended to increase with greater variation on more complex sites and higher gag counts, while relative weights trended in the opposite direction. Implications of these findings include caution about habitat suitability indexes that require an underlying Ideal Free Distribution and a concern for hyperstability issues in the gag fishery. This project, while inconclusive in many respects, laid a foundation for expanded efforts to quantify gag EFH on the shallow continental shelf and to incorporate that into fisheries independent monitoring of female gag entering the spawning stock.
Age, Growth and Sex Maturity of Greater Amberjack (*Seriola dumerili*) in the Gulf of Mexico
MARFIN Grant No. NA05NMF4331071

Funding Amount: $134,785 Federal ($64,046 non-Federal)

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**Study Objective:** To determine age and growth, and age and size of sexual maturity, of greater amberjack (*S. dumerili*) in the Gulf of Mexico. Specifically: 1) to collaborate with federal and state agencies to collect and process otoliths to age greater amberjack throughout its range in the Gulf of Mexico by fishery/gear; 2) to establish aging criteria and ageing validation based on sectioned otoliths; 3) to compare aging between otoliths and fin rays, as an alternative non-lethal aging method; 4) to determine age and size at sexual maturity; and 5) to model and construct age-length keys for use in age-structured stock assessments, specific to region, fishery, and gear.

**Methods and Materials:** In cooperation with state and federal fisheries agencies in the southeastern U.S., a total of 1,838 greater amberjack were sampled in 1989-2008 for both length and age. All fish were measured for fork length (FL) and sagitta were extracted for aging. Aging criteria were set through identification of the core and validation of the aging method; then checked with known readers for the South Atlantic stock. Ages and growth of greater amberjack were modeled and compared for major fisheries in the Gulf of Mexico, including charterboat, private recreational, headboat, and commercial. Fish smaller than the legal size limits were primarily sampled through UF-Fisheries research sampling. In addition to sampling amberjack for otoliths, a subsample of amberjack in 2006-2008 had pectoral finrays removed for aging to develop both a quicker method of port-sampling these large fish, as well as a non-lethal aging method for this species for future tag-and-release studies.

Gonads were collected for a subsample of 769 amberjack, either by UF-Fisheries research sampling or through collaboration with the Louisiana Department of Wildlife and Fisheries. Gonads were weighed whole, visually inspected for sex determination and reproductive stage, and a subset was processed for histological analysis. Spawning season was identified through the maximum gonadosomatic index and maturity ogives were modeled based on proportion of mature females during the spawning season.
Conclusions and Recommendations: Greater amberjack otoliths were aged with relatively high precision, with between-reader agreement of 89% overall and 100% agreement within ±1 year. The aging coefficient of variation was 2.3% and the average percent error was 1.6%, again both indicating high aging precision. The core, first annulus and second annulus of the otolith were consistently identified in age classes up to at least 8 years. Identification of annuli, including the first, was supported by a consensus view held by three other expert readers. The otolith aging method was validated using marginal-increment analysis (growth at the edge of the otolith) with deposition of the opaque zone in the annulus occurring during April to August.

Comparison of ages assigned using finrays versus otoliths indicated that finrays were a precise aging method for amberjack over age classes ≤5 years. Agreement was 91% for perfect agreement, and 100% for agreement ±1 year, with average percent error of 7.8%. Lin’s correlation coefficient was 0.908 ± 0.086, indicating that the relationship between otolith and finray ages was not different from 1:1, and with further development for older fish the method could be accurate as an alternative aging method for greater amberjack.

Greater amberjack in the Gulf of Mexico ranged in size from 74 to 1829 mm fork length and in age from young-of-year to 15 years of age. Length frequencies were truncated at the lower end by minimum length limits of the various fisheries, with the exception of the UF-Fisheries research samples. Male amberjack ranged from 74 to 1394 mm FL and females from 180 to 1772 mm FL (1829 mm FL fish was unsexed). The majority of fish caught in private and charterboat fisheries were 2, 3 and 4 years of age, headboats caught primarily 3 year old fish, and commercial fisheries also landed a majority of 3 and 4 year old fish.

Comparatively, growth of greater amberjack based on length at observed age was similar for private, charter, and headboat fisheries. Growth of amberjack landed in the commercial fisheries was larger at age for fish 2-4 years, reflecting a greater minimum size regulation. Amberjack caught in UF-Fisheries sampling were smaller at age than amberjack sampled in any other fisheries. When growth comparisons were restricted to only fish >711 mm FL (28 inch), to be comparable to amberjack landed in the recreational fisheries, then the mean lengths at age of the fish were similar to amberjack landed in charterboat, headboat, and private recreational fisheries. Although based on a relatively small sample size, this indicated that amberjack caught in the recreational fisheries are the fastest-growing component of the cohorts.

Amberjack were only slightly sexually dimorphic in size, with 2, 4 and 5 year old females larger at age than males. Gonadosomatic index and histological examination of gonads indicated that greater amberjack from the northern and eastern Gulf of Mexico had a peak spawning period during March and April during 2006-2008. This spawning period was similar to that of the South Atlantic stock of greater amberjack, which spawns off the Florida Keys in March to early May. Approximate 50% maturity in females occurred between 850 and 900 mm FL, which was larger than amberjack sampled from the South Atlantic spawning stock (719-745 mm FL). Age of 50% maturity for female greater amberjack in the Gulf of Mexico was between 3 and 4 years of age compared to 1.3 years for the South Atlantic stock. Potentially, this difference may be due to sampling biases and interpretation of resting, but mature, females (i.e., skip spawners).
Validation of longevity, growth and production in reef fish and deep-water tilefish

MARFIN Grant No. 07MFIH007

Funding Amount: 55,912 (Federal)

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Study Objectives: To validate the timing of band deposition in sagittal otoliths from golden tilefish (Lopholatilus chamaeleonticeps) by radiometric ageing through the use of the natural decay of lead (\(^{210}\text{Pb}\)) and radium (\(^{226}\text{Ra}\)).

Methods and Materials: Both sagittal otoliths were collected from a large size range of golden tilefish. To reduce the bias of annual fluctuations in the natural decay of lead (\(^{210}\text{Pb}\)) and radium (\(^{226}\text{Ra}\)), all otoliths were collected in the same year and from the same approximate location. Otoliths were cleaned, dried, and weighed (to the nearest 0.0001 g). One of each pair of sagittal otoliths was interpreted for patterns of growth increments (band). Sagittal otoliths were sectioned using a Hillquist thin sectioning saw, and sections were viewed and digitally imaged to visually determine patterns. One of each pair of sagittal otoliths was cored to the first few years of growth by grinding the whole sagittal otolith by hand. The whole otolith weight from the youngest fish determined the ideal weight for the cored samples. At least 0.10 g of core material was removed from each otolith. Otolith cores from the same age group and sex were pooled and submitted for radiometric analysis. The \(^{210}\text{Pb}\) and \(^{226}\text{Ra}\) activity levels were estimated from cores using isotope-dilution thermal ionization mass spectrometry. \(^{210}\text{Pb}\) and \(^{226}\text{Ra}\) activity levels for the age groups were plotted with the expected \(^{210}\text{Pb}:^{226}\text{Ra}\) activity ratio as an indication of age estimate accuracy.
Conclusions and Recommendations: Golden tilefish thin sectioned otoliths were difficult to interpret given several different shapes of otolith sections and diverse patterns of growth deposition. Agreement between radiometric age and estimated age from growth zone counts was good for some sample groups and markedly different from what was expected for other groups. Young female and the older unknown sex age groups were largely in agreement, but the oldest male age groups were not in agreement by approximately a decade. These findings provided some support for the age estimation methodology, but also elucidated potential problems with the age estimation of males and sexual dimorphism in otolith growth. These data may indicate that otolith growth zones in sectioned otoliths from males need to be counted in a different manner relative to otoliths from females. Lead-radium dating indicated the otoliths of some males may accrete at a rate that is close to half as much as some females. Work is currently being performed to gain a better understanding of the reproductive life history of golden tilefish. There is evidence that hermaphroditism is exhibited, but not by all members of the population.
Essential data collection of tilefish and deepwater grouper using on-board observers for age-based estimates of mortality and reproductive potential

MARFIN Grant No. 08MFIH007

Funding Amount $134,000

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Study Objectives: To obtain at-sea biological samples for tilefish and deepwater grouper to characterize commercial long-line catch by age and sex.

Methods and Materials: Representative scientific samples of the tilefish and deepwater bottom longline fleets were obtained by randomly selecting vessels generated from the Coastal Fishery Logbook database and landing records from the years’ previous fishing season. Once the permit holder receives the selection letter, the owner/operator was required to make contact with the observer coordinator and to indicate intent to fish during the upcoming fishing season. If the permit holder intended to fish, the observer coordinator deployed an observer to the port of departure. Vessels were required to pass a Coast Guard Vessel Safety Examination as well as a safety evaluation by the observer prior to coverage. Contracted observers were trained prior to deployment on vessels to record detailed information concerning gear characteristics, location and time the gear is set and retrieved, environmental conditions, status and action of the marine life caught by the gear (alive or dead, kept or discarded), as well as morphometric measurements (length and weight) and sex identification of each animal. Collections of biological samples from tilefishes and deepwater groupers were performed at sea. Otoliths and gonads were removed from randomly selected specimens. Otoliths were stored in envelopes while gonads were fixed in a solution of 10% formalin until the vessel returns to port and samples were processed at the Panama City Laboratory.
Conclusions and Recommendations: There were 147 hauls on 7 trips observed targeting grouper/snapper or grouper/tilefish in the Gulf of Mexico for a total of 81 sea days. Vessels fished mostly in the eastern Gulf of Mexico. The mainline length ranged from 7 to 19 km with an average of 11.2 km. The bottom depth fished ranged from 33.5 to 160.5 m with an average of 99.7 m, and the number of hooks ranged from 180 to 2300 hooks with an average of 1135 hooks fished. Circle hooks sized 13.0 were the most common hook utilized (32.7% of hauls). Two different hook sizes were used 14.3% of the time; all hooks used were circle hooks. The average soak duration (the time from when the last hook entered the water until the first hook was hauled back) was 2.0 hr. There were 10,253 individual animals caught; teleosts comprised 86.1% of the catch, followed by sharks (12.0%), invertebrates (1.8%), and batoids (0.04%). Yellowedge grouper, *Epinephelus flavolimbatus*, was the most frequently caught species of teleost (37.7%), followed by blueline tilefish, *Caulolatilus microps* (20.6%). A total of 673 otolith and/or reproductive samples were taken from 12 grouper and tilefish species, with the majority of samples taken from yellowedge grouper and blueline tilefish. Of the otolith samples taken, more than half (56%) have been aged. Length measurements were taken of all fish sampled and a range of lengths obtained. Although fishery closures and limited funds prevented further observer coverage, the otolith and reproductive samples from these species are invaluable sources of at-sea reproductive data that is otherwise unobtainable due to the normally gutted condition of landed fish.
Study Objectives:

- Age U.S. South Atlantic reef fish species on the SEDAR schedule for 2008 including vermillion snapper
- Participate in an age workshop on vermillion snapper with partner agencies to assess consistency on ageing methodology for this species
- Receive and log age samples for U.S. South Atlantic snapper-grouper complex species collected by NMFS port agents and various state agencies

Methods and Materials: A total of 15,482 vermillion snapper otoliths were collected from recreational and commercial fisheries operating between 1975 and 2007. The otoliths were sectioned on a low speed saw, adhered to glass slides, and analyzed under a dissecting microscope to determine the age of each fish.

An age workshop was held with South Carolina Department of Natural Resources (SCDNR), and a set of 600 sectioned otoliths were exchanged to assess between-lab ageing consistency. From these data, an ageing error matrix was created for use in the stock assessment model.

All age structure samples sent to us from NMFS fishery monitoring programs and various state agencies were logged into our in-house data base. Any missing, incomplete, or erroneous data will be rectified if possible. The samples were sorted by species and stored for future studies. Sources for samples include NMFS TIP, NMFS Headboat Survey, North Carolina Division of Marine Fisheries commercial sampling program, SCDNR commercial sampling program, Florida Fish and Wildlife Commission sampling program, as well as various fishery-independent studies.

Conclusions and Recommendations: Of the 15,482 otolith samples collected from vermillion snapper, 8,876 were selected for processing due to time constraints and excessive sampling from some fisheries and ports. A total of 8,621 (97%) of the processed otoliths were assigned ages. These samples were combined with 6,769 ages from SCDNR Marine Monitoring and Prediction (MARMAP) fishery-independent program and 1,170 ages from a thesis study by J. Potts (1997) for inclusion in SEDAR 17 South Atlantic vermillion snapper stock assessment. Total lengths ranged from 118 – 635 mm, and ages ranged from 1 - 19 years.

NMFS Beaufort Laboratory and SCDNR participated in an ageing workshop for vermillion snapper. Both labs were using similar methodology for processing the otoliths. Some questions were raised regarding first annulus, but for the majority of the samples, personnel from both labs agreed on what structure was first annulus. Both labs provided two readers and
exchanged 600 samples for analysis. Sixty percent of the readings were in agreement, and 95% were within ± 1 year. Overall average percent error (APE) was 8.32%, which is comparable to the APE (8.4%) reported by personnel ageing vermilion snapper from the Gulf of Mexico. There was no apparent reader bias for one lab or another. Ageing error matrices were created based on the exchanged samples.

Vermilion snapper do not have a strong length-at-age relationship, thus making it difficult to model growth (figure 1). There were no discernable differences in growth between the Carolinas and Florida, though there was some evidence that larger older fish inhabit deeper water. The minimum size limits on the fisheries exclude smaller, but not younger fish in the population, which makes the samples from the MARMAP survey very valuable. The von Bertalanffy growth model for all data provided to SEDAR 17 was \( L_t = 506(1 - e^{-0.12(t+3.5)}) \).

Samples from 2002-2007 were the most inclusive of all fisheries, areas, and fishery-independent sources. From these data, a strong year class from 2001 was detected in the 2004 – 2007 age frequencies.

In conclusion, comprehensive sample collection needs to continue from all fisheries, gears and areas, as well as fishery-independent monitoring throughout the region. As many fish captured in the various fisheries need to be aged to truly characterize the catches. For a species that does not have a strong correlation of size with age, analysis needs to be done as to how many samples is enough to characterize the population. Also further research needs to be conducted to determine if larger, older fish inhabit deeper water and if more fine scale regional differences in growth do exist.

Figure 1. Total length at age of vermilion snapper caught in the U.S. South Atlantic recreational and commercial fisheries and fishery-independent surveys. Black circles = fishery-dependent samples; Yellow diamonds = fishery-independent samples.
Evaluating species interactions in reef fish communities: Potential impact of red snapper (*Lutjanus campechanus*) on vermillion snapper (*Rhomboplites aurorubens*).

**MARFIN Grant No. NA06NMF4330050**

Funding Amount: $192,338

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Recognition that improved fisheries management will require a more ecological framework has led to the broad mandate to incorporate ecosystem level interactions that influence populations of species into traditional fisheries management plans. As efforts succeed in restoring troubled fishery stocks, it remains unknown if recovery efforts of one stock will have negative effects on others. Here, we test if red snapper (*Lutjanus campechanus*) impact vermillion snapper (*Rhomboplites aurorubens*) and other reef inhabitants by applying top-down pressure on the system. We examined stomach contents of red snapper and vermillion snapper to examine the direct impact of reef predators on vermillion snapper. To test indirect effects, we examined predator-prey relationships on an artificial reef designed to control for depth, habitat quality, predator abundance while taking into account predator diversity and the presence of adjacent reefs. We found that red snapper and vermillion snapper each prey upon juvenile vermillion snapper; however, the frequency of occurrence was low enough to suggest that the direct effects of red snapper and vermillion snapper on juvenile vermillion snapper is negligible. Results suggest that red snapper may have a strong indirect effect on vermillion snapper if preferred depth preferences are indicative of indirect effects. Red snapper were found in more shallow waters while vermillion snapper were in deeper waters. Additionally, regardless of depth, when red snapper abundances exceeded a threshold level, vermillion abundance dropped close to zero. Additional examination of community structure showed that abundance of juvenile fish and benthic organisms was not influenced by depth, habitat quality, predator abundance, predator diversity, or adjacent reefs. Examination of individual juvenile and benthic species showed that depth, fishing pressure, and abundance of a small pelagic fish species may be influential in structuring the reef community.
Incorporating Protogyny into Stock Assessment Models
MARFIN Grant No. NA06NMF4330056

Funding Amount: $135,353 Federal

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Study Objectives: Many harvested species off the Atlantic US coast are protogynous hermaphrodites and change sex from female to male during their lives. However, the effects of this important life history trait on sustainability and harvest are rarely investigated. In this study, our primary goal was to develop population models for red porgy (Pagrus pagrus) and black sea bass (Centropristis striata) that incorporated protogyny. This allowed us to evaluate the role of protogyny in susceptibility to overharvest and to compare population-level impacts of different management approaches for these species.

Methods and Materials: We conducted individual-based model simulations for red porgy and black sea bass under a range of harvest approaches and levels. In these simulations, fish were subjected to natural mortality, harvest mortality, and discard mortality; growth in length and weight; maturity and protogynous sex transition; and production of gametes, fertilization of eggs, and recruitment. We investigated the impacts of external stock-level factors (sex ratio, male abundance, and male biomass) on sex transition rate and the resulting changes to simulated populations. To determine whether protogyny increased the susceptibility to overharvest, we also modeled a non-sex changing (gonochoristic) population that was otherwise identical to the protogynous population. For all simulations, we monitored sex- and maturity-specific biomass and abundance in both the simulated population and harvest.

Conclusions and Recommendations: We found that simulated protogynous populations were more susceptible to overharvest than simulated gonochoristic populations, under all management scenarios we investigated for both red porgy and black sea bass. We found no evidence of sperm limitation at the levels of fishing mortality that we modeled, and the number of eggs produced was the limiting factor for population growth. The biggest females produced the most eggs, but, in a protogynous population, females changed sex before reaching large sizes. External population-level factors affecting transition rate had only minimal impact on population trends or productivity.

Since eggs were the limiting factor for simulated red porgy and black sea bass populations, the best management approach was one that harvested the fewest females: a minimum size limit. To be sustainable, the minimum size limit needed to be set at a length that was larger than the length at which 50% of the females become male. Red porgy experienced a relatively high release mortality (35%), so a highly restrictive size limit still resulted in
significant loss of females. Ideally, fishing effort should be reduced to effectively manage a species like red porgy that has a high discard mortality rate.

Expanding these modeling results to other protogynous species in the South Atlantic, we were able to estimate susceptibility to overharvest based on population parameters. High natural mortality rate (black sea bass, red grouper, and yellowfin grouper), high discard mortality rate (gag grouper and red porgy), late maturity (black grouper and gag grouper), and early sex transition (black sea bass and red porgy) all increased a species’ susceptibility to overharvest. Species at highest risk included black sea bass, black grouper, red porgy, and yellowfin grouper.

For species in which eggs are believed to be the limiting factor (like red porgy and black sea bass), we recommend that stock assessments evaluate status of females; male biomass and abundance are unlikely to impact the population trajectory. In this type of stock, a minimum size limit would be the most effective management approach, since an appropriate length limit would lead to a harvest of predominantly males. For species in which eggs may not be the limiting factor (like black grouper and gag grouper, potentially), assessing and monitoring male biomass and abundance becomes much more important. If large males are necessary for mating aggregations and successful fertilization, quotas or slot limits might be suitable management approaches. By tailoring assessment and management to the biological characteristics of these protogynous species, we will improve our ability to sustainably harvest these fish.
Development of DNA microsatellites for genetic applications in greater amberjack (*Seriola dumerili*) and other amberjacks of genus *Seriola*

**MARFIN Grant No. NA05NMF4331075**

Funding Amount: $101,714 ($23,764 non-Federal)

John R. Gold

Center for Biosystematics and Biodiversity
Texas A&M University
College Station, Texas 77843-2258

**Study Objective:** To develop 25-30 polymorphic microsatellite DNA markers specific for greater amberjack (*Seriola dumerili*). Optimization of experimental conditions for assay of the microsatellites was a key experimental objective.

**Methods and Materials:** Methods employed followed routine procedures in the PI's laboratory. Tissue samples of greater amberjack caught off of John's Island, South Carolina, were kindly provided by R. Chapman.

**Conclusions and Recommendations:** A total of 31 nuclear-encoded microsatellites from genomic DNA libraries of greater amberjack were isolated and characterized. The microsatellites include 25 perfect (five tetranucleotide, eight trinucleotide, and 12 di-nucleotide) and six imperfect (three tetranucleotide, one tri-nucleotide, one combination dinucleotide-trinucleotide, and one di-nucleotide) repeat motifs. The number of alleles at the 31 microsatellites among a sample of 29 fish ranged from two to 25; gene diversity (expected heterozygosity) ranged from 0.068 to 0.950, while observed heterozygosity ranged from 0.069 to 0.966. Following Bonferroni correction, genotypes at all 31 microsatellites fit expectations of Hardy-Weinberg equilibrium and only one pair-wise comparisons of microsatellites deviated significantly from genotypic equilibrium. The microsatellites developed will be useful for population genetic studies of 'wild' populations of *Seriola* in U.S. waters and for breeding studies of domesticated populations. Additional research included in this project was the design and implementation of multiplexed PCR primers for mtDNA sequences that allow rapid and unequivocal identification of each of the four species of *Seriola* in the U.S. Atlantic.
Publications:


Population structure and genetic demography of red snapper in the Gulf of Mexico and development of genetic tools for population-genetic studies of lane, gray, mutton, and vermilion snappers

MARFIN Grant No. NA04NMF4330074

Funding Amount: $276,233 ($71,574 non-Federal)

John R. Gold

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**Study Objectives:** Utilize nuclear-encoded microsatellites to (1) assess population structure and gene flow (migration) of age-0 red snapper (*Lutjanus campechanus*) in the northern Gulf of Mexico, and (2) estimate effective population size (*N_e*) across the sampling surface. (3) Develop suitable population-genetic tools for assessment of stock structure and genetic demography in lane snappers, gray snappers, mutton snappers, and yellowtail snappers.

**Methods and Materials:** Methods were those routinely used in the PI's laboratory to assay genotypes at microsatellites (red snapper) and generate 'new' microsatellite markers (lane, gray, mutton, and yellowtail snappers). Young-of-the-year (age-0) red snapper were sampled in 2004 and 2005 during fall groundfish surveys by the National Marine Fisheries Service. Sampling was conducted by trawling on benthic habitats offshore of Brownsville (Texas), Port Aransas (Texas), Freeport (Texas), along the western coast of Louisiana, and along the coastline of the Mississippi-Alabama border (Figure 1). Only fish less than 125 mm total length were selected for genetic analysis. Sampling was restricted to age-0 fish to examine temporal stability of spatial genetic patterns. Sample sizes (2004/2005) in each region were 110/100 (Brownsville), 105/103 (Port Aransas), 103/103 (Freeport), 103/102 (Louisiana), and 104/110 (Mississippi-Alabama). Samples were obtained from multiple tows in each region. Samples of lane and gray snapper were obtained by angling from Fort Myers, Florida, and Tequesta, Florida; samples of mutton and yellowtail snappers were obtained at recreational fishing docks in Key West, Florida. Additional samples of both lane and gray snappers were obtained from multiple sources across the northern Gulf of Mexico.

**Conclusions and Recommendations:** Hierarchical analysis of molecular variance of samples of red snapper revealed genetic heterogeneity among habitat patches within regions but not among regions. A significant, positive spatial autocorrelation of microsatellite genotypes among fish sampled within a geographic range of 50 - 100 km was detected. Bayesian coalescent analysis of historical demography indicated a decline of nearly an order of magnitude in effective population size for red snapper across the area surveyed. The highest posterior probability for current effective population size was 2,163, approximately four orders of magnitude smaller than
estimates of red snapper census size. Results of the study demonstrate that spatial genetic structuring among young-of-the-year red snapper in the Gulf occurs at small geographic scales and are consistent with a metapopulation stock-structure model of partially connected populations. This accentuates the importance of maintaining healthy local spawning populations of red snapper in all regions across the northern Gulf. PCR primer pairs were developed from genomic DNA libraries of lane snapper (*Lutjanus synagris*), gray snapper (*L. griseus*), mutton snapper (*L. analis*), and yellowtail snapper (*Ocyurus chrysurus*). The microsatellites include 24 perfect (21 dinucleotide and three trinucleotide) and one imperfect (combination tetranucleotide-tetranucleotide) repeat motifs. Multiplex panels were developed for lane (15 loci) and gray snappers (14 loci). Additional research included in this project was a geographic survey of spatial genetic variation among samples of both lane and gray snapper across the northern Gulf of Mexico and at one locality along the east (Atlantic) coast of Florida. Genetic analysis of lane snappers revealed two very distinct (genetic) groups: a Western Group that included six localities from the northwestern and north-central Gulf and an Eastern Group that included three localities, one from the west coast of Florida, one from the Florida Keys, and one from the east (Atlantic) coast of Florida. Genetic analysis of gray snappers revealed weak but significant divergence among three distinct groups: one from the northwestern Gulf, one from the north-central/northeastern Gulf, and one from the east coast of Florida. Spatial autocorrelation analysis of microsatellite genotypes revealed an isolation-by-distance effect among samples from the northern Gulf. The evidence of genetically distinct stocks in both lane and gray snappers in U.S. waters has implications for management of these resources.

**Publications:**


Is Habitat Availability Limiting Recruitment of Calico Scallops (*Argopecten gibbus*)?  
MARFIN Grant No. NA04NMF4330078

Funding Amount: $106,140 Federal ($0 non-Federal)

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**Study Objectives:** To determine if: 1) there are significant differences in the distribution of calico scallops or relict shell between seasons or years within each area, or between east and southwest coastal areas; 2) there are significant differences between present and historic estimates in the distribution and abundance of relict shell on the east Florida shelf; 3) there are significant differences in the frequency of occurrence of the pathogenic ciliate protozoan *Marteilia* spp. between seasons or years within each area, or between east and southwest coastal areas.

**Methods and Materials:** Dredge surveys were conducted during four seasons on each coast. The Cape Canaveral fishing zone was sampled during November 2004, April-May 2005, October 2005, and July 2006. The near shore southwest Florida shelf was sampled during October 2004, September-November 2005, April 2006 and August-September 2006. A sample grid of four latitudinal zones with 60 cells in each zone was established on each coast on historic fishing grounds. Dredge samples collected from 15 randomly selected cells in each season and each zone were processed to determine total catch, calico scallop abundance and weight, calico scallop spat (bysally attached juveniles) abundance and settlement substrate, calico scallop shell weight, non-scallop shell weight, and the abundance and weight of live animals to the lowest practicable taxon. Live calico scallop samples were retained and preserved for histological examination to determine infection intensity.

**Conclusions:** Our findings suggest that the Cape Canaveral calico scallop bed currently has a similar spatial extent to historic records, and that calico scallops are seasonally abundant and are associated with shell deposits. The southwest Florida scallop bed is limited in extent and abundance, but calico scallops are more widely distributed on Florida’s Gulf of Mexico continental shelf than previously described. Rocks and hard bottom were common on both coasts and we tentatively identified 243 taxa.

The total catch in east and west coast samples was similar, as was catch in all four east coast zones. On the west coast, the total catch off the coast of Sanibel Island was heavier than other areas. There was significant seasonal variation. Adult scallops were most abundant in the summer cruise samples, less abundant in the two fall cruises, and essentially absent during
spring. This pattern was observed on both coasts. On the east coast, spat (and other juveniles; < 20 mm shell height) were most commonly found on scallop shells, but were also found loose, on other shells, rocks and trash. Shell from other molluscs was 1.75 times as abundant as scallop shell. On the west coast, spat were most common on other mollusc shells but were also found loose, on rocks, and on calico scallop shells. Shell from other molluscs was 20 times as abundant as scallop shell. Calico scallop spat were present at higher than expected frequencies on calico scallop shell, relative to other available substrates.

Over the course of our eight cruises, we rarely captured commercial size scallops, those over 40 mm. Parasitic infection of a presumed protozoan (*Marcellia* sp.), which has been implicated in 1990s population crashes, was detected in every animal inspected. Stage 5 animals, where pathologies are observed, were common. It is possible that infections by *Marcellia* are truncating the life span and maximum size of calico scallops, resulting in reduced commercial value of this fishery.
SESSION III – Essential Fish Habitat

Session Chair: Mr. James Franks
Size and age structure, and catch-and-release mortality estimates of sub-adult and adult red drum (*Sciaenops ocellatus*) in the Tampa Bay estuary and nearshore Gulf of Mexico waters

**MARFIN Grant No. NA05NMF4331078**

Funding Amount: $399,302 Federal ($0 non-Federal)

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**Study Objectives:** The harvest of red drum throughout the Gulf of Mexico is currently managed under restrictive size and bag limits to assure that adequate numbers of immature red drum survive to maturity and recruit into adult populations in nearshore gulf waters. The objectives of this study were to describe the size and age structure of sub-adult and adult red drum in Tampa Bay and in nearshore gulf waters, determine the catch-and-release mortality and the sizes of released red drum captured in Tampa Bay, track ontogenetic changes in habitat use from upper estuary nursery areas to lower estuary habitats to nearshore gulf habitats, and utilize available data to estimate the escapement of red drum in the west-central region of Florida.

**Methods and Materials:** A commercial spotter-pilot and purse seine vessel were hired to locate and capture schools of adult red drum in the nearshore Gulf of Mexico waters outside of Tampa, Florida. Aerial surveys were normally 2 hours in duration and were conducted during the late summer and fall months to coincide with the fall spawning season. When a school of red drum was sighted, the spotter-pilot contacted the purse vessel captain to encircle the fish with their gear. A sub-sample of ~100 red drum was kept from each purse seine set. Retained fish were iced immediately and transported back to the laboratory where they were weighted, measured, and sexed. Additional samples were taken from each fish including gonad tissues, muscle tissue for mercury content analyses, fin clips for genetic analyses, stomach contents for dietary analyses, and sagittal otoliths for aging. Ages of red drum were determined using observed annulus counts and then adjusted to their age on October 1 of the calendar year in which they were sampled.

Catch and release mortality experiments were conducted in Tampa Bay, and study sites were selected based upon the presence of preferred habitat and sufficient numbers of red drum confirmed by previous hook-and-line sampling crews. Nine total field experiments were conducted; five on shallow seagrass beds near the inter-bay peninsula in upper Tampa Bay, three in the Alafia River and associated creeks in upper Tampa Bay, and one in seagrass beds on lower Tampa Bay. A large nylon-mesh net pen was deployed for each experiment and used to hold the captured fish. Red drum were collected using conventional spinning tackle to best mimic the existing recreational fishery for this species in Tampa Bay. In addition to various physiochemical metrics, a variety of catch and handling-associated metrics were recorded to identify potential factors contributing to observed mortalities. All red drum were measured and
tagged externally with a Hallprint dart tag with the exception of every fifth individual that was not tagged to serve as a control for evaluating effects of tagging on short-term survival. All red drum were held in the main holding pen for a minimum of 48 hours. Logistic regression analysis was used to determine whether variables significantly affected the probability of mortality or deep-hooking (throat or gut hooked).

To examine ontogenetic movement of red drum, red drum were tagged externally with Hallprint dart tags. Tagged individuals were either recaptured through routine sampling by FWC personnel or by recreational anglers reporting recaptured individuals. Geographic coordinates at the point of recapture and lengths were recorded for all individuals recaptured through FWC sampling. Recapture data were summarized to assess the relationship between days at large, distance traveled, and direction of movement.

Fish age and date-of-capture information obtained from individuals collected during this study as well as ongoing monitoring efforts within Tampa Bay were used to estimate the birth date of subadult and adult red drum collected from the Tampa Bay estuary and nearshore Gulf of Mexico waters. Existing estimates of red drum young-of-the-year (YOY) abundance were used to identify years of peak YOY recruitment into the Tampa Bay estuary and assess whether strong recruitment classes persisted into subadult and adult populations, indicating survival and escapement of red drum from estuarine to nearshore coastal adult habitats.

**Conclusions and Recommendations:** An examination of size- and age-structure of red drum collected in nearshore gulf waters off of Tampa Bay indicated that red drum stocks are continuing to recover following significant reductions in fishing pressure initiated during the late 1980s. A total of 821 adult red drum were collected from nearshore Gulf of Mexico waters off Tampa Bay ranging in length from 674 to 1,074 mm TL, and from 3 to 35 years of age. The size and age structure of red drum in nearshore gulf waters has changed significantly over the past decade in comparison with similar work conducted in the late 1990s.

Catch-and-release mortality experiments indicated that discard mortality rates for red drum in Tampa Bay were comparable to those reported in other similar studies. A total of 251 red drum were collected during nine different experiments, of which 14 individuals died within 48 hours, for an overall average mortality rate of 5.6%. Logistic regression analyses indicated that both temperature and hook position significantly influenced the probability of mortality, and that J-hooked fish were more likely to be deep-hooked.

A total of 3,889 red drum were tagged and released, of which 414 individuals were subsequently recaptured, for an overall recapture rate of 10.6%. Results from mark-recapture studies indicated that most red drum (69%) were recaptured within the general area within which they were originally tagged. Among individuals that moved, most exhibited ontogenetic movement towards lower Tampa Bay and nearshore gulf waters.

Comparisons of data obtained during the current study with data collected by routine monitoring of juvenile red drum populations within Tampa Bay indicated that strong year classes of juvenile recruitment persisted into adult populations from nearshore gulf waters, and that these juveniles are surviving to maturity. By tracking survival of strong recruiting classes of red drum, this study verifies the benefits of continued monitoring of these fish in Florida gulf waters.
Studies on Dolphin (Coryphaena hippurus) and Greater Amberjack (Seriola dumerili) in the Northcentral Gulf of Mexico: Early Life History and Recruitment of Larvae and Young Juveniles to Pelagic Sargassum Habitat

MARFIN Grant No. NA05NMF4331080

Funding Amount: $222,046 Federal ($62,040 non-Federal)

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Study Objective: Provide information on the early life history of common dolphin (dolphin) and greater amberjack (amberjack) in the northcentral Gulf of Mexico, and to develop an understanding of recruitment processes of these two species to pelagic Sargassum habitat in the region.

Methods and Materials: Fieldwork was conducted aboard the research vessel Tommy Munro in the vicinity of the continental shelf-break in the northcentral Gulf of Mexico. Five cruises were conducted between May 2005 and May 2008. Cruises were conducted during May and June because peak spawning of both dolphin and amberjack occur during this time. Three primary gear types, 1x2 m neuston net, 60 cm bongo net, and neuston net used to "scoop" clumps of Sargassum, were used equally in this study. Collections were taken at a variety of Sargassum features including through scattered, isolated clumps, under scattered clumps, adjacent to windrows, beneath the center of a windrow, and at open water "control" sites. Taxonomic characters were developed to identify larval greater amberjack, and illustrations of a size-series of young juvenile and larval amberjack as small as 2.4 mm in length were completed. Identifications were verified using genetic analyses. Larvae and young juveniles were aged using daily otolith growth increments. These growth increments could be observed in whole otoliths of amberjack larvae, but for juvenile amberjack and all dolphin, otolith growth increments could only be clearly observed in otolith cross-sections.
Conclusions and Recommendations: Dolphin larvae were as abundant in open water control locations as they were near Sargassum habitat, whereas amberjack were statistically more abundant in collections at Sargassum habitat. Growth rates of dolphin larvae based on otolith analyses were faster near Sargassum habitat than in open water. This comparison could not be fully assessed for amberjack larvae because of the relatively few amberjack collected in open water. Dolphin larvae grew faster than larval amberjack, and these increased growth rates may have lowered predation mortality rates of dolphin larvae in open water environments.

Amberjack collected at open water sites were relatively small (2.5-6.6 mm), suggesting that these young fish had not yet recruited to Sargassum habitat and that there was a higher mortality rate of amberjack larvae in open water than in the vicinity of Sargassum habitat. Only larger juvenile amberjack were collected at isolated clumps of Sargassum. These fish probably had been associated with larger accumulations of Sargassum that had become dispersed during rough seas. We originally thought that amberjack larvae might utilize isolated clumps as a microhabitat until the clumps became advected to larger accumulations of Sargassum, but this is unlikely because no small larvae were found at isolated clumps. Our results suggest dolphin larvae that find Sargassum habitat grow quicker; however, their biological traits, including fast growth rates, allow them to survive better in the open water habitat compared to amberjack. Unlike dolphin, the survival of larval amberjack appears to be heavily influenced by the availability of Sargassum habitat.
A Trap and Stationary Video Survey of Inner Shelf Hard Bottom Habitat in the NE Gulf of Mexico

MARFIN Grant No. 08MFIH004

Funding Amount: $50,000

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Study Objectives: 1) compare the performance of chevron traps and digital video drop camera arrays in assessing the relative abundance and community structure of reef fish on the inner shelf of the NE Gulf of Mexico, 2) continue using chevron traps to examine annual catch, recruitment, and demographic patterns of exploited reef fish species in the NE Gulf, and 3) continue surveying for new reef sites to expand the sampling universe.

Methods and Materials: A video drop camera array and chevron fish trap were used to survey natural hard bottom sites on the inner and mid shelf between 86°10'W off the Florida Panhandle and 28°50'N off the NW Florida peninsula. The survey sampling design was systematic (fixed sites – natural hard bottom only) because of a limited sample site universe and logistic constraints.

At each site, during daylight hours, the camera array was deployed first for 30 min, followed by the trap for 1.5 hr. The array consisted of 4 high definition, digital video cameras mounted horizontally at 90° to each other in, and 30 cm above, the bottom of an aluminum frame. Fish sizes were estimated using parallel lasers mounted above and below each camera. Traps were identical to those used in the MARMAP survey except throat size (area) was 50% smaller, and were baited with 3 Atlantic mackerel. All fish were identified, counted and measured (TL and FL). Otoliths were removed from all groupers and from a maximum of 5 individuals/species/site from red, vermilion, and lane snappers, black seabass, red porgy, white grunt, hogfish, and gray triggerfish (dorsal spine). In catches with >5 of any of these species, a random subsample of 5 was processed. Fish sampled for otoliths were sexed macroscopically; all others were released alive.

From each site, video tapes of all 4 cameras were scanned, then 20 min of the one with the best view of the habitat was analyzed in detail. If none was obviously better, one tape was randomly chosen. All fish were identified to the lowest discernable taxon. The estimator of abundance was the maximum number of a given species in the field of view at any time during the first unoccluded 20 min of the tape. Video data from all sites were screened, and those with no evidence that hard bottom was in close proximity, or on which the view was obscured because the array landed on its side or turbidity was high, were excluded from analyses involving comparisons of species abundances between gears and across regions.

Seven cross-shelf transects in depths from ~30 to 40 m were surveyed with side scan sonar in the Big Bend, and a sample were ground-truthed using a live video drop camera and hook and line gear.
Conclusions and Recommendations: In 2008, 97 stations were sampled with the camera array (31 west and 66 east of Cape San Blas) and 92 with a chevron trap (31 west and 60 east). After screening, 56 of 66 stations east of the Cape and 29 of 31 from west were retained for video analysis. Of those retained, the 29 from west and 51 of the 56 from east were retained for trap analysis. Stations east of the Cape were shallower (\(\bar{x} = 15\) m, range 7-23 m) than those west (\(\bar{x} = 29\) m, range 17-41 m). Far more species and individuals were visually detected than caught in the traps. Trap samples yielded 2,072 specimens of 22 species compared to visual (min) counts of 4,669 specimens (11,053 if small-bodied schooling species in which numbers can only be estimated are included) from approximately 70 species.

Based on video min counts from sites across all depths, the most abundant exploited reef fishes west of the Cape were vermilion snapper and east of the Cape were white grunt. White grunt also dominated eastern trap catches from the same sites, but unlike the video data, red snapper was more common than vermilion snapper in the west. Gag, scamp, lane snapper, and especially gray snapper and hogfish were far more detectable with video than traps. Red porgy, gray triggerfish, and white grunt were somewhat more detectable with video, while red grouper and red snapper were about equally detected with each gear. Only black seabass was detected more often with the trap than video. It was apparent that there are gear selectivity differences among most species, but overall, video observations appeared to be the most suitable method for monitoring annual abundance trends for most species. Chevron traps are essential for providing age and length data needed for the age-length keys needed to yield more reliable, age-specific estimates of recruitment from video data.

A comparison of size structure of red snapper derived from laser measurements in the video data with that from the individuals caught in the trap revealed an apparent bias of the chevron trap for larger individuals, with a modal size of 325 mm TL for the former versus 375 mm for the latter.

In 2008 gag averaged much smaller than in the previous 4 years, with most in the 250-300 mm size groups. These small fish could be clearly seen in the age structure, where one year olds dominated, and none exceeded age 2. These data suggest that the 2007 year class may be relatively strong. Sampling in 2008 clearly showed that the 2006 cohort of red grouper was very strong (68% of catch) and was present region-wide, and that the dominant 1999 year class was still quite abundant. The size structure of red snapper has been quite consistent from year to year, with the exception that modal size was slightly higher (~20 mm) in 2008 than it has been in the previous 4 years. Annual trends in age structure, not unexpectedly, were similarly consistent, with 2 yr olds dominating and 3 yr olds second most abundant each year since 2005.

There were distinct faunal differences east and west of Cape San Blas, supporting the hypothesis that it represents a zoogeographic boundary. Red snapper, observed in 86% of video samples west of the Cape, were nearly absent east of the Cape, where white grunt dominated. Red porgy were very common west of the Cape (86% frequency of occurrence in video samples and 55% in traps) but was completely absent to the east. White grunt, black seabass and hogfish video data showed the opposite pattern, being present in 86, 21, and 57% of eastern samples, respectively, compared to 14, 0, and 3% in the west. These faunal differences may be due to 1) habitat or environmental differences, 2) other factors such as the depths sampled, or 3) some combination of these. Sampling depth differences likely played an important role in catch and or observation rate differences in scamp, red snapper, vermilion snapper, lane snapper, and red porgy; while habitat differences probably account for the patterns in hogfish, white grunt and black seabass.
SESSION IV – Other

Session Chair: Mr. James Franks
Reduction Rates, Species Composition and Effort: Assessing Bycatch

Within the Gulf of Mexico Shrimp Trawl Fishery

MARFIN Grant No. NA07NMF4330125

Funding Amount: $100,000 Federal

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Judy L. Jamison, Executive Director

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Study Objective: The specific objectives of this project were to:

1. Update and analyze Bycatch Reduction Device (BRD) performance to verify if previously tested BRDs meet, exceed, or fail to achieve revised BRD certification criteria set forth by the Gulf of Mexico Fishery Management Council;
2. Assess BRD performance for dominant species (longspine porgy, Atlantic croaker) and for red snapper and seatrout; and
3. Analyze available databases and literature to elucidate any changes in composition of Gulf of Mexico shrimp trawl bycatch and abundance of key species as a result of recent declines in shrimp trawl effort.

Methods and Materials: The analysis and assessments were conducted by a joint industry/National Marine Fisheries Service (NMFS) team of scientists utilizing planning meetings, analysis workshops and follow-up teleconferences. The data and methods utilized for the analysis were the same as those used by NMFS in previous analyses except that the data were updated to include new data that were not available for previous assessments. All data were screened in the same way prior to analysis, and the analysis protocols were identical with one minor exception. The estimation of total finfish weight based upon subsamples of the total catch was conducted in a slightly different manner in this study. Side-by-side analysis showed that this change had insignificant impacts on the overall results.

Conclusions and Recommendations: Based upon our updated analyses, only one BRD (Fisheye ≤ 9 ft) would meet the certification criteria and only two (Modified Jones-Davis and Extended Funnel) showed enough promise to be provisionally certified. In February 2008, the NMFS listed five certified and two provisionally certified BRDs. However, in a subsequent update, they decertified the Gulf Fisheye, all Fisheye BRDs except when located ≤ 9 ft from the
tie-off rings, and the Expanded Mesh BRD. The Jones-Davis BRD was certified based upon historical analyses which, because the position of BRD and control nets were not swapped during the trips, would not meet the present protocol.

The Fisheye ($\leq 9$ ft) was highly effective at reducing bycatch of the two nearshore sciaenids tested (Atlantic croaker and seatrout) but none of the BRDs (except for the Modified Jones-Davis) effectively removed longspine porgy, an offshore species. The Modified Jones-Davis reduced longspine porgy catch rates by about 25%. Atlantic croaker were also effectively removed by the Extended Funnel (54.4% reduction), Composite Panel (34.8% reduction) and the Expanded Mesh (29.7% reduction).

Despite the observed differences in BRD performance as shown by updated analyses versus the previous NMFS analyses, the absolute values obtained for past and present estimates of percent finfish reduction were all about the same, and all the values for which paired data are available are close to pass-fail levels, the Fisheye BRD ($\leq 9$ ft) being the only exception. This Fisheye BRD had the highest shrimp loss of any BRD (~10%) but also exhibited the highest reduction in estimated red snapper fishing mortality (27%). The Modified Jones-Davis and Extended Funnel BRDs also reduced red snapper F by 25 to 27%.

While the dominant species in the bycatch appeared to have remained about the same for the entire period from the 1940’s to the present, changes in the fish to shrimp ratios have been evident. Shrimp catch rates have remained relatively constant, but finfish catch rates (mainly sciaenids, especially Atlantic croaker) have declined in several step-like reductions. The finfish to shrimp ratios in the Gulf of Mexico shrimp fishery are presently about 4 to 1, much below the 10 to 1 ratio estimated in the late 1970’s. The change likely reflects the basic weight differences between the shrimp and fish taken by the fishery today as compared to the 1970’s, as well as better estimates from more comprehensive sampling.

Longspine porgy, Atlantic croaker and inshore lizardfish (the latter two are potential shrimp and red snapper predators) dominate the bycatch offshore of the western Gulf states of Texas and Louisiana as well as offshore Mississippi/Alabama. Atlantic croaker and inshore lizardfish appear to be increasing in abundance in recent years in conjunction with shrimp fishing effort reductions, whereas longspine porgy and juvenile red snapper abundance has remained relatively stable.

The observed increases in abundance appear to coincide with the reduction in shrimp trawling effort. If these trends continue, we can expect a shift in the Gulf of Mexico shrimp trawl bycatch composition in favor of the species that are increasing in abundance. The species that has demonstrated the greatest increase in abundance, Atlantic croaker, also exhibits one of the highest BRD reduction rates. The reduction estimates for croaker are greater than 50% with the certified BRDs. As croaker gain proportionally in the bycatch composition, there may be a resulting increase in the relative performance of BRDs.
Investigating the Potential for Modified Circle Hooks with Wire Appendages to Reduce Hook Ingestion Rates in Incidentally Captured Sea Turtles

MARFIN Grant No. 07MFIH011

Funding Amount: $45,000

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Study Objectives:

- To investigate the potential of circle hooks modified with a wire appendage for reducing post-hooking mortality and serious injury of incidentally caught sea turtles by reducing the incidence of hook ingestion.
- To determine the size range of modified wire appendage circle hooks most effective in reducing hook ingestion by sea turtles.

Methods and Materials- Trials were conducted to examine the effects of hook and animal size, bait type, and baiting technique on loggerhead sea turtles’ ability to swallow a baited appendaged hook during laboratory trials. The experiments were conducted using captive reared loggerhead (Caretta caretta) sea turtles at the sea turtle facility at the NOAA Fisheries Galveston, Texas Laboratory. Tests were conducted on 45, 55, and 65 CM SCL (standard straight carapace length, notch to tip) sea turtles. Trials were conducted using 14/0, 15/0, and 16/0 Mustad AP39960D circle hooks affixed with wire appendages and modified to prevent injury. Bait types tested included Spanish sardines (Sardinella aurita) and squid (Illex illecebris). The baits were attached to the hook by single baiting or threading the bait on the hook. Turtles were contained in individual holding tanks and a baited hook was presented to the turtle. Each turtle’s reaction to the baited hook was coded into four response categories: “Did not take into mouth,” “Partially in mouth,” “Fully in mouth,” or “Attempted to swallow”. Attempted to swallow is defined as “the turtle taking the entire hook completely into the mouth and is marked by the disappearance of the crimp that connects the leader to the hook). If a turtle attempted to swallow the bait the baited...
hook was removed immediately to eliminate risk of injury to the animal. Each encounter was scored and videotaped to allow review of the results.

**Conclusions and Recommendations:** This study implies that turtles are less likely to ingest hooks baited with sardines than with squid. Other findings were that turtles seem generally less likely to ingest single baits than threaded baits particularly with sardines. The results also indicate that although these appendaged hooks show some potential in small sea turtles, results were not promising for turtles larger than 55 CM SCL, particularly with 14/0 and 15/0 hooks. These preliminary results suggest the advantage of larger hook sizes (>16/0) on reducing serious injury or mortality from ingestion. Future robust statistical analysis is planned.
Examination of Non-Fishery Factors on the Welfare of Fishing Communities in the Florida Keys: A Focus on the Cumulative Effects of Trade, Economic, Energy, and Aid Policies, Macroeconomic (County and Regional) Conditions, and Coastal Development on the Monroe County Commercial Fishing Industry

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Study Objective: To determine the effects of non-fishery factors, comprised of socio-demographic trends, macroeconomic conditions, fishery and non-fishery management measures, and climatic and environmental shifts, on the performance of commercial fisheries and fishing communities in the Florida Keys (Monroe County, Florida) from 1950 to the present.

Methods and Materials: A multi-pronged approach was utilized to obtain information on each of the four, non-fishery factors, consisting of existing literature research, dataset analyses, and key informant interviews. Literature obtained from a variety of sources (historical newspapers and periodicals, State of Florida fisheries publications, academic journals, and grey literature) comprised a majority of the historical information on the region’s fisheries and fishing communities. Statistical data, gathered from US census reports from 1950-2000, State of Florida fishery trip ticket summaries, US National Marine Fisheries Service (NMFS) landings summaries, NMFS fishery trade datasets, and state and federal macroeconomic databases, provided the quantitative information on the region’s landings history, energy prices, and trade conditions, among others. Finally, key informant interviews and results from past socioeconomic studies conducted by the principal investigator in the region from 1995 to the present served to provide detailed information on local fishery performance and the effects of non-fishery factors.

Conclusions and Recommendations: The study findings show that non-fishery factors have interacted to influence the present, diminished status of Florida Keys commercial fisheries. Most importantly, management measures have increasingly adopted limited and transferable effort systems, which have increased financial barriers to entry while facilitating exit from the fisheries as three non-fishery factors have increased their effects on overall costs. The first of these has been a steady increase in the land-side costs, as measured by the higher Florida Price of Living Index, potable water prices, and housing costs, among others. The second factor is related to trip costs, which have increased considerably more than ex-vessel values; the main reason for the increase has been the recent spike in fuel prices. The final factor that has exacerbated the effects of management has been the flattened prices of most seafood products landed in the Florida Keys. In some cases, as supply has dropped, as in pink shrimp, ex-vessel values have plummeted. In other fisheries, ex-vessel values have held or slightly weakened but have not increased tantamount either to the increased management costs, cost of living increases, or higher trip costs. The common factor in these fisheries has been a dominant, constant, and competitive import sector. Of all the fisheries evaluated, only the stone crab fishery has shown an increasing trend in ex-vessel values that could withstand the spikes in other costs. The case of the Florida Keys commercial fisheries is instructive as it demonstrates that fishery management cannot make decisions in isolation of the wider socioeconomic environment. If the retention of fishing communities, owner operators, and small and medium scale operations
remain a priority, then fishery managers and community leaders should consider the following approaches: The promotion of locally landed seafood above non-local products such that the commercial fishing industry may be integrated into the economy of a coastal zone; the retention of smaller operations, i.e. owner-operators, within the fishing industry that typify the tradition of many fisheries and maintain diversity in fishery fleets; and the preservation (even subsidization) of commercial, working waterfronts that can accommodate the re-establishment of commercial fishery sectors where they have been dislodged by non-fishery factors, among others.

**Figure 1: Monroe County landings and fishery product value, 1950-2007**

Figure 1 shows the rise and decline of the Florida Keys fisheries, from 1950 to 2007. Landing peaked in the mid-1970s, after which landings in most major fisheries decreased over the next three decades. Non-fishery factors were instrumental in either promoting or exacerbating the effects of the decline.

**Figure 2: Ex-vessel values of major commercial fisheries landed in Monroe County, 1986-2007**

Figure 2 demonstrates that prices for most major fisheries in the Florida Keys showed flat or declining ex-vessel value trends from 1986-2007; the only fishery that had a positive ex-vessel trend was the stone crab fishery, which does not have suitable import substitutes and is branded as a Florida fishery (but whose ex-vessel value is not immune to economic downturns, ex. 1990-91 and 2000-01 recessions).