Southeast Data, Assessment, and Review

SEDAR Procedural Workshop 6

South Atlantic Shrimp Data Evaluation

July 22-24, 2014

SEDAR
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North Charleston, SC 29405

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Executive Summary

SEDAR Procedural Workshops provide an opportunity for focused discussion and deliberation on topics that arise in multiple assessments and are structured to develop best practices for addressing common issues across assessments. The sixth procedural workshop provided a review and evaluation of shrimp data in the South Atlantic. The impetus for the workshop began when Rick Hart presented the 2011 Gulf of Mexico pink shrimp stock assessment to the SAFMC SSC at their October 2012 meeting. The SSC recommended proceeding with an exploratory phase to assess the applicability of the assessment in the South Atlantic. The first step was to determine what shrimp data were available in this region.

SEDAR convened the procedural workshop from July 22-24, 2014 in North Charleston, SC. The main objective of the workshop was to explore available South Atlantic shrimp datasets for potential use in future shrimp stock assessments and to estimate commercial shrimp bycatch for use in finfish assessments. Participants included representatives from state and federal agencies, ASMFC, SAFMC SSC members, and SAFMC/SEDAR staff. Prior to the workshop, panelists compiled inventories of the available shrimp and environmental datasets in the South Atlantic and Gulf of Mexico.

The workshop began Tuesday morning with state agency representatives giving an overview of the shrimp monitoring and management programs in each South Atlantic state. Presentations were given by Trish Murphey and Kevin Brown (North Carolina Division of Marine Fisheries), David Whitaker (South Carolina Department of Natural Resources), Pat Geer (Georgia Department of Natural Resources), and Ryan Gandy and Steve Brown (Florida Fish and Wildlife Conservation Commission). Next, Kate Michie gave a presentation on federal shrimp management in the South Atlantic and Gulf of Mexico and Elizabeth Scott-Denton gave an overview of the Southeast Fisheries Science Center (SEFSC) Shrimp Observer Program. Tuesday afternoon began with presentations from Xinsheng Zhang, Jeff Isely, and Katie Drew on recent methods that have been used to estimate shrimp bycatch in finfish assessments in the Atlantic and Gulf of Mexico. The panel then identified possible shrimp bycatch estimation methods and the data requirements for each method. The day concluded with presentations from Rick Hart and Katie Drew on recent assessments conducted on shrimp stocks in the Gulf of Mexico and Gulf of Maine. The panel then discussed potential stock assessment methods and identified the data requirements for each method.

Wednesday morning opened with a plenary session discussion. SEDAR staff used the shrimp and environmental inventories compiled before the workshop to draft a list of the available South Atlantic data sources for each data type identified as a requirement during the discussions Tuesday afternoon. The panel reviewed and edited the list of available data sources for each data type as necessary. For the remainder of Wednesday, the panel was divided into three working groups to: (1) discuss the strengths and weaknesses of the datasets for use in shrimp bycatch

estimation and/or shrimp stock assessment, (2) to identify data gaps and research recommendations, and to (3) identify overall recommendations on the use of the data sources. The Life History/Environmental group was tasked with discussing life history parameters important to stock assessment and their application to shrimp, evaluating the datasets available in the South Atlantic for shrimp age/length and other life history parameters, and discussing the environmental parameters that would be important when evaluating shrimp stocks. The Fishery Statistics group was tasked with evaluating the data sources identified for fishery effort, shrimp catch, kept bycatch/fish, discarded bycatch/fish, and fish age/length. The Index group evaluated the data sources available for Bycatch Catch per Unit Effort (BCPUE) estimates, for quantifying the effect of bycatch reduction devices (BRDs) / turtle excluder devices (TEDs) on BCPUE estimates, and for shrimp indices.

Thursday morning the three working groups reported back to the full panel highlighting the key points and recommendations identified during their discussions. The workshop concluded Thursday afternoon with John Carmichael leading the panel through discussions on best practice recommendations for both shrimp stock assessment and shrimp bycatch estimation methods.

Contents

1. Introduction

1.1 Workshop Time and Place

The SEDAR Procedural Workshop 6 – South Atlantic Shrimp Data Evaluation was held July 22-24, 2014 in North Charleston, SC. Planning webinars were held April 2, 2014 and May 7, 2014.

1.2 Terms of Reference

1. Create an inventory of the available Penaeid shrimp data in the South Atlantic and Gulf of Mexico. Inventory should include biological, landings, effort, survey, and relevant environmental data. All datasets should provide metadata including variable descriptions, geographic coverage, time series, timeliness, and point of contact. (NOTE: This ToR will be addressed prior to the workshop, so the information is available to address the other ToRs during the workshop.)

2. Review potential shrimp stock assessment approaches and data requirements for identified approaches including consideration of the effects of environmental conditions on shrimp populations and assessment efforts.

3. Review shrimp fishery bycatch estimation methods and data requirements for identified methods.

4. Evaluate strengths and weaknesses of the available datasets for potential use in shrimp stock assessments. Consider both what is feasible given available data as well as additional data necessary to apply preferred approaches.

5. Evaluate strengths and weaknesses of the available datasets for potential use in shrimp fishery bycatch estimation methods. Consider both what is feasible given available data as well as additional data necessary to apply preferred approaches.

6. Identify data gaps and provide recommendations for future shrimp research, monitoring and data collection efforts.

7. Provide best practice recommendations for estimating finfish bycatch by the South Atlantic shrimp fishery, and for estimating population and management parameters of South Atlantic shrimp resources.

1.3 List of Participants

Appointee	**Affiliation**
Carolyn Belcher, Workshop Chair	SAFMC SSC
Alan Bianchi	NCDMF
Jeanne Boylan	SCDNR/SEAMAP-SA
Kevin Brown	NCDMF
Steve Brown	FL FWCC
Julie DeFilippi	ACCSP
Larry DeLancey	SCDNR
Katie Drew	ASMFC
Amy Fowler	SCDNR
Ryan Gandy	FL FWCC
Jeff Gearhart	SEFSC - Pascagoula
Pat Geer	GADNR
Dave Gloeckner	SEFSC - Miami
Rick Hart	SEFSC - Galveston
Frank Helies	Gulf and SA Fisheries Foundation
Eric Hiltz	SCDNR
Jeff Isely	SEFSC - Miami
Eric Johnson	SAFMC SSC
Jennifer Lee*	SERO
Kate Michie	SERO
Trish Murphey	NCDMF
Blake Price	SEFSC - Pascagoula
Marcel Reichert	SAFMC SSC
Elizabeth Scott-Denton	SEFSC - Galveston
Mark Stratton	VIMS
David Whitaker	SCDNR
Xinsheng Zhang	SEFSC – Panama City

SEDAR / SAFMC Staff

Julia Byrd	SEDAR
John Carmichael	SEDAR/SAFMC
Chip Collier	SAFMC
Mike Errigo	SAFMC
Julie Neer	SEDAR
Julie O'Dell	SEDAR/SAFMC

Workshop Observers

Jeff Brunson, SCDNR

Rusty Hudson, SFA

*Participated in planning webinars, but was not able to attend the workshop.

1.4 Document List

Document #	Title	Authors
Documents Prepared for the Procedural Workshop		
SEDAR-PW6-WP01	SCDNR Crustacean Monitoring Trawl Sampling	DeLancey 2014
SEDAR-PW6-WP02	FL FWCC Fishery Independent Monitoring (FWC-FIM): Additional Metadata	MacDonald 2014
SEDAR-PW6-WP03	Federal Shrimp Permit Data Information	Michie 2014
SEDAR-PW6-WP04	NCDMF Shellfish Sanitation Water Sampling	Murphey 2014
SEDAR-PW6-WP05	South Atlantic Federal Shrimp Management History	Michie 2014
SEDAR-PW6-WP06	ACCSP Commercial Catch and Effort Data	DeFilippi 2014
SEDAR-PW6-WP07	South Carolina Recreational Shrimp Baiting Preliminary Data Summary: Shrimp Baiting Mailing Survey	Hiltz 2014
SEDAR-PW6-WP08	South Carolina Commercial Shrimp Fishery Preliminary Data Summary: Commercial Trawl Ticket Program	Hiltz and Dukes 2014
SEDAR-PW6-WP09	South Carolina Tidal Creek Temperatures Preliminary Data Summary: James Island Creek Temperature Monitoring Program	Hiltz 2014
SEDAR-PW6-WP10	Observer Coverage of the US Gulf of Mexico and Southeastern Atlantic Shrimp Fishery, February 1992 – December 2013 – Methods	Scott-Denton 2014
SEDAR-PW6-WP11	Seasonal estimates of relative abundance of Penaeid shrimp in Coastal Georgia	Geer 2014
Final Procedural Reports		
SEDAR-PW6-FinalReport	SEDAR Procedural Workshop 6: South Atlantic Shrimp Data Evaluation Final Report	To be prepared by SEDAR PW6
Reference Documents		
SEDAR-PW6-RD01	Stock Assessment of White Shrimp (*Litopenaeus setiferus*) in the U.S. Gulf of Mexico for 2011	Hart 2012
SEDAR-PW6-RD02	Stock Assessment of Brown Shrimp (*Farfantepenaeus aztecus*) in the U.S. Gulf of Mexico for 2011	Hart 2012
SEDAR-PW6-RD03	Stock Assessment of Pink Shrimp (*Farfantepenaeus duorarum*) in the U.S. Gulf of Mexico for 2011	Hart 2012

Document #	Title	Authors
SEDAR-PW6-RD04	Correlation of winter temperature and landings of pink shrimp *Penaeus duorarum* in North Carolina	Hettler 1992
SEDAR-PW6-RD05	Assessment Report for Gulf of Maine Northern Shrimp – 2013	ASMFC Northern Shrimp Technical Committee 2013
SEDAR-PW6-RD06	A comparison on the catch from two types of shrimp nets off South Carolina, USA	Stender and Barans 1991
SEDAR-PW6-RD07	A project to augment the data collection and development of an electronic logbook system used within the Gulf of Mexico shrimp fishery	Gulf and South Atlantic Fisheries Foundation 2008
SEDAR-PW6-RD08	Continuation of a project of augment the data collection of an electronic logbook system used within the Gulf of Mexico shrimp fishery	Gulf and South Atlantic Fisheries Foundation 2012
SEDAR-PW6-RD09	Development and assessment of bycatch reduction devices with the Southeastern shrimp trawl fishery	Gulf and South Atlantic Fisheries Foundation 2012
SEDAR-PW6-RD10	Pilot study to characterize fishing effort of the South Atlantic Penaeid shrimp trawl fishery through the use of electronic logbooks	Gulf and South Atlantic Fisheries Foundation 2013
SEDAR-PW6-RD11	Characterization of the near-shore commercial shrimp trawl fishery from Carteret County to Brunswick County, North Carolina	Brown 2009
SEDAR-PW6-RD12	Compare catch rates of shrimp and bycatch of other species in standard (control) and modified (experimental) otter trawls in the Neuse River and Pamlico Sound, North Carolina	Brown 2010
SEDAR-PW6-RD13	Characterization of the inshore commercial shrimp trawl fishery in Pamlico Sound and its tributaries, North Carolina	Brown 2010
SEDAR-PW6-RD14	FL FWRI Fisheries Independent Monitoring Program 2012 Annual Data Summary Report	FL FWCC – FWRI 2012
SEDAR-PW6-RD15	ASMFC Atlantic Croaker 2010 Benchmark Stock Assessment	ASMFC 2010
SEDAR-PW6-RD16	SEDAR34-WP18: Shrimp fishery bycatch estimates for Atlantic sharpnose and bonnethead sharks in the Gulf of Mexico, 1972-2011	Zhang et al. 2013
SEDAR-PW6-RD17	SEDAR31-DW30: Shrimp fishery bycatch estimates for Gulf of Mexico red snapper, 1972-2011	Linton 2012

Document #	Title	Authors
SEDAR-PW6-RD18	SEDAR28-AW02: SEDAR 28 Spanish mackerel bycatch estimates from US Atlantic coast shrimp trawls	NMFS-SFB 2012
SEDAR-PW6-RD19	SEDAR28-DW06: Methods for estimating shrimp bycatch of Gulf of Mexico Spanish mackerel and cobia	Linton 2012
SEDAR-PW6-RD20	Low temperature tolerance in white shrimp, *Litopenaeus setiferus,* in South Carolina (Thesis Proposal)	Frede 2014
SEDAR-PW6-RD21	Model for white shrimp landings for the central coast of South Carolina	C.F. Lam et al. 1989
SEDAR-PW6-RD22	Results of long-term, seasonal sampling for *Penaeus* postlarvae at Breach Inlet, South Carolina	DeLancey et al. 1994
SEDAR-PW6-RD23	Predicting the abundance of white shrimp (*Litopenaeus setiferus*) from environmental parameters and previous life stages	Diop et al. 2007
SEDAR-PW6-RD24	A possible mechanism for recruitment of postlarval brown shrimp	Whitaker 1981
SEDAR-PW6-RD25	An assessment of turtle excluder devices within the Southeastern shrimp fisheries of the United States	Gulf and South Atlantic Fisheries Foundation 2008
SEDAR-PW6-RD26	North Carolina Shrimp Fishery Management Plan – Draft Amendment 1	NCDMF 2014
SEDAR-PW6-RD27	Field observations on white shrimp, *Litopenaeus setiferus*, during spring spawning season in SC, USA, 1980-2003	DeLancey et al. 2005
SEDAR-PW6-RD28	Evaluation of stock-recruitment curves for white shrimp in Georgia	Belcher and Jennings 2004
SEDAR-PW6-RD29	Assessment of Georgia's Marine Fishery Resources	Geer and Roberson 2003
SEDAR-PW6-RD30	Interstate Fisheries Management Planning and Implementation: Assessment of Georgia's shrimp trawl fishery	Ottley et al. 1998
SEDAR-PW6-RD31	Long-term trawl monitoring of white shrimp, *Litopenaeus setiferus* (Linnaeus), stocks within the ACE Basin National Estuarine Research Reserve, South Carolina	Delancey et al. 2008
SEDAR-PW6-RD32	North Carolina Beach Monitoring Project Quality Assurance Project Plan	Potts 2009
SEDAR-PW6-RD33	FerryMon: NC DOT ferry-based automated monitoring of water quality and fisheries habitat condition in the Pamlico Sound System, NC	Paerl 2013

Document #	Title	Authors
SEDAR-PW6-RD34	Neuse River Estuary Dataset - metadata	Paerl et al. 2011
SEDAR-PW6-RD35	Characterization of the U.S. Gulf of Mexico and South Atlantic Penaeid and Rock Shrimp Fisheries Based on Observer Data	Scott-Denton et al. 2012
SEDAR-PW6-RD36	Assessment of participation and resource impact of shrimp baiting in coastal South Caroling during 1987	Theiling 1988
SEDAR-PW6-RD37	The South Carolina Shrimp Baiting Fishery 1988-2002: A review of trends and issues	Lowe 2003
SEDAR-PW6-RD38	Survey of the South Carolina Shrimp Baiting Fishery, 2006	Byrd 2007
SEDAR-PW6-RD39	Decadal Trends in the North Atlantic Oscillation: Regional Temperatures and Precipitation	Hurrell 1995
SEDAR-PW6-RD40	The Atlantic multidecadal oscillation and its relation to rainfall and river flows in the continental U.S.	Enfield et al. 2001
SEDAR-PW6-RD41	The Past, Present, and Future of the AVHRR Pathfinder SST Program	Casey et al. 2010
SEDAR-PW6-RD42	Enhancing Industry Contribution Towards Documentation of Fishing Effort and Bycatch Reduction in the Shrimp Fishery of the Southeastern United States	Gulf and South Atlantic Fisheries Foundation 2004
SEDAR-PW6-RD43	Biological Program Documentation: North Carolina Estuarine Trawl Survey	West et al. 2009
SEDAR-PW6-RD44	Biological Program Documentation: Juvenile Shrimp Sampling	Murphey 2013
SEDAR-PW6-RD45	Pamlico Sound Survey: June 2013 Cruise Report	Knight et al. 2013
SEDAR-PW6-RD46	South Atlantic Shrimp System Overview	Hardy and Gold 1995
SEDAR-PW6-RD47	Synopsis for Marine Fisheries of North Carolina Part I: Statistical Information, 1980-1973	Chestnut and Davis 1975
SEDAR-PW6-RD48	Efficiency of bycatch reduction devices in small otter trawls used in the Florida shrimp fishery	Steele et al. 2002
SEDAR-PW6-RD49	The efficiency of a bycatch reduction device used in skimmer trawls in the Florida shrimp fishery	Warner et al. 2004
SEDAR-PW6-RD50	Effectiveness of bycatch reduction devices in roller-frame trawls used in the Florida shrimp fishery	Crawford et al. 2011

Document #	Title	Authors
SEDAR-PW6-RD51	Status and Trends Report: 2012 Rock Shrimp Species Account	FL FWCC – FWRI 2012
SEDAR-PW6-RD52	Status and Trends Report: 2012 Penaeid Shrimp Species Account	FL FWCC – FWRI 2012
SEDAR-PW6-RD53	Relationship between environmental factors and brown shrimp production in Pamlico Sound, North Carolina	Hunt et al. 1980
SEDAR-PW6-RD54	Estimation of bycatch in shrimp trawl fisheries: a comparison of estimation methods using field data and simulated data	Diamond 2003
SEDAR-PW6-RD55	SEDAR7-DW24: Estimation of Effort in the Offshore Shrimp Trawl Fishery of the Gulf of Mexico	Nance 2004
SEDAR-PW6-RD56	Comparison of the Catch from Tongue and Two-Seam Shrimp Nets off South Carolina	Stender & Barans 1994
SEDAR-PW6-RD57	Description of Commercial Landings Programs in the Southeast and ALS Database	Gloeckner 2014
SEDAR-PW6-RD58	Description of the Vessel Operating Units Database	Gloeckner 2014
SEDAR-PW6-RD59	Description of the Gulf Shrimp System Database	Gloeckner 2014
SEDAR-PW6-RD60	Turtle Excluder Device Regulatory History	NOAA – revised 2011
SEDAR-PW6-RD61	SEDAR38-RW2: Methods Used to Compile South Atlantic Shrimp Effort Used in the Estimation of King Mackerel Bycatch in the South Atlantic Shrimp Fishery	Gloeckner 2014
SEDAR-PW7-RD62	Role of high and low energy seagrass beds as nursery areas for Penaues duorarum in North Carolina	Murphey and Fonseca 1995

1.5 SEDAR Abbreviations

ABC Allowable Biological Catch

ACCSP Atlantic Coastal Cooperative Statistics Program

ADMB AD Model Builder software program

ALS Accumulated Landings System; SEFSC fisheries data collection program

AMRD Alabama Marine Resources Division

ASMFC Atlantic States Marine Fisheries Commission

B stock biomass level

BAM	Beaufort Assessment Model
BCPUE	bycatch catch per unit effort
BMSY	value of B capable of producing MSY on a continuing basis
BRD	bycatch reduction device
CFMC	Caribbean Fishery Management Council
CIE	Center for Independent Experts
CPUE	catch per unit of effort
DBSRA	depletion-based stock reduction analysis
DCAC	depletion-corrected average catch
EEZ	exclusive economic zone
F	fishing mortality (instantaneous)
FMSY	fishing mortality to produce Maximum Sustainable Yield under equilibrium conditions
FOY	fishing mortality rate to produce Optimum Yield under equilibrium
FXX% SPR	fishing mortality rate that will result in retaining XX% of the maximum spawning production under equilibrium conditions
FMAX	fishing mortality that maximizes the average weight yield per fish recruited to the fishery
F0	a fishing mortality close to, but slightly less than, Fmax
FL FWCC	Florida Fish and Wildlife Conservation Commission
FWRI	(State of) Florida Fish and Wildlife Research Institute
GADNR	Georgia Department of Natural Resources
GLM	general linear model
GMFMC	Gulf of Mexico Fishery Management Council
GSAFF	Gulf and South Atlantic Fisheries Foundation
GSMFC	Gulf States Marine Fisheries Commission
GULF FIN	GSMFC Fisheries Information Network
HMS	Highly Migratory Species
LDWF	Louisiana Department of Wildlife and Fisheries
M	natural mortality (instantaneous)

MARMAP	Marine Resources Monitoring, Assessment, and Prediction
MDMR	Mississippi Department of Marine Resources
MFMT	maximum fishing mortality threshold, a value of F above which overfishing is deemed to be occurring
MRFSS	Marine Recreational Fisheries Statistics Survey; combines a telephone survey of households to estimate number of trips with creel surveys to estimate catch and effort per trip
MRIP	Marine Recreational Information Program
MSST	minimum stock size threshold, a value of B below which the stock is deemed to be overfished
MSY	maximum sustainable yield
NCDMF	North Carolina Division of Marine Fisheries
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
ORCS	only reliable catch stocks
OY	optimum yield
SAFMC	South Atlantic Fishery Management Council
SAS	Statistical Analysis Software, SAS Corporation
SCDNR	South Carolina Department of Natural Resources
SEAMAP	Southeast Area Monitoring and Assessment Program
SEDAR	Southeast Data, Assessment and Review
SEFIS	Southeast Fishery-Independent Survey
SEFSC	Southeast Fisheries Science Center, National Marine Fisheries Service
SERO	Southeast Regional Office, National Marine Fisheries Service
SPR	spawning potential ratio, stock biomass relative to an unfished state of the stock
SSB	Spawning Stock Biomass
SS	Stock Synthesis
SSC	Science and Statistical Committee
TIP	Trip Incident Program; biological data collection program of the SEFSC and Southeast States.
TPWD	Texas Parks and Wildlife Department

VPA	virtual population analysis
Z	total mortality, the sum of M and F

2. Workshop Findings

2.1 Data Inventory (TOR 1)

Create an inventory of the available Penaeid shrimp data in the South Atlantic and Gulf of Mexico. Inventory should include biological, landings, effort, survey, and relevant environmental data. All datasets should provide metadata including variable descriptions, geographic coverage, time series, timeliness, and point of contact. (NOTE: This ToR will be addressed prior to the workshop, so the information is available to address the other ToRs during the workshop.)

Prior to the procedural workshop, data workshop panelists compiled two data inventories:
1) Shrimp datasets available in the South Atlantic and Gulf of Mexico; and
2) Environmental datasets available in the South Atlantic and/or Gulf of Mexico.

The inventories provided a general overview of the available shrimp and environmental data. Gulf of Mexico data sources were included in the inventories in addition to South Atlantic data sources, so that panelists could familiarize themselves with the data collected throughout the Southeast. If data gaps were identified within the South Atlantic, the panel would be able to reference the Gulf of Mexico data to look for examples of how these data gaps have been addressed elsewhere. Originally the panel was only planning to compile an inventory of shrimp data sources, but during the planning process panelists noted the importance of environmental conditions on shrimp populations. An additional inventory was developed to house stand-alone environmental data sources. In addition to providing a general overview of data sources in the inventories, panelists were also asked to provide additional documentation (working paper or reference document) with more detailed information for each submitted dataset.

Data fields included in the inventories and instructions to submit and edit data are in Appendix 1. Final inventories are available in the corresponding Excel spreadsheets.

- SEDAR_PW6_ShrimpInventoryCompiled_7.23.2014
- SEDAR_PW6_EnvironmentalInventory_6.30.2014.

In addition to compiling inventories, during the first morning of the workshop panelists shared information on the monitoring and management programs across the region and within each South Atlantic state. North Carolina, South Carolina, Georgia, and Florida state agency representatives gave overviews of the shrimp monitoring and management occurring within each of their states. Presentations were given by Trish Murphey and Kevin Brown (NCDMF), David Whitaker (SCDNR), Pat Geer (GADNR), and Ryan Gandy and Steve Brown (FL FWCC). Kate Michie (SERO) gave a presentation on federal shrimp management in the South Atlantic and Gulf of Mexico for the Penaeid, rock, and royal red shrimp fisheries and Elizabeth Scott-Denton (SEFSC) gave an overview of the SEFSC's Penaeid and rock shrimp fisheries observer program. Copies of the presentations can be found in Appendix 2.

2.2 Shrimp Stock Assessment Approaches & Data Requirements (TOR 2)

Review potential shrimp stock assessment approaches and data requirements for identified approaches including consideration of the effects of environmental conditions on shrimp populations and assessment efforts.

Rick Hart and Katie Drew gave presentations on recent assessments conducted on shrimp stocks. Dr. Hart described the 2011 Gulf of Mexico pink shrimp stock assessment and Dr. Drew presented the 2013 Gulf of Maine Northern Shrimp stock assessment conducted by ASMFC. (See Appendix 3 for copies of the presentations.) After the presentations, the panel was asked to identify potential shrimp stock assessment methods and the data required for each method. A variety of stock assessment methods ranging from data intense catch at age models to data poor methods (ORCS, DBSRA, etc.) were discussed. The stock assessment methods and corresponding data requirements identified during the discussion are summarized in Table 1. During the discussion, the panel noted additional items to address during the workshop related to the identified stock assessment methods and their application to shrimp (see below).

- Which, if any, of these traditional stock assessment methods are appropriate for shrimp? Is there a need to develop a 'new' model?
- Penaeid shrimp stocks in the South Atlantic are regulated by environmental conditions (e.g. winter water temperatures for white shrimp). It will be important to include environmental variables in an assessment.
- Is it necessary to be predictive in shrimp assessment models?
- The current fishery is constrained by fuel and market prices. How can that be captured in a model?
- Timeliness of data and management of the fishery are likely an issue given the life span of the species (e.g. annual crop).
- Management and environmental data are not required for many of the assessment techniques but would likely be necessary to interpret model results.

Table 1. Potential shrimp stock assessment methods and corresponding data requirements identified by the SEDAR Shrimp Workshop Panel.

	Assessment Methods									
Data Type	**Catch at age/length**	**Collie Sissenwine**	**Surplus Production**	**Trends Analysis**	**Yield Per Recruit**	**VPA**	**DBSRA**	**DCAC**	**ORCS (Catch only)**	**Catch Curve**
Fishery Effort	**X**	**H**	**X (or CPUE)**	**X (need one)**					**H**	
Shrimp Catch	**X**	**X**	**X**	**X (need one)**		**X**	**X**	**X**	**X**	
Shrimp Age/Length	**X**	**X (define recruit & post-recruit)**			**X**	**X**				**X**
Shrimp Indices	**X**	**X (FI or FD)**	**X (or effort)**	**X (need one)**		**H**	**H**		**H**	
Life History	**X (Growth, M, Maturity Schedule)**	**X (Growth, M, Maturity Schedule)**			**X**		**X (M or Fmsy)**	**X (M)**	**X**	
Environmental	**H**	**H**	**H**	**X**						
Management	**X**	**H**	**H**	**X**			**H**			
Selectivity					**X**					
Assumed Production Curve							**X**			
Depletion							**X**	**X**		

X = required; H = not required, but helpful

2.3 Shrimp Fishery Bycatch Estimation Methods & Data Requirements (TOR 3)

Review shrimp fishery bycatch estimation methods and data requirements for identified methods.

Xinsheng Zhang, Jeff Isley, and Katie Drew gave presentations highlighting the shrimp fishery bycatch estimation methods that have been used in recent stock assessments. Dr. Zhang described the bycatch catch per unit effort (BCPUE) method used in the SEDAR 39 smoothhound shark assessment. Dr. Isley presented the BCPUE methods used to estimate both Gulf and South Atlantic shrimp bycatch for the SEDAR 38 king mackerel assessment. Dr. Drew described the ratio method used to estimate bycatch in the 2012 Atlantic croaker assessment. After the presentations, the panel was asked to identify potential shrimp bycatch estimation methods and the data required for each method. The panel identified two primary methods: the BCPUE method which relies on observer BCPUE (when available or a fishery independent proxy) and fishery effort data; and the ratio method which relies on a ratio of shrimp landings to discarded and ideally, kept bycatch for the species of interest. More details on both of these methods can be found in the presentations and in various reference documents (see Appendix 4 and/or SEDAR-PW6-RD15-19 and SEDAR-PW6-RD54). The bycatch estimation methods and corresponding data requirements identified during the discussion are summarized in Table 2. During the discussion, the panel noted specific items to address during the workshop for the different methods and/or data requirements identified (see below).

Fishery effort

- Gear characteristics (number of nets, headrope length, BRD/TED type and position, etc.) are important to fishery effort calculations and need to be quantified.
- Strata specific effort (depth, season area) data are needed.
- Effort data collected on trip tickets is not consistent between South Atlantic states.

Bycatch estimation methods

- Top down (shrimp landings) and bottom up (observers/bycatch focused) approaches are both valid and will depend on the perspective of the user group.
- Typically assume 100% mortality for shrimp bycatch; if this isn't the case, need information on discard mortality.
- Typically assume finfish bycatch caught in shrimp trawls are age 0; may be helpful to verify this assumption.
- Need paired BRD/control studies to get more information on the effect of BRD's on species specific BCPUE.
- Need to discuss what minimum level of data is needed to estimate bycatch.

Table 2. Commercial shrimp bycatch estimation methods and corresponding data requirements identified by the SEDAR Shrimp Workshop Panel.

	Bycatch Estimation Methods		
Data Type	**CPUE Method (King Mackerel)**	**CPUE Method (Sharks)**	**Ratio Method**
Fishery Effort (Depth x Season x Strata x Gear Characteristics)	**X**	**X**	
Shrimp Catch	**X (used to estimate effort)**	**X**	**X**
Kept Bycatch/Fish			**X (Ideally)**
Discarded Bycatch/Fish	**X (mortality estimate)**	**X**	**X**
Fish age/length	**X (Age 0 assumed)**	**X**	**X (Age 0 - check assumption)**
Fish BCPUE (Observer CPUE)	**X**	**X**	
Fishery Independent CPUE	**X**	**X**	
Minimum Data Requirement	**Should be defined**	**Should be defined**	**Should be defined**
BRD/Ted – Type & Impact	**X (need paired research)**	**X**	**X**

X = required

2.4 Strengths and Weaknesses for Available Datasets for Stock Assessment & Shrimp Bycatch Estimation (TOR 4 & 5)

Evaluate strengths and weaknesses of the available datasets for potential use in shrimp stock assessments. Consider both what is feasible given available data as well as additional data necessary to apply preferred approaches.

Evaluate strengths and weaknesses of the available datasets for potential use in shrimp fishery bycatch estimation methods. Consider both what is feasible given available data as well as additional data necessary to apply preferred approaches.

SEDAR staff used the shrimp and environmental inventories compiled before the workshop to draft a list of the available South Atlantic data sources for each data requirement identified for the shrimp stock assessment and bycatch estimation methods. The panel reviewed and edited the list of available data sources for each data type. The finalized lists of South Atlantic data sources for each data type are below. Language in parentheses notes whether the data type was identified as a requirement for bycatch estimation, shrimp assessment, or both.

Fishery Effort (Requirement for bycatch estimation and assessment)

- ACCSP
- State trip tickets
- South Atlantic shrimp electronic logbook (ELB) program
- South Atlantic shrimp system (SAS)
- Vessel operating units (VOU)
- NCDMF license data (number of nets – not on trip ticket data)
- SERO federal permit data
- SCDNR shrimp baiting
- NCDMF bycatch characterization studies

Additional panel comment on ‘Fishery Effort’:
*Port agents in the South Atlantic (federal and state) are not conducting shrimp fishery interviews.

Shrimp Catch (Requirement for bycatch estimation and assessment)

- ACCSP (includes Accumulated Landings System and General Canvas)
- State trip tickets
- SCDNR shrimp baiting
- South Atlantic shrimp system (SAS)
- Chestnut and Davis (NC historic data)

Kept Bycatch/Fish (Requirement for bycatch estimation)

- ACCSP
- State trip tickets

Discarded Bycatch/Fish (Requirement for bycatch estimation)

- SEFSC observer program
- NCDMF bycatch characterization studies (historic information found in observer program database)
- GADNR bycatch characterization studies (historic information found in observer program database)
- SEAMAP

Additional panel comments on 'Discarded Bycatch':
*Fishery independent datasets can be used as a proxy to help characterize bycatch, but important to discuss gear type/comparability caveats of fishery independent versus dependent trawls.
*Historic data sets, if available, should also be considered here as they can be useful for species that are lumped into larger species groupings to actually get counts or percentages for species.

Fish Age/Length (Requirement for bycatch estimation)

- SEFSC observer program
- NCDMF bycatch characterization studies (historic information found in observer program database)
- GADNR bycatch characterization studies (historic information found in observer program database)
- South Atlantic shrimp electronic logbook program
- Fishery independent data sources: SEAMAP, NCDMF Pamlico Sound Survey, NCDMF Estuarine Trawl, GADNR Ecological Monitoring, SCDNR Crustacean Monitoring
- Gear testing studies; but will be important to discuss gear comparisons

Fish BCPUE (Requirement for bycatch estimation)

- SEFSC observer program
- NCDMF bycatch characterization studies (historic information found in observer program database)
- GADNR bycatch characterization studies (historic information found in observer program database)

<u>Fishery Independent CPUE</u> (Requirement for bycatch estimation)
- SEAMAP
- Other state fishery independent surveys

<u>BRD/TED Type</u> (Requirement for bycatch estimation)
- SEFSC observer program
- NCDMF bycatch characterization studies (historic information found in observer program database)
- GADNR bycatch characterization studies (historic information found in observer program database)
- 2003 Florida shrimper survey
- Gulf and South Atlantic Fisheries Foundation BRD testing (historical)

Additional panel comments on ‘BRD/TED Type’:
*Need to develop a timeline for state regulations.
*Need to consider different types of BRD/TED positions when compiling information.
*BRD type used can vary regionally and temporally.

<u>BRD/TED Impact</u> (Requirement for bycatch estimation)
- SEFSC TED testing
- SEFSC BRD testing
- SEFSC NC skimmer trawl TED testing
- GADNR bycatch characterization studies
- UGA Marine Extension studies (contact: Lisa Ligouri)
- NCDMF BRD certification
- NCDMF Sea Grant fisheries resource grants (gear component)

Additional panel comment on ‘BRD/TED Impact’:
*Some gear testing studies identify fish to group level, not necessarily to species.

<u>Shrimp Indices</u> (Requirement for assessment)
- Fishery Independent
    - SEAMAP
    - GADNR ecological trawl survey
    - SCDNR crustacean monitoring survey
    - FL FWCC Fishery Independent Monitoring (FIM) survey
    - NCDMF estuarine trawl survey
    - NCDMF Pamlico Sound survey
    - NCDMF juvenile shrimp sampling
- Fishery Dependent

  - SEFSC Observer Program
  - State trip tickets
  - SCDNR shrimp baiting
  - University of South Carolina Baruch Survey

Additional panel comment on 'Shrimp Indices':
*Should investigate academic institutions with surveys that could have potentially useful information.

Life History (Requirement for assessment)

- Sex
  - GADNR ecological monitoring trawl survey
  - GADNR juvenile trawl survey
  - GADNR bycatch characterization
  - SCDNR crustacean monitoring
  - SEAMAP

Additional panel comment on 'Life History'
*Need to discuss life history parameters important to assessment and their application to shrimp.

Environmental (Requirement for assessment)

- Large number of datasets were submitted in both the shrimp and environmental inventories (see inventories for complete list)
- Need to determine what environmental factors are important to shrimp stocks

Shrimp Age/Length (Requirement for assessment)

- GADNR ecological monitoring trawl survey
- GADNR bycatch characterization
- SCDNR crustacean monitoring
- SEAMAP
- FL FWCC Fishery Independent Monitoring (FIM) survey
- NCDMF estuarine trawl survey
- NCDMF Pamlico Sound survey
- NCDMF juvenile shrimp sampling
- SEFSC Observer Program
- NCDMF bycatch characterization
- State trip tickets (counts only)
- South Atlantic shrimp system (counts only)
- SEFSC BRD testing

- SEFSC TED testing (counts only)
- SEFSC NC skimmer trawl TED testing (counts only)

After developing the lists of available South Atlantic data sources for each data type, the panel was divided into three working groups to discuss the strengths and weaknesses of the datasets for use in shrimp bycatch estimation and/or shrimp stock assessment, to identify data gaps and research recommendations, and to identify overall recommendations on the use of the data sources. The Life History/Environmental group was tasked with discussing life history parameters important to stock assessment and their application to shrimp, evaluating the datasets available in the South Atlantic for shrimp age/length and other life history parameters, and discussing the environmental parameters that would be important when evaluating shrimp stocks. The Fishery Statistics group was tasked with evaluating the data sources identified for fishery effort, shrimp catch, kept bycatch/fish, discarded bycatch/fish, and fish age/length. The Index group evaluated the data sources available for Bycatch Catch per Unit Effort (BCPUE), shrimp indices, and BRD/TED impact on BCPUE estimates. Summary reports from each working group are below.

2.4.1 Life History / Environmental Working Group

2.4.1.1 Group Membership

Carolyn Belcher (leader/moderator), Amy Fowler, Ryan Gandy, Rick Hart, Eric Johnson, Trish Murphy, Mark Stratton, David Whitaker, SEDAR/SAFMC staff – Chip Collier

2.4.1.2 Group Objective

The Life History / Environmental working group was charged with discussing life history parameters important to stock assessment and their application to shrimp; evaluating the datasets available in the South Atlantic for shrimp age/length and other life history parameters; determining what environmental parameters are important to consider when evaluating shrimp stocks and discussing the available environmental datasets.

2.4.1.3 Life History Parameter and Modeling Discussions

Natural mortality

- Contributing factors
    - Predation (very important), but data aren't available: some evidence of competitive exclusion of pink shrimp by white shrimp in NC (in warmer winters, more white shrimp are produced and less pink shrimp); some predation data from diet studies
    - Disease, some data available

  - Environmental extremes, namely cold stunning of mature adults
  - Density dependence of early life stages
- How to measure
  - Existing tagging studies
  - Changes in length-frequency distributions over time
  - Use mortalities calculated in the Gulf of Mexico; however, borrowing natural mortality from the Gulf of Mexico for other species has not been accepted in some other assessments
  - Need to consider regional differences, even within states, due to differential habitat preferences between the species (e.g. pink shrimp and sea grass)
- Natural mortality is likely much more impactful to the population than fishing mortality. Natural mortality rates do exist in the literature for adults and juveniles, but based on older studies

Ageing

- No one is ageing shrimp, but could you do it for year and hindcast based on length?
- Ageing is hard and the age structure is relatively simple. Monthly sizes could be used, but there are not multimodal cohort structures for these species.
- Notable growth curve differences and nutritional requirements among Penaeid species, which could impact length frequency interpretations as a proxy for age. For example, brown shrimp stop growing in ocean, white shrimp continue (because they are omnivorous). Relatively good growth curves calculated for Gulf of Mexico pink shrimp – could use as proxy?
- There is information in the lengths, but are they a good proxy for age? Probably not due to variation in growth curve due to density-dependence, non-continuous growth, and environmental conditions. For this reason, should include environmental parameters in any von Bertalanffy or stock recruitment before feeding this information into a stock assessment.

Stock recruitment

- Poor relationship for white shrimp.
- Stock recruitment curve of Chesapeake Bay blue crab can move up and down with environmental conditions. There was some indication that shrimp might have a similar response due to the changes in rainfall pattern in the 2000s.
- Even low SSB can sustain the population. Protection of critical habitats can act as a buffer.
- Location of spawning stocks for pink and brown shrimp unknown. For pink shrimp, likely that spawning stocks are located offshore in NC which then supplies GA and SC with juveniles and adults. Work has been done in the FL Keys on pink spawning stock.

Habitat

- Definite regional differences in nursery areas: shrimp type, salinity, predator types/abundance, and habitat.
- Consider critical habitat protection. This would also impact many other managed species and activities in the area.

Modeling

- Can shrimp ever be overfished? If not, what's the point in building a model that provides this?
- Are models that have output of MSY necessary for management?
- There have been some yield-per-recruit models fit for shrimp. Yield-per-recruit model to provide recommendations on optimal harvest size?
- Models that rely on a stock-recruitment relationship may not be appropriate, unless variability in the relationship can be accounted for by environmental factors.
- Age-structured models are likely not appropriate given these are annual species. Length-based models perhaps better, but the environment and density-dependence can cause incredible variability in individual growth rates. A benefit of South Atlantic Penaeid stocks is that they don't have a protracted spawning season (spring-spawning only).
- Possible to incorporate economics into a model about best/optimal size at harvest?
- Recommended to not segregate by sex, as the fishery does not target one sex over another, but growth rates may be different between the sexes (especially white shrimp).

Management

- Need to define the stock. This will impact management (state vs. basin-wide). Genetic studies suggest a regional white shrimp population.
- Perhaps the lowest hanging fruit for shrimp fishery management is to optimally manage fleet size. Economics places a cap on the upper end of fleet size, but a few good years could result in fleet size inflation that may be problematic if the environment negatively impacted the species in the following years.
- The current assessment and then management cycle is relatively long and could exceed the life span of the stock. Are there other techniques that are available to managers for sustaining the population within a shortened timeframe? Need to decide if assessment is useful given the short life cycle of the species and the relatively long time it takes to enact management action.

Environmental influences

- Temperature/salinity consistently noted as important
- Regime shifts possibly important (e.g. rainfall, temperatures). Climate change/oscillations informed the Gulf blue crab assessment. If included on the front end, environmental

effects would inform the biological patterns but might be difficult to interpret in management decisions. Taking this 'intrinsic' approach is not classical.

- Overfishing/overfished may not be based on changes in effort but more on environmental changes.
- How would any capable assessment model account for environmental impacts? Will natural mortality be varied? Other methods?

2.4.1.4 Dataset Review

Datasets

- Fishery-dependent datasets are perhaps not useful for informing population dynamics (NCDMF Juvenile Shrimp Sampling not useful either)
- Both fishery-independent environmental datasets and external environmental datasets will be important to include, certain characteristics should be considered.

Datasets useful for shrimp age/length

- Any available fishery-dependent datasets are likely biased for population life history data—do not use
- Useful fishery-independent datasets by species:

Whites

- SCDNR Crustacean Monitoring – juvenile to adult; for growth rates may be most informative for juveniles
- GADNR EMS – juvenile to adult
- FL FIMS
- SEAMAP – abundance (adult size), sex, size, disease, maturity
- NCDMF Estuarine Trawl Survey (perhaps only older data that had more months)
- NCDMF Pamlico Sound Survey

Browns

- SCDNR Crustacean Monitoring – juvenile to adult; for growth rates may be most informative for juveniles
- GADNR EMS – does not sample spawning areas
- FL FIMS?
- SEAMAP?
- NCDMF Estuarine Trawl Survey
- NCDMF Pamlico Sound Survey

Pinks

- GADNR EMS – limited use. Not frequently encountered
- FL FIMS
- NCDMF Pamlico Sound Survey

- NCDMF Estuarine Trawl Survey (perhaps only older data that had more months and sampled at night)

Available Environmental Data (from biological datasets)

- Any fishery-independent survey that measures standard water quality parameters is potentially useful (definitely temperature and salinity, others such as dissolved oxygen also helpful)
- GADNR Juvenile Trawl Survey not useful for habitat mismatch reasons (salinity in particular)
- NCDMF Juvenile Shrimp Sampling not useful due to spotty sampling

Available Environmental Data (from external datasets)

- The datasets in the inventory were not individually evaluated because the group was not familiar with most of them.
- USGS water quality data collected from estuaries should be added (definitely temperature and salinity, perhaps rainfall and river flow).
- There was talk of climate indices being important to inform local water quality conditions (some of these are already included in the inventory).
- Available habitat; e.g., Submerged Aquatic Vegetation coverage in NC should be added to inform pink shrimp habitat availability.
- There was concern that some data available are from “virtual buoys”. These buoys should not be used because information is inferred from surrounding buoys to estimate water quality data at that station.
- The following characteristics should be considered for any dataset:
  - Data collection tool (actual readings or virtual buoy type)
  - Consistency (i.e., number of data gaps)
  - Length of time series
  - Coverage area
  - Temporal/spatial overlap with biological sampling (life stage-specific)
  - Impact to time series from water management

Life History

- Important life history components to consider for modeling purposes
  - Stock recruitment
  - Natural mortality
  - Age or length
  - Growth (also maturity, but perhaps less important for shrimp)
- GADNR EMTS has useful data throughout the year.
- Other GADNR surveys (juvenile trawl survey, bycatch characterization) not useful because of mismatch with habitat and population.

- SCDNR Crustacean Monitoring data useful for spring white shrimp data.
- Sex may not be needed, but could inform growth rates.
- Need to standardize for gear types.

2.4.1.5 Recommendations / Take-home points

- Shrimp are not fish.
- The environment and economics matter.
- Protect habitat. No-fishing zones and times are likely important for ensuring stock health.
- No good way to age. This major issue has implications for model type choice.
- Stock-recruitment relationships, growth, and natural mortality are all influenced by environmental factors.
- Sex identification is not crucial for assessment.
- Fishery-dependent data are not useful for characterizing population life history characteristics.
- Species coverage and time series for fishery-independent surveys vary.
- Management for fishery capacity and optimal yield could be useful approaches.
- In general, there is very limited directed shrimp research.

2.4.2 Fisheries Statistics Working Group

2.4.2.1 Group membership

Marcel Reichert (leader/moderator), Alan Bianchi, Steve Brown, Julie Defilippi, Dave Gloeckner, Frank Helies, Eric Hiltz, Kate Michie, Jeff Isley, Blake Price, SEDAR/SAFMC staff: Julie Neer

2.4.2.2 Group Objective and Overview

The Fishery Statistics Group was tasked with discussing and identifying current statistical data sources and data gaps for the South Atlantic Penaeid and rock shrimp fisheries. The group reviewed the adequacy of most known sources of data for effort, bycatch, and length/age of bycatch including:

- ACCSP
- State trip tickets
- Vessel operating units (VOU)
- E-logbooks
- South Atlantic shrimp system
- State databases

- the federal permit database
- the Southeast Fisheries Science Center (SEFSC)observer program
- SEAMAP

2.4.2.3 Types of Effort Data Needed

The Fishery Statistics Group began their session with a discussion of what types of information are required or most desired as effort data. The group determined the following elements are most necessary to compile an adequate suite of shrimp fishery effort data:

- Long time series of data, including historical data.
- Catch data: Entire catch and species specific data are ideal. Other factors such as age or other information are desired.
- Unit time: It is ideal to have active hours fishing, tow times, and numbers of tows in the data set. Must achieve a consistent definition of "trip" across programs for analytical purposes.
- Location: Statistical grid area is sufficient. Depth, or distance from shore is also needed.
- Gear: It is ideal to have a detailed gear description including head rope length, number of nets, mesh size, and BRD/TED type.
- Consistent documentation: Documentation should be consistent across programs, and should include historical changes in the fishery.

Each data set was discussed in terms of the adequacy of each of these information elements.

2.4.2.4 Fishery Effort/Catch Data Set Discussion

The group proceeded to discuss each of the data sets identified during the prior plenary session to determine whether or not they provide information that could be used in a future stock assessment or to fulfill other analytical needs.

ACCSP

- Catch data are available, but information varies by state, by species, and over time. It is not known whether or not these data are sufficient for characterizing effort.
- Unit of fishing time collected by ACCSP could possibly be sufficient depending on the state. Active time trawling is available through the observer program.
- Gear characterization is insufficient. Only captures number of nets. (SC is collecting gear data that is not being sent to ACCSP.)
- Location data are sufficient. Includes statistical grids, and depth (distance from shore as a proxy)
- Time series information is better for catch than for effort. Sufficiency of time series data is unknown.
- **ACCSP DATA GAP RECOMMENDATIONS:**

- States provide increased information to ACCSP
- Coordination/comparison/verify between state data and ACCSP to strengthen historical data.

State Trip Tickets

- Catch data: Good for all states
  - NC: good, minimal exceptions
  - SC: good, shrimp species are grouped (creel clerk information is used as a proxy for shrimp species).
  - GA: good species ID (species identification is augmented with fishery independent information. Dealers separate by count size, but not species.
  - FL: Good
- Unit of time: Sufficient
  - NC: Collects days at sea back to 1999, not reliable.
  - SC: Active time fishing, trip start time and unload date, number of tows.
  - GA: Tow time by hours, trip start time and unload date, number of tows.
  - FL: Time fished, days at sea, number of tows.
- Gear Information: Insufficient
  - NC: General gear type (wingnet, otter trawl, cast net, etc.), records up to three gears per trip, number of nets and mesh size not collected. BRD/TED assumed based on management, mostly "fish eye".
  - SC: Number of nets, head rope length, BRD/TED assumed based on management.
  - GA: General gear type, number of nets.
  - FL: General gear type (older information ca be merged with license data for more specific information). More recently recording specific gear type, number of nets.
- Location: Sufficient. All states have at least a code for area fished.
- **STATE TRIP TICKET DATA GAP RECOMMENDATIONS:**
  - Verify what it reported on trip tickets through
    - Increased coverage by the observer program, or
    - A periodic survey of the fishery

Vessel Operating Units (VOUs)

- A data source to supplement other data sources.
- May verify existing information.
- May be used for tuning proxies.
- Not useful for effort or catch characterization because it is more of an index.

South Atlantic Logbook

- GA: Pilot program with 20 vessels 2012-2013, provided tow time, location, gear info etc.
- E-logbooks may make VMS redundant

South Atlantic Shrimp System

- Catch data: Sufficient within time series. Species and size specific for shrimp only. Not useful for bycatch characterization.
- Unit of time: Insufficient (historic data only). Days at sea were recorded for GA from 1978-2001, in NC since 1991, in FL from 1981-1986, in SC from 1978-2001, and falls off when trip tickets were implemented.
- Location: Sufficient for all states within the available time series.
- Gear: General descriptions, historical data only.

NCDMF License Data

- Catch data: Not collected from license sales
- Unit of time: Based on a fiscal year
- Location: Insufficient, not collected
- Gear: Insufficient. Number of nets, head rope length. (Information on number of nets is not included on the trip ticket).

Other State License Data Sets

- Similar issues as NC.

NMFS Southeast Regional Office Federal Permit Database

- Catch/Effort: Insufficient. No log books.
- Vessel characteristics are available.
- Permit data are reliable from 2008 to present. Before that time permit data resided in R-Base and requires additional work to get accurate annual permit counts.
- Captures only federal permits, many vessels in the South Atlantic do not have a federal shrimp permit.
- Supplementary data set.

SCDNR Shrimp Baiting

- Annual mail survey (may be issues with voluntary survey and recall)
- Catch: Estimates general catch by trip: Sufficient for effort, not sufficient for catch.
- Effort: Sufficient. Trip data collected.
- Gear: Sufficient. Cast net only, mesh size determined by regulations.
- Location: Sufficient.
- Useful for historical catch trends.

Chestnut and Davis (NC Historic)

- Shrimp landings and landings for other species prior to 1950, back to 1880's.

- No gear or other information.
- Useful for historical trends.

2.4.2.5 Bycatch Data Discussion

The Fishery Statistics Group next discussed various data sets that include bycatch information. Each dataset was discussed in terms of its adequacy for shrimp kept and discarded bycatch information. In general, shrimp catch and kept bycatch data sets have issues similar to those for fishery effort listed above. Discarded bycatch data used for rarely encountered species may not be useful as it results in spikey data points; and therefore, should be avoided. The following outlines the attributes and inadequacies for each of the data sets used for bycatch information.

SEFSC Observer Program

- Observer coverage: Insufficient, the shrimp fishery is not adequately sampled. The program only targets vessels with federal shrimp permits; however, many vessels harvest shrimp with only a state license and do not get sampled by the observer program.
- Sampling is less than 1% of federal permitted vessels, and much less than 1% for all fleets.
- Data: The only federal source of shrimp bycatch information. Includes species, length, and no age data.
- Length/Age Data: lengths during special projects only, no gonads or otoliths from the shrimp fishery.
- Important for characterizing the fleet.
- Includes several gear comparison studies.
- **OBSERVER PROGRAM RECOMMENDATIONS:**
    - Increase coverage to 2-5% or 20-30% PSE (number of trips/sea days) for all fleets.
    - Requires data collection consistency among non-mandatory programs.

NCDMF Bycatch Characterization

- Data: Sufficient. Species, length, gear, trawl duration, location. No age information collected.
- Length/Age Data: length data for all samples. Age data for certain species through the estuarine trawl and Pamlico Sound surveys.
- The program is grant funded for the short term only, and only observes otter trawls. From 2007-2008 nearshore coverage was 5%, in 2009 Pamlico Sound coverage was 1%, and from 2012-2015 statewide year round coverage is less than 1%.

GADNR Bycatch Characterization

- Data: Sufficient. Length, gear, effort to species.

- Length/Age Data: Length; no age collected
- Program covered large shrimp trawl vessels from 1995-1998. During this time, it was a voluntary program targeting four observer trips per month. From 1998-2005, covered two trip per month.

SEAMAP-SA Coastal Trawl Survey

- Data: Only source of FL bycatch data, reliable effort, full catch characterization, lengths, total weights, age/reproductive data, and detailed gear descriptions.
- Length/Age Data: Subsample lengths, age and reproductive data for certain species.
- Samples during three sampling seasons with 20 minute tows, in areas between Cape Hatteras to Cape Canaveral in depths of 8-12 m.
- Data are available online with a 6-12 month delay.
- **SEAMAP TRAWL SURVEY RECOMMENDATIONS:**
    - Compare SEAMAP-SA data and observer data where there is temporal and spatial overlap.
    - Address calibration issues by: 1) doing paired trawls with commercial and SEAMAP gear; 2) consider tow durations, time of day, BRD/TED covariant; and 3) account for variety of commercial gear and fishing behavior.

LENGTH/AGE BYCATCH DATA RECOMMENDATIONS:

- Need additional age data, could use age/length relationships from other sources.

FISHERY STATISTICS GROUP OVERALL RECOMMENDATIONS:

In addition to making recommendations for how fishery effort, bycatch, and length/age bycatch data could be improved, the group also discussed several general data gathering and improvement recommendations. Those recommendations include:

- Investigate other sources of data such as state and academic sources i.e., Baruch long term creek data for (juvenile) index of abundance.
- Establish a gear type overview and assemble historical timelines.
- Increase observer coverage with special attention to temporal and spatial factors such as seasons, day vs. night, and coverage of various fleets without compromising statistical design.
- Develop video techniques to characterize catch.
- Add depth sensors to trawls to increase data collection.
- Participate in and support state cooperative projects.
- Account for the effects of fishing behavior on catch and bycatch.

2.4.3 Indices Working Group

2.4.3.1 Group membership
Katie Drew (leader/moderator), Pat Geer, Jeanne Boylan, Kevin Brown, Larry DeLancey, Jeff Gearheart, Liz Scott-Denton, Xinsheng Zhang, Jeff Brunson, SEDAR/SAFMC staff: Mike Errigo

2.4.3.2 Group Objectives
The Indices Workgroup covered two main topics:

1. The development of a bycatch catch-per-unit-effort (BCPUE) for non-shrimp species, either to be combined with effort estimates to develop a time-series of bycatch, or to be used as a fishery-dependent index of abundance for non-shrimp species.
2. The evaluation of existing fishery-independent and -dependent indices of abundance for use in shrimp stock assessments.

2.4.3.3 Development of a BCPUE
Bycatch catch-per-unit-effort of non-shrimp species is a function of many different factors, including gear type and configuration, area fished, season, and abundance of the non-shrimp species. The WG recommends using a stratified mean approach or a GLM-standardization approach to take into account these factors.

The WG identified three major strata or factors that should be used when developing a BCPUE in the south Atlantic:

- Year
- Season
- Area (Sounds/Estuaries, nearshore, offshore)

In addition, four secondary strata/factors were identified that could improve the estimates of BCPUE and should be used if sample size allows:

- Gear
- North/South or state
- Target (bait vs. food, Penaeid vs. rock shrimp)
- Depth

However, the WG recognized that achieving an adequate sample size within even the primary strata may be difficult, especially for early years. Analysts may need to pool over some or all of the recommended strata, depending on the length of the time-series needed and the species in question (e.g, estimates of BCPUE of rare-event species like sharks will most likely require pooling over more strata that estimates of BCPUE for more common bycatch species like Atlantic croaker). The final strata or factors used to develop BCPUE should be determined by the analysts based on species-specific considerations.

The WG evaluated the utility of three observer program datasets to develop estimates of BCPUE in the south Atlantic.

1. SEFSC Observer Program: early 1990s – present
2. NCDMF Bycatch Characterization: 2007-2008, 2009, 2012 – present (funded to 2015)
3. GADNR Bycatch Characterization: 1995 – 2005

SEFSC Observer Program

The SEFSC Observer Program represents the longest time-series and the largest area covered out of the three datasets. In the early 1990s, the focus was split between bycatch characterization and TED/BRD evaluations. In 2003, the focus shifted to bycatch characterization. Gear evaluation studies are clearly indicated within the database, and analysts should be conscious of those distinctions when developing BCPUE estimates.

Participation in the program was voluntary for vessels at the beginning, but became mandatory for federally permitted vessels in 2008. In 2009, the sampling protocol was adjusted slightly to identify certain priority species like sharks down to species level. The observed trips from the mandatory period are more representative of the fishery than those from the voluntary fishery.

Coverage has been ~1% of trips in the south Atlantic after the program became mandatory. Sampling levels varied in earlier years, but were generally lower.

There may need to be further discussion of state versus federally permitted vessels and whether there would be significant differences in bycatch rates that would not be accounted for with other factors (area fished, etc.).

Pros:

- Long time-series
- Coverage throughout the south Atlantic
- Commercial gear configurations and behavior observed

Cons:

- Sample size by recommended strata is low, especially for early years and for certain species
- Identification to species level not done for all species (requiring extrapolation for some species groups)

Recommendation: Despite sample size issues, the SEFSC Observer Program represents the best available data for most years and areas to develop BCPUE for non-shrimp species and should be used.

The NEFSC Pelagic Observer Program has explored the possibility of funding observer coverage on shrimping vessels in North Carolina. The WG recommends that analysts check with the NEFSC in the future to track progress of this possibility.

NCDMF Bycatch Characterization Program

NCDMF used observers to characterize bycatch rates in three areas of NC. From mid-2007 to mid-2008, coverage was focused in nearshore waters (~5% of trips). In 2009, coverage was focused in Pamlico Sound (~1% of trips). From 2012 – present, coverage was statewide (~1% of trips). The program is funded through 2015 in theory, but continuation of the program is contingent on funding levels.

The sampling protocol is very similar to the SEFSC observer program, although NCDMF samples from all nets deployed (instead of just one) and identified all shrimp and bycatch down to species level.

Pros:

- Sample size within recommended strata (year-season-area) is good for years and areas covered
- More detailed species information is collected

Cons:

- Length of time-series is limited
- Area covered is limited

Recommendation: The NCDMF Bycatch Characterization Program should be used to supplement the SEFSC Observer Program to develop BCPUE estimates.

GADNR Bycatch Characterization Program

GADNR operated a voluntary observer program on shrimping vessels from 1995-2005. Coverage was low (~0.5%) and the program was eventually discontinued because the cost was deemed not worth the coverage obtained.

Sampling protocols were similar to the SEFSC Observer Program. GADNR only sampled from one net, but identified shrimp and bycatch to the species level. Sampling occurred in nearshore water, as sounds are closed to shrimping in GA. The dataset does include coverage of trips prior to BRD regulations.

There is some discrepancy (mainly number of observed trips) between the data that GA holds and the data from this program that are held in the SEFSC database. Until this discrepancy is resolved, data should be obtained from GA directly.

Pros:

- More detailed species information is collected
- Adequate sample size by strata for some years and areas
- Pre-BRD data are available

Cons:

- Voluntary, low coverage rates
- Limited time and area coverage

Recommendation: The GADNR Bycatch Characterization Program should be used to supplement the SEFSC Observer Program to develop BCPUE estimates.

The WG also discussed the use of fishery-independent surveys to develop BCPUE estimates. Fishery-independent surveys are not proxies in and of themselves for commercial BCPUE effort estimates but may be useful when combined with observer data. Even surveys that use shrimping vessels and nets as survey platforms (e.g., SEAMAP) show much higher rates of BCPUE than observer programs do. This is most likely due to differences in gear configuration (TEDs and BRDs are not used in FI surveys), timing of sampling (most FI surveys take place during the day while shrimping is often done at night), and areas fished (FI sampling sites are randomly distributed throughout available habitat, while shrimpers target areas with high shrimp abundance). However, fishery-independent indices may be correlated with commercial BCPUE, since both could reflect the abundance of non-shrimp species. Thus, the WG recommends that analysts should explore the use of FI indices to scale/extrapolate/tune BCPUE estimates where observer sample size is not adequate to produce year-specific BCPUE estimates. When exploring this approach, analysts should consider:

- the strength of relationship in overlap years
- the timing of BRD implementation
- the spatial and temporal coverage of the survey relative to fleet
- the size/age structure of survey-caught individuals vs. bycatch individuals
- the quality of index for species of interest (e.g., if the survey is not an adequate index of abundance for your bycatch species, do not use it to tune BCPUE)
- whether to use smoothed or observed index values, and the relationship between CPUEs based on shrimp fleet Observer Program and survey (e.g. SEAMAP) to scale/extrapolate BCPUE when Observer program data were very limited

The WG also discussed quantifying the effects of TED and BRD regulations when developing BCPUE estimates. TEDs became mandatory in the late 1980s (large-opening TEDs became required in 2003). BRDs were required in the mid- to late-1990s. The date of implementation and the type of BRD required varied between states and between state and federal waters.

The most recent observer data, with the best sample size by strata, only cover years when BRDs and TEDs are required. As a result, these estimates of BCPUE will be biased relative to earlier years, when one or both sets of devices were not used commercially. To extend estimates of BCPUE back in time, the estimates will need to be calibrated to account for the effects of TEDs and BRDs.

The SEFSC Observer Program database does contain data from gear testing work that could be used to develop calibration coefficients. In addition, the WG identified possible gear testing datasets that are not included in the SEFSC database that could also be used to develop calibration coefficients. This includes GA Sea Grant projects and older SEFSC datasets that were used to develop the original estimates of sea turtle bycatch. The WG recommends that these data be obtained and evaluated.

There is very little information on levels of compliance with TED and BRD regulations, so analyses will have to assume perfect compliance with regulations to estimate and/or calibrate BCPUE. The WG recommends creating a matrix of regulations by state and year to identify regulatory periods and gear testing or observer datasets that could allow estimation or calibration for those periods.

2.4.3.2 Evaluation of Shrimp Indices for Use in Shrimp Assessments

The WG identified a number of factors that should be considered when evaluating the utility of a dataset as an index of abundance:

- Percentage of positive tows
- Length of the time series
- Spatial and seasonal coverage
- Size structure – juveniles and adults
- Survey design
- Major modifications to gear/vessel/survey design
- Identified to species
- Associated environmental data

Overall, the WG recommends that fishery-dependent CPUEs should not be used as indices of abundance in shrimp assessments. There are several good fishery-independent indices for shrimp, and developing a standardized unit of effort for fishery-dependent data is difficult, due to changes in gear configuration and efficiency over time in the fishery. The recommendations are highlighted to qualitatively rank the utility of the data source for developing an index (green = good, should explore for use; yellow = okay to use, should be used to compliment other indices; red = not recommend for use if other indices available).

Fishery Independent Surveys

SEAMAP-SA Coastal Survey

- Contacts: Marcel Reichert and Jeanne Boylan
- Design: Random Stratified Survey
- Gear:
  - Paired 22.9 m (75 ft) mongoose-type Falcon trawls
  - 47.6 mm (1.875 in) stretch mesh in body, 41.3 mm (1.625 in) in cod end
  - 305 x 102 cm (120 x 40 in) wooden doors with tickler chain
- Tow Duration: 20 minutes, Speed ~ 2.5 kt
- Longevity: 1990 to present
- Temporal: 3 cruises. Spring: Apr-May, Summer: Jul-Aug, Fall: Sep-Nov
- Spatial: Offshore, Hatteras to Canaveral
- Depth Ranges: 4-10 m
- Annual Effort: 3 seasons x 112/season = 336
- Shrimp Information
  - Mostly adults
  - Some juveniles
  - Size
  - Sex
  - Gonad information
  - Identified to species
  - High percent of positive tows
- Clean dataset (all questionable data excluded)
- Consistent vessel and protocols over time
- Environmental data
- Cons:
  - Funded year to year
  - Not in sounds and estuaries
- Recommend use as adult CPUE for all 3 species

GADNR Ecological Monitoring Trawl Survey

- Contacts: Pat Geer and Jim Page
- Design: Fixed Station, Stratified Design (by sector: creek, sound, ocean)

- Gear:
  - 12.2 m headrope (40 ft) flat trawl
  - 48 mm (1.875 in) stretched mesh throughout
  - Tickler chain
  - 152 x 71 cm (60 x 28 in) wooden trawl doors
- Tow Duration: 15 min
- Longevity: 1976 to present
- Temporal: Monthly, January - December
- Spatial: Six Sound Systems: Wassaw, Ossabaw, Sapelo, St Simons, St Andrew, and Cumberland. Minimum a two stations per sector per sound.
- Depth Ranges: 3 – 10 m
- Annual Effort 42 per month, 504 annually
- Shrimp Information
  - Both adults and juveniles
  - Size
  - Sex
  - Gonad information
  - Identified to species
  - Disease
  - High percent positive tows for whites and browns (pinks are uncommon)
- Consistent vessel, gear, protocols, and effort over time
- Environmental data
- Cons:
  - Fixed stations
  - Spatially limited
  - Data may need a thorough QA/QC
- Recommend as inshore CPUE to supplement SEAMAP

SCDNR Crustacean Monitoring Survey

- Contacts: Larry DeLancey
- Design: Fixed Stations
- Gear:
  - 6.1 m (20 ft) headrope flat otter trawl
  - 25.4 mm (1 in) stretch mesh throughout
  - tickler chain
  - Prior to 2002: twin trawls
- Tow Duration: 15 minutes, 30 minutes in 1980s
- Longevity: 1979 – present

- Temporal:
  - Monthly in Charleston Harbor
  - Quarterly south of Chas. (Mar, Apr, Aug, Dec): Edisto R., St. Helena, Port Royal, and Calibogue Sounds.
- Spatial: Sounds and Estuaries: Charleston Harbor, Edisto River, St. Helena, Port Royal Sounds
- Depth Ranges: 3.7 – 15.2 m (12 – 50 ft)
- Effort: ranged from 111 to 159 collections annually in the last five years
- Shrimp Information
  - Both adults and juveniles
  - Size
  - Sex
  - Gonad information
  - Identified to species
  - Disease
  - Very high percent positive tows for all 3 species (not much pink recently, lots historically)
- Environmental data
- Cons:
  - Fixed stations
  - Spatially limited
  - Vessel and gear changes (twin vs single trawl) 2002. Changed vessels with side-by-side comparisons
- Recommend as inshore CPUE to supplement SEAMAP

FWRI Fishery Independent Monitoring Survey (FIMS)

- Contact: Ryan Gandy
- Design: Random Stratified Design
- Gear(s):
  - 21.3 m (70 ft) center bag seine, 3.2 mm (0.125 in) mesh
  - 6.1 m (20 ft) otter trawl, 38.1 mm (1.5 in) body, 3.2 mm (0.125 in) liner
- Depth: Seine $\leq$ 1.8 m, Trawl 1.0 – 7.6 m
- Tow Duration: 1 min
- Longevity: 1990 - present
- Temporal: Seasonal prior to 1996, monthly afterwards
- Spatial: Sounds and Estuaries: Northeast Florida (2001), Northern Indian River Lagoon (1990)
- Depth Ranges: 1.8 – 7.6 m

- Effort: 2012 numbers
  - 21.3m Seine: 1064 collections
  - 6.1 m trawl: 684 collections
- Shrimp Information
  - Both adults and juveniles
  - Size
  - Sex
  - Gonad information
  - Identified to species
  - High percent of positive tows for each white, brown, and pink shrimp
- Consistent in vessel, methodology, and gear
- Environmental data
- Cons:
  - Spatially limited
- Recommend as inshore CPUE to supplement SEAMAP

NCDMF Pamlico Sound Survey (Program # 195)

- Contact: Katy West and Jason Rock
- Design: Random stratified design (7 strata based on depth and region)
- Gear:
  - double rigged 9.1 m (30 ft) demersal mongoose trawls
  - 44 mm (1.75 in) stretched mesh body, 38 mm (1.5 in) cod end, and 100 mesh tailbag,
  - 100 x 60 cm doors
- Tow Duration: 20 min, 2.5 kt
- Longevity: 1987 - present
- Temporal: Spring (June) and Fall (September)
- Spatial: Sounds and Estuaries: Pamlico Sound
- Depth: $\geq$ 2 m (6 ft)
- Effort: 54 stations per season, 108 stations annually
  - Shrimp Information
  - Both adults and juveniles
  - Size
  - Identified to species
- High percent of positive tows for whites and browns (mostly browns)
- Consistent in vessel, methodology, and gear
- Environmental data
- Cons:

  - Spatially (Pamlico Sound) and temporally (June and September) limited
- Recommend as inshore CPUE to supplement SEAMAP

NCDMF Juvenile Trawl Survey (Program # 120)

- Contact: Katy West
- Design: Fixed stations – 105 core stations
- Gear: 3.2 m (10.5 ft) two seam otter trawl, 3.175 mm (0.125 in) bag
- Tow Duration: 1 minute
- Longevity: 1978-present
- Temporal: May and June after 1989, (monthly 1978-1988)
- Spatial: Estuaries, statewide, typically in nursery areas
- Depth Ranges: unknown (?)
- Effort: 105 stations per year
- Shrimp Information
  - Both adults and juveniles
  - Size
  - Identified to the species
  - High percent of positive tows for white, brown, and pink shrimp (mostly browns)
- Consistent in vessel and gear
- Environmental data
- Cons:
  - Spatially limited
  - Temporally limited since 1989
- Recommend as inshore CPUE to supplement SEAMAP; probably best for brown shrimp; older monthly data good for the other species or for scaling/tuning historical data/recruitment

NCDMF Juvenile Shrimp Sampling (Program # 510)

- Contact: Trish Murphey
- Design: need information here
- Gear: Varies based on species and areas, 10.5 to 25 ft trawls
- Depth Range: unknown (?)
- Tow Duration: 1 to 10 minutes based on abundance and gear
- Longevity: 1978-2011
- Temporal: June to November dependent on shrimp recruitment
- Spatial: Estuaries not designated as primary or secondary nursery areas – statewide
- Effort: variable

- Shrimp Information
  - Lengths
  - Brown, white, and pink shrimp
  - Mostly juveniles
- Environmental data
- Cons:
  - Spatially limited
  - Discontinued
  - Methodologies are designed for management purpose to determine when to open areas to trawling.
- Recommend use for scaling/tuning historical data/recruitment

<u>Fishery-Dependent Surveys</u>

SEFSC Observer Program

Contact: Elizabeth Scott-Denton (NMFS, SEFSC – Galveston)

- Longevity: 1992 – present, Mandatory since 2008
- Coverage: ~1% coverage since 08, Less than 0.5% coverage prior
- Methods
  - Total weight for 2 outboard nets
  - Kg/net
  - Can get distance from speed and duration of tow
  - Lengths, weight, and count of net subsamples during bycatch characterization studies
  - Have all gear and vessel info
  - Adults only
  - All species
  - May be able to model time blocks with different selectivity?
- Pros:
  - Set level info
  - Gear and vessel info
  - Best of fishery-dependent datasets
- Cons:
  - Low coverage; may not be in center of abundance for brown shrimp
  - Change in design
  - Short time series
- Can use for CPUE if fishery-independent data is unavailable or to fill gaps

State Trip Tickets

- Contacts: NC: Alan Bianchi; SC: Amy Dukes; GA: Julie Califf; FL: Steve Brown
- Longevity:
    - Varies state to state. Contains harvest and value data back to at least 1950's
    - Trip level data – early 1990's; varies by state
    - Lbs per trawl-hour since early 2000s; varies by state
- Methods:
    - Need to estimate number of nets and tow time
- Pros:
    - Long time series with thousands of records
- Cons:
    - Data is not fine scale enough for use as a decent CPUE
    - Non-reporting issues
    - Reliability issues
- Recommend not using this for Penaeid CPUE
- Recommend exploring use for rock shrimp CPUE with VMS data

SCDNR Shrimp Baiting Survey (Recreational)

- Contacts: David Whitaker
- Longevity: 1988 – present
- Methods:
    - Self-reported
    - Mail out after season ends
    - Due 60 days later (recall bias)
    - Random sample of permittees selected for survey
    - Creel survey for ground truthing – matches well with self-reported data
    - White Shrimp only
    - Estuaries only
    - During fall cast net season
    - Information includes catch per trip, effort, , and location
- Pros:
    - 25% return rate
    - Catch rates stable over time
- Cons:
    - SC only (baiting has started in FL recently)
    - Reporting bias
- Up to 1/3 of commercial catch at highest
- Recommend using fishery-independent surveys for CPUE over this one

Baruch Survey

- Contact: http://www.baruch.sc.edu/biological-databases
- Pros:
    - Long time series, 1980's to present
    - Lots of data, lots of species – much of which is available online
- Cons:
    - North Inlet, SC only
    - Some net and design changes
- Recommend exploring for use in life history studies
- Recommend for possible use as supplement to SEAMAP since the SCDNR Crustacean Monitoring Survey does not sample North Inlet, if effort can be standardized

FL Shrimper Survey

- Contact: Steve Brown, FL FWCC
- 2003 only
- Surveyed shrimpers for their gear
- Can be used for estimating compliance of shrimpers to the BRD/TED regulations

2.5 Data Gaps and Research Recommendations (TOR 6)

Identify data gaps and provide recommendations for future shrimp research, monitoring and data collection efforts.

Each working group (Life History/Environmental, Fishery Statistics, and Indices) was tasked with identifying data gaps and research recommendations during their discussions. Specific recommendations from each working group are listed below.

2.5.1 Life History / Environmental Working Group

- Better port sampling of species and sizes.
- More accurate information is needed on where shrimp are actually being fished, not just where they are landed.
- Data/models to understand trophic dynamics related to shrimp as an important lower trophic level species.
- Collect new data to define the stock and center of abundance for each species. Genetic evidence indicates stock homogeneity for all three species, but response to environmental factors may differ within the region (e.g., a cold winter in SC may not impact individuals in FL).
- Conduct an interstate tagging study to look at stock connectivity and migration patterns.

- Need sampling to identify habitat usage by life stage (all stages) for pinks (see SEDAR-PW6-RD62) and browns, especially for mature adults.
- Determine how to incorporate environmental factors into any assessment model that would be developed. Should they be incorporated intrinsically into the population dynamics (e.g. into a stock-recruitment function), or extrinsically once the model outputs has been generated? It is possible to use environmental factors to predict the next harvest because these are annual species.
- Assuming time-varying natural mortality should be included, how should this be done for any selected assessment model?
- Quantify/estimate benefit of nursery areas.

2.5.2 Fishery Statistics Working Group

ACCSP Data Gap Recommendations

- States provide increased information to ACCSP.
- Coordination/comparison/verify between state data and ACCSP to strengthen historical data.

State Trip Ticket Data Gap Recommendations

- Increased coverage by the observer program or a periodic survey of the fishery if states can't conduct an observer program to verify data collected on trip tickets.

SEFSC Observer Program

- Increase coverage of SEFSC Observer Program coverage to 2-5% or 20-30% PSE (number of trips/sea days) for all fleets.
- Require data collection consistency among non-mandatory programs.

SEAMAP-SA Coastal Trawl Survey

- Compare SEAMAP-SA data and observer data where this is temporal and spatial overall.
- Address calibration issues by: 1) Doing paired trawls with commercial and SEAMAP gear; 2) Consider tow durations, time of day, BRD/TED covariant; 3) Account for variety of commercial gear and fishing behavior.

Length/Age Bycatch Data

- Need additional age data, could use age/length relationships from other sources.

Overall Recommendations

- Investigate other sources of data such as state and academic sources i.e., Baruch long term creek data for (juvenile) index of abundance.
- Establish a gear-type overview and assemble historical timelines.

- Increase observer coverage with special attention to temporal and spatial factors such as seasons, day vs. night, and coverage of various fleets without compromising statistical design.
- Develop video techniques to characterize catch.
- Add depth sensors to trawls to increase data collection.
- Participate in and support state cooperative projects.
- Account for the effects of fishing behavior on catch and bycatch.

2.5.3 Indices Working Group

- Obtain older datasets that looked at TED and BRD impacts to calibrate observer data back in time.
- Develop matrix of regulations by state and year to identify need for calibration and link to appropriate study.
- Investigate possible NEFSC observer coverage on shrimp trawls.
- Look at surveys north of NC (e.g., VIMS) for changes in shrimp abundance and distribution.
- Increase observer coverage in the S. Atlantic to increase sample size by strata.
- Data gaps
    - Bait shrimp fishery
    - Rock shrimp
    - Gears other than otter trawls

2.6 Best Practice Recommendations (TOR 7)

Provide best practice recommendations for estimating finfish bycatch by the South Atlantic shrimp fishery, and for estimating population and management parameters of South Atlantic shrimp resources.

2.6.1 Best Practices for Shrimp Stock Assessment

Stock assessments are done to evaluate stock status (overfishing/overfished), to describe past dynamics (abundance, biomass, exploitation) and to predict future dynamics to determine the yield available to be managed. Many of the traditional ‘finfish’ stock assessment methods whether they are data rich (catch at age/length) or data poor (trends, ORCS, etc.) rely on the same basic underlying principles: the stock/recruitment relationship is key to production; fishing is a primary population influence; stability and precaution are gained from preservation of the spawners; and the dynamics ‘of interest’ are on yearly scales. John Carmichael led the panel discussion on whether these principles are applicable to shrimp stocks. A summary of the panel discussion by topic is below.

Maximum Sustainable Yield (MSY) and Application to Shrimp

- MSY in the traditional sense - connecting YPR to the stock recruitment relationship to get model based estimates of MSY may not be appropriate for shrimp.
- Applicability of MSY to shrimp stocks depends on definition of MSY; if MSY is defined as a proxy of Bmsy using a historical reference point (through indices or model based approaches) where managers were satisfied with the productivity of the stock and the behavior, economics, and dynamics of the fishery and try to maintain this level – then concept is potentially realistic and appropriate for shrimp.

Can shrimp experience overfishing?

- Growth and recruitment overfishing are both possible in shrimp fisheries; the Gulf of Mexico brown shrimp fishery has experienced growth overfishing; the Mexican pink and white shrimp fisheries have experienced recruitment overfishing.
- Recruitment overfishing is less probable in the South Atlantic due to management and the way the fishery is executed; for example, most states have some measure of seasonal white shrimp spawning stock protections (fishery closure to protect overwintering shrimp); precaution is justified by experience.
- Recently many South Atlantic states have seen several years with poor fall stocks; likely due to disease or other environmental factors, not overfishing; panelists noted seems to be a new paradigm – is there a lower spawner recruit curve perhaps due to disease and other environmental factors?
- Available stock recruitment relationships are flat over a large range of stock sizes; doesn’t seem that stock size (at least over ranges observed) has a large impact on recruitment.
- Natural mortality may be a bigger concern than fishing mortality.
- Much of management is directed toward growth overfishing.

How to measure growth overfishing

- Yield per recruit (YPR) models
    - Can be modified to include economics.
    - Availability versus size versus price.
    - Many states do some management based on shrimp size.
    - Little (or no) formal modeling of yield per recruit used in shrimp management.
    - YPR are long term equilibrium models; can be modified to incorporate stochastic effects; may be useful to think about long term trends in growth rates and natural mortality; rates vary a lot by year which can affect YPR model, but may be trending over time with climate change, etc. and would potentially affect reference points.
- Management typically practiced without formal models and through experience

  - Rely considerably on judgment and experience
  - Rely upon monitoring of size and abundance
  - Considerable collaboration/feedback between managers and fishermen for season openings and closings

<u>Considerations for assessment</u>

- Monitoring of broodstock
  - Would it be helpful to establish minimum standards and have a management response when below this level?
  - Have good information for white broodstock, but do not have data for spawning pink and brown shrimp.
  - Need more information before can sufficiently answer this question.
- Is there a need to develop more robust YPR approaches, especially when more experienced managers leave?
  - Not clear; need research to better understand spawning stock/stock identification, ecosystem factors, and reference values for metrics used by states.

<u>Shrimp Productivity Factors</u>

- Productivity tied to environmental factors.
  - Temperature – for example, winter temperatures affect next spawning stock for white shrimp. SC cold temperatures have resulted in sustained closure of white shrimp.
  - Salinity/rainfall
  - Habitat – for example, grass beds important for pink shrimp
- Disease
  - Blackgill causes shrimp to molt more frequently and may make more prone to predation
- Fishing mortality
- Productivity factors may vary by species.
- What do managers want to do with this information – explain past trends or forecast?
- Important to note what time scale is needed to address issues; this will dictate the forecast projection window and will greatly influence how to model the populations in an assessment; shrimp likely need to be looked at annually or monthly.

<u>Can shrimp be overfished?</u>

- Possibly, particularly if management allows for unlimited fishing effort on spawners early in the year (white shrimp).
- Conceptually different than finfish assessment where preserving multiple age classes; no carryover biomass from year to year - more similar to salmon.

Recommendations for shrimp assessment

- Investigate combining state fishery-independent surveys; develop region-wide, comprehensive approach; then pursue rigorous evaluation.
    - Recommended as next appropriate step.
    - Convene workshop with individuals who conduct state fishery-independent indices and individuals with experience combining indices.
- Could develop stoplight or ARIMA trends approach; bring surveys together in a consistent framework that can be updated every year; would have quantitative, more rigorous approach to manage shrimp stocks; seems to be what is needed for management in short term.
- Management and assessment must occur within season.
    - States are able to apply a variety of methods quickly.
    - Current federal temperature based trigger can operate quickly.
- Improve or develop other management triggers (environmental or population level) similar to current temperature trigger; need to identify parameters and appropriate levels.
- Compare fishery-independent and fishery-dependent data; how did fishery/population respond?
- Further research and field testing of more complex models (length/stage based) worthwhile for long term.

2.6.2 Shrimp Bycatch Estimation Method Best Practices

Shrimp bycatch estimation is important for finfish stock assessments because it is a potential source of mortality (could be significant for some finfish species) and it can be a potential indicator of finfish abundance particularly for many federally managed species in the South Atlantic that lack traditional young of the year indices. During the workshop two methods were identified to estimate shrimp bycatch: the ratio method and the BCPUE method.

The panel determined the ratio method was NOT the preferred method for bycatch estimation and noted it should be phased out as the fishery effort time series becomes more reliable. However it was noted that a slightly modified version of this is used in the Gulf of Mexico to get effort estimates. The following issues were identified as potential problems with the ratio method.

- Difficult to separate fishing trends from fish population trends.
- Shrimp and fish populations are often on different trends. Unless there is a correlation between shrimp and the species of interest, should not use the ratio method.
- Should only use the ratio method when you have fishery-independent indices for shrimp and the fish species of interest so the ratio can be scaled.

The panel identified the BCPUE method as the preferred method for bycatch estimation. It provides a better measure but needs a reliable effort time series. Based on the discussions at this workshop, there seems to be the potential to fill gaps in the effort time series to produce more reliable estimates. When applying this method if observer sample size is not adequate to calculate BCPUE and fishery-independent data must be used to scale/extrapolate BCPUE estimates, it is important to understand how representative the fishery independent data are of the fishing activities and patterns of the commercial fishery. Panelists also noted it was important to incorporate regulatory information into bycatch estimates and that it would be helpful to develop regulatory histories for each South Atlantic state.

Appendix 1:

Shrimp and Environmental Inventory

Data Fields and Instructions

SEDAR Procedural Workshop 7: South Atlantic Shrimp Data Evaluation
SHRIMP Inventory Spreadsheet (ToR #1) Instructions
Updated: 5/12/2014

TO ENTER NEW DATA

(Please see page 4 for instructions on how to edit existing data entries.)

- Open the Excel file titled 'SEDAR_ShrimpInventory_3.6.2014. This file has macros and **in order to enter your data into the file you will need to enable the macros**.
- Click the 'ShrimpDataForm' button on 'Sheet2' to open the form to enter information about your dataset(s).
- The information below will walk you through the data form. This information is also available on 'Sheet2' of the Excel file.
- **Please complete the data form once for each of your datasets. However, if there have been significant changes in your dataset (e.g. trip ticket program collected monthly summary data and then switched to trip level data) - please use two data entries to describe the dataset.**
- **Data form fields**
    - **Agency Name** - Enter the agency associated with the program, if applicable (e.g. SCDNR).
    - **Program Name** - Enter the name of your data program (e.g. SCDNR Trip Ticket Program).
    - **Contact Name** - Enter the name of the contact person for your data program. Enter First Name, then Last Name (e.g. Joe Shrimp).
    - **Contact Email** - Enter the email address for the contact person (e.g. joeshrimp@data.com).
    - **Contact Phone** - Enter the phone number for the contact person (e.g. 843-571-1234).
    - **Data Type** - Select the data type that best describes your dataset (fishery independent, fishery dependent - recreational or commercial, permits/licenses).
    - **Gear Testing Study -** Select whether or not your data was collected as part of a gear testing study (yes = gear testing study, no = NOT gear testing study).
    - **Data Confidentiality -** Select whether or not your dataset is confidential (yes = confidential, no = NOT confidential).
    - **Data Collection and Storage** - Select the button that best describes the entity responsible for collecting and storing the data from your program. Examples of the latter two options are below: 'Data collect/store by same program & store by additional partners' (e.g. state trip ticket program: data collected and stored by state and also stored by another partner, such as ACCSP); 'Data collect/store by different programs (e.g. South Atlantic Shrimp System: data collected by states and stored in NMFS database).
    - **Fishery Dependent Data Type** - Check the data type box that best describes your fishery dependent dataset. Check all applicable boxes. If your dataset is fishery independent, check 'not fishery dependent'.

- **Species** - Select the box that best describes what species are represented in this dataset.
- **Time Series: Start Year** - Enter the year your data program began collecting data. Please use a 4 digit year (e.g. 2000).
- **Time Series: End Year** - Enter the year your data program stopped collecting data. If your program is currently collecting data, please enter 2014 as the end year and check the corresponding 'ongoing' box. Please use a 4 digit year (e.g. 2000).
- **Geographic Area** - Check the box that best describes the geographic range of your data program. Please check all applicable boxes (e.g. if you collect data in NC, SC, GA, and FL - please check the 'Regional - South Atlantic' box in addition to each state box). If your data set focuses on a few specific water bodies within a state, please enter those into the water body text box.
- **Fishing Area** - Check the boxes that best describe the fishing area(s) represented by your dataset. Check all applicable boxes.
- **Sampling Season** - Check the boxes that best describe the seasons sampled in your dataset. Check all applicable boxes.
- **Data Type: Catch** - Check the box that best describes the finest level of catch data collected by your program. If your program does not collect catch data, check 'No catch data'. If your data set originally collected monthly catch data and switched to trip level data, please fill out two separate data forms to describe the dataset.
- **Data Type: Catch Unit** - Check the boxes that describe the units in which your catch data is collected. If your program does not collect catch, check 'No catch'.
- **Gear** - Check the boxes that best describe the gear represented in your dataset. Check all applicable boxes. If you check the 'Other' box, please specify what 'other' represents in the corresponding text box.
- **Data Type: Size** - Check the box that best describes the finest level of size data collected by your program. If your program does not collect size data, check 'No size data'.
- **Data Type: Effort** - Check the box that best describes the finest level of effort data collected by your program. If your program does not collect effort data, check 'No effort data'. If you select 'Other', please specify what 'other' represents in the corresponding text box.
- **Data Type: Environ.** - Check the boxes that describe the environmental data collected by your program. Check all applicable boxes. If your program does not collect environmental data, check 'None'. If you check the 'Other' box, please specify what 'other' represents in the corresponding text box.
- **Data Type: Research** - If your data program collects other shrimp research information (e.g. tagging information, etc.), please list that in the corresponding text box.
- **Shrimp Disease Data** - Select whether or not your program collects information on shrimp disease (yes = collect info on shrimp disease, no = do NOT collect info on shrimp disease). If yes, please identify the types of diseases your program collects data on in the corresponding text box.

  - **Shrimp Sex** - Select whether or not your program collects information on shrimp sex/gender (yes = collect info on shrimp gender, no = do NOT collect info on shrimp gender).
  - **Web Availability** - Select whether or not the data source is available on the internet (yes = can get dataset online, no = cannot get dataset online). If yes, please list the website in the corresponding text box.
  - **Additional Comments** - Please list any additional comments you feel would be relevant for workshop participants to know about your dataset.
- **Please check the data form to make sure the information you have entered accurately represents your data program.**
- If the information in the form is correct, please click the 'Submit' button. This button will transfer the information from your form into a row on the 'Sheet3' worksheet. You are welcome to review the data in this spreadsheet, but please DO NOT alter the information in these cells. If you made a mistake on the data form, simply delete the row representing your data and re-enter it on the form. **Please leave all information submitted on the 'new' datasets in worksheet 'Sheet3', do not transfer this info to the 'Compiled' worksheet.**
- To enter information for another dataset, please make sure the information from your first data sheet has transferred to the spreadsheet. If it has, then simply hit the 'Clear' button to clear the form and enter the data for your additional dataset(s). When you click the submit button for your new dataset, it will populate the next row down in the 'Sheet3' spreadsheet.
- To close the form without transferring any of your data to the 'Sheet3' spreadsheet, hit the 'Cancel' button.
- **After you have submitted information on all of your available shrimp data, please save as SEDAR_ShrimpInventory_YourLastName (e.g. SEDAR_ShrimpInventory_Byrd.xls) and email to Julia Byrd (julia.byrd@safmc.net). When possible, please try to enter all data sets from a particular state or lab on one spreadsheet.**

TO EDIT EXISTING DATA ENTRIES - 5/12/2014

(Please see page 1 for instructions on how to enter new data.)

- Open the Excel file titled 'SEDAR_ShrimpInventory_3.6.2014. Open the worksheet titled 'Compiled'. This spreadsheet is a compilation of all of the information submitted as of 5/12/2014.
- **All edits to existing data entries MUST be done on the 'Compiled' worksheet NOT using the data entry form on 'Sheet2'.**
- Please review all of the information on the datasets you submitted.
- If you are aware of other datasets that are not represented in this inventory, please complete the data entry form (found on 'Sheet2') for these data, pass on the inventory to the individuals responsible for those datasets directly, or send Julia contacts for the datasets. **Please leave all information submitted on 'new' datasets in worksheet 'Sheet3', do not transfer this info to the 'Compiled' worksheet.**

TO SUBMIT EDITS

- **Use RED FONT for any edits you make to the 'Compiled' worksheet.**
- Please review all of the information on the datasets you submitted to ensure it accurately describes your data.
- Cells highlighted in yellow were either left blank or the information in the cell was altered during the spreadsheet compilation. Please be sure to look closely at the information in these cells to ensure it is correct. Primary reasons information was altered in cells during compilation are below:
    - 'End Year' – End year was left blank for many of the datasets identified as ongoing. If datasets ongoing, would like 2014 to be listed as end year and the 'ongoing' box checked. This allows current length of the dataset to be calculated easily.
    - Geographic Area – When the inventory was originally distributed, asked individuals to select the largest scale appropriate for your dataset. **To make data filtering easier, would like all appropriate geographic areas checked for each dataset (e.g. if you collect data in NC, SC, GA, and FL - please check the 'Regional - South Atlantic' box in addition to each state box**).
- Columns highlighted in gray are 'new' data fields on the inventory spreadsheet. **Please enter information on the new data fields directly into the 'Compiled' worksheet cells.** Explanation of the new data fields is below.
    - **AgencyName** - Enter the agency associated with the program, if applicable (e.g. SCDNR; see column A).
    - **ShrimpDisease** - Select whether or not your program collects information on shrimp disease (Yes = collect info on shrimp disease, No = do NOT collect info on shrimp disease; see column BE).

- **DiseaseType** - If yes to shrimp disease, please identify the types of diseases your program collects data on (see column BF). Multiple disease types can be included in the same cell.
- **Shrimp Sex** - Select whether or not your program collects information on shrimp sex/gender (Yes = collect info on shrimp gender, No = do NOT collect info on shrimp gender; see column BG).
- **WebsiteAvailability** - Select whether or not the data source is available online (Yes = can get dataset online, No = cannot get dataset online; see column BH).
- **WebAddress** - If yes to web availability, please list the corresponding web address (see column BI).
- **AdditionalComments** - Please list any additional comments you feel would be relevant for workshop participants to know about your dataset (column BJ).
- **CorrespondingDocument** - Please make sure the working paper or reference document included in this field corresponds to the dataset (column BK). As Julia receives additional reference documents and working papers, she will update this column on the spreadsheet.

- Please do a final check of your data to make sure the information in the 'Compiled' worksheet accurately represents your data program(s). (REMINDER – all edits MUST be made in red font.)
- **After you have edited information on the data you submitted, please save as SEDAR_ShrimpInventory_YourLastName (e.g. SEDAR_ShrimpInventory_Byrd.xls) and email to Julia Byrd (julia.byrd@safmc.net). When possible, please try to submit all edits from a particular state or lab on one spreadsheet.**

SEDAR Procedural Workshop 7: South Atlantic Shrimp Data Evaluation
ENVIRONMENTAL Inventory Spreadsheet Instructions
Updated: 6/6/2014

TO ENTER NEW DATA

(Please see page 3 for instructions on how to edit existing data entries.)

- Open the Excel file titled 'SEDAR_EnvironmentalInventory_6.6.2014. This file has macros and **in order to enter your data into the file you will need to enable the macros**.
- Click the 'EnvironmentalDataForm' button on 'Sheet2' to open the form to enter information about the dataset(s).
- The information below will walk you through the data form. This information is also available on 'Sheet2' of the Excel file.
- **Please complete the data form once for each of the datasets. If there have been significant changes to the dataset over time (e.g. if temperature data were originally collected daily and later in the time series were collected hourly) - please use two data entries to describe the dataset.**
- **Data form fields**
    - **Agency Name –** Enter the agency associated with the program, if applicable (e.g. United States Geological Survey).
    - **Program Name** - Enter the name of your data program (e.g. USGS Rainfall Data).
    - **Contact Name** - Enter the name of the contact person for your data program. Enter First Name, then Last Name (e.g. Joe Smith).
    - **Contact Email** - Enter the email address for the contact person (e.g. joesmith@data.com).
    - **Contact Phone** - Enter the phone number for the contact person (e.g. 843-571-1234).
    - **Web Availability** - Select whether or not the data source is available online (yes = can get dataset online, no = cannot get dataset online). If yes, please list the website in the corresponding text box.
    - **Data Confidentiality -** Select whether or not your dataset is confidential (yes = confidential, no = NOT confidential).
    - **Data Collection and Storage** - Select the button that best describes the entity responsible for collecting and storing the data from your program. Examples of the latter two options are below: 'Data collect/store by same program & store by additional partners' (e.g. state trip ticket program: data collected and stored by state and also stored by another partner, such as ACCSP); 'Data collect/store by different programs (e.g. South Atlantic Shrimp System: data collected by states and stored in NMFS database).
    - **Time Series: Start Year** - Enter the year your data program began collecting data. Please use a 4 digit year (e.g. 2000).

  - **Time Series: End Year** - Enter the year your data program stopped collecting data. If your program is currently collecting data, please enter 2014 as the end year and check the corresponding 'ongoing' box. Please use a 4 digit year (e.g. 2000).
  - **Fishing Area** - Check the boxes that best describe the fishing area(s) represented by your dataset. Check all applicable boxes.
  - **Geographic Area** - Check the box that best describes the geographic range of your data program. Please check all applicable boxes (e.g. if you collect data in NC, SC, GA, and FL - please check the 'Regional - South Atlantic' box in addition to each state box). If your data set focuses on a few specific water bodies within a state, please enter those into the water body text box.
  - **Environmental Data Available** - Check the boxes that describe the environmental data collected by the dataset. Check all applicable boxes. If you check the 'Other' box, please specify what 'other' represents in the corresponding text box.
  - **Data Frequency** - Please indicate the finest frequency of data collected by the data program. If you check the 'Other' box, please specify what 'other' represents in the corresponding text box.
  - **Additional Comments of Dataset** - Please list any additional information about the dataset that would be relevant for workshop participants.

- **Please check the data form to make sure the information you have entered accurately represents the data program.**
- If the information in the form is correct, please click the 'Submit' button. This button will transfer the information from your form into a row on the 'Sheet3' worksheet. You are welcome to review the data in this spreadsheet, but please DO NOT alter the information in these cells. If you made a mistake on the data form, simply delete the row representing your data and re-enter it on the form.
- To enter information for another dataset, please make sure the information from the first data sheet has transferred to the spreadsheet. If it has, then simply hit the 'Clear' button to clear the form and enter the data for your additional dataset(s). When you click the submit button for the new dataset, it will populate the next row down in the 'Sheet3' spreadsheet.
- To close the form without transferring any of your data to the 'Sheet3' spreadsheet, hit the 'Cancel' button.
- **After you have submitted information on all of your available environmental data, please save as SEDAR_EnvironmentalInventory_YourLastName (e.g. SEDAR_EnvironmentalInventory_Byrd.xls) and email to Julia Byrd (julia.byrd@safmc.net). When possible, please try to enter all data sets from a particular state or lab on one spreadsheet.**

TO EDIT EXISTING DATA ENTRIES - 6/6/2014

(Please see page 1 for instructions on how to enter new data.)

- Open the Excel file titled 'SEDAR_ EnvironmentalInventory_6.6.2014. Open the worksheet titled 'Compiled'. This spreadsheet is a compilation of all of the information submitted as of 6/6/2014.
- **All edits to existing data entries MUST be done on the 'Compiled' worksheet NOT using the data entry form on 'Sheet2'.**
- Please review all of the information on the datasets you submitted.
- If you are aware of other datasets that are not represented in this inventory, please complete the data entry form (found on 'Sheet2') for these data, pass on the inventory to the individuals responsible for those datasets directly, or send Julia contacts for the datasets. **Please leave all information submitted on 'new' datasets in worksheet 'Sheet3', do not transfer this info to the 'Compiled' worksheet.**

TO SUBMIT EDITS

- **Use RED FONT for any edits you make to the 'Compiled' worksheet.**
- Please review all of the information on the datasets you submitted to ensure it accurately describes your data.
- Cells highlighted in yellow were either left blank or the information in the cell was altered during the spreadsheet compilation. Please be sure to look closely at the information in these cells to ensure it is correct. Primary reasons information was altered in cells during compilation are below:
    - Program Name and/or contact information – Contact information was left blank for many of the datasets (assume this is because it was not available). I've added 'NA' to the cells to indicate when contact info is not available. Please correct as necessary.
    - 'End Year' – End year was left blank or was listed as 2013 for many of the datasets identified as ongoing. If datasets ongoing, would like 2014 to be listed as end year and the 'ongoing' box checked. This allows current length of the dataset to be calculated easily.
    - Corresponding Document – This is a new column that was added to the spreadsheet. Please make sure the working paper or reference document included in this field corresponds to the dataset (column AT). As Julia receives additional reference documents and working papers, she will update this column on the spreadsheet.
- Please do a final check of your data to make sure the information in the 'Compiled' worksheet accurately represents the data program(s). (REMINDER – all edits MUST be made in red font.)
- **After you have edited information on the data you submitted, please save as SEDAR_EnvironmentalInventory_YourLastName (e.g. SEDAR_EnvironmentalInventory_Byrd.xls) and email to Julia Byrd (julia.byrd@safmc.net). When possible, please try to submit all edits from a particular state or lab on one spreadsheet.**

Appendix 2:

Shrimp Monitoring and Management Presentations

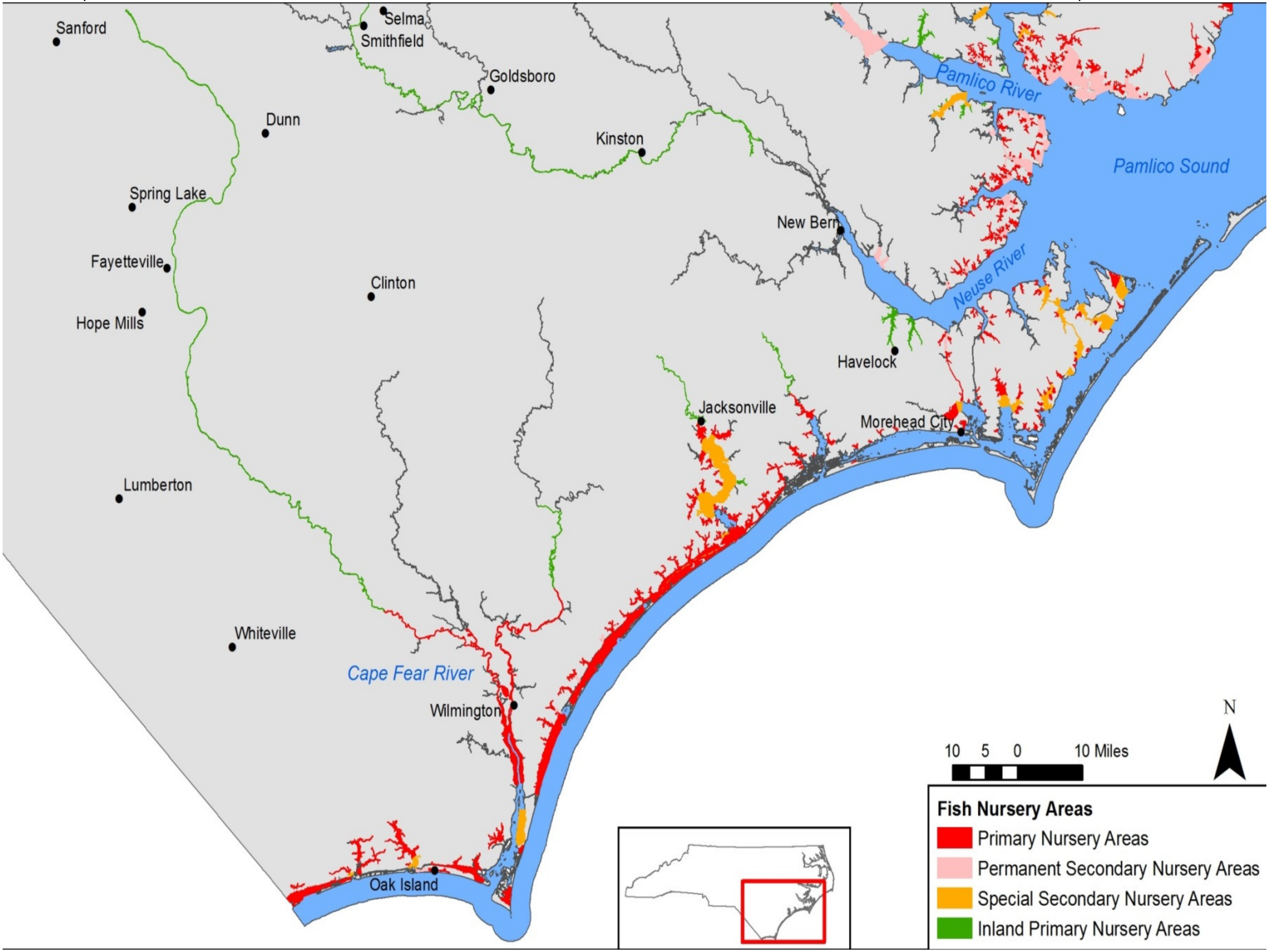

Shrimp Monitoring and Management in North Carolina
Trish Murphey
Kevin Brown
NC Division of Marine Fisheries
NORTH CAROLINA MARINE FISHERIES

NC Shrimp Management

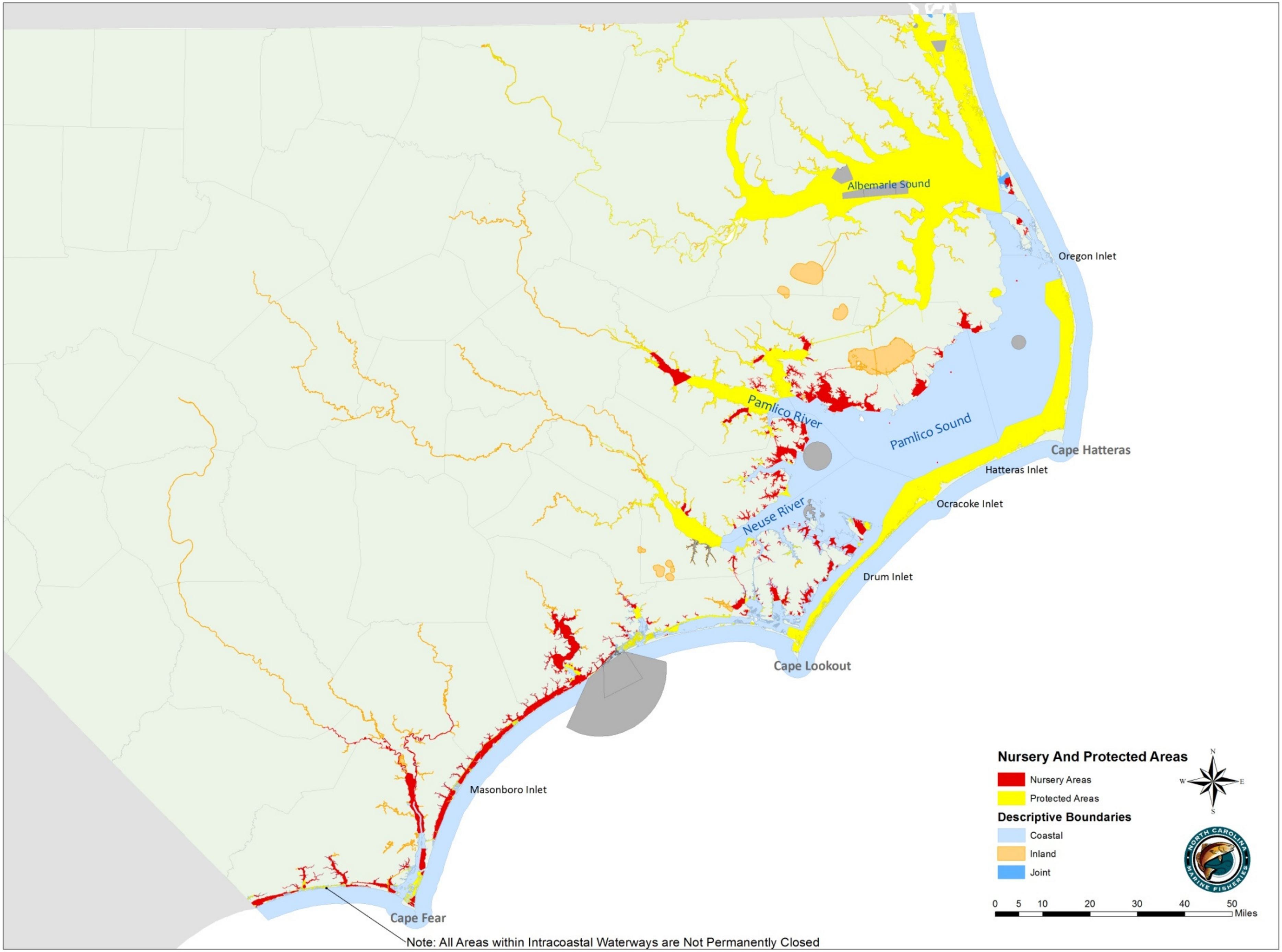
- Three Species of Shrimp
  - Brown Shrimp
  - White Shrimp
  - Pink Shrimp
- Estuarine and Ocean Fishery
- Commercial Gears
  - Otter Trawls
  - Skimmer Trawls
  - Channel Nets
- Recreational Gears
  - Otter Trawls
  - Seines
  - Cast Nets
- Proclamation Authority
  - Specify time, area, means and methods, season, size and quantity

The Early Days

- Migration
  - Offshore and southerly
- Growth
  - Rapid during juvenile
  - Declined at larger sizes
- Total Mortality
  - Computed weekly rates of reduction
- Critical Nursery Habitat

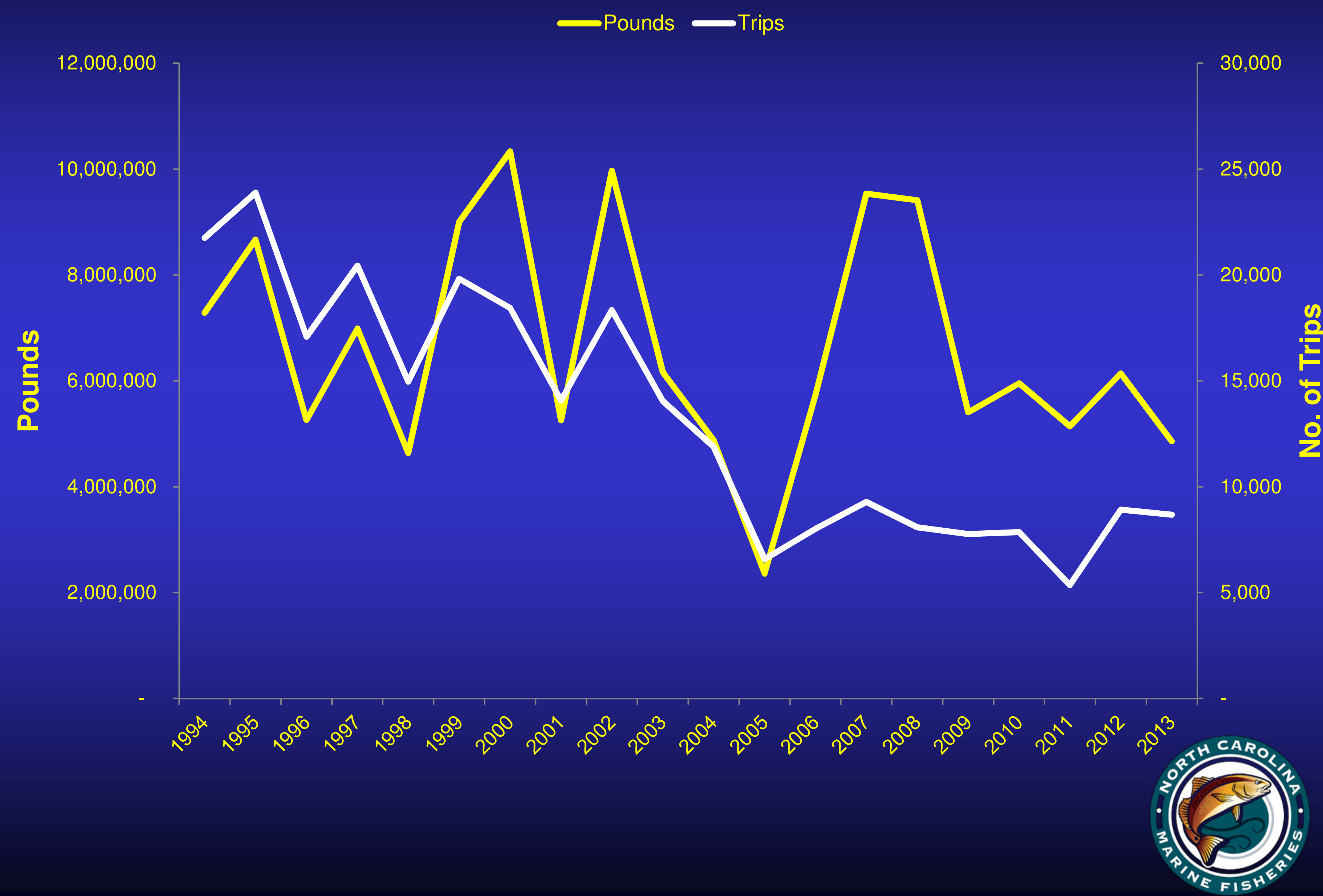


Sanford
Selma
Smithfield
Goldsboro
Dunn
Kinston
Pamlico River
Pamlico Sound
Spring Lake
New Bern
Neuse River
Fayetteville
Clinton
Hope Mills
Havelock
Jacksonville
Morehead City
Lumberton
Whiteville
Cape Fear River
Wilmington
Oak Island
10 5 0 10 Miles
N
Fish Nursery Areas
Primary Nursery Areas
Permanent Secondary Nursery Areas
Special Secondary Nursery Areas
Inland Primary Nursery Areas



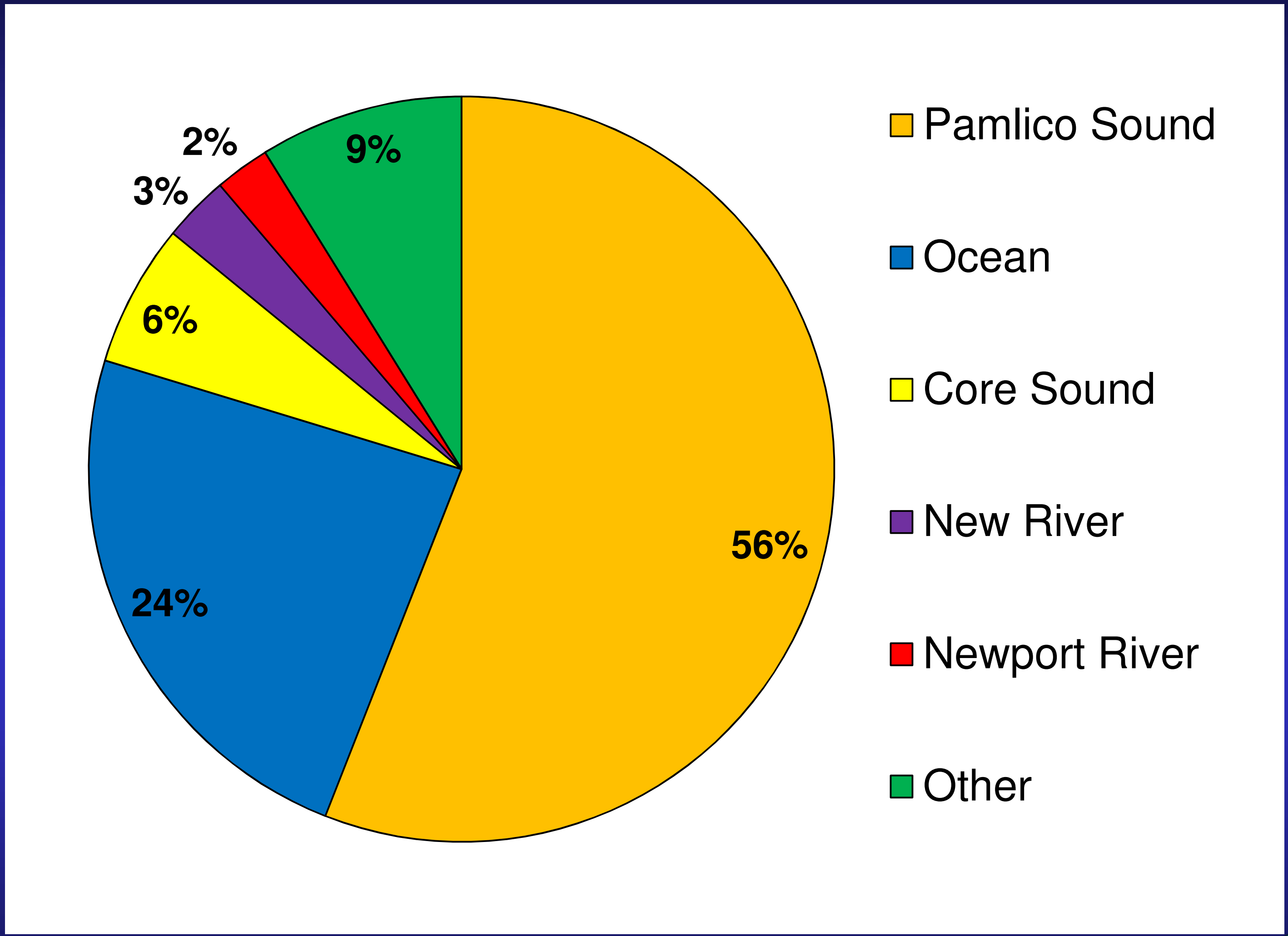
Albemarle Sound
Oregon Inlet
Pamlico River
Pamlico Sound
Cape Hatteras
Hatteras Inlet
Ocracoke Inlet
Neuse River
Drum Inlet
Cape Lookout
Masonboro Inlet
Cape Fear
Note: All Areas within Intracoastal Waterways are Not Permanently Closed
Nursery And Protected Areas
Nursery Areas
Protected Areas
Descriptive Boundaries
Coastal
Inland
Joint
0 5 10 20 30 40 50
Miles

NC Landings



Pounds
Trips
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
-
30,000
25,000
20,000
15,000
10,000
5,000
-
Pounds
No. of Trips
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
NORTH CAROLINA MARINE FISHERIES

Landings by Water Body



2006 Fishery Management Plan Management Strategies

- Issues
  - Trawling and bycatch
  - User Conflict
- Outcomes
  - Area closures
  - Gear restrictions
  - RGCL gears
  - Recreational limit

Amendment 1

Motion by the NCMFC:

Amend the Shrimp Fishery Management Plan but limit the scope of the amendment to bycatch issues in the commercial and recreational fisheries

Bycatch Issues

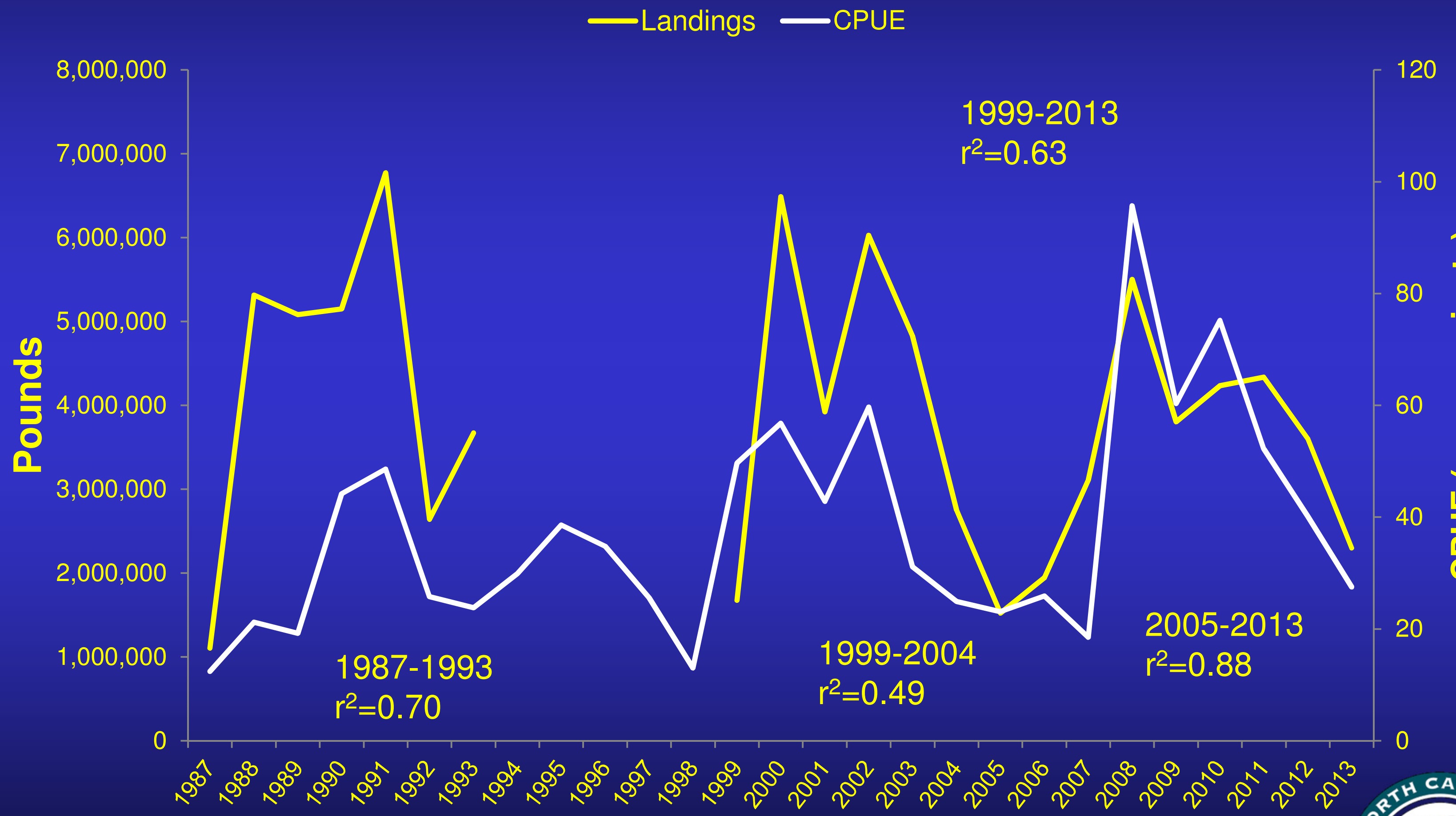
- Area Restrictions
- Fleet Restrictions
- Effort Management
- Other Fishing Gears
- New River Skimmer Trawl Fishery
- Bait Shrimp Fishery
- TEDs in Skimmer Trawls
- Gear Modifications

Brown Shrimp Harvest Model

- Pamlico Sound
- Salinity and Temperature
  - Late April through late May
- Growth Rates
- Other Variables
  - Wind
  - Precipitation
  - Air Temperature
  - Heating Degree Days
  - River Discharge

Brown Shrimp Landings

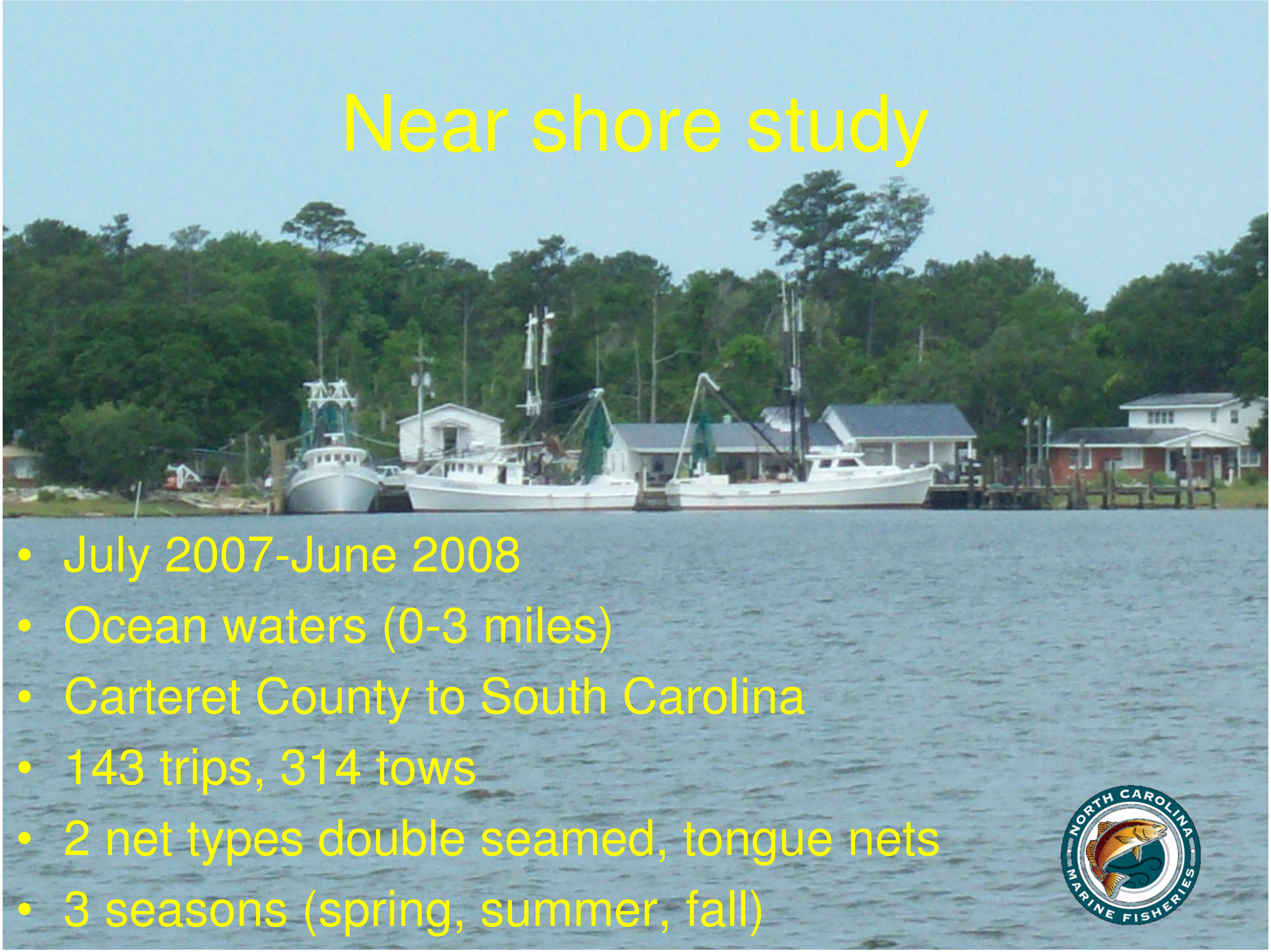
$r^2=0.50$

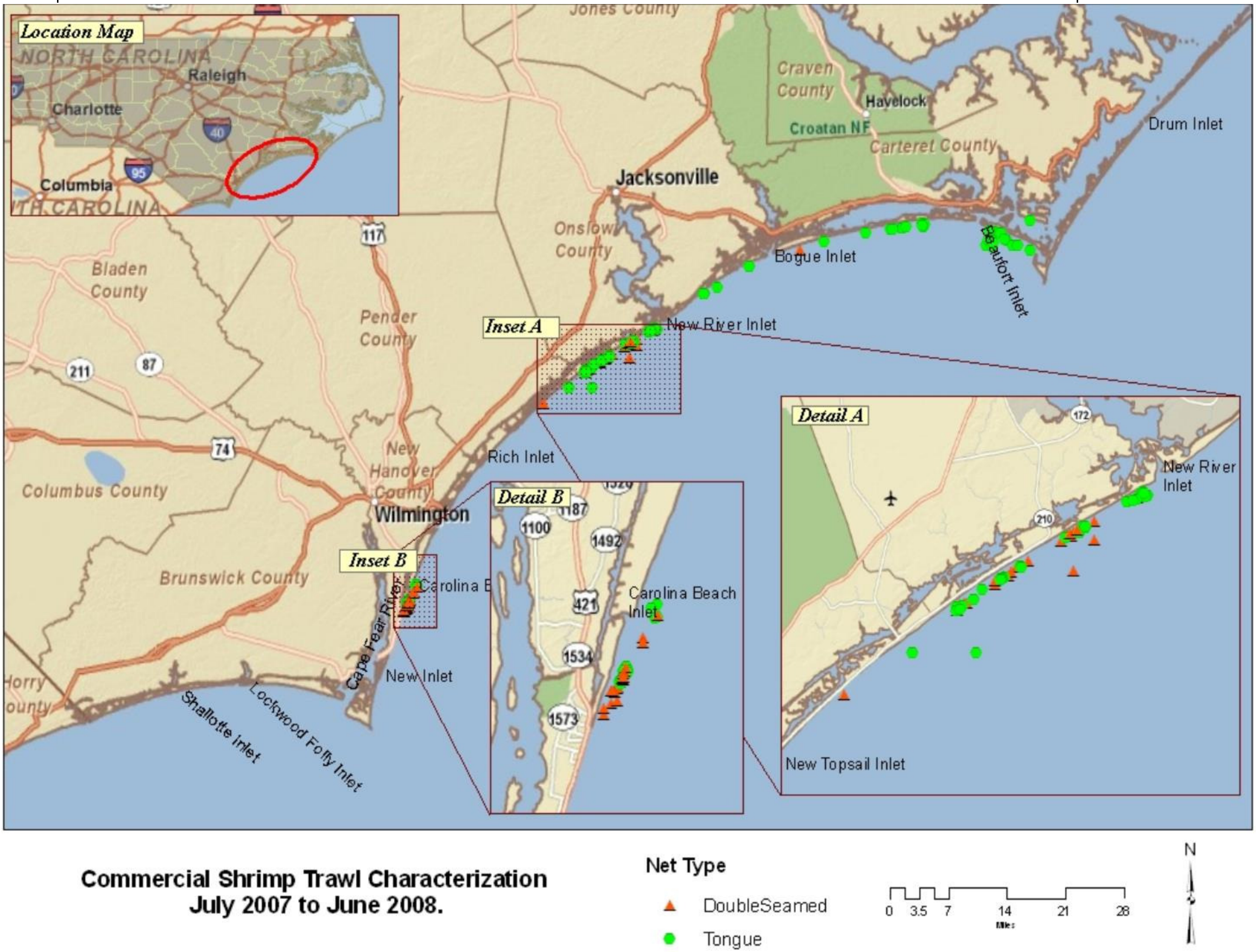


Shrimp Trawl Characterization And Gear Testing (Program 570)

- One year near shore fishery
- Six month Pamlico sound
- Current three year statewide
- BRD testing

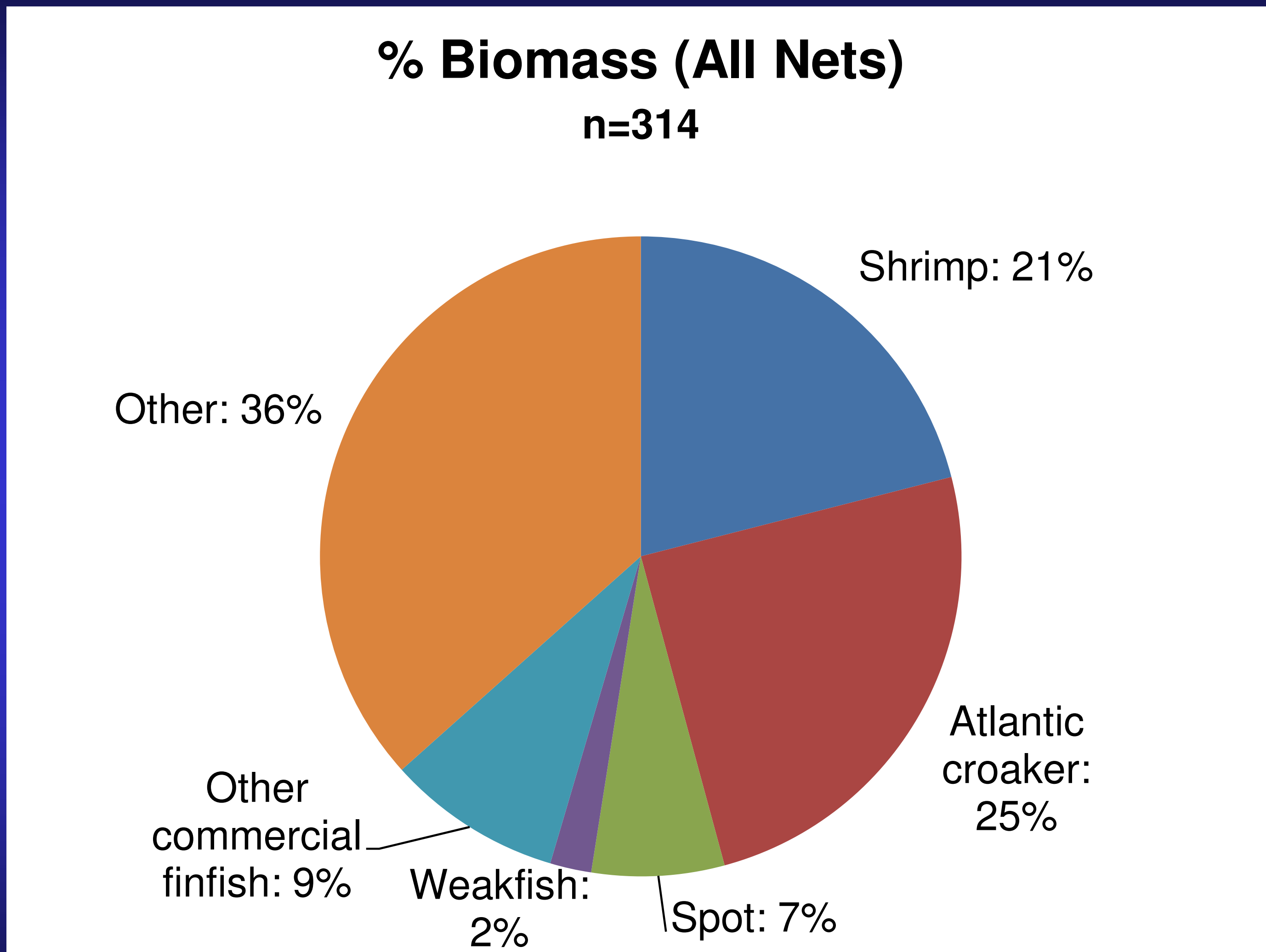
NORTH CAROLINA MARINE FISHERIES

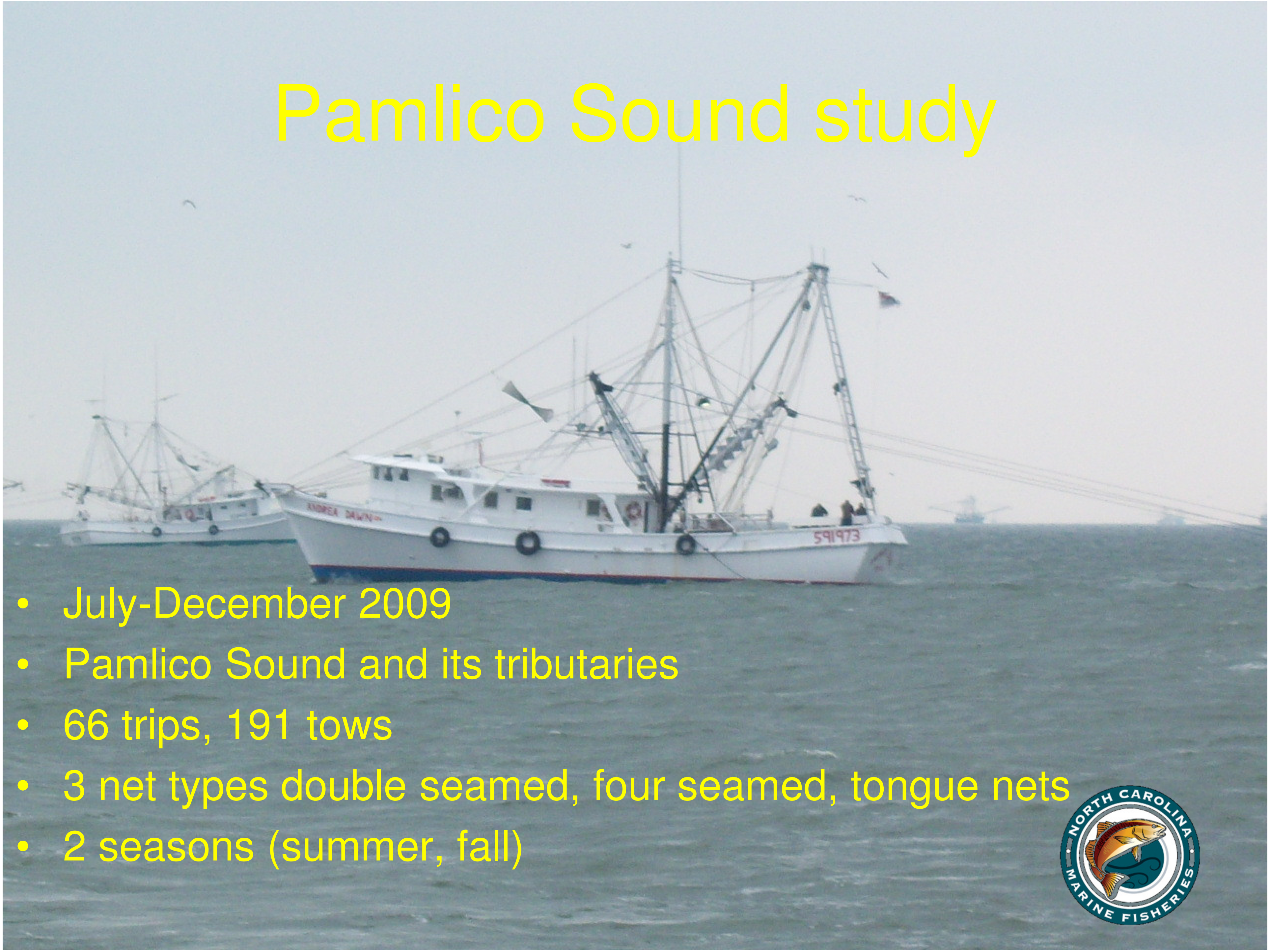

Near shore study
• July 2007-June 2008
• Ocean waters (0-3 miles)
• Carteret County to South Carolina
• 143 trips, 314 tows
• 2 net types double seamed, tongue nets
• 3 seasons (spring, summer, fall)
NORTH CAROLINA
MARINE FISHERIES

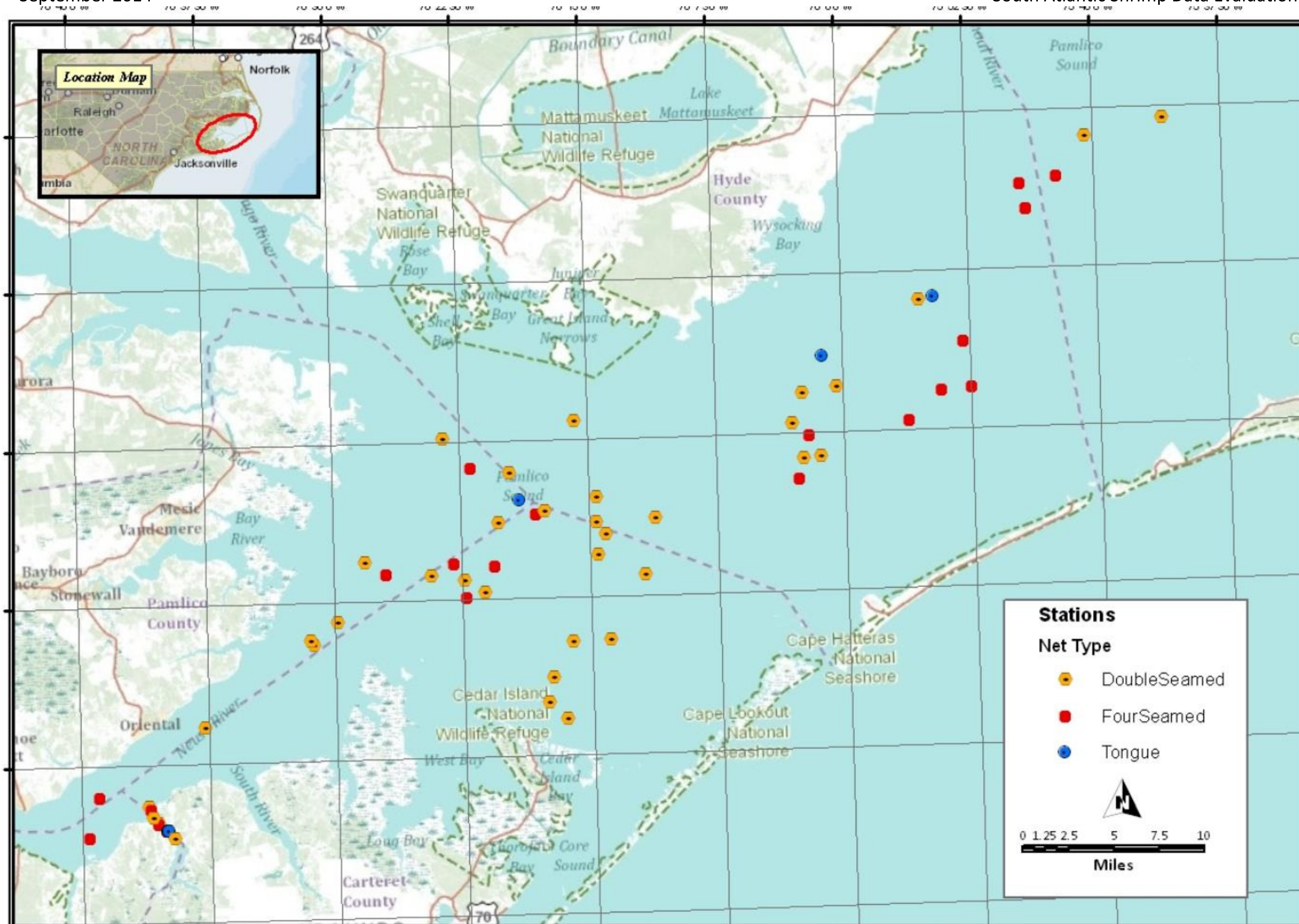


Commercial Shrimp Trawl Characterization
July 2007 to June 2008.

Species Composition

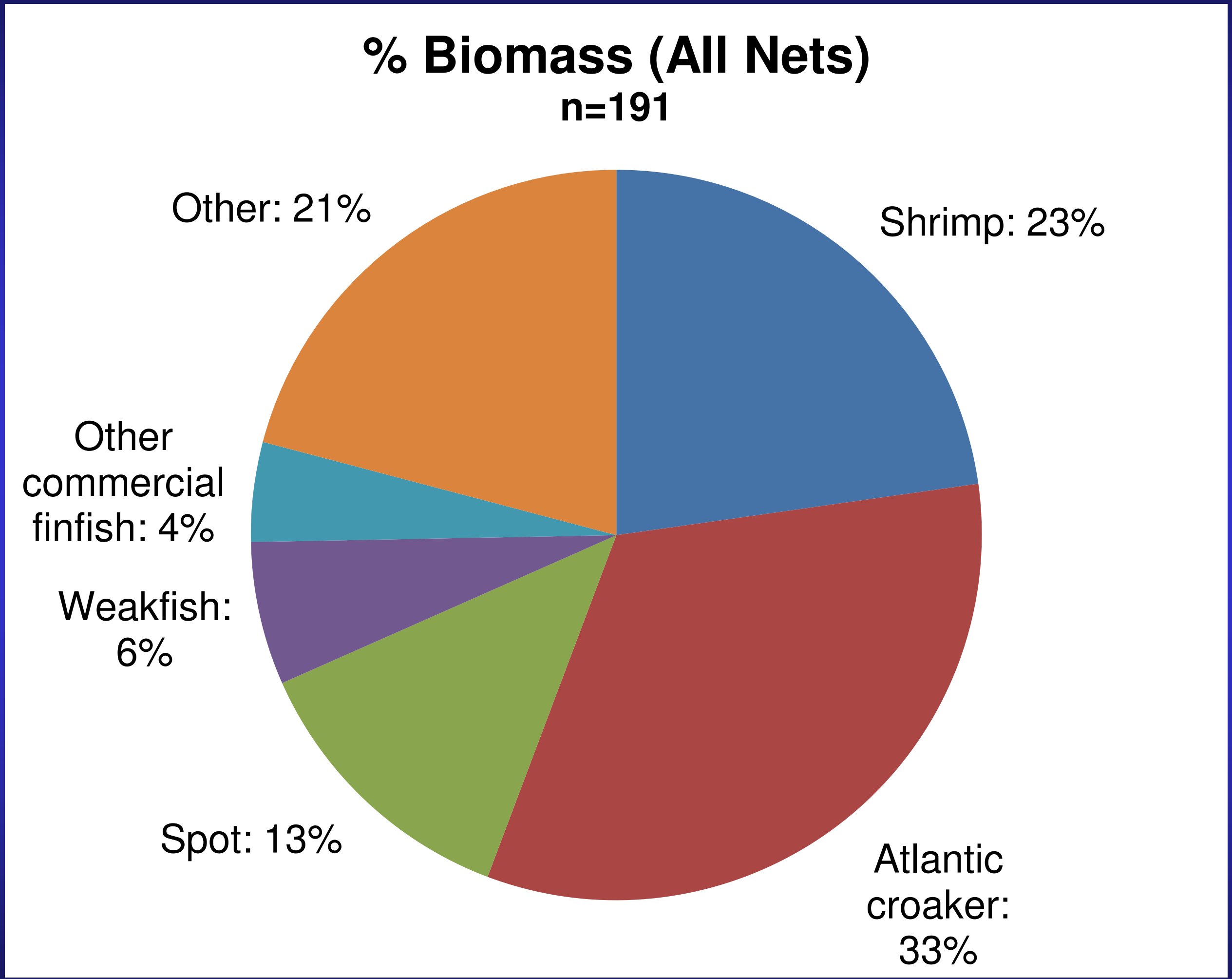


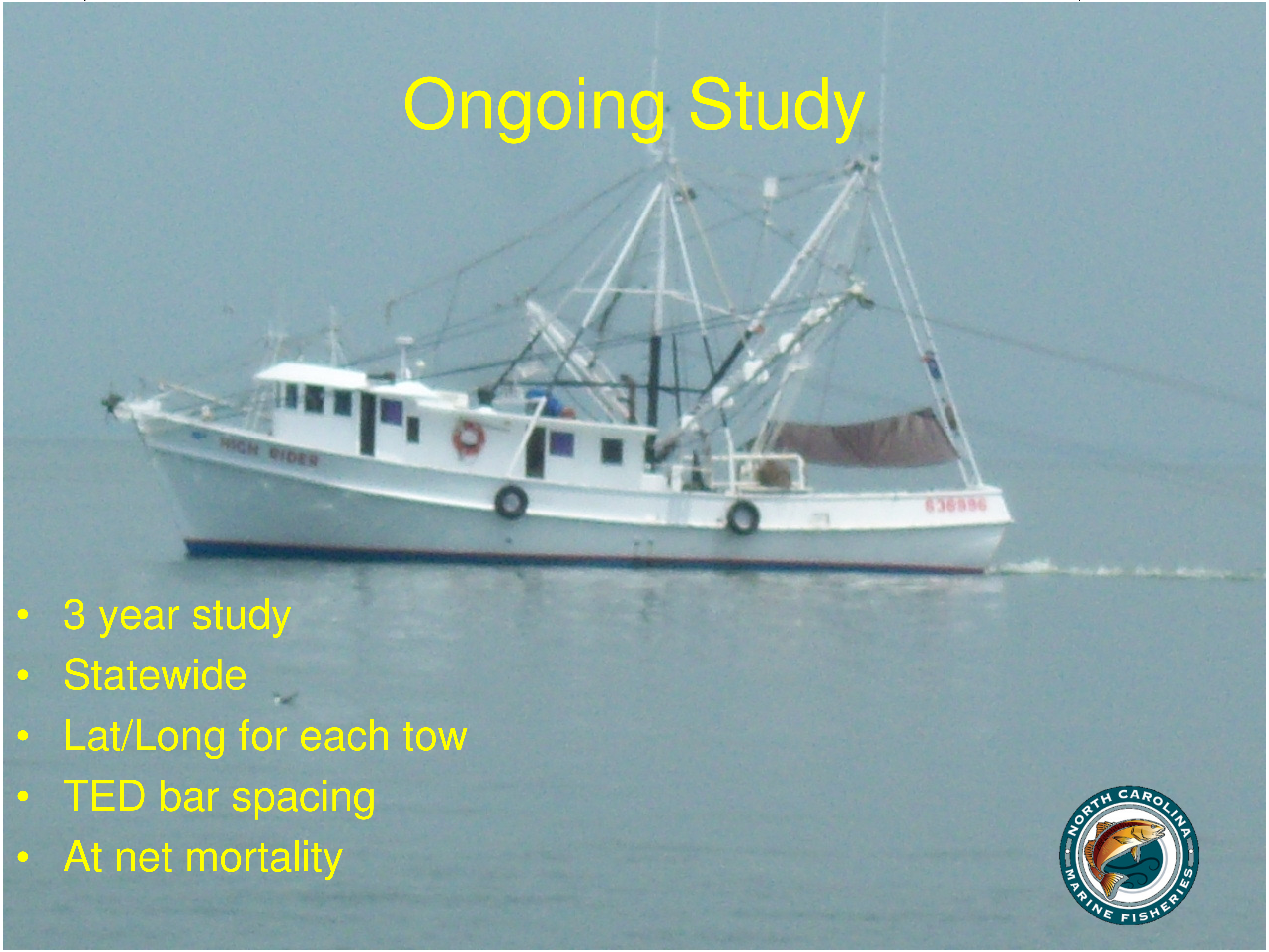

Pamlico Sound study
• July-December 2009
• Pamlico Sound and its tributaries
• 66 trips, 191 tows
• 3 net types double seamed, four seamed, tongue nets
• 2 seasons (summer, fall)
NORTH CAROLINA MARINE FISHERIES

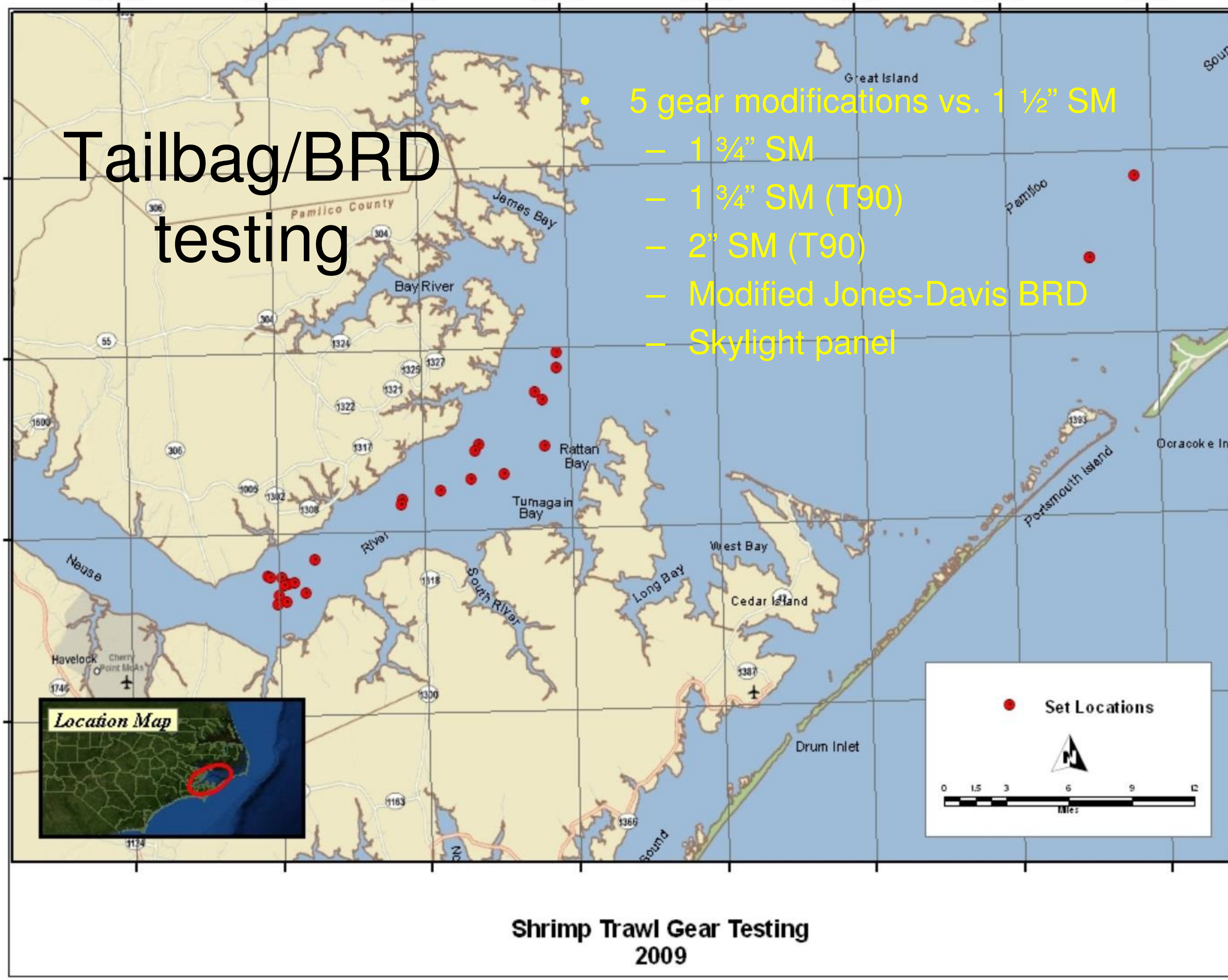


Pamlico Sound Shrimp Trawl
Characterization Study

Species Composition



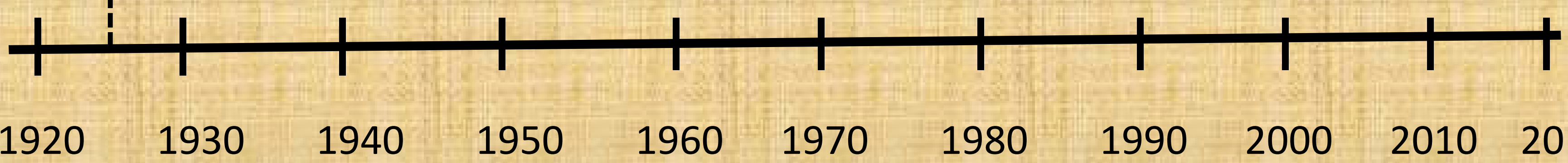

Ongoing Study
• 3 year study
• Statewide
• Lat/Long for each tow
• TED bar spacing
• At net mortality

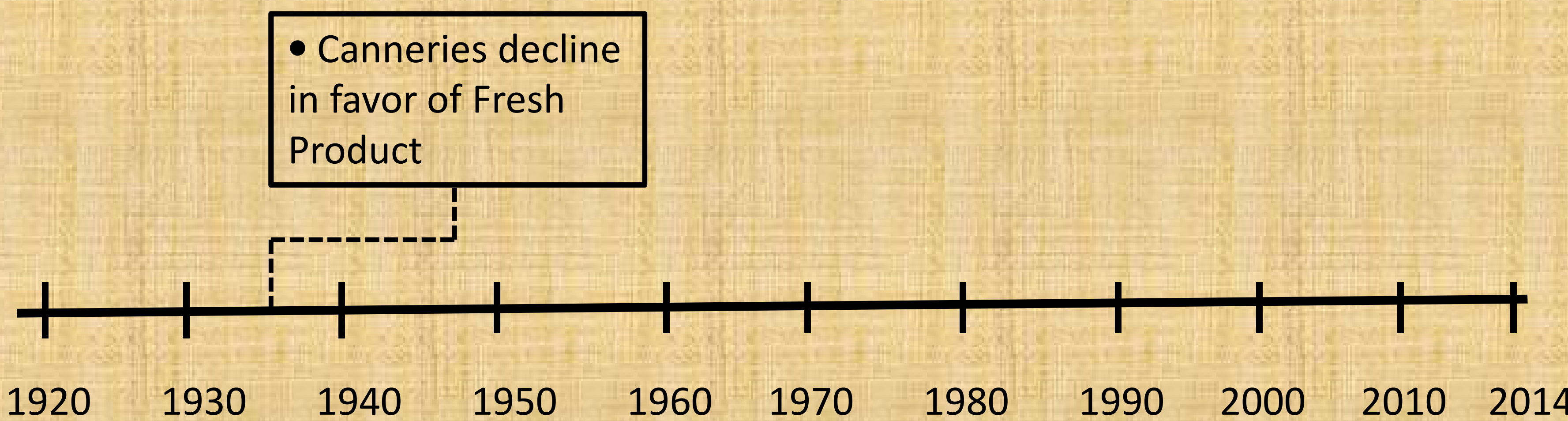

Tailbag/BRD testing
• 5 gear modifications vs. 1 ½" SM
– 1 ¾" SM
– 1 ¾" SM (T90)
– 2" SM (T90)
– Modified Jones-Davis BRD
– Skylight panel
Great Island
Pamlico County
James Bay
Bay River
Pamlico
Rattan Bay
Tumagain Bay
Neuse
River
South River
West Bay
Long Bay
Cedar Island
Portsmouth Island
Ocracoke In
Havelock
Drum Inlet
Sound
Location Map
Set Locations
0 1.5 3 6 9 12
Miles
Shrimp Trawl Gear Testing
2009


Questions?
Kevin.H.Brown@ncdenr.gov 252-808-8089
Trish.Murphey@ncdenr.gov 252-808-8091
NORTH CAROLINA MARINE FISHERIES


Monitoring and Management of the SC Shrimp Fishery
David Whitaker and Larry DeLancey
SOUTH CAROLINA
DEPARTMENT OF NATURAL RESOURCES
DNR

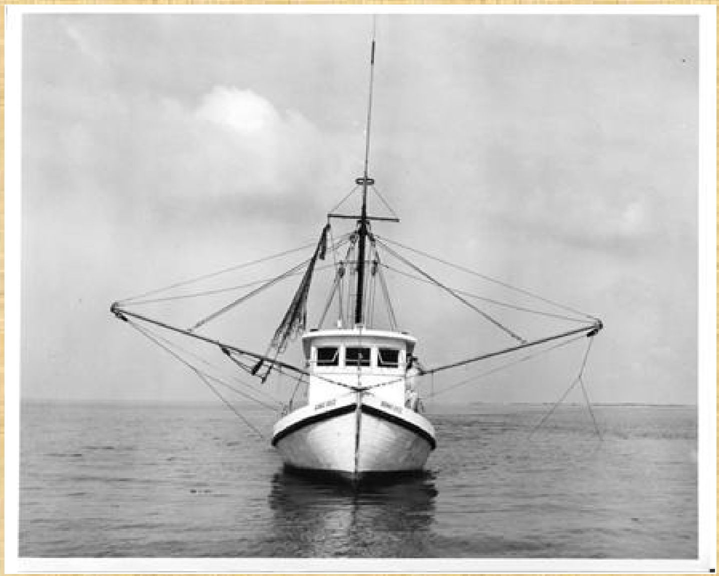
- Gasoline Engines
- Single nets
- Some Winches



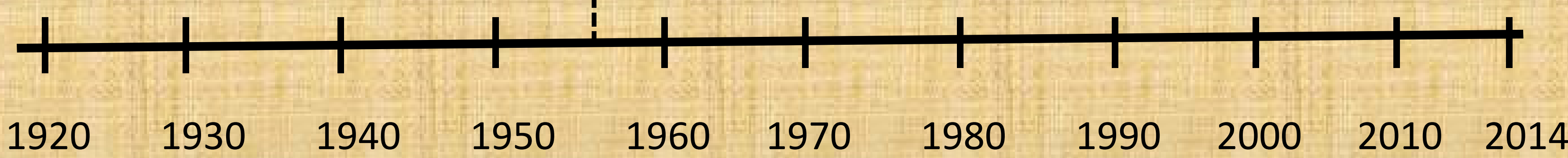

• Canneries decline in favor of Fresh Product
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2014

- Larger “Florida Trawlers” with Diesel Engines Emerge
- Sounds Opened to Trawling during WWII

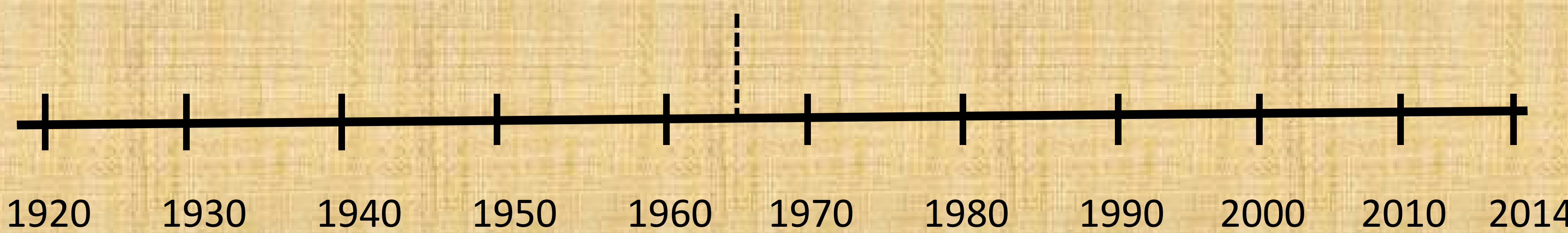
1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 2014

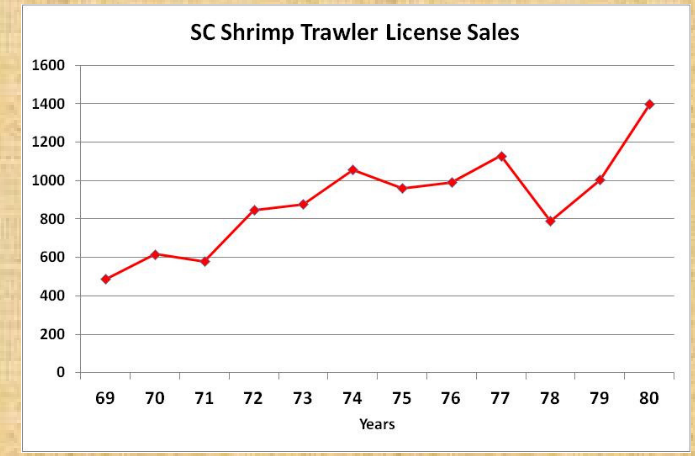


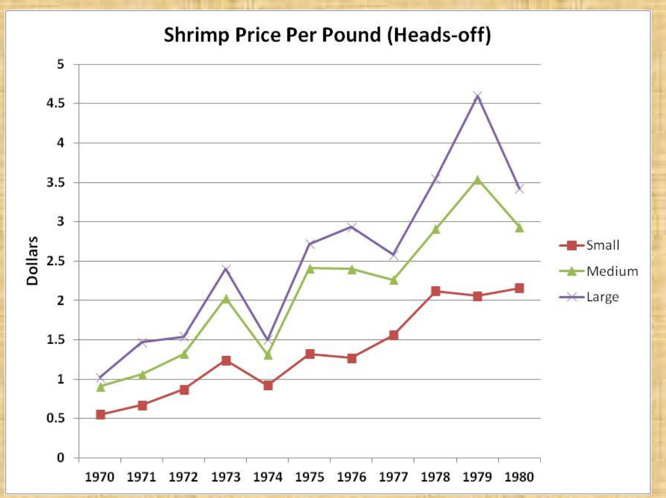
- Double Rigged Trawlers begin to Dominate
- Beginning in 1953, Sounds opened to trawling on Sept 1.
- Shrimp Farming Experiments begin in SC
- Law Enacted in 1956 to allow trawling in Sounds Aug 15- Dec 15



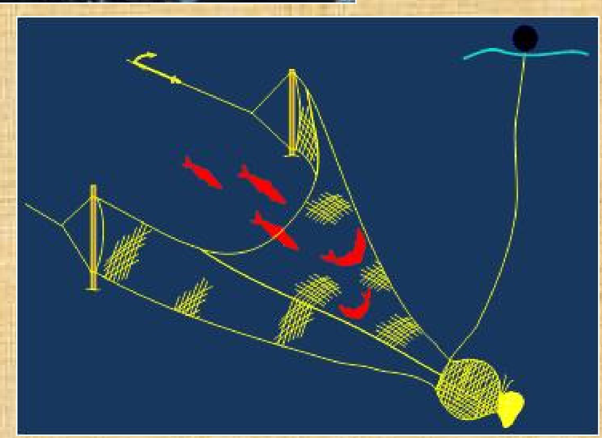
• Cold Winters and Poor Catches Thwart Growth in the SC Fishery

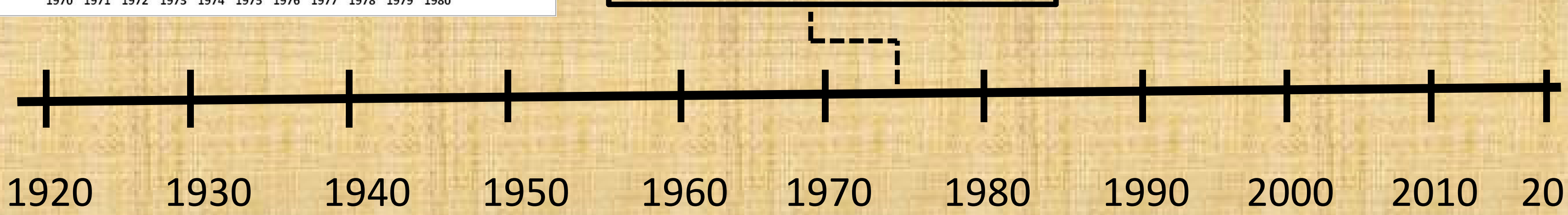


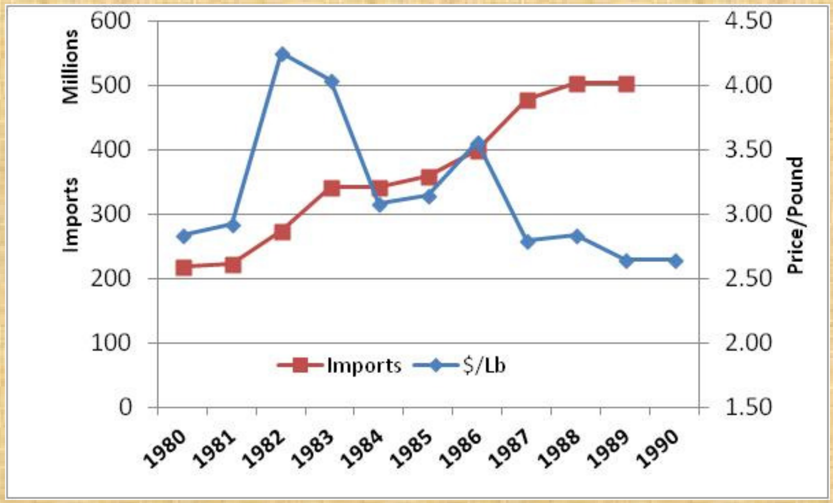




•Prices Rise quickly, Industry Grows
• License Sales Triple
•States seek Closure of Federal Waters during Winter
• Concerns about Sea Turtle Mortality Grow
•Channel Net Fishery Begins
• Marine Division Created

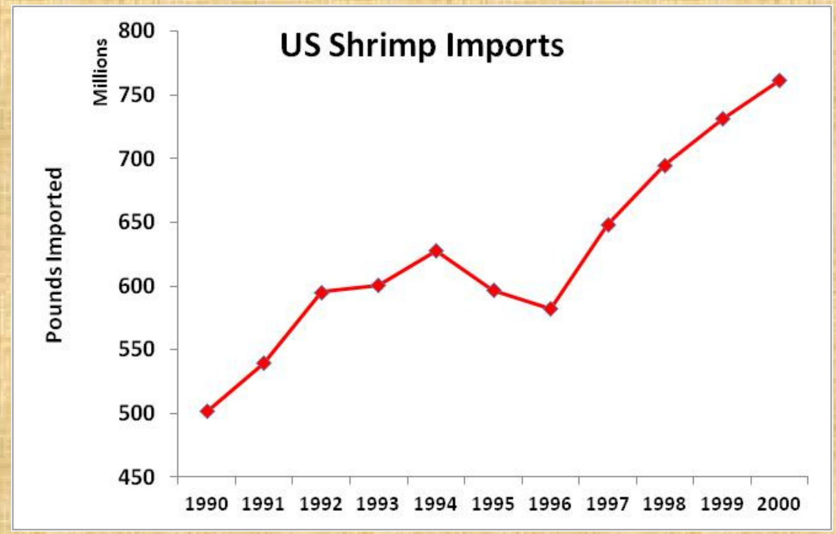




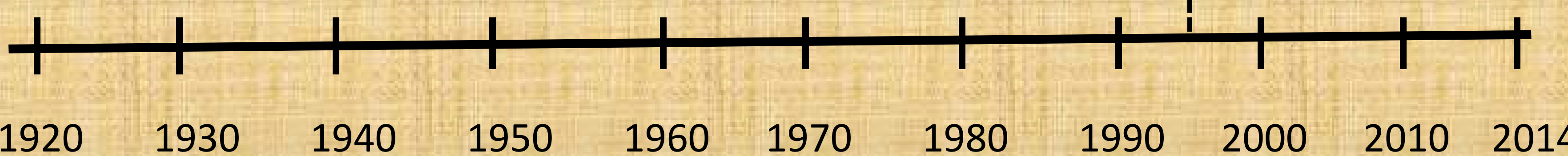


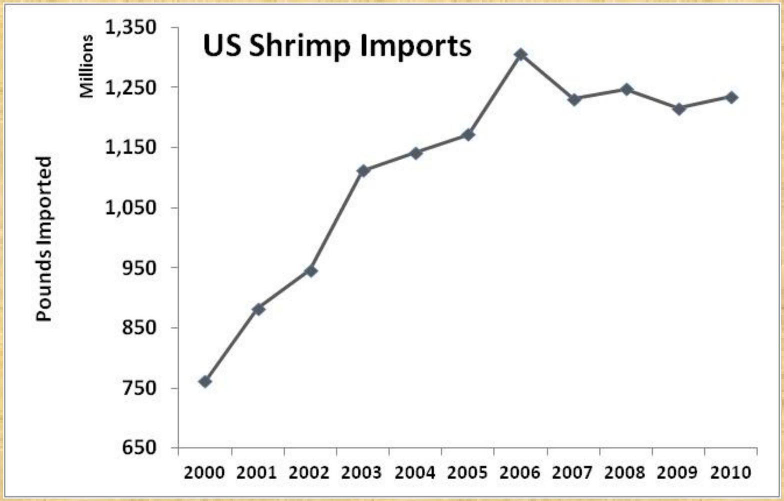
- Shrimp Seining Study
- Shrimp Baiting Begins 1984; licensed in 1988
- Imports Grow Rapidly
- Sounds Closed to Trawling in 1986
- Turtle Excluders First Required

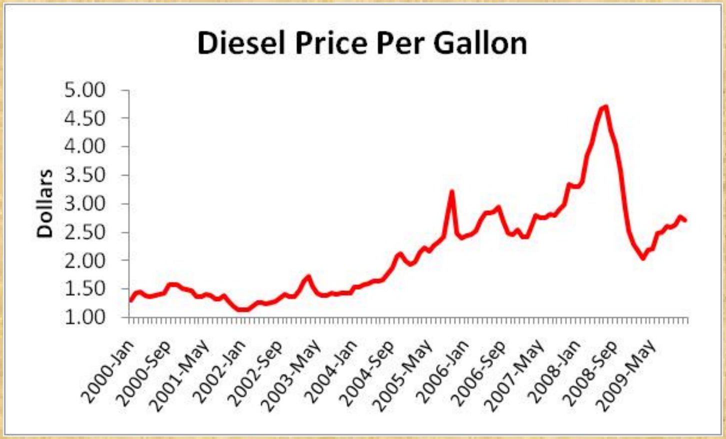
1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 2014



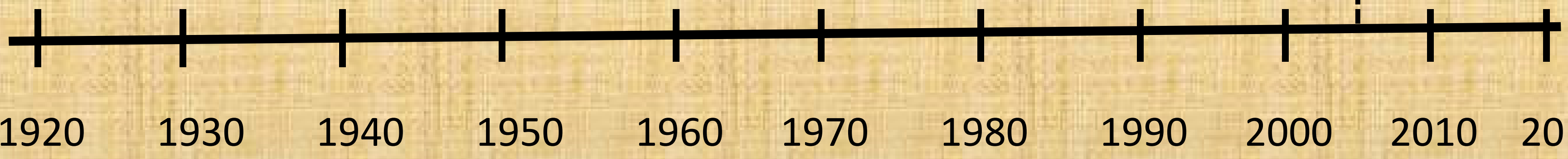
- **Bycatch Reduction Devices Required**
- **Imports Soar**

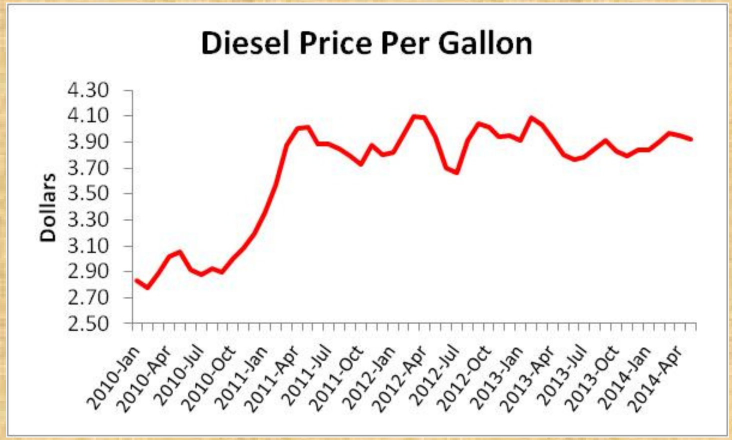




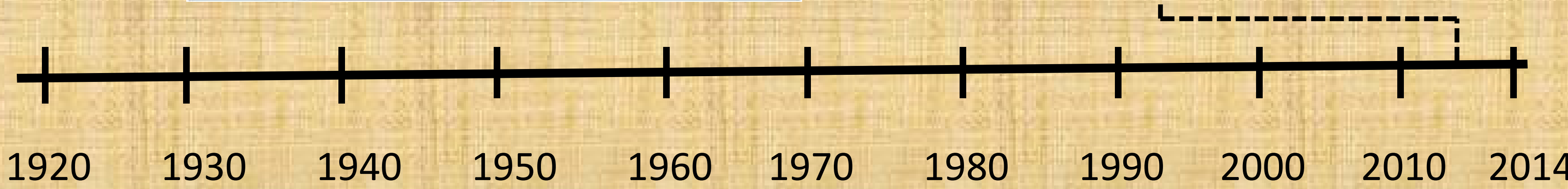


- **Shrimp effort Data Collected**
- **Diesel Prices Rise**
- **Deep Hole Shrimping begins**
- **Imports Peak**
- **License Required for Recreational Shrimping**





- **Invasive Shrimp More Common**
- **Diesel Remains High**
- **Shrimp Prices Climbing**



Fishery-Independent Shrimp Monitoring in South Carolina

- **Plankton Sampling**
- Juvenile Trawling
- Estuarine Trawling
- SEAMAP Trawling
- Preseason Commercial Boats

- 1974-2001
- 1-m Nets
- 1-hour soaks
- Feb-June

Fishery-Independent Shrimp Monitoring in South Carolina

- Plankton Sampling
- **Juvenile Trawling**
- Estuarine Trawling
- SEAMAP Trawling
- Preseason Commercial Boats

- 1978-Present
- 10-ft Trawl; ¼-in mesh
- 5-min tow
- Mostly Chas. Harbor Area Creeks
- May - early August

Fishery-Independent Shrimp Monitoring in South Carolina

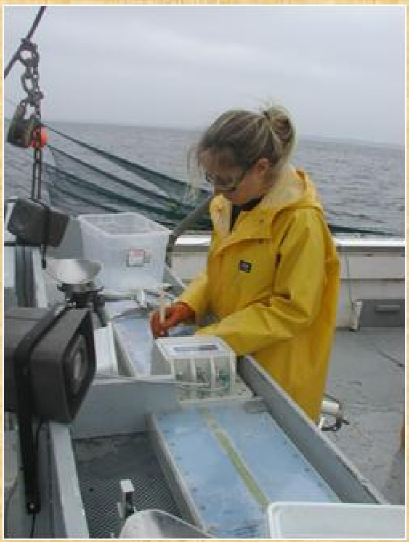
- Plankton Sampling
- Juvenile Trawling
- **Estuarine Trawling**
- SEAMAP Trawling
- Preseason Commercial Boats

- 1974-Present
- 20-ft Trawls; 1-in mesh
- 15-min tow
- Chas. Harbor 1-2/mo.; 4 state-wide cruises

Fishery-Independent Shrimp Monitoring in South Carolina

- Plankton Sampling
- Juvenile Trawling
- Estuarine Trawling
- **SEAMAP Trawling**
- Preseason Commercial Boats

- 1990-Present
- two 75- Trawls; 1.875/1.625 Stretch mesh
- 20-min tow
- 4-10 m depth Zone Offshore
- Spring/Summer/Fall



Fishery-Independent Shrimp Monitoring in South Carolina

- Plankton Sampling
- Juvenile Trawling
- Estuarine Trawling
- SEAMAP Trawling
- **Preseason Commercial Boats**

- 1974-Present
- Late April and May
- Usually 30-60 min tows
- Covers most of the state with multiple boats.

Fishery-Dependent Shrimp Monitoring in South Carolina

- **Landings Reports**
  - Detailed/reliable Landings begins ~ 1974
  - "Ticket system" with daily effort starts in 2002
  - Species/size composition data could be better
- **Shrimp Baiting Survey**
- **Pre-season Channel Net Sets**
- **Oral Reports From Shrimpers/Divers/Crabbers**

Fishery-Dependent Shrimp Monitoring in South Carolina

- Landings Reports
- **Shrimp Baiting Survey**
  - Annual post-season mail survey 1988-present
  - Randomly selected subset of fishermen are sent survey cards
  - Provides total effort, total catch by general area
  - Provides average catch per fisherman
- Pre-season Channel Net Sets
- Oral Reports From Shrimpers/Divers/Crabbers

Fishery-Dependent Shrimp Monitoring in South Carolina

- Landings Reports
- **Shrimp Baiting Survey**
- **Pre-season Channel Net Sets**
- **Oral Reports From Shrimpers/Divers/Crabbers**

- Two or three nets set before the season to assess Shrimp Size and Abundance
- Biologists monitor fishing and examine the Catch

Fishery-Dependent Shrimp Monitoring in South Carolina

- Landings Reports
- Shrimp Baiting Survey
- Pre-season Channel Net Sets
- **Oral Reports From Shrimpers/Divers/Crabbers**

- Shrimpers provide observations – particularly when unusual events occur
- During unusually cold winters, crabbers and divers will provide reports on shrimp mortality.

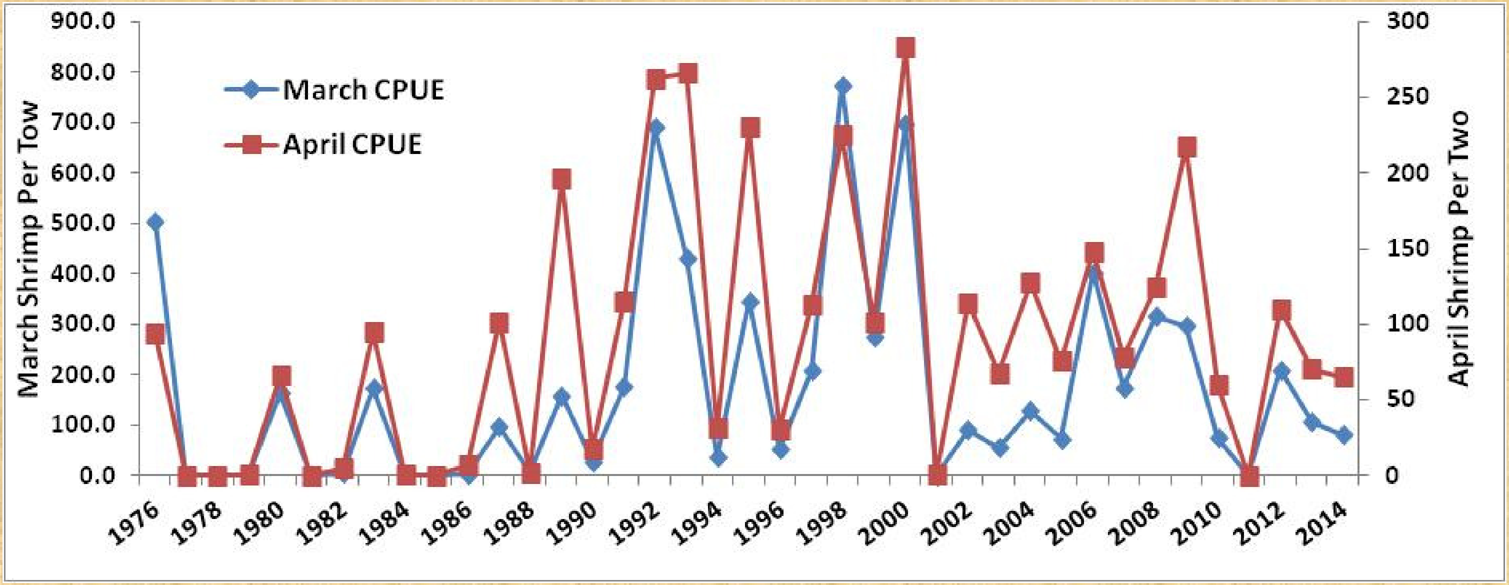
Shrimp Assessment and Monitoring

- **Winter Conditions**

	DECEMBER	JANUARY	FEBRUARY	April CPUE	SC Spring Roe Shrimp landings (1,000's)
1976				93.8	666
1977				0	0
1978				0	0
1979				0.4	28
1980				66.5	243
1981				0	2
1982				4.8	35
1983				94.9	230
1984				0.4	1
1985				0	3
1986				6.9	21
1987				101.7	304
1988				2.3	5
1989				196.1	398
1990				17.9	25
1991				115.4	837
1992				262.6	618
1993				265.9	826
1994				31.2	92
1995				230	890
1996				30.7	62
1997				112.9	462
1998				224.8	800
1999				101.6	600
2000				282.8	875
2001				0.4	1
2002				114.4	296
2003				67.9	100
2004				127.7	324
2005				75.5	90
2006				148.3	524
2007				78.3	364
2008				124.5	352
2009				217.2	320
2010				59.8	203
2011				0	11
2012				110.1	481
2013				70.6	350
2014					

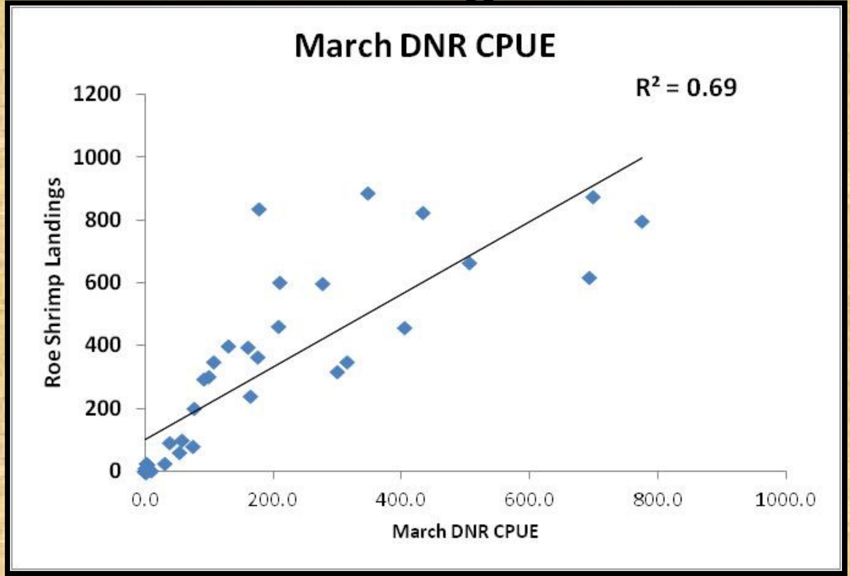
Shrimp Assessment and Monitoring

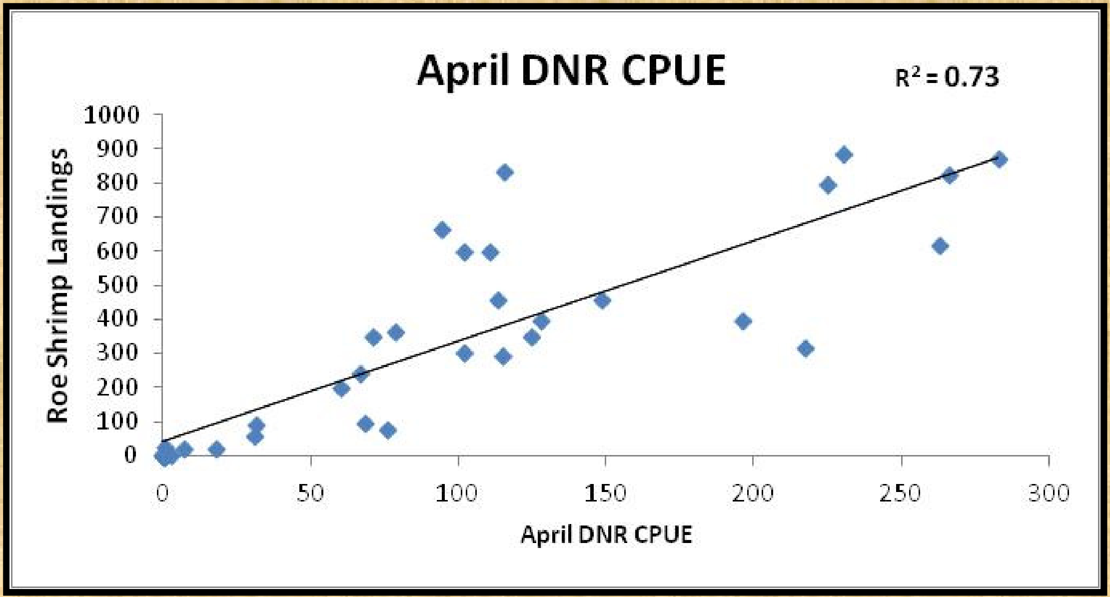
- Winter Conditions
- **Mar/Apr Estuarine Trawling**



Shrimp Assessment and Monitoring

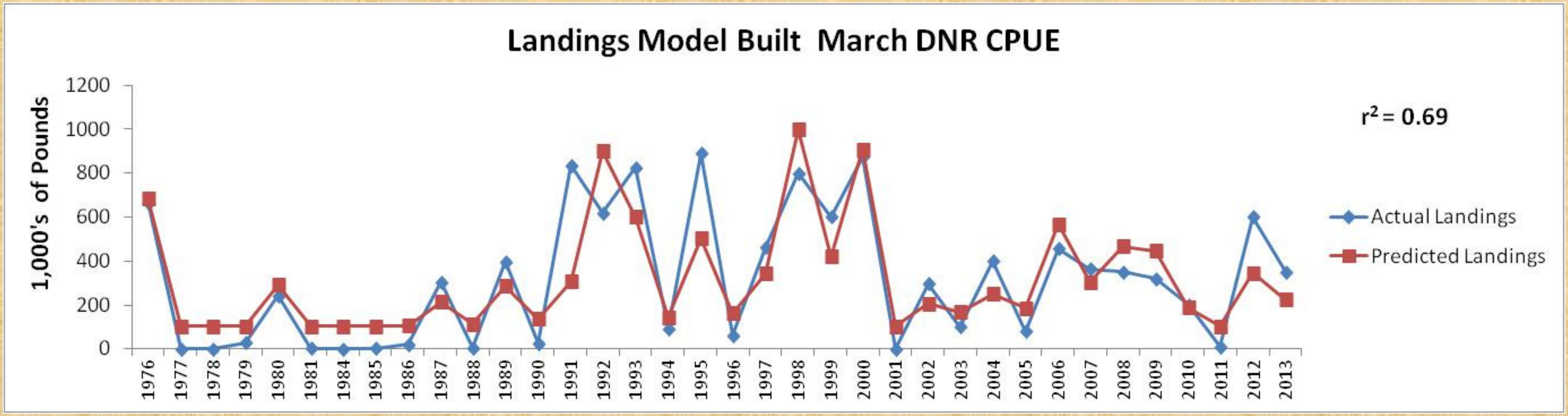
- Winter Conditions
- **Mar/Apr Estuarine Trawling**

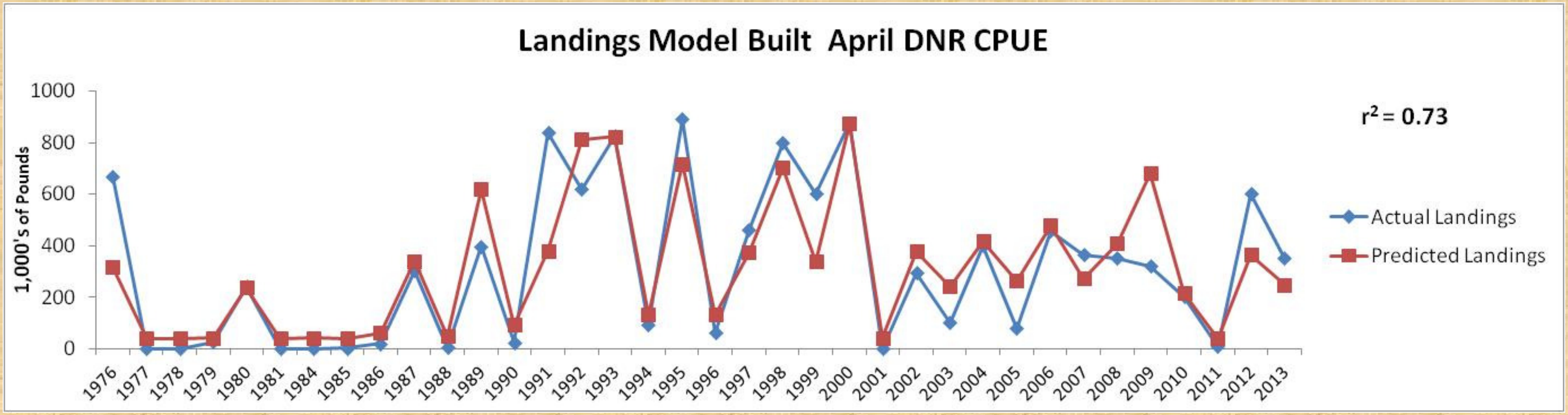




Roe Shrimp Assessment and Monitoring

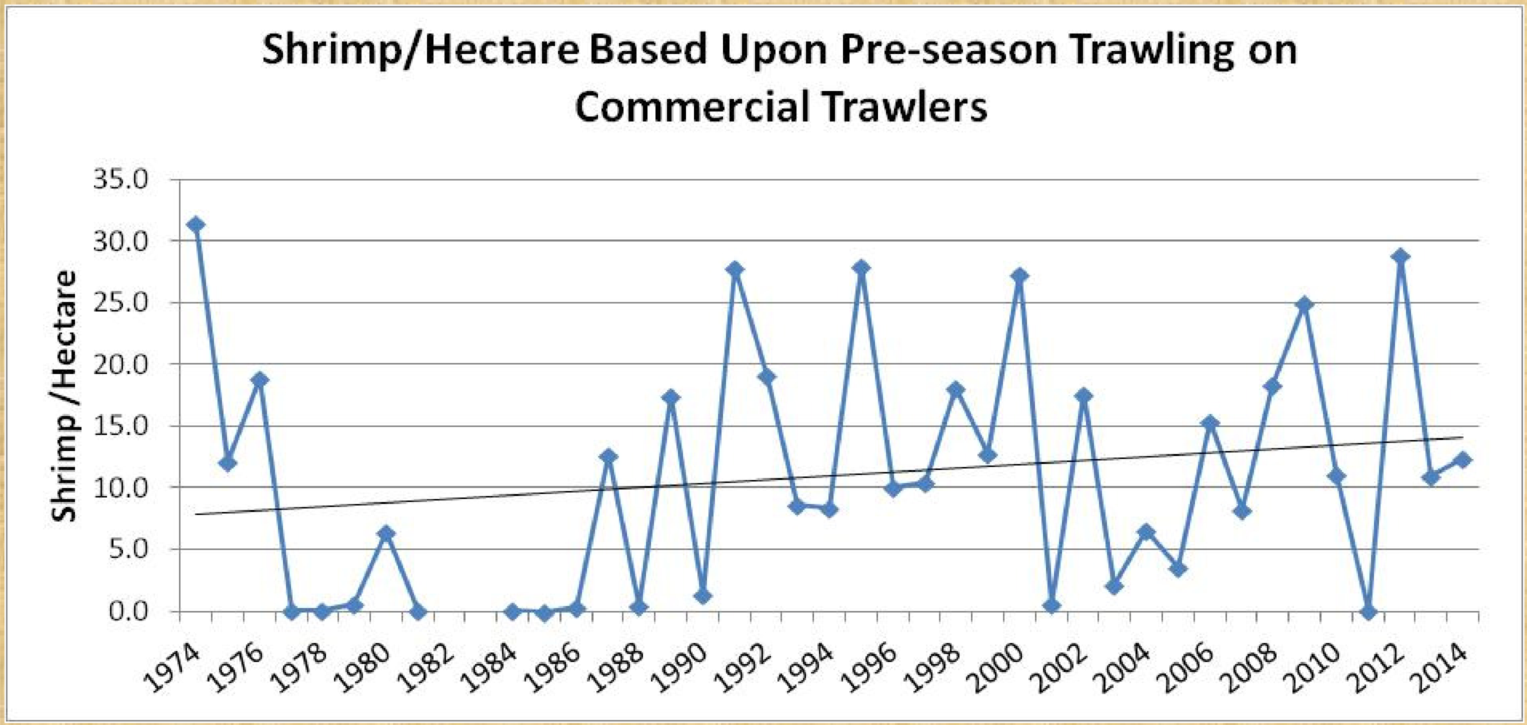
- Winter Conditions
- **Mar/Apr Estuarine Trawling**





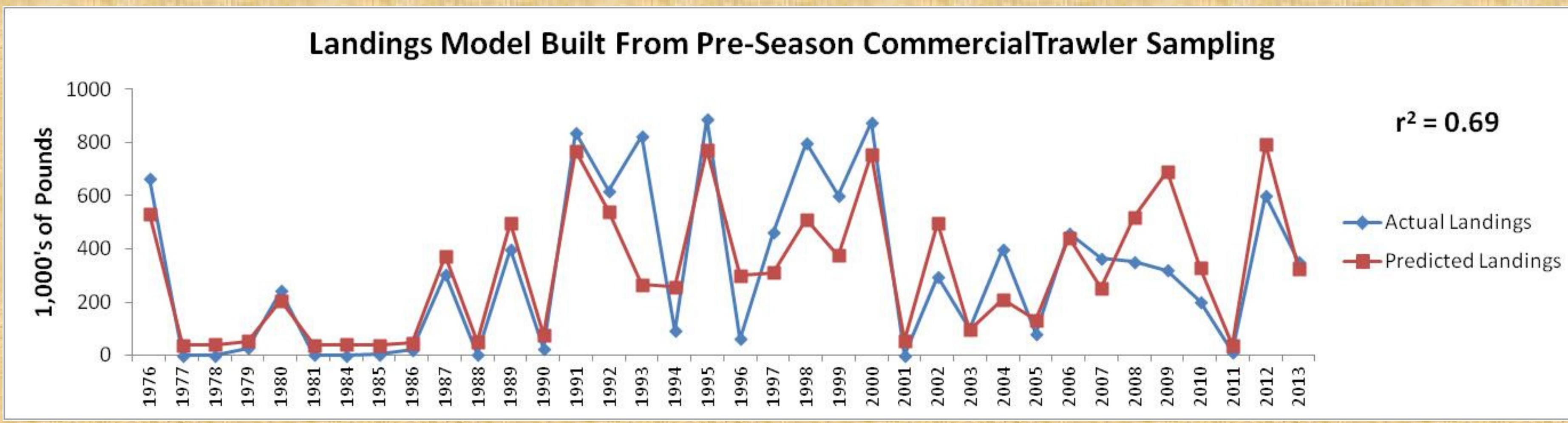
Roe Shrimp Assessment and Monitoring

- Winter Conditions
- Mar/Apr Estuarine Trawling
- **Pre-season Comm. Trawler No/Acre**



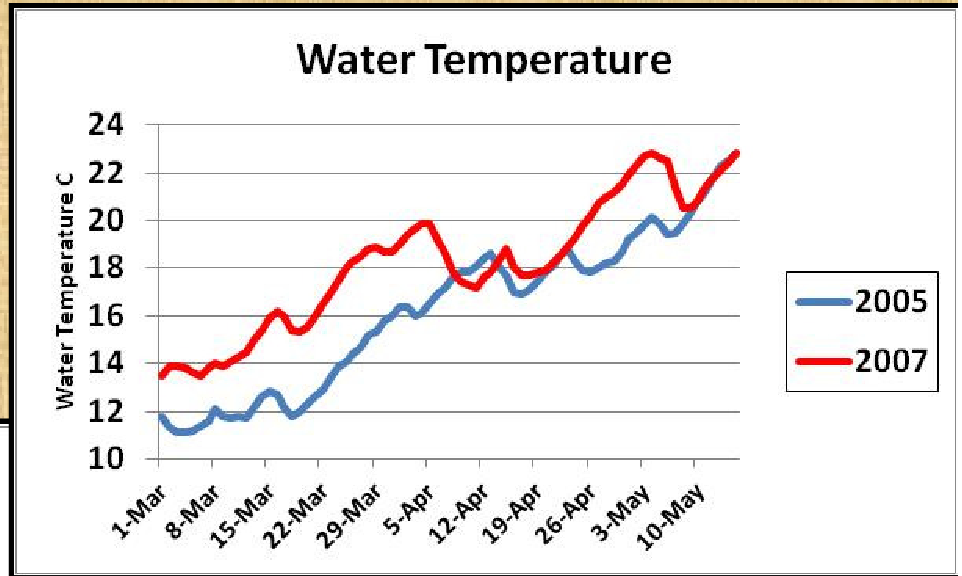
Roe Shrimp Assessment and Monitoring

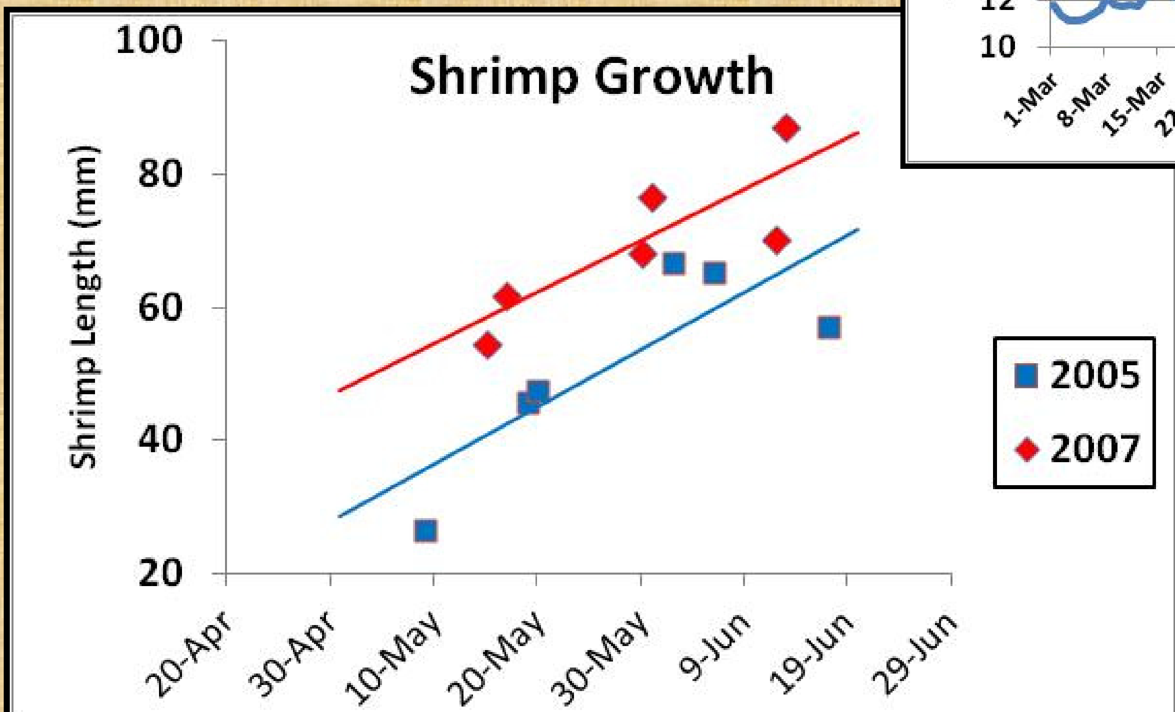
- Winter Conditions
- Mar/Apr Estuarine Trawling
- **Pre-season Commercial Trawler (Shrimp/Acre)**



Brown Shrimp Assessment and Monitoring

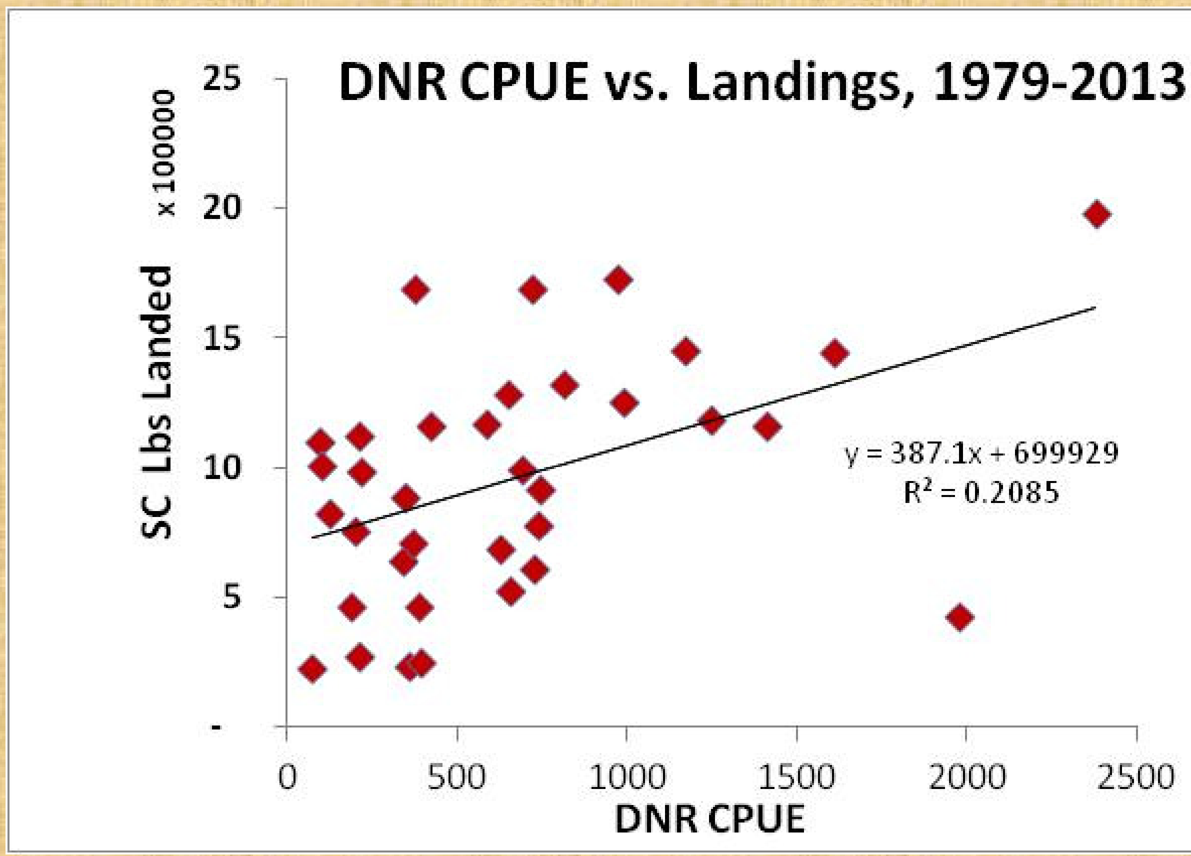
- **Juvenile Shrimp Trawling**





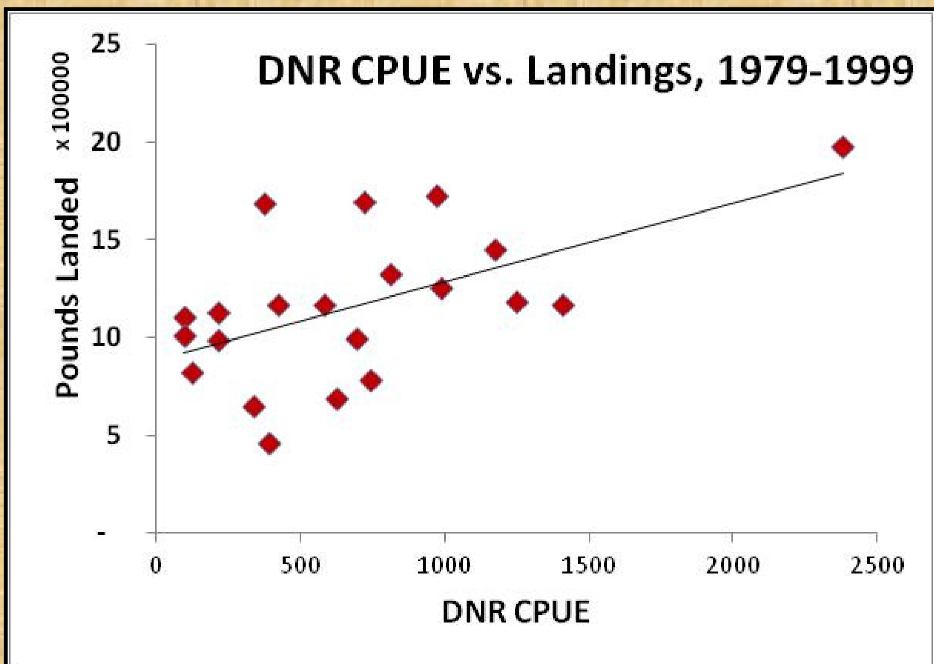
Brown Shrimp Assessment and Monitoring

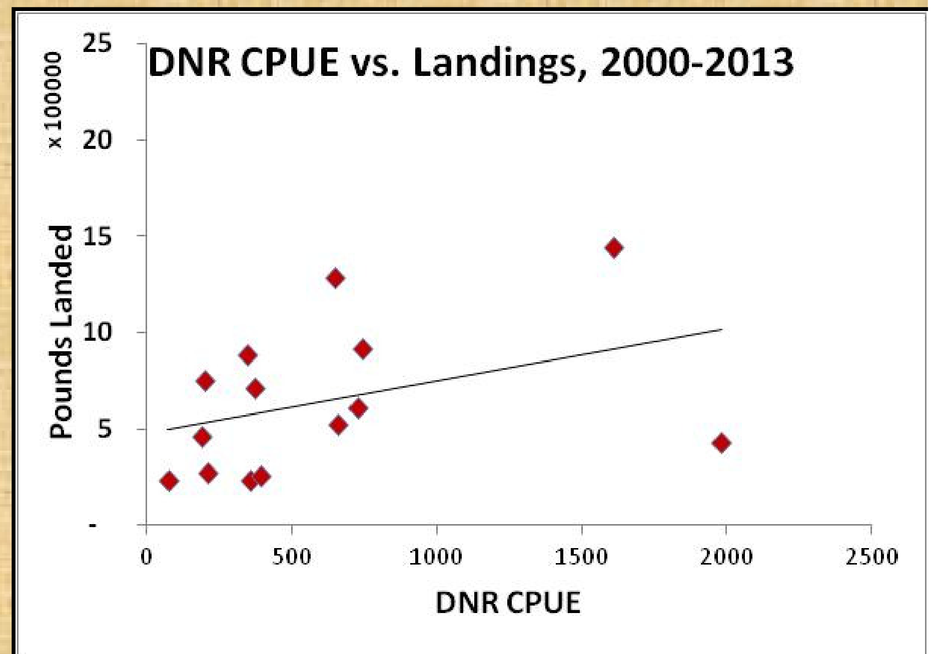
- Juvenile Shrimp Trawling
- **Estuarine Open Water Trawling**



Brown Shrimp Assessment and Monitoring

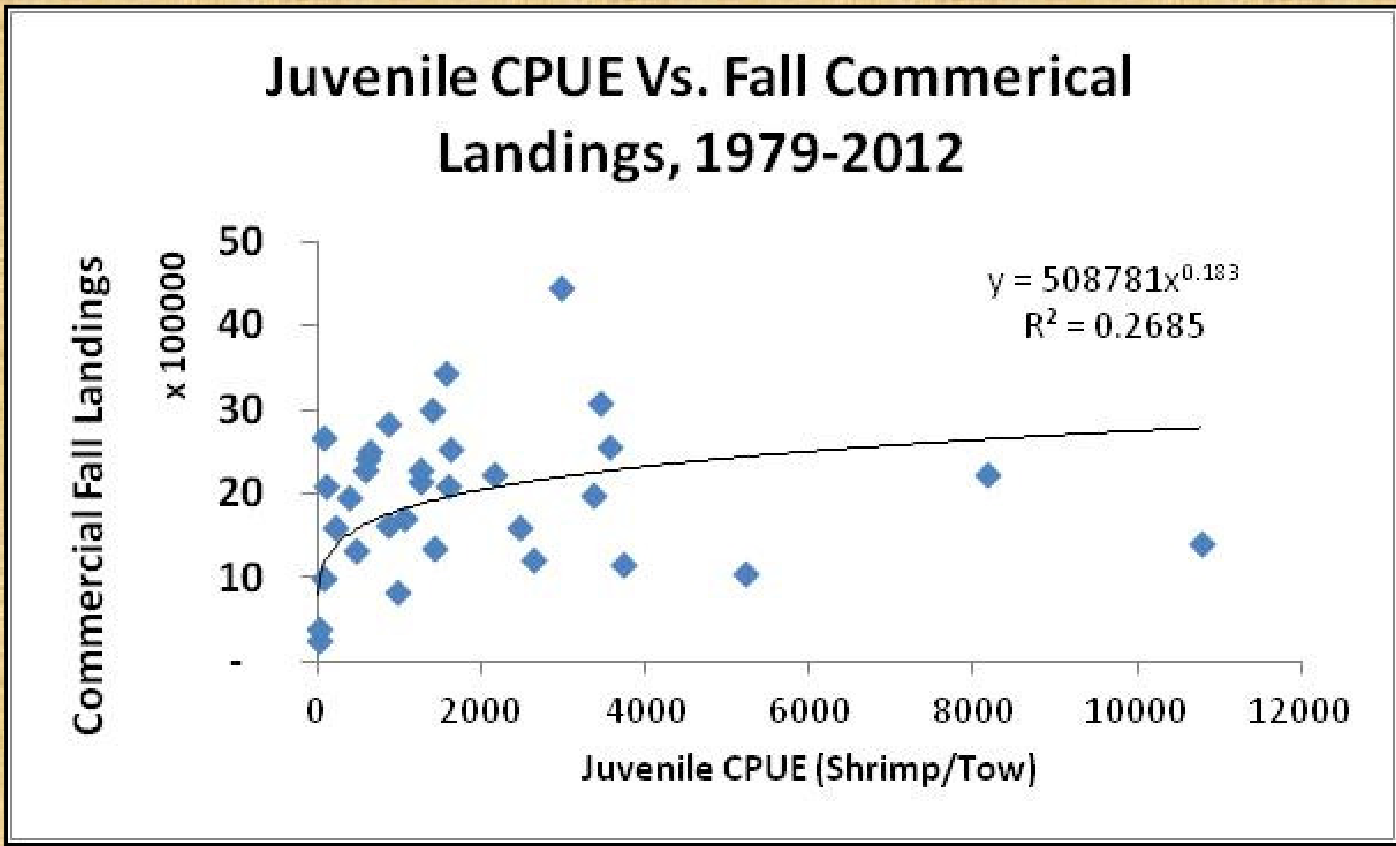
- Juvenile Shrimp Trawling
- **Estuarine Open Water Trawling**





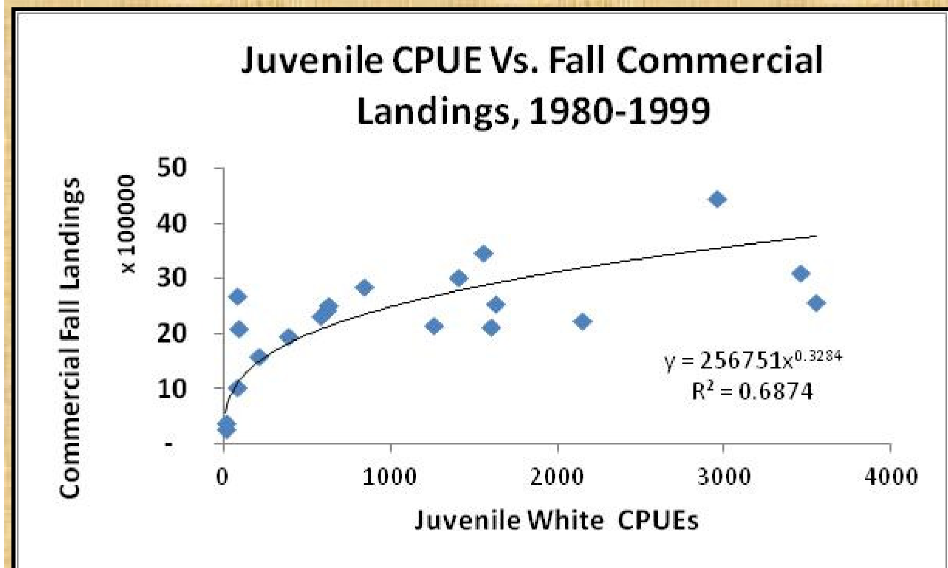
Fall White Shrimp Assessment and Monitoring

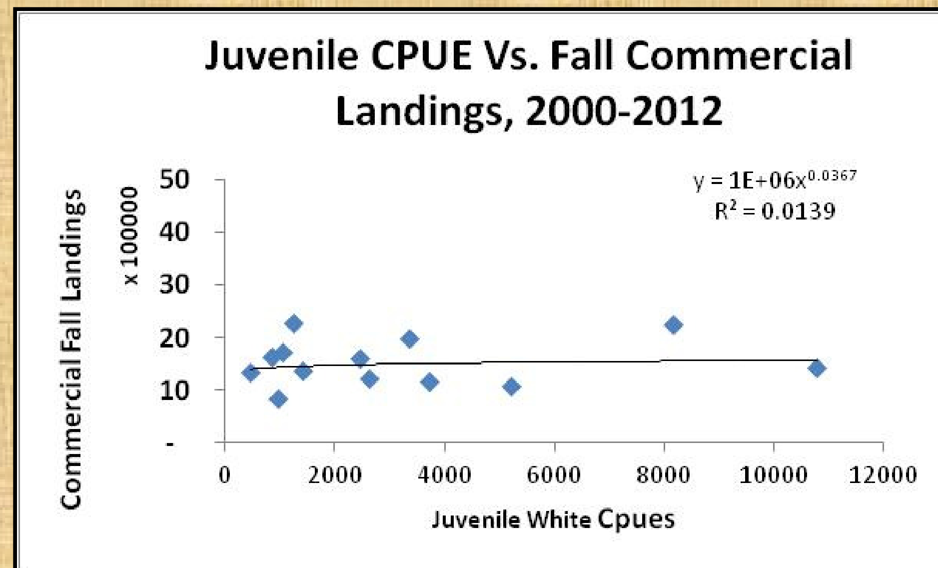
- **Juvenile Shrimp Trawling**



Fall White Shrimp Assessment and Monitoring

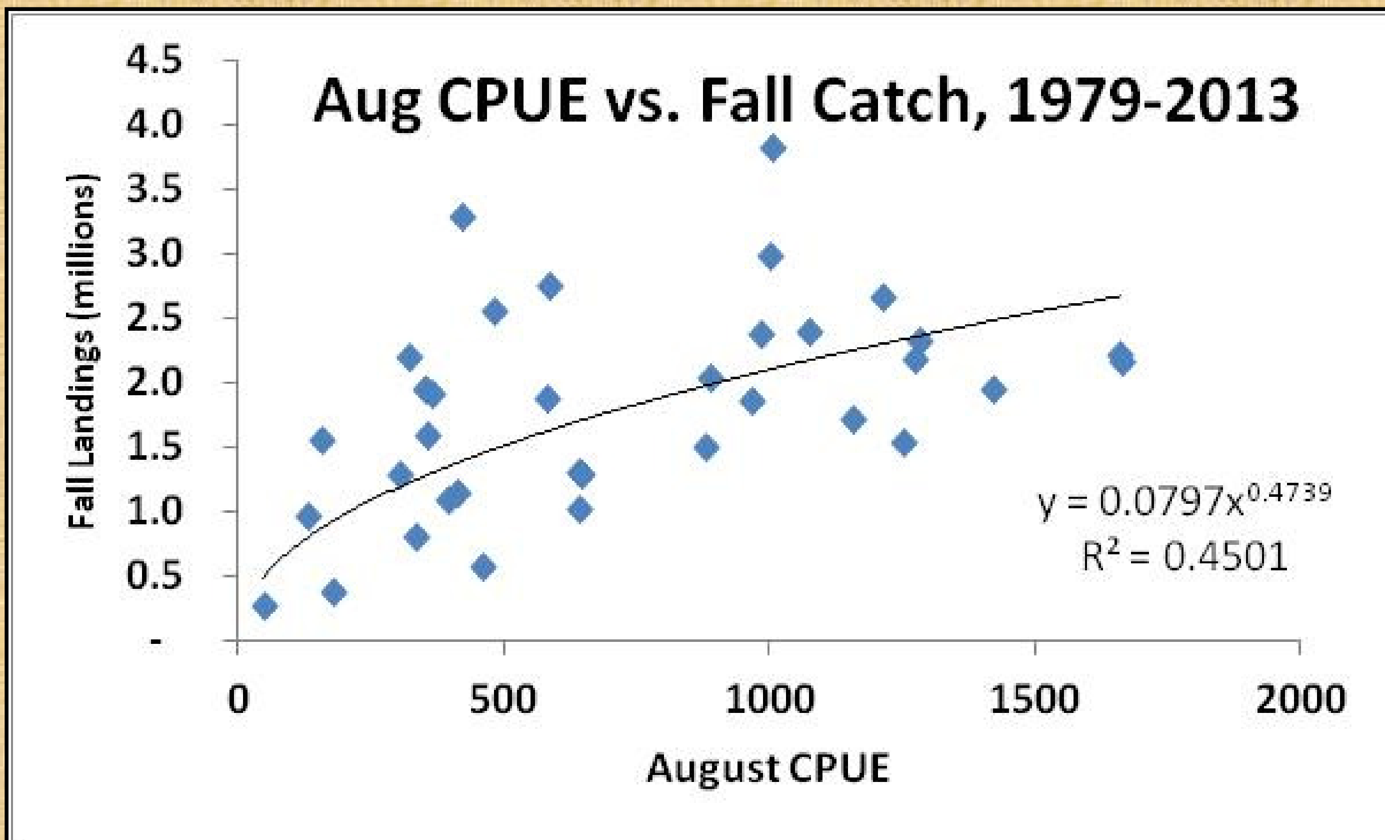
- **Juvenile Shrimp Trawling**





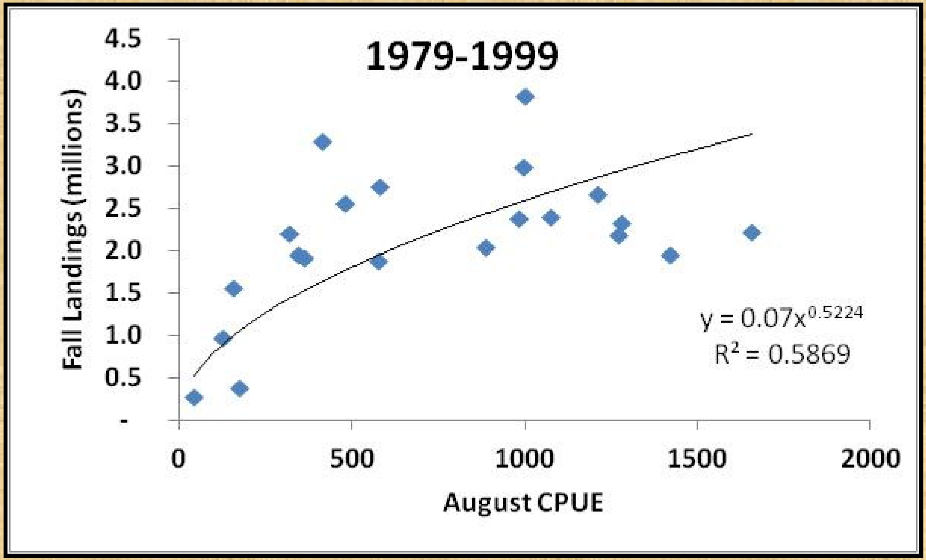
Fall White Shrimp Assessment and Monitoring

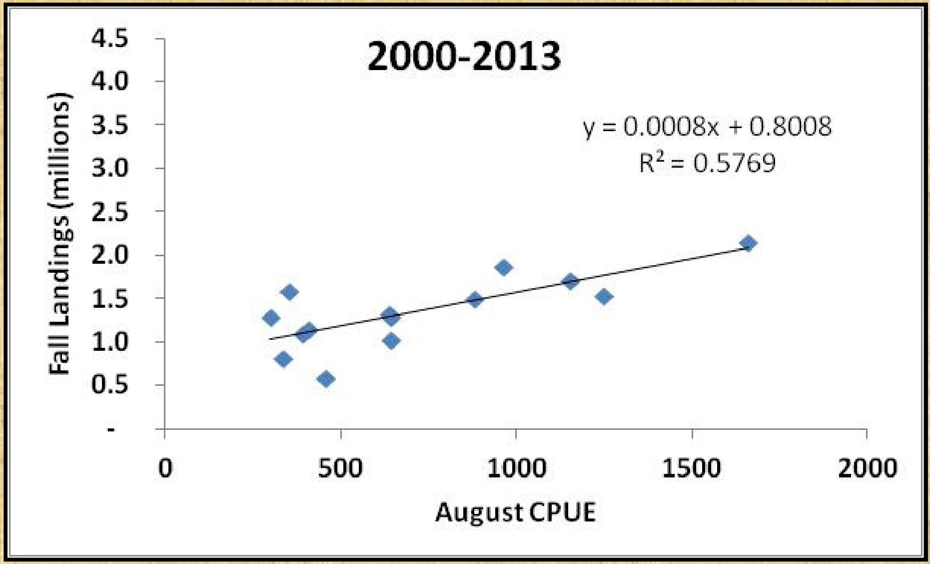
- Juvenile Shrimp Trawling
- **Estuarine Open Water Trawling**



Fall White Shrimp Assessment and Monitoring

- Juvenile Shrimp Trawling
- **Estuarine Open Water Trawling**





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DEPARTMENT OF NATURAL RESOURCES
COASTAL RESOURCES DIVISION

Georgia’s Shrimp Fishery

July 22, 2014. Shrimp SEDAR Procedural Workshop, N. Charleston

Patrick Geer

Georgia Shrimp Management

- **Primarily Two Species**
  - White Shrimp (winter, spring, fall)
  - Brown Shrimp (summer)
  - Other Species: Pink, Rock, Royal, Sea Bobs, **Tiger**

- **Components**
  - Commercial
    - Trawls – Ocean
    - Bait Trawls – estuaries (bait zones)
    - Cast Nets – estuaries (limited entry, N = 200)
    - Seine Nets – beaches and barrier islands
  - Recreational
    - Cast Net – estuaries
    - Seine Nets - beaches and barrier islands
    - Bait Sport Trawls – estuaries (bait zones)

- **Regulations**
  - Season & Areas: Commissioner – Administrative Order
  - Size and Quantity – Legislation
  - Gear – Legislation and DNR Board Rule

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Coastal Resources Division

Shrimping Regulations

Method	Type	Gear Specs	Catch Limits (heads-on)	Areas
Seines	Comm	Length < 100 ft Mesh(st) > 1.25in	24 qts pp	Any sand beach of any barrier island.
	Rec	1:< 12 x 4 ft x 1 in sm, 2: < 100 ft x 1.25 in sm, 3: < 300 ft x 2.5 in sm	Bait: 4 qts pp Food: 24 qts pg	1: anywhere 2: sand beaches & barrier islands 3: oceanfront
Cast Nets	Comm	Mesh > 5/8in str	150 qts pp/boat Dec 1-Feb 28: 75 qts pp/boat	No closed areas unless otherwise noted.
	Rec	Mesh: Bait: > 3/8 in bar Food: >5/8 in bar	Bait: 4qts pp Food: 48 qts pg	
Bait Shrimp Trawls	Comm	Size: < 20 ft cl Mesh(str): 1-1 3/8in	50 qts per boat[a] 200 qts per facility	Specified zones, creeks, and rivers only
	Rec	Size: < 10 ft	4 qts per boat	
Food Shrimp Trawls	Comm	TEDs/BRDs Size: < 220ft fr[b]	None	Sounds: Closed[c]; Beaches: May 15 – Dec: count size < 45/lb. Jan – Feb < 50/lb.

Season: Generally the same for food shrimp trawl, cast net, and seine – State waters may be open between May 15 – Feb 28. Bait shrimp season is generally open year round.
Hours: All Sectors: ½ hr before sunrise to ½ hr after sunset.
a: allowance for 10% dead shrimp
b: excludes trynet
c: Sounds can be opened by administrative order. Have not been opened since November 1989.

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Coastal Resources Division

11 Criteria for Sound Principles of Wildlife Research and Management (1981-2012)

O.C.G.A. Sections 27-4-130, 27-4-133, and 27-4-132(c)

1. The abundance and size of the seafood species in question.
2. The number of persons licensed to take seafood.
3. The Department's forecast for commercial catches.
4. The quantity in terms of pounds, and the value in terms of dollars.
5. The available climatological and meteorological data and influence on water temperature.
6. The life history of each species in question.
7. The coastal ecological features directly related to the life history of such species.
8. Anticipated amount and location of the demand for a seafood species.
9. The resources which influence or are influenced by the abundance, spatial, and temporal variations in seafood species.
10. The water quality and other biogenic factors which influence sound wildlife research and management.
11. Any other factors based on recent scientific and technological advances which could result in better management of Georgia's seafood resources.

Criteria for Shrimp Management
(Effective as of 2012)

Removes the 11 criteria and simply states, *"… in accordance with current, sound principles of wildlife research and management…"*

1. The abundance and size of the seafood species in question.
2. The number of persons licensed to take seafood.
3. The Department's forecast for commercial catches.
4. The quantity in terms of pounds, and the value in terms of dollars.
5. The available climatological and meteorological data and influence on water temperature.
6. The life history of each species in question.
7. The coastal ecological features directly related to the life history of such species.
8. Anticipated amount and location of the demand for a seafood species.
9. The resources which influence or are influenced by the abundance, spatial, and temporal variations in seafood species.
10. The water quality and other biogenic factors which influence sound wildlife research and management.
11. Any other factors based on recent scientific and technological advances which could result in better management of Georgia's seafood resources.

Season Criteria

- Opening
  - No sooner than May 15th
  - Average$_{(79-14)}$: June 10th, Earliest: May 24, Latest: July 1
  - Abundance - within long term confidence intervals
  - Gonadal Development: 70% of females in advance stages
  - Consultation with Shrimp AP
  - Protected Species Strandings / Interactions

- Extension and Closing
  - Closes December 31 with no action (6 years since 1978)
  - Average$_{(79-14)}$ Close Date: Jan 29, Earliest: Dec 31, Latest: Feb 29.

  - To Extend Season
    - Abundance – within long term confidence intervals
    - Count Size: < 50/lb (ho) (*aim for < 40/lb)*
    - Water Temperature
    - Consultation with Shrimp AP
  - Must close by last day of February

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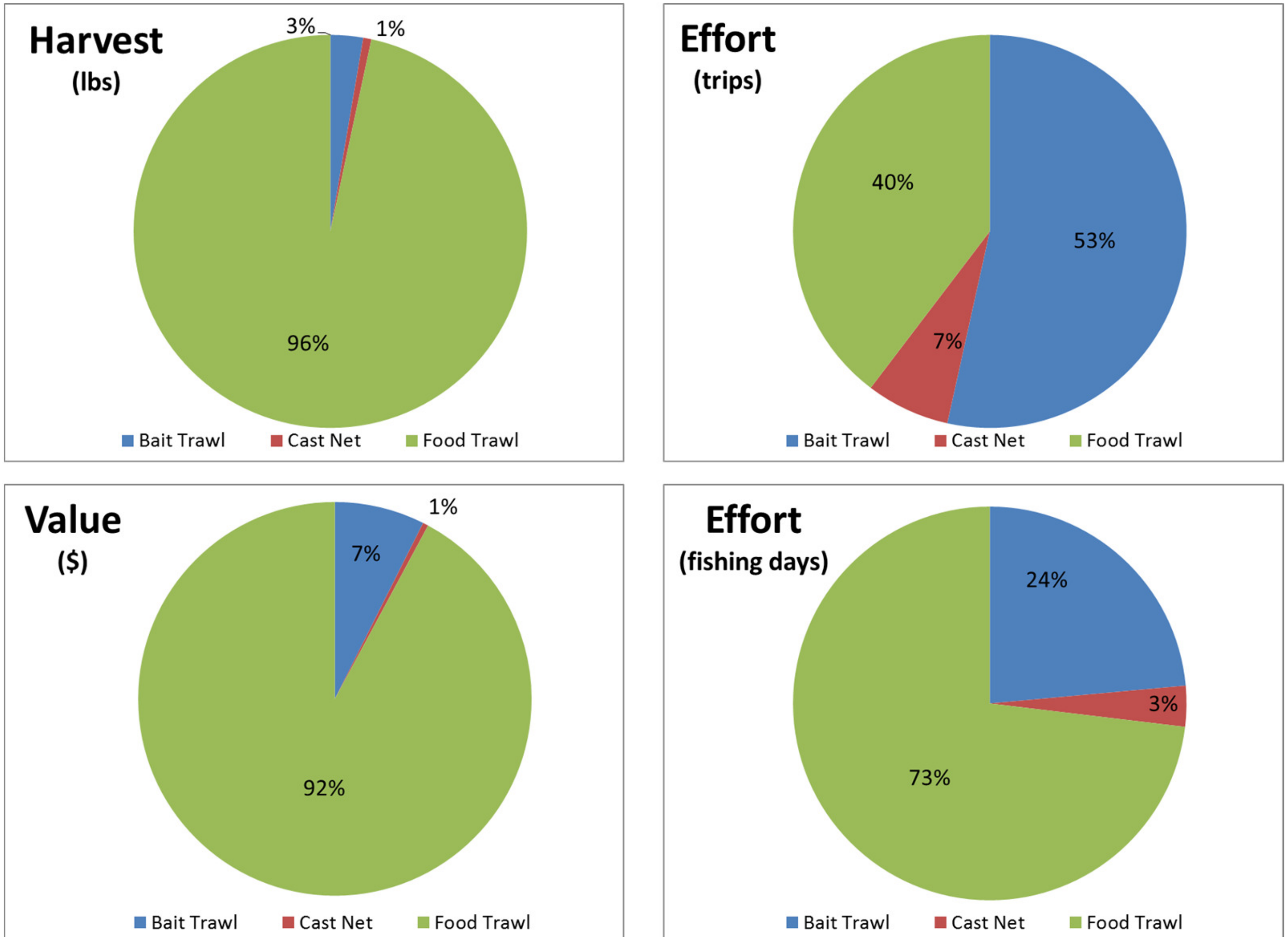
Commercial Harvest by Sector (2009-2013)



Annual Average (2009-2013)				
Sector	**lbs**	**Value**	**Days**	**Trips**
Bait Trawl	44,503	$486,474	1,419	1,612
Cast Net	11,137	$29,868	201	208
Food Trawl	1,603,738	$6,055,096	4,405	1,196
Total	1,659,379	$6,571,438	6,026	3,016

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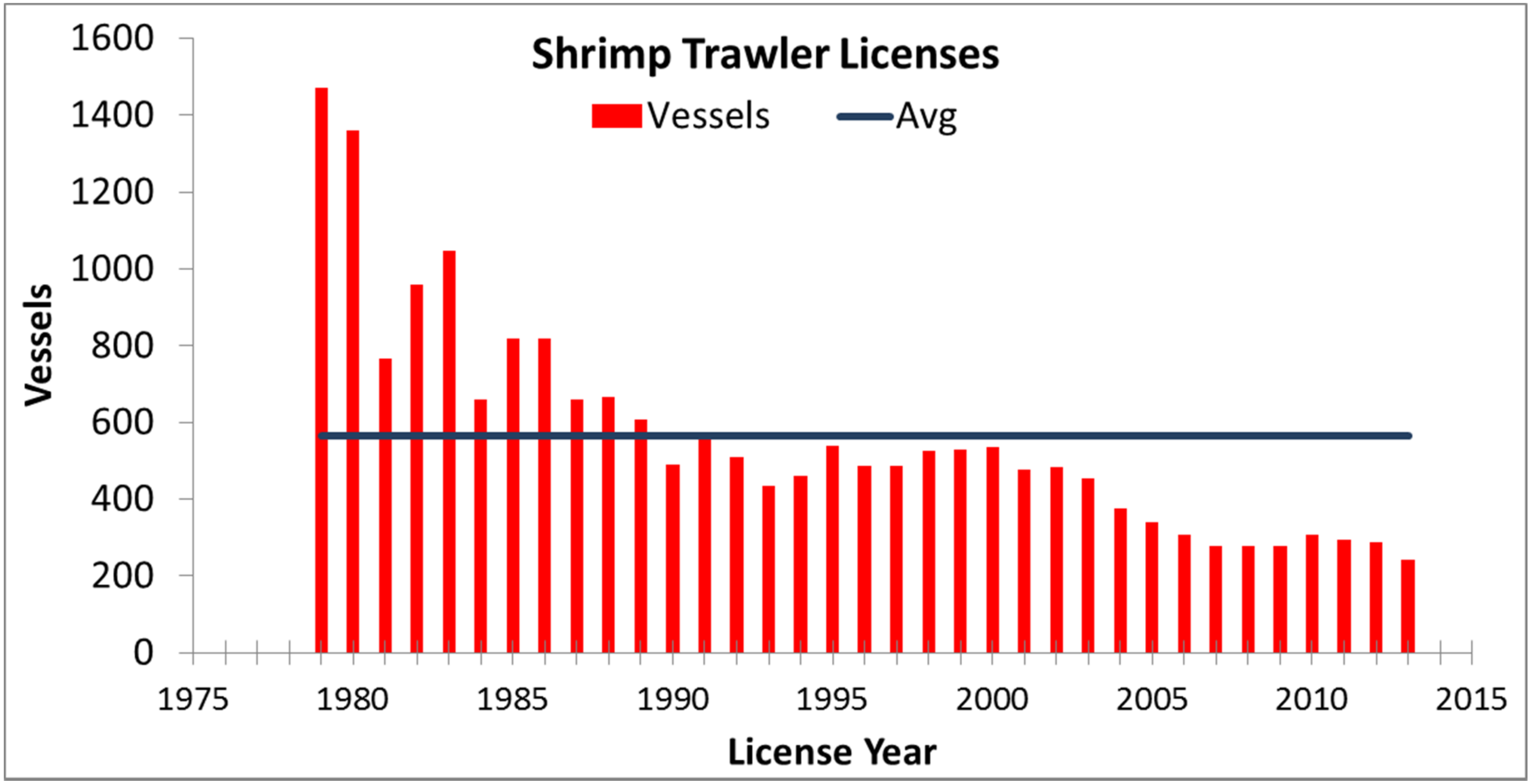
Commercial Shrimp Statistics



YEAR	Catch				Avg. Vessel Age	Hull Type					Number of Nets				Vessel length (ft)					
	Vessels with Reported Harvest	Pounds	Trips	Days Fished		Unk	Fglass	Wood	Steel	Other	Unk	One	Two	Four	< 20	21-40	41-60	61-80	81-100	> 100
2013	106	1,239,154	1,389	4,294	36.27	8	32	45	19	2	0	2	37	67	11	7	34	47	7	0

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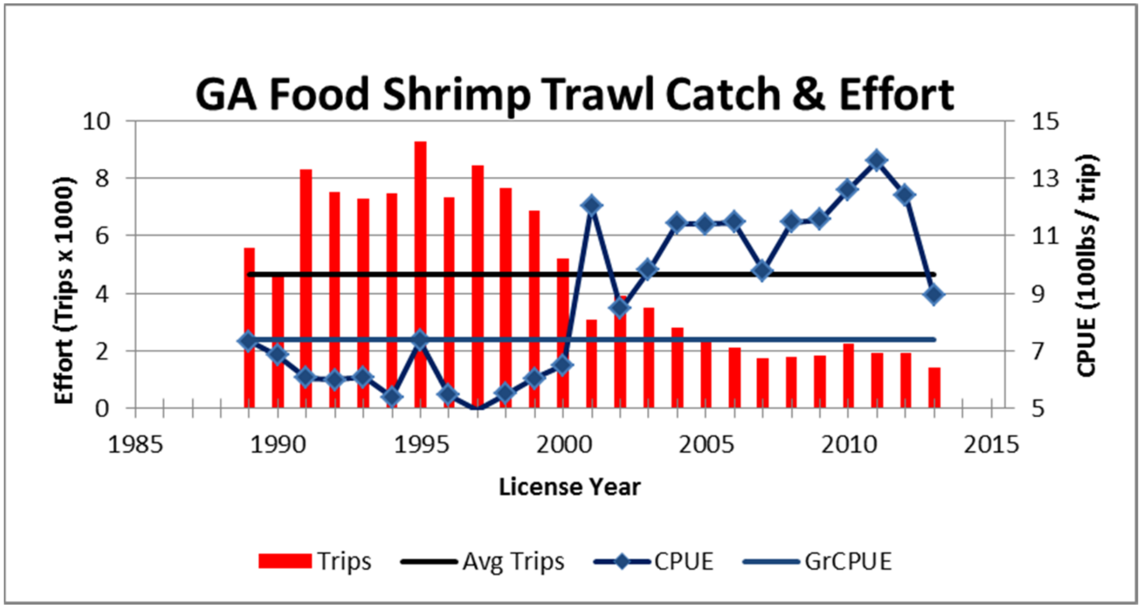
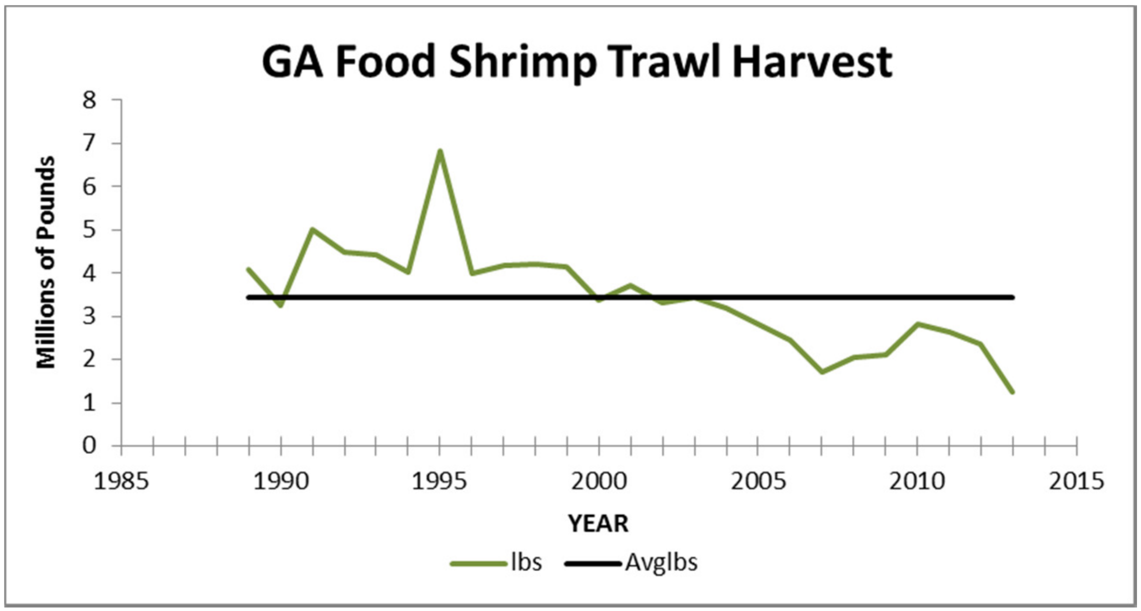
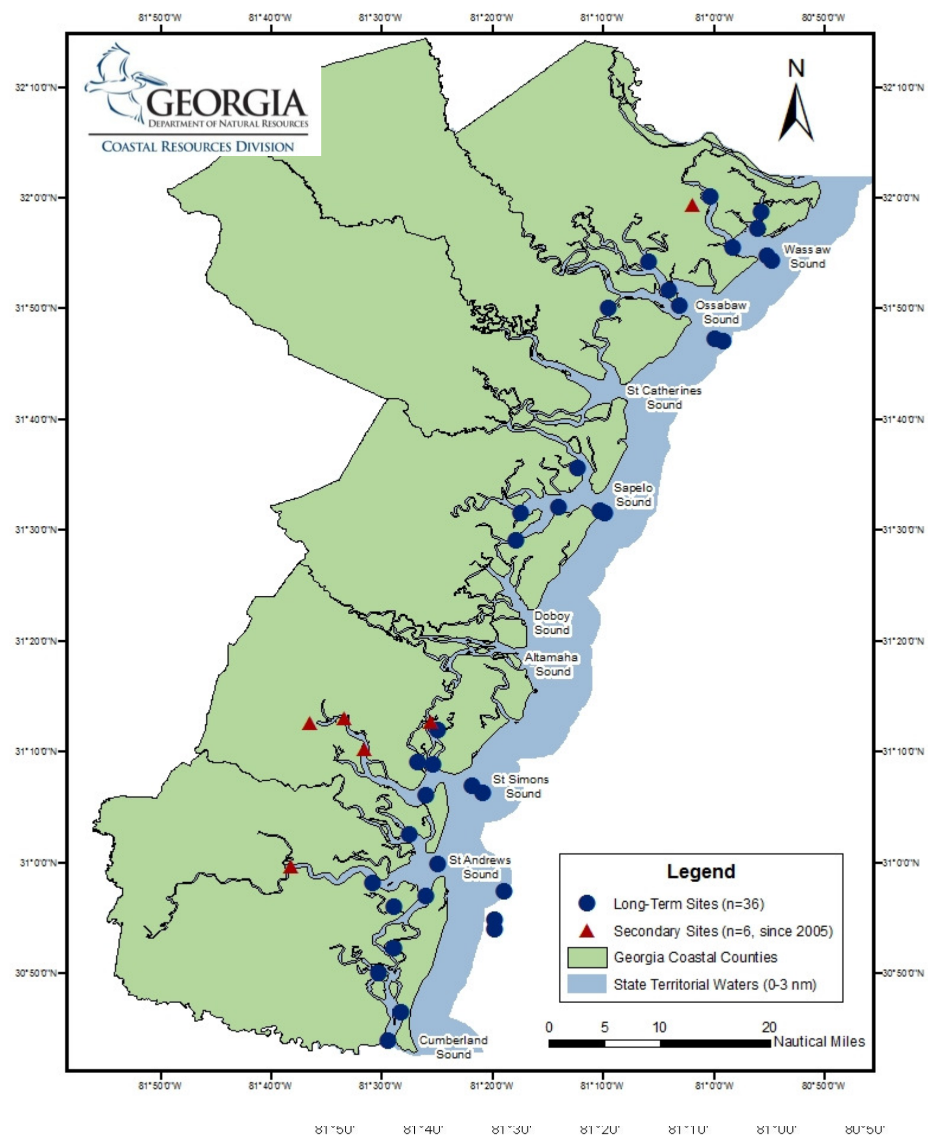
Catch and Effort





GADNR Ecological Monitoring Trawl Survey

- Conducted since 1976
- Presently 42 discrete sites each month
- Stratified by Sound and Sector:
  - Rivers & Creeks
  - Sounds
  - Beaches (0-3nm)
  - Upriver (added March 2005)
- Six Sound Systems:
  - North: WA, OS, SP
  - South: SS, SA, CU
- Shrimp Data (by species) since 1976
  - Total Number and Weight
  - Count Size (#/lb, heads on)
  - Detailed Info
    - Size (total length) and Sex
    - Gonadal Development
    - Disease (BG since 1996)
  - Abundance
    - CPUE (kg per standard trawl)
      - Monthly, Seasonal, Annual



GADNR EMTS
Sampling Protocol

- Vessel: R/V *Anna*
  - 18.3 m (60ft) trawler. Built in 1968.
  - Side trawler, double warp winch
- Gear:
  - 12.2m (40 ft) flat trawl
  - 4.8 cm (1.875 in) stretched mesh body and bag
  - 152 x 71 cm (60x 28 in) trawl doors
  - Tickler chain

- Sampling methods
  - Sampling first half of month on neap tides (when possible)
  - 42 stations per month
    - WA-7, OS-6, SP-6, SS-10, SA-7, CU-6
    - Up-River Sector added in 2005 for blue crab issues (excluded)
  - Tow Duration: 15 minutes bottom time
  - Avg. Tow Distance: 967m.

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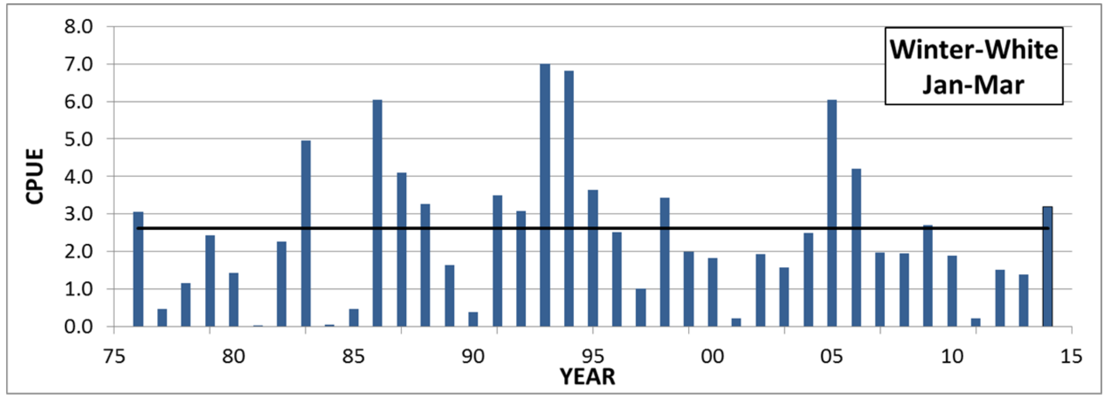
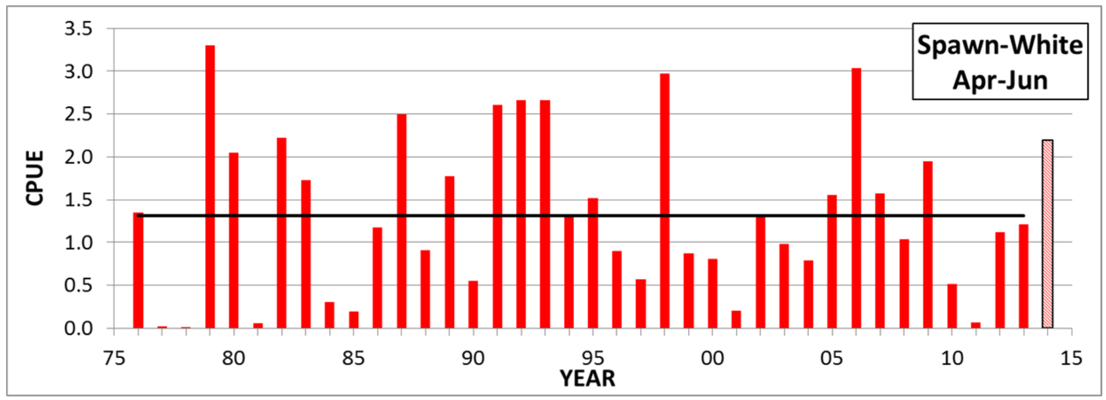
Ecological Monitoring Trawl Survey

White Shrimp Season Estimates

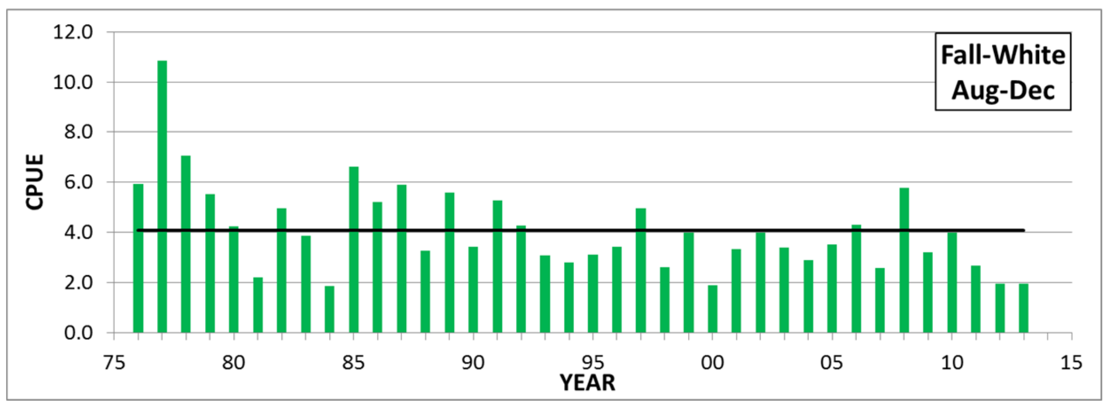
Winter: Jan - Mar
Avg: 2.614 kg/trawl
95% C.I.: 2.336 - 2.891
Trawls: 3,803



Spawners: Apr - Jun
Avg: 1.314 kg/trawl
95% C.I.: 1.187 – 1.441
Trawls: 3,890



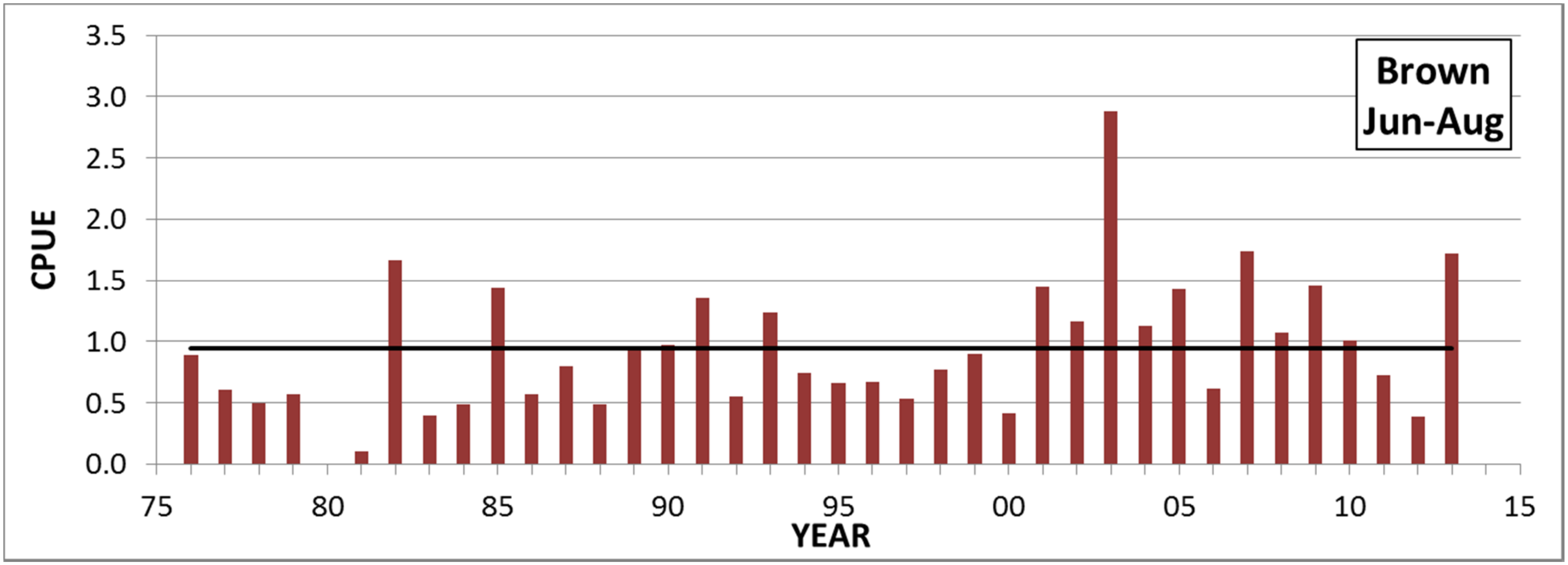
Fall: Aug - Dec
Avg: 4.080 kg/trawl
95% C.I.: 3.783 – 4.377
Trawls: 6,381



CPUE in kg per standard 15 minute trawl

Ecological Monitoring Trawl Survey

Brown Shrimp Estimates



CPUE in kg per standard 15 minute trawl

Brown: Jun to Aug
Avg: 0.949 kg/trawl
95% C.I.: 0.882 – 1.016
Trawls: 3,793

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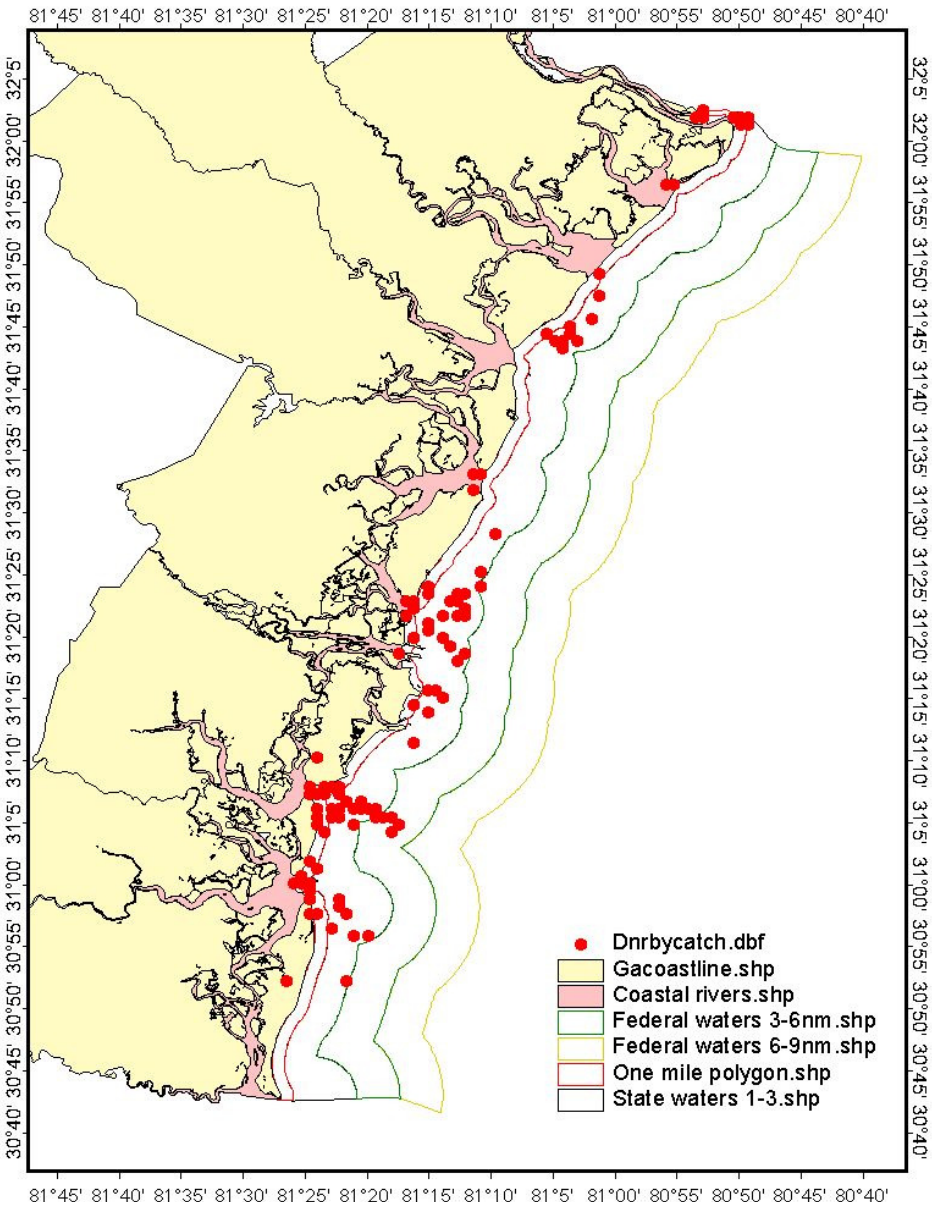
DNR Shrimp Trawl Bycatch Observer Study



- May 1995 to December 2005
- Recorded numbers, weight, lengths. For all species.
- 185 total samples
  - 129 trips observed
  - 60,618 commercial trips during the same period.
  - 0.213% coverage

Month	Samples	Trips
J	6	6
F	0	0
M	0	0
A	6	4
M	20	12
J	39	20
J	19	15
A	31	17
S	14	13
O	18	14
N	16	14
D	16	14
Total	185	129

Trawls	185
Trawl Hours	483.3
Avg # of Nets Fished	3.09
First Date	18-May-95
Last Date	30-Nov-05
Fish Species	97
Shark Species	8
Ray and Skate Species	8
Invertbrate Species	29

GA DNR Large Shrimp Trawl Bycatch Observer Survey (May 1995 - Dec2005)

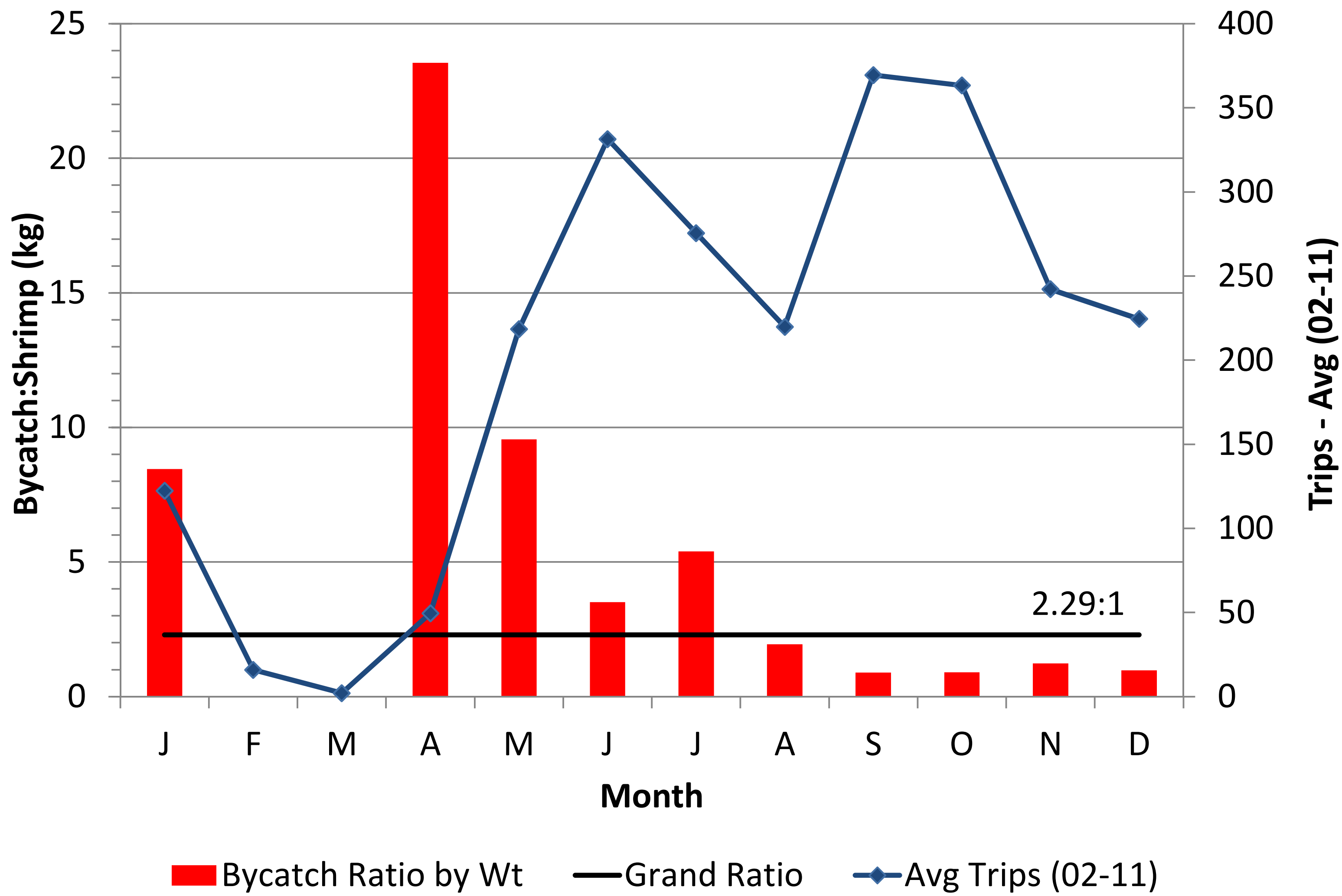
Common	Species Code	Freq	Catch				Weight (Kg)			
			Rank	Total	CPUE	%	Rank	Total	CPUE	%
Star Drum	50	175	1	153,412	317.43	42.36%	1	2,608	5.40	16.57%
Mixed Crabs	112	150	2	31,882	65.97	8.80%	8	529	1.09	3.36%
Atl. Croaker	8	157	3	23,891	49.43	6.60%	5	830	1.72	5.27%
Atl. Menhaden	37	142	4	21,959	45.44	6.06%	6	817	1.69	5.19%
Spot	9	165	5	14,700	30.42	4.06%	7	587	1.21	3.73%
Atl. Brief Squid	113	177	6	13,822	28.60	3.82%	16	180	0.37	1.14%
Weakfish	2	163	7	10,637	22.01	2.94%	10	470	0.97	2.99%
Bay Anchovy	19	138	8	8,463	17.51	2.34%	51	15	0.03	0.10%
Southern Kingfish	10	179	9	6,963	14.41	1.92%	11	388	0.80	2.46%
Shrimp	154	100	10	6,367	13.17	1.76%	2	2,249	4.65	14.29%
Silver Sea Trout	13	101	11	6,209	12.85	1.71%	14	210	0.43	1.33%
Atl. Cutlassfish	125	108	12	5,527	11.44	1.53%	12	377	0.78	2.40%
Banded Drum	20	128	13	4,401	9.11	1.22%	25	103	0.21	0.65%
Mantis Shrimp	121	141	14	4,190	8.67	1.16%	27	68	0.14	0.43%
White Shrimp	167	81	15	3,862	7.99	1.07%	3	2,182	4.52	13.86%
Gafftopsail Catfish	27	70	16	3,301	6.83	0.91%	20	118	0.24	0.75%
Hog Choker	31	149	17	3,299	6.83	0.91%	22	114	0.24	0.72%
Atl. Thread Herring	109	85	18	2,478	5.13	0.68%	28	62	0.13	0.39%
Atl. Bumper	24	79	19	2,404	4.97	0.66%	40	31	0.06	0.20%
Silver Perch	55	106	20	2,366	4.89	0.65%	23	113	0.23	0.72%
Atl. Spadefish	48	74	23	1,861	3.85	0.51%	34	51	0.11	0.32%
Spanish Mackerel	70	69	24	1,758	3.64	0.49%	18	138	0.29	0.88%
Atl. Sharpnose Shark	122	46	31	920	1.90	0.25%	15	206	0.43	1.31%
Summer Flounder	5	74	48	403	0.83	0.11%	38	32	0.07	0.20%
Bluefish	14	52	49	380	0.79	0.10%	30	59	0.12	0.37%
Southern Flounder	4	59	52	293	0.61	0.08%	34	51	0.11	0.32%
Bonnethead Shark	94	32	60	143	0.30	0.04%	19	127	0.26	0.81%
Spotted Sea Trout	1	19	62	130	0.27	0.04%	47	20	0.04	0.13%
Black Sea Bass	104	7	81	30	0.06	0.01%	91	1	0.00	0.01%
Black Drum	6	6	86	22	0.04	0.01%	81	3	0.01	0.02%
Cobia	64	3	98	10	0.02	0.00%	38	32	0.07	0.20%
Tripletail	86	4	108	5	0.01	0.00%	50	17	0.04	0.11%
Sheepshead	7	1		.	.		91	1	0.00	0.01%
Red Drum	3	1		.	.		111	0	0.00	0.00%
Jack Creavalle	32	7	90	17	0.04	0.00%	91	1	0.00	0.01%
Grand Total				362,154	749.34			15,741	32.57	
CPUE is #/trawl hr and kg/trawl hr										

Top 20 Species and Important Recreational Fishes

Top 10 Fishes by Number

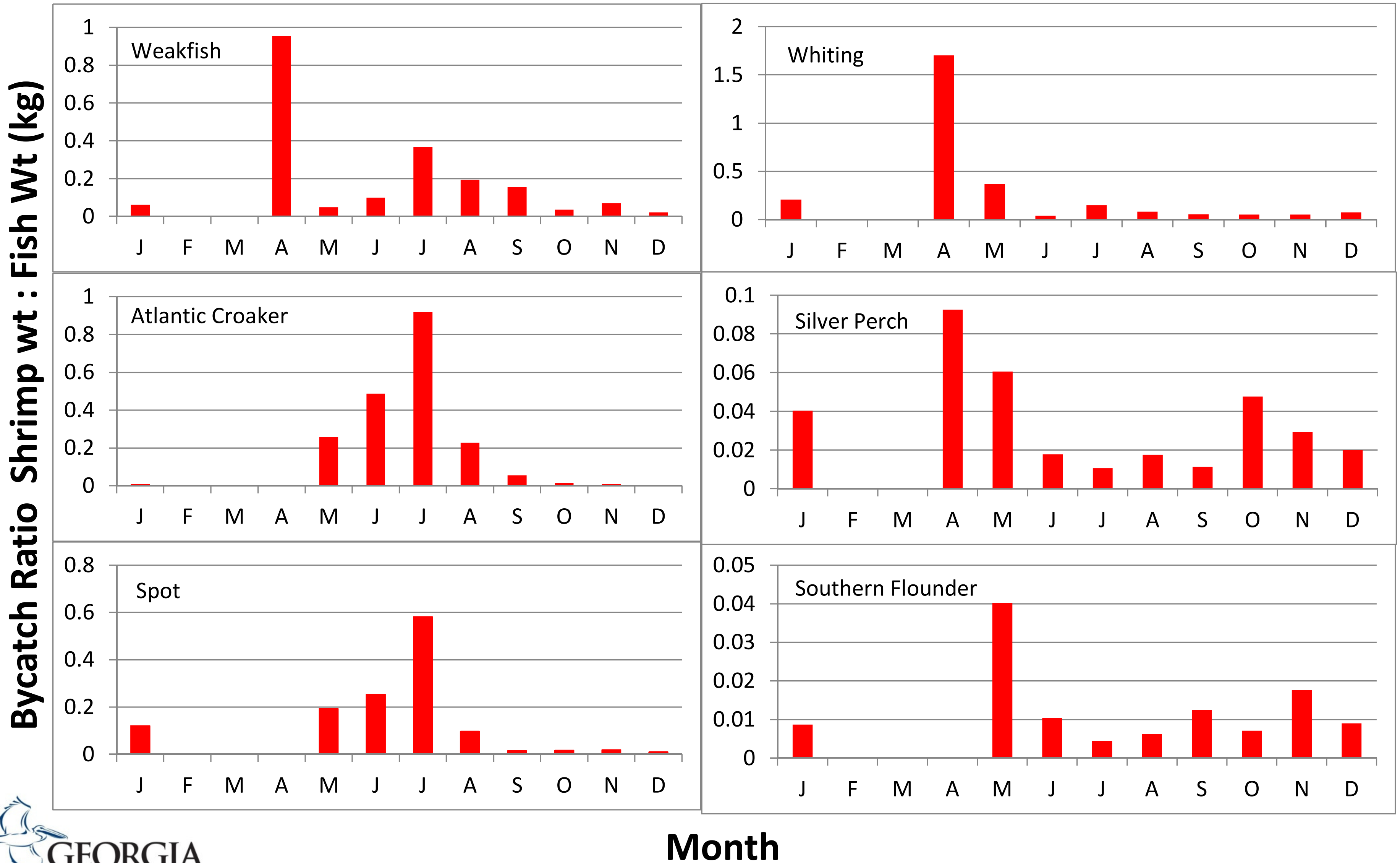
1. Star Drum
2. Atl. Croaker
3. Atl. Menhaden
4. Spot
5. Weakfish
6. Bay Anchovy
7. Whiting (S. kingfish)
8. Silver Sea Trout
9. Atl. Cutlassfish
10. Banded Drum

Bycatch Ratio and Trawl Effort



GEORGIA DEPARTMENT OF NATURAL RESOURCES
COASTAL RESOURCES DIVISION

Bycatch Ratios by Recfish Species



GEORGIA
Department of Natural Resources
Coastal Resources Division

Questions ?

Florida Fish and Wildlife Conservation Commission Shrimp Monitoring and Management

Fish & Wildlife Research Institute
100 8th Avenue SE
St. Petersburg, FL 33701

Fisheries-Independent Monitoring Program

Fish & Wildlife Research Institute
100 8th Avenue SE
St. Petersburg, FL 33701

SPORT FISH RESTORATION

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

Fisheries-Independent Monitoring

- Funded in part by:
  - Department of the Interior, U.S. Fish and Wildlife Service Federal Aid for Sport Fish Restoration, Project F-43
  - Florida saltwater fishing license sales.
- Long-term program designed to monitor the relative abundance of fishery resources in Florida's major estuarine, coastal, and reef systems.

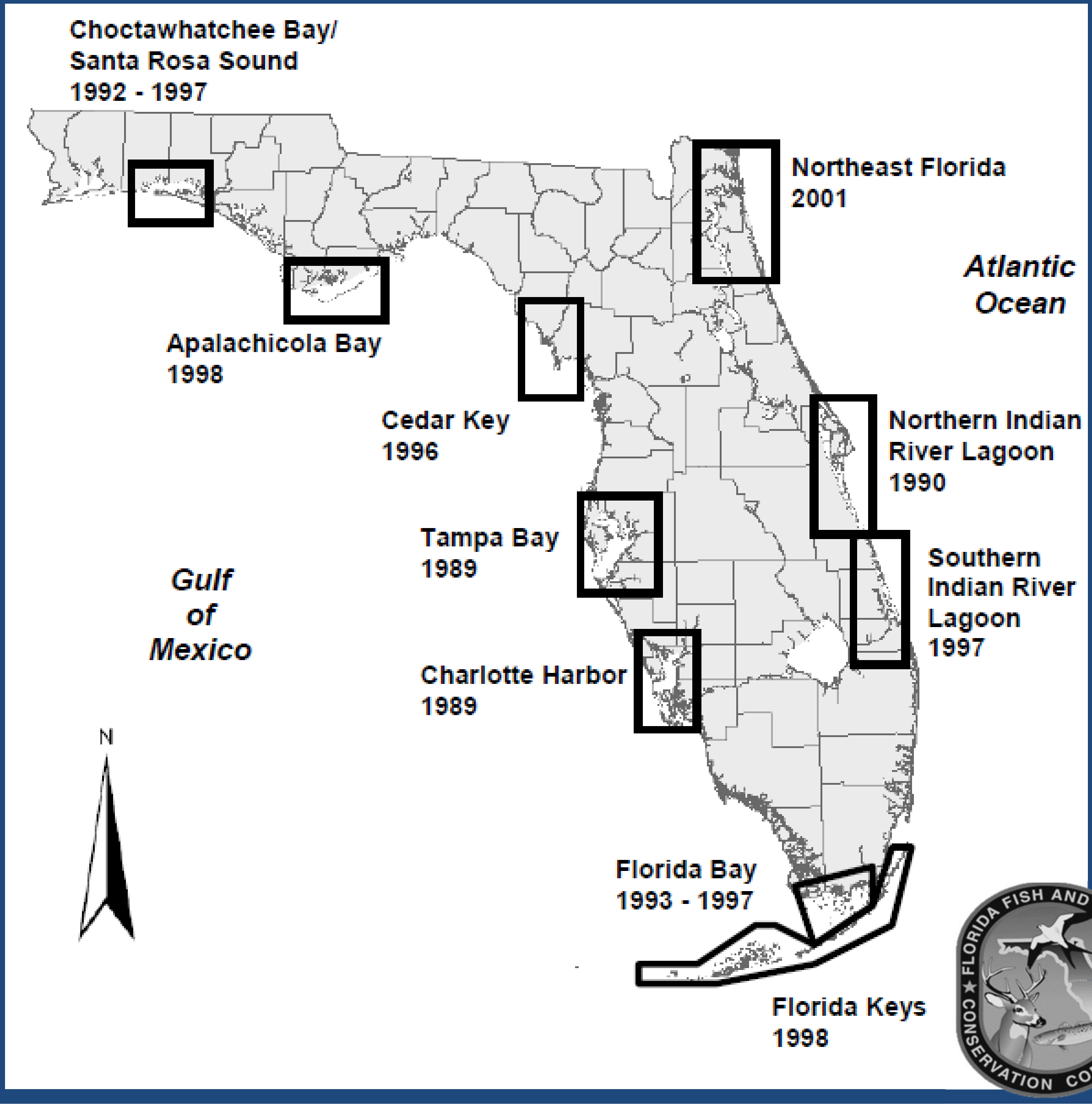
Fisheries-Independent Monitoring

The program was developed to:

1) Address the critical need for effective assessment techniques for an array of species and sizes of fishes and selected invertebrates.

2) Provide timely information for use in management plans.

3) Monitor trends in the relative abundance of taxa in a variety of estuarine and marine systems throughout Florida.



Fisheries-Independent Monitoring

- Stratified-Random Sampling (SRS) design in all study areas.
- Study areas are divided into sampling zones based upon geographic and logistical criteria, and each zone is further subdivided into 1-nm^2 grids that are randomly selected for sampling.
- Sampling grids are stratified by habitat and depth, thereby identifying the gear types that could be used in those areas.
- A single sample is collected at each randomly selected site. In most cases, the number of monthly samples collected in each zone with each gear was proportional to the number of grids in the zone that could be sampled with a particular gear.

Fisheries-Independent Monitoring

Multi-gear approach to collect data on various life history stages of fishes and selected invertebrates from a wide variety of habitats.

Gear	Deployment	Mesh Size (mm)	Area Sampled	Description of use
21.3-m Seine (center bag)	Bay	3.2	140 m^2	• used in near-shore and shoreline areas ≤ 1.5 m
	River	3.2	68 m^2	• used along river shorelines ≤ 1.8 m
183-m Haul Seine (center bag)	Boat	38.1	4,120 m^2	• used along shorelines and exposed sandbars ≤ 2.5 m
6.1-m Otter Trawl	Straight Tow	38.1 (3.2-mm liner)	1,130 m^2- 2,259 m^2	• used in areas from 1.8-m to 7.6-m deep
	Arc Tow	38.1 (3.2-mm liner)	1,130 m^2- 2,259 m^2	• used in areas from 1.0-m to 1.7-m deep

21.3-m bay seine
Juveniles and Small Adults

183-m haul seine

Subadults and Adults

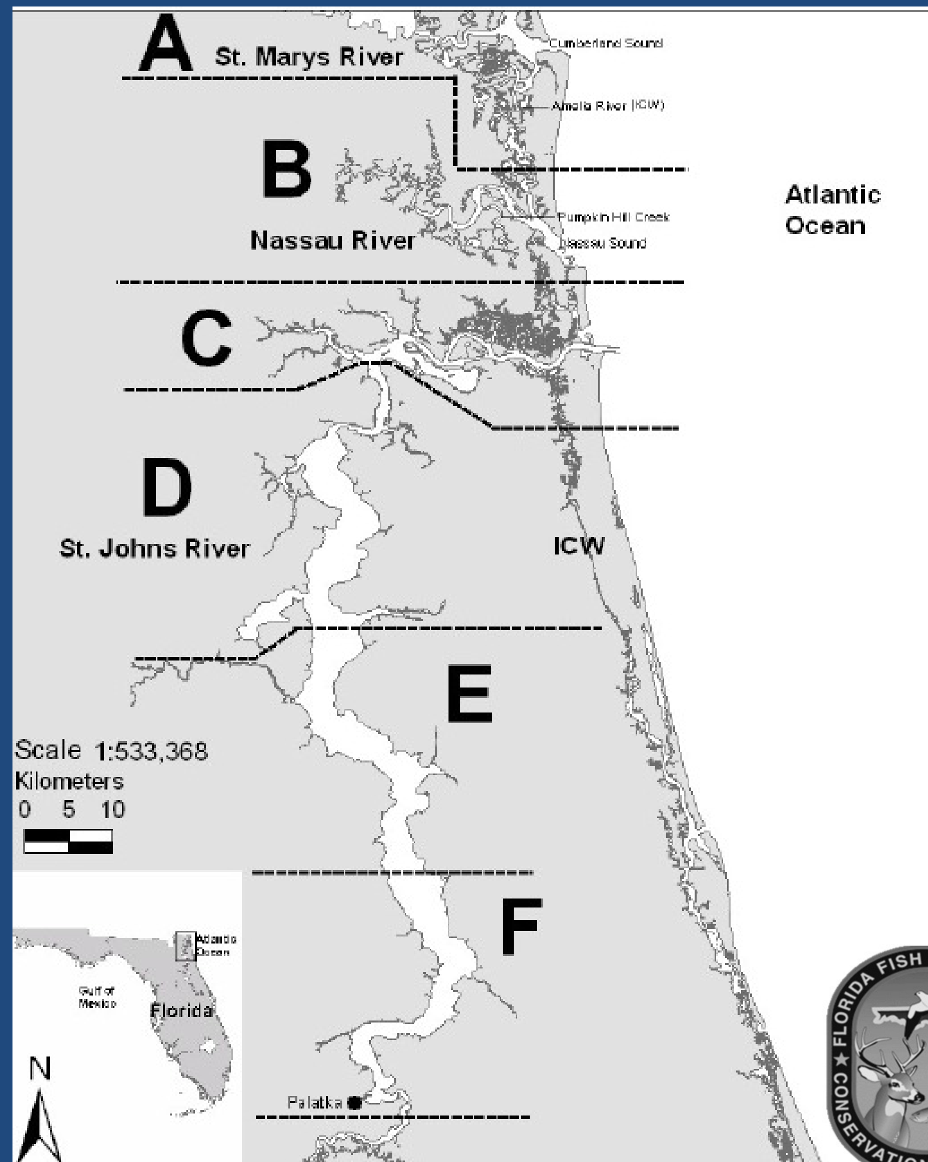

FLORIDA FISH AND WILDLIFE
CONSERVATION COMMISSION

6.1-m otter trawl

Juveniles and small adults

North East Florida Sampling Zones

- Sampling in northeast Florida since 2001.
- The area sampled is divided into six geographically-defined riverine zones.
- Monthly SRS is conducted in Zones A-D using 21.3--m river seines, 183-m haul seines, and 6.1-m river otter trawls.
- Monthly SRS is conducted in Zone E and F with only 21.3-m river seines and 6.1-m river otter trawls.



East Florida, North Indian River Lagoon Sampling Zones

•Sampling in the northern IRL since 1990.

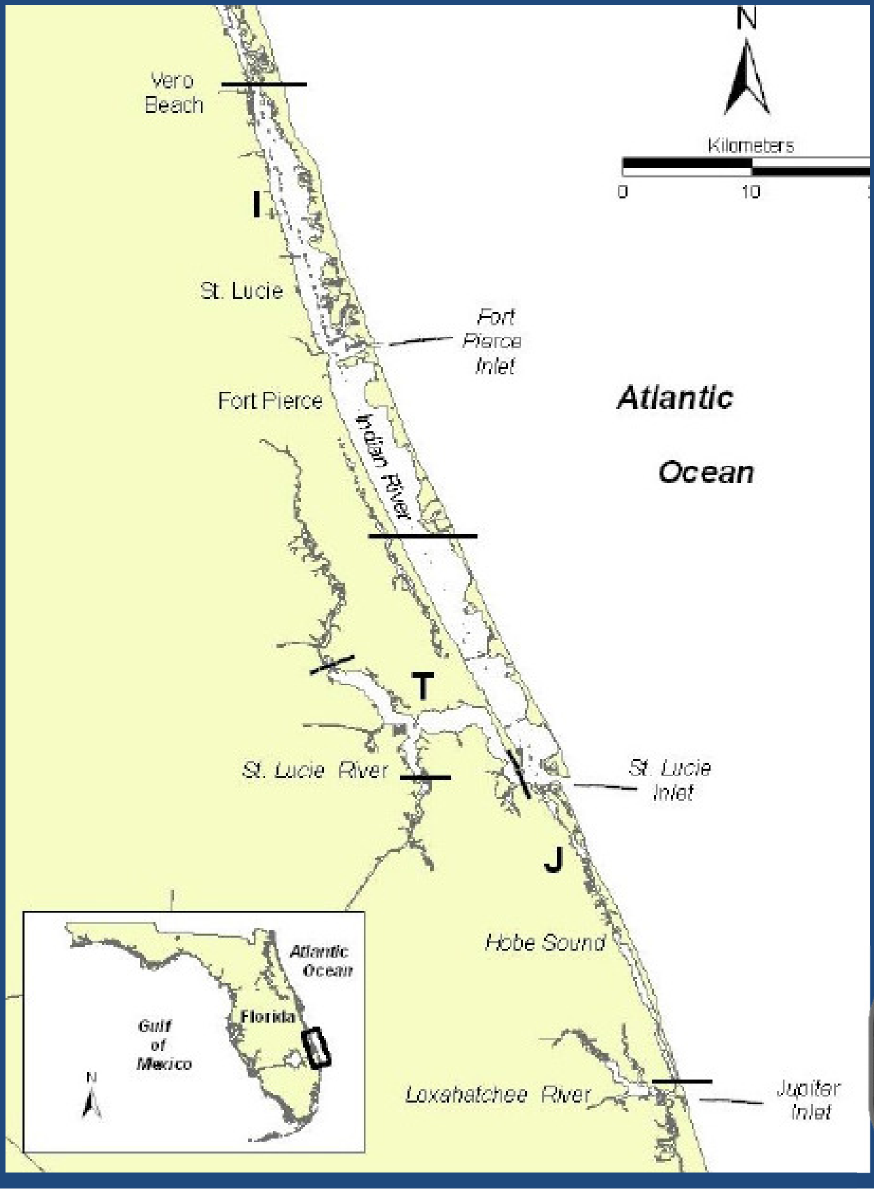
•The area sampled is divided into six geographically-defined bay zones (A-E, and H) and two riverine zones (F and O).

•Monthly SRS is conducted in Zone E with only 183-m haul seines. Zones F and O are sampled monthly with 21.3-m river seines.

•Zones A, B, and E are sampled seasonally (October and November) with 21.3-m bay seines.

East Florida, South Indian River Lagoon Sampling Zones

- Sampling in the southern IRL since 1997.
- The area sampled is divided into two geographically-defined bay zones (I and J) and one riverine zone (T).
- Monthly SRS is conducted in all zones using the 183-m haul seine.



Florida Shrimp Regulations

Florida Administrative Code Chapter 68B-31

Commercial Harvest

– Saltwater Products License
– Restricted Species Endorsement

Recreational Harvest

– Valid Saltwater Fishing License

State water limited to 3 nm on the Atlantic

– Live Bait
– Food
– Recreation

Recreational Shrimping Regulations

Bag Limit: 5 gallons, heads on, per harvester per day.
Size limit: None
Closed season: April and May closed in six NE counties.
Allowable gear:

- Landing or dip net 96”
- Push net
- A beach or haul seine with a mesh area no larger than 500 square feet.
- One frame net with an opening no larger than 16 feet around the perimeter.
- Shrimp Trap
  - Four shrimp traps per harvester.
  - 36” X 24” X 12” cannot have external or unattached wings, weirs or other devices.
- Cast net with a stretched length no greater than 14 feet.
- Baiting
  - Five poles marked with white reflective tape, set no closer than 10 yards apart fished during daylight hours and tended at all times.

Commercial Shrimp Regulations

- Shrimp may not be harvested as live bait and food shrimp on the same trip.
- Turtle Excluder Device (TED) required on all otter and skimmer trawls, except single try net or roller frame trawl.
- Bycatch Reduction Devices (BRD) must be installed on otter and skimmer trawls.
- Brine Box Prohibited

Live Bait Shrimp Regulations

Northeast Region, except as provided for Volusia County

The transfer of shrimp to another vessel while in or on the waters of the state is prohibited.

Live Well Requirements

- Vessel 16ft^3
- Vehicle and Storage 32 ft^3

Commercial Food Shrimp Regulations

Northeast Region

- Size Limit
  - Heads on average count < 47 shrimp per pound
  - Heads off average count < 70 shrimp per pound
- Roller Frame
  - Upper and Lower beam limit of 16’
  - Trawl bars no wider than 3”
  - Maximum of 2 unconnected trawls
  - Mesh 7/8” bar in the body and 3/4” bar in cod

Commercial Food Shrimp Regulations

Northeast Region

Otter Trawl

- No more than two unconnected otter trawls
- Mesh 7/8” bar in the body and 3/4” bar in cod
- Turtle excluder device (TED)required
- Bycatch reduction device (BRD) required
- Inshore Try Net limited to 10’ head rope
- Offshore Try Net limited to 20’ head rope

Commercial Food Shrimp Regulations

Northeast Florida Shrimping Closed Seasons

- Inshore closure April and May in six NE counties
- No harvest of shrimp in tributaries of Nassau and Duval counties.

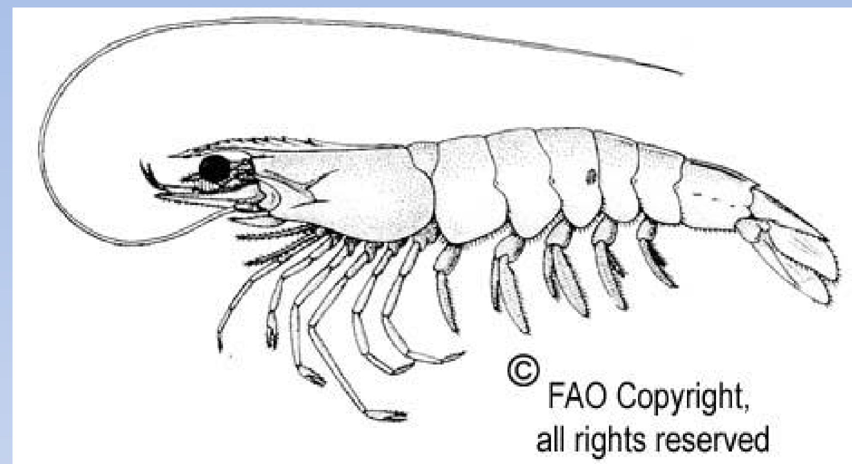
Night Trawling allowed in counties that solely boarder the Atlantic Ocean June, July and August

Commercial Food Shrimp Regulations

Southeast Florida Shrimping Regulations

- Otter Trawl Prohibited
- Wing net or Frame Net
  - Opening <28 feet around the perimeter
  - No more than two unconnected wing nets shall be attached to or fished from a single vessel
  - No wing net shall be fished by towing or dragging it over the bottom
- Open Season
  - November 1 each year and continue through May 31 the following year


FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION



Fish and Wildlife Research Institute
St. Petersburg, Florida
Fisheries Dependent Monitoring

Commercial Shrimp Fishery Monitoring

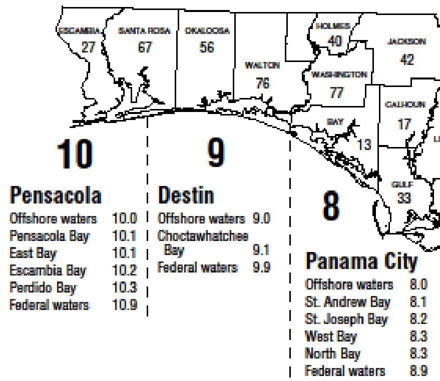
Florida's Marine Fisheries Trip Ticket Program

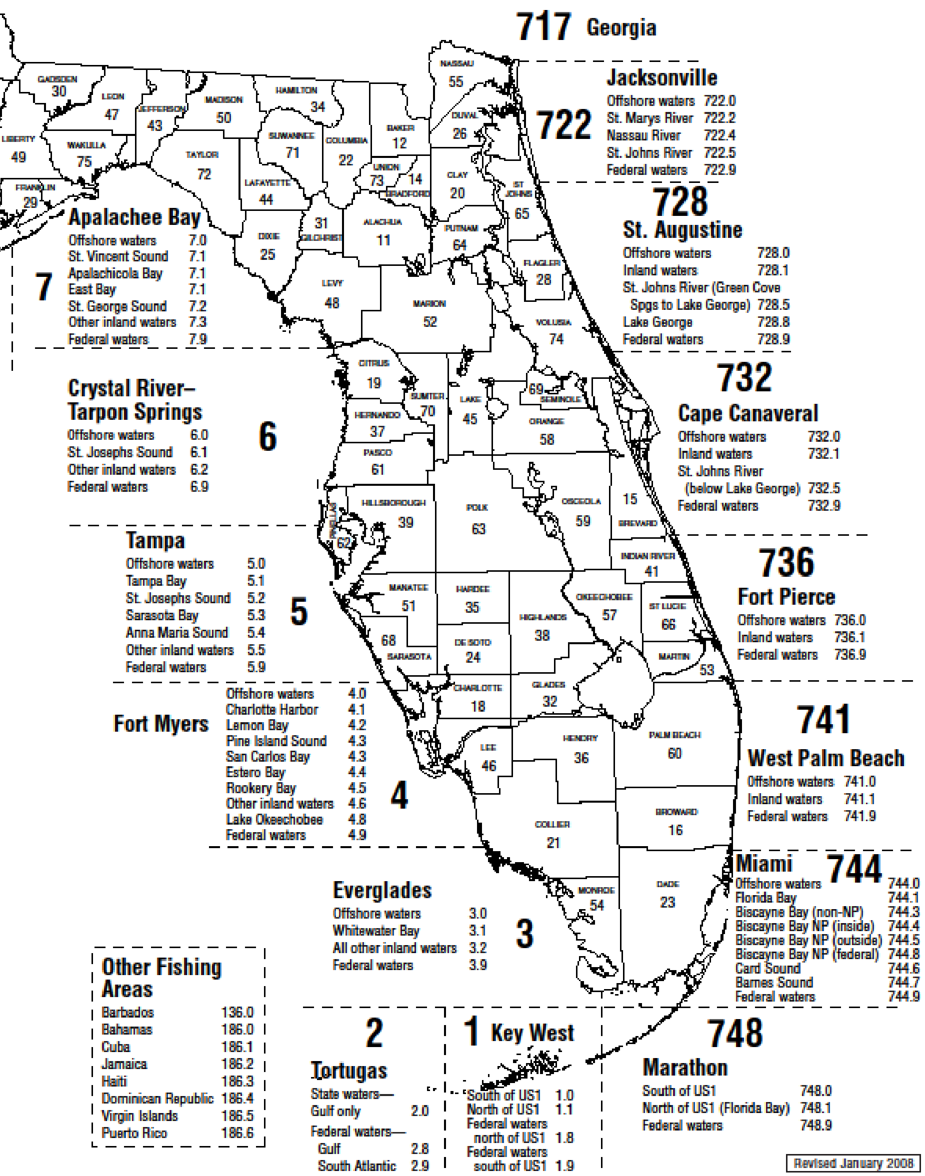
- Mandatory since 1984
  - State wide – all commercially harvested species
  - Replaced NMFS monthly dealer reports
  - Dealer based detailed trip level reporting
    - Fisher/dealer identifiers, area fished, gear, county landed, gear qty., depth, time fished, sets, trip start and end dates, species, amount of catch, unit price
- Significant changes/improvements
  - Gear added and required beginning Oct. 1991
  - Area fished required in 1995 (always part of trip ticket)
    - More detailed maps for the Florida Keys and Tortugas added in 2008
  - Trip start date added in 2000
    - Time fished vs days at sea
  - Electronic reporting

Florida Fish and Wildlife Conservation Commission

Fish and Wildlife Research Institute
Marine Fisheries Trip Ticket Office
100 8th Ave. SE, St. Petersburg, FL 33701-5020
Telephone 727/822-8783 Fax 727/894-6181
TOLL-FREE:
Telephone 866/447-5515 Fax 866/447-5514

Marine Fisheries Trip Ticket FISHING AREA CODE MAP





Fishery Management Regulations can be found at the following Web sites:

Federal Waters

South Atlantic Fishery Management Council www.safmc.net/
Gulf of Mexico Fishery Management Council www.gulfcouncil.org/
NOAA Fisheries www.nmfs.noaa.gov
National Marine Fisheries Service Southeast Regional Office http://sero.nmfs.noaa.gov

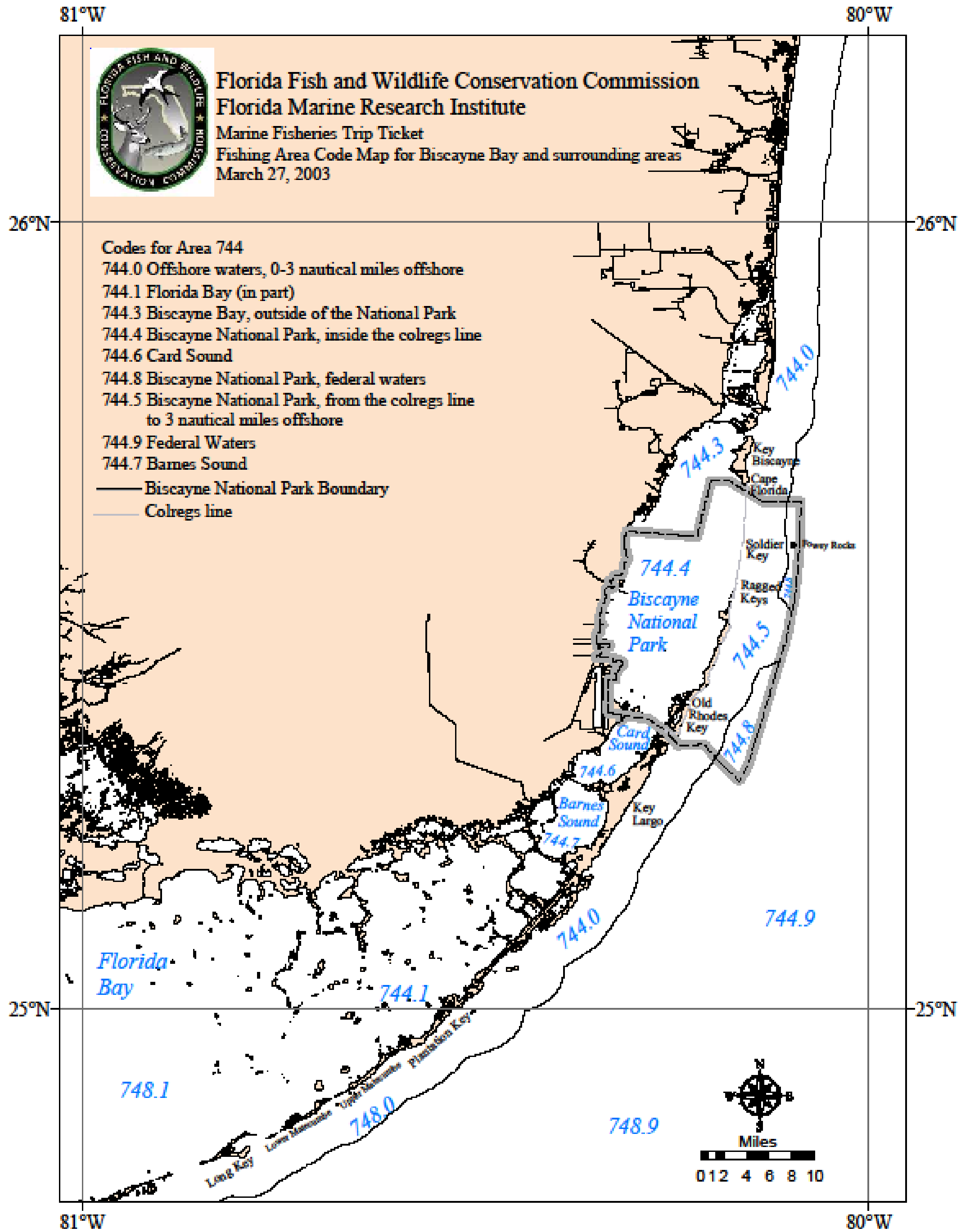
State Waters

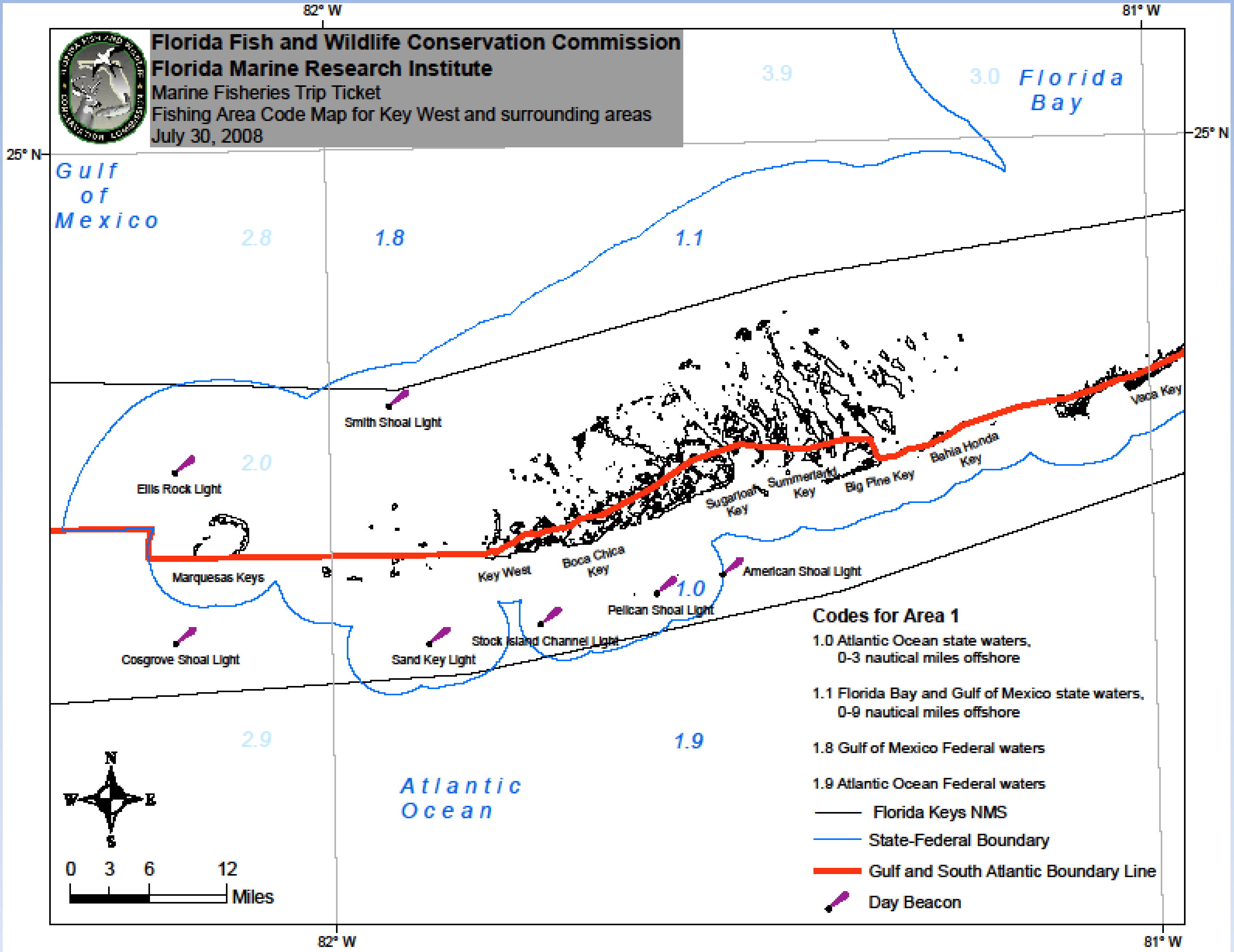
Florida Fish and Wildlife Conservation Commission www.MyFWC.com

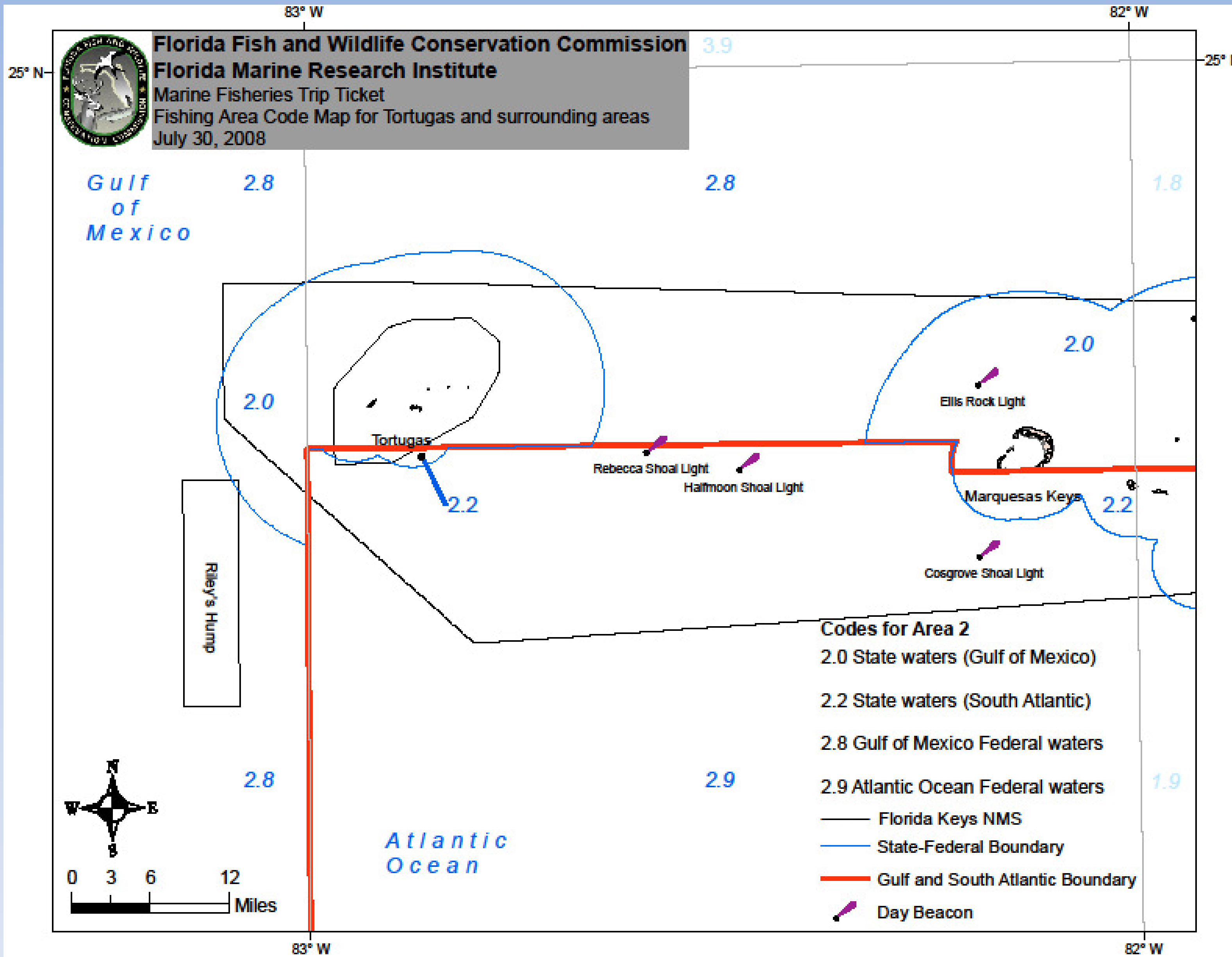
Our Website

Fish and Wildlife Research Institute http://research.MyFWC.com

FWC–FWRI St Petersburg		**National Marine Fisheries Service**	
Marine Fisheries Trip Ticket Office	727/822-8783	St. Petersburg—Fisheries Mgmt.	727/824-5305
Trip Ticket Office Fax	727/894-6181	St. Petersburg—Permits	727/824-5326
Trip Ticket Office Toll-Free Telephone	866/447-5515	Miami—Logbooks	305/361-4581
Trip Ticket Office Toll-Free Fax	866/447-5514		
Fish and Wildlife Research Institute	727/896-8626	**Federal Councils**	
FWC Tallahassee		S. Atlantic Fishery Mgmt. Council	843/571-4366
Division of Marine Fisheries	850/487-0554	Gulf of Mexico Fish. Mgmt. Council	813/348-1630
Licenses and Permits Section	850/487-3122		
Marine Fisheries Management	850/488-6058	**Interstate Commissions**	
Marine Fisheries Services	850/922-4340	Atlantic States Marine Fish. Comm.	202/289-6400
LAW ENFORCEMENT	**888/404-3922**	Gulf States Marine Fish. Comm.	228/875-5912


81°W
80°W
Florida Fish and Wildlife Conservation Commission
Florida Marine Research Institute
Marine Fisheries Trip Ticket
Fishing Area Code Map for Biscayne Bay and surrounding areas
March 27, 2003
26°N
Codes for Area 744
744.0 Offshore waters, 0-3 nautical miles offshore
744.1 Florida Bay (in part)
744.3 Biscayne Bay, outside of the National Park
744.4 Biscayne National Park, inside the colregs line
744.6 Card Sound
744.8 Biscayne National Park, federal waters
744.5 Biscayne National Park, from the colregs line to 3 nautical miles offshore
744.9 Federal Waters
744.7 Barnes Sound
Biscayne National Park Boundary
Colregs line
744.0
744.3
Key Biscayne
Cape Florida
Soldier Key
Ragged Keys
744.4
Biscayne National Park
744.5
Old Rhodes Key
Card Sound
744.8
744.6
Barnes Sound
744.7
Key Largo
744.9
744.0
Florida Bay
744.1
25°N
748.1
748.0
748.9
Long Key
Plantation Key
Miles
0 1 2 4 6 8 10

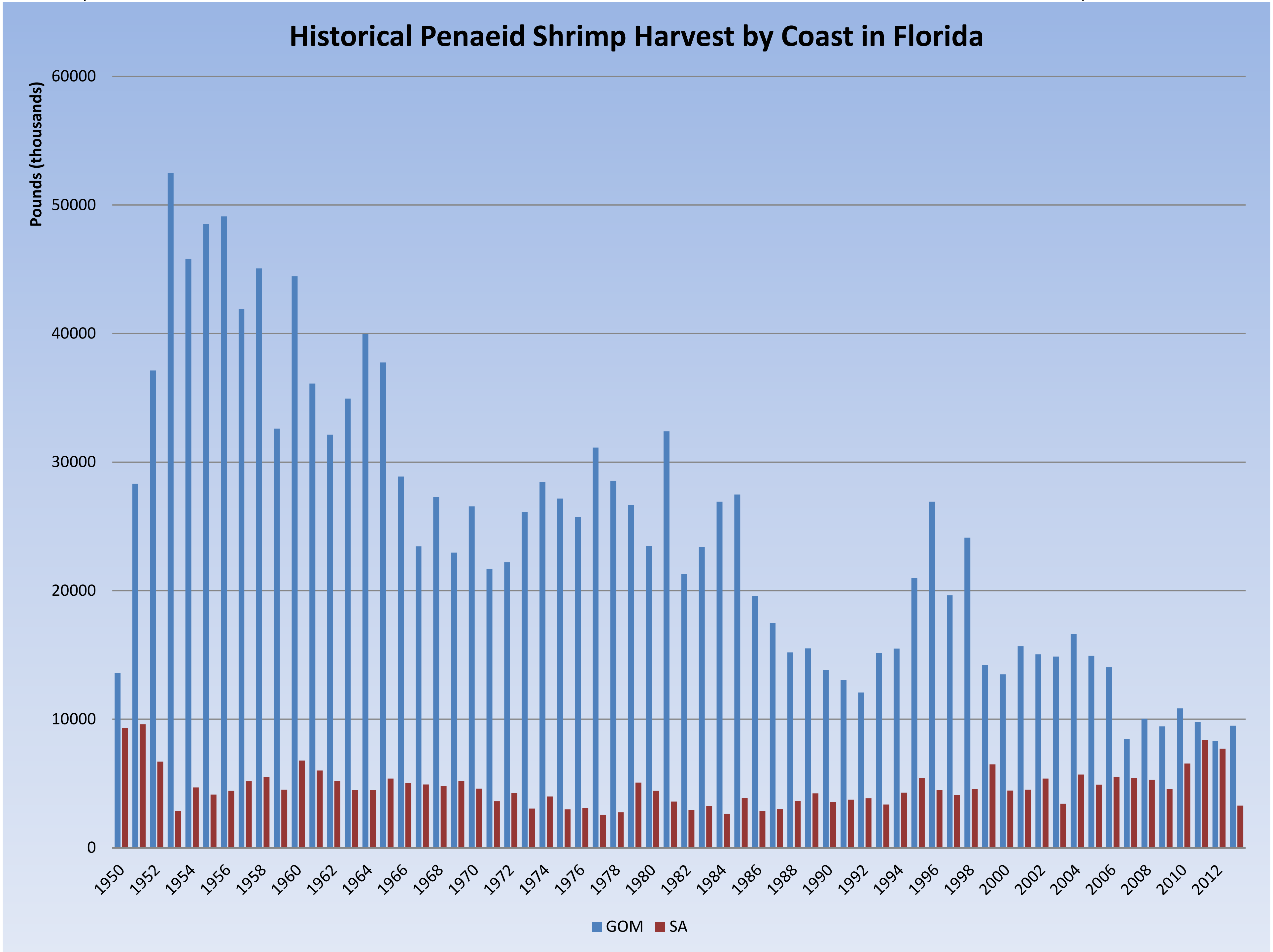

Florida Fish and Wildlife Conservation Commission
Florida Marine Research Institute
Marine Fisheries Trip Ticket
Fishing Area Code Map for Key West and surrounding areas
July 30, 2008
82° W
81° W
25° N
Gulf of Mexico
Florida Bay
Atlantic Ocean
3.9
3.0
2.8
1.8
1.1
2.0
1.0
2.9
1.9
Smith Shoal Light
Ellis Rock Light
Marquesas Keys
Cosgrove Shoal Light
Sand Key Light
Key West
Boca Chica Key
Stock Island Channel Light
Pelican Shoal Light
American Shoal Light
Sugarloaf Key
Summerland Key
Big Pine Key
Bahia Honda Key
Vaca Key
Codes for Area 1
1.0 Atlantic Ocean state waters, 0-3 nautical miles offshore
1.1 Florida Bay and Gulf of Mexico state waters, 0-9 nautical miles offshore
1.8 Gulf of Mexico Federal waters
1.9 Atlantic Ocean Federal waters
Florida Keys NMS
State-Federal Boundary
Gulf and South Atlantic Boundary Line
Day Beacon
N
S
E
W
0 3 6 12
Miles

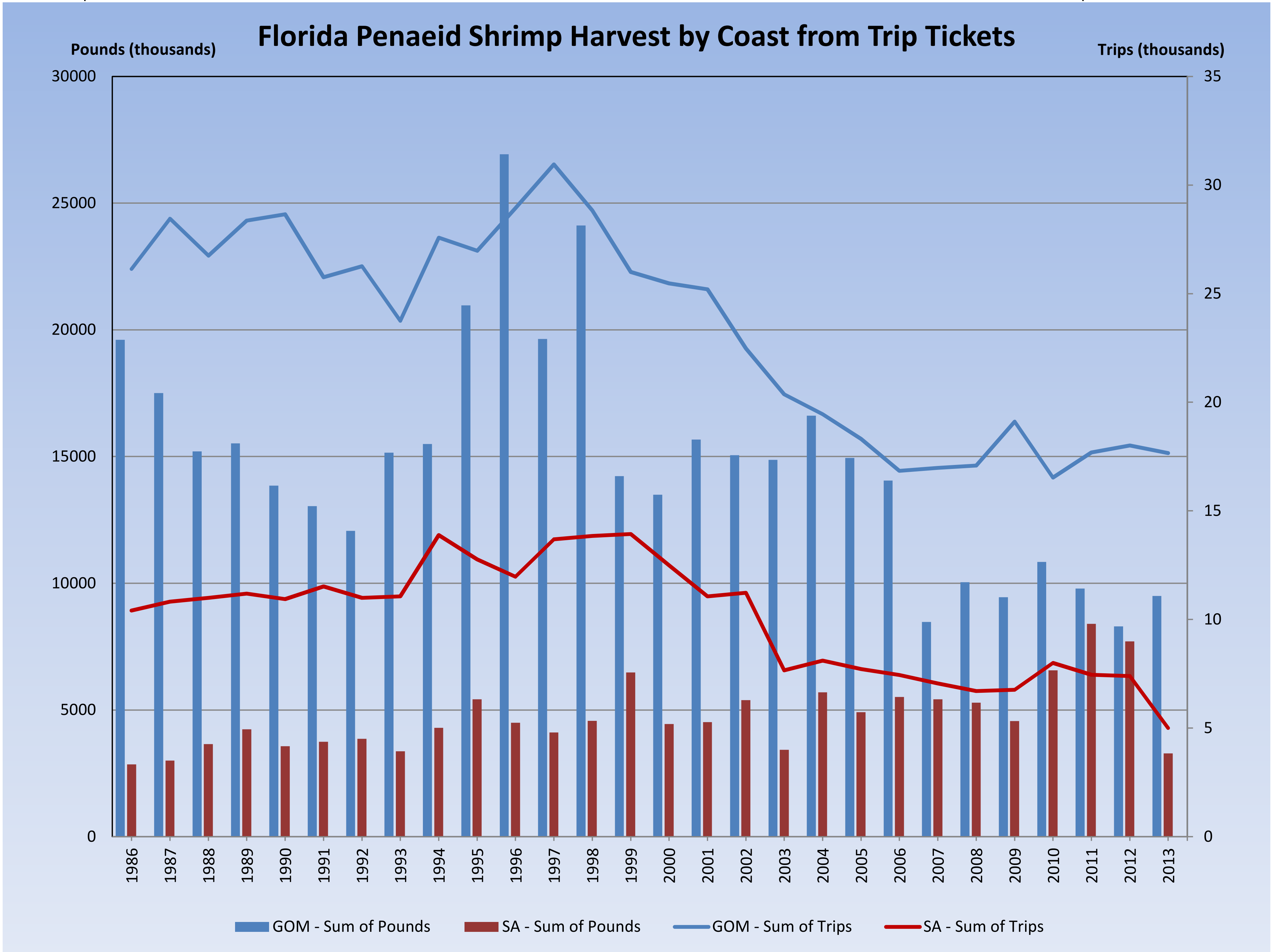

83° W
82° W
25° N
Florida Fish and Wildlife Conservation Commission
Florida Marine Research Institute
Marine Fisheries Trip Ticket
Fishing Area Code Map for Tortugas and surrounding areas
July 30, 2008
3.9
Gulf of Mexico
2.8
2.8
1.8
2.0
2.0
Ellis Rock Light
Tortugas
Rebecca Shoal Light
Halfmoon Shoal Light
2.2
Marquesas Keys
2.2
Cosgrove Shoal Light
Riley's Hump
Codes for Area 2
2.0 State waters (Gulf of Mexico)
2.2 State waters (South Atlantic)
2.8 Gulf of Mexico Federal waters
2.9 Atlantic Ocean Federal waters
Florida Keys NMS
State-Federal Boundary
Gulf and South Atlantic Boundary
Day Beacon
2.8
2.9
1.9
N
W
E
S
0 3 6 12
Miles
Atlantic Ocean

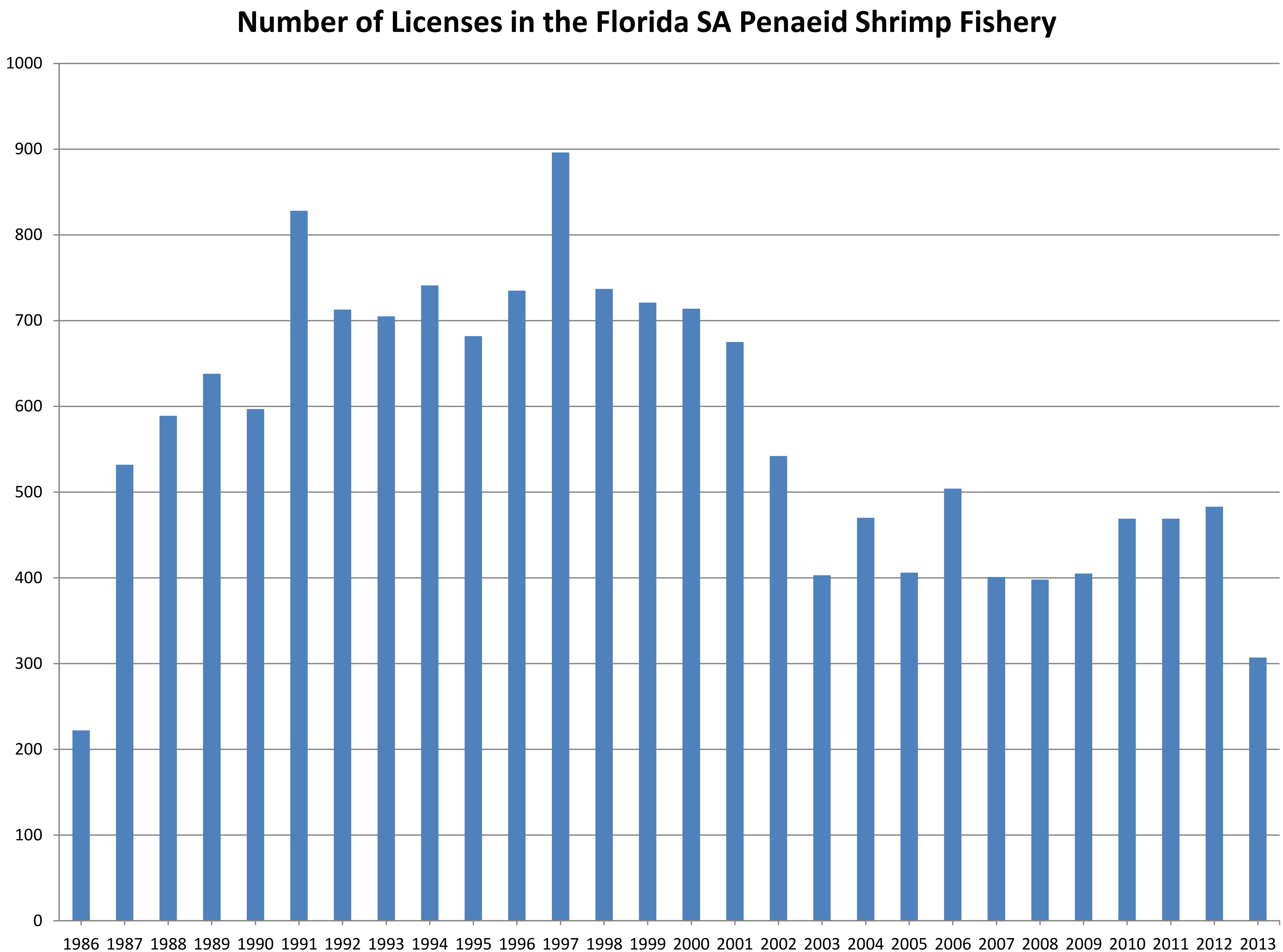
Marine Fisheries Trip Ticket Program

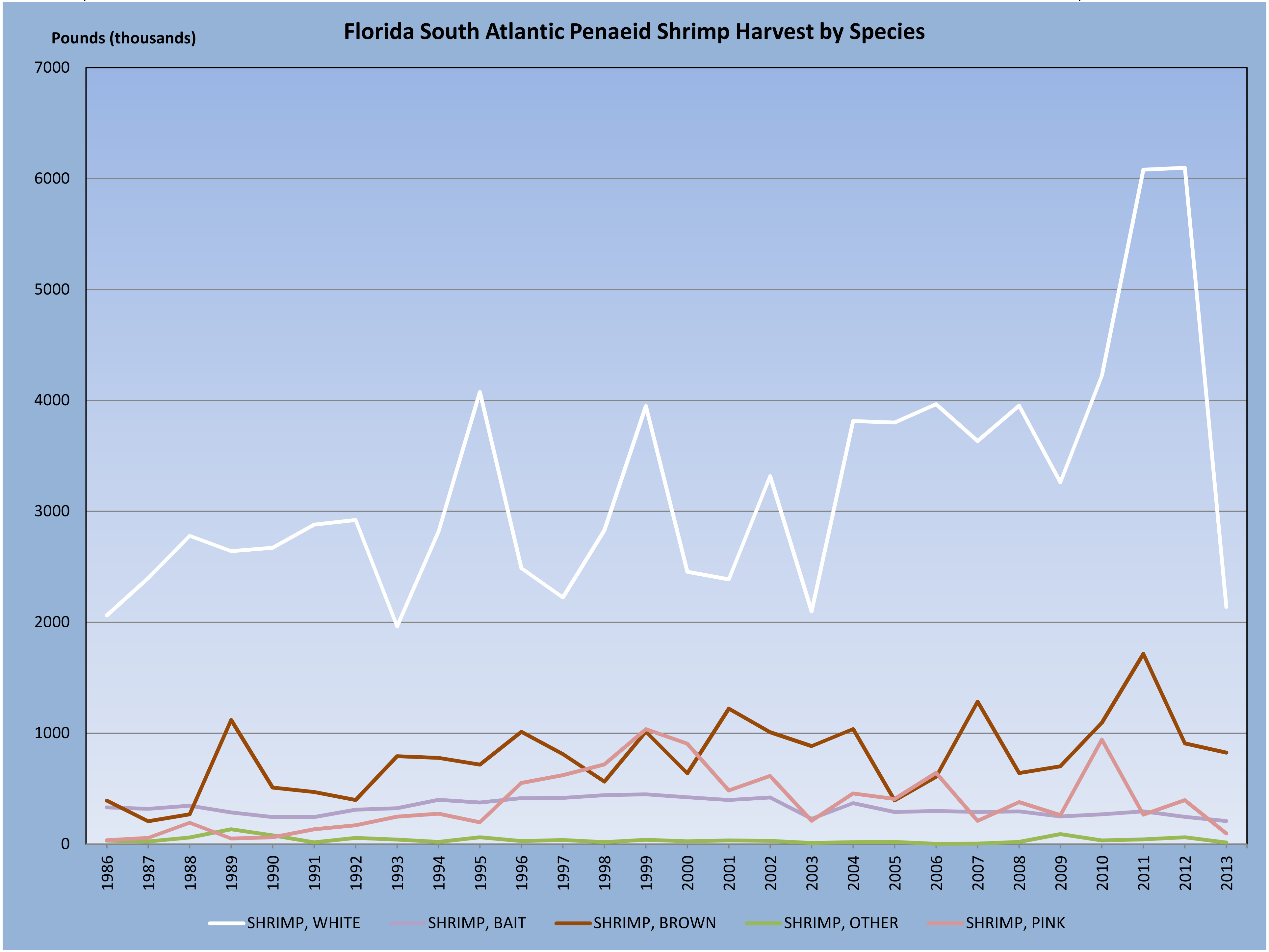
Electronic vs Paper Ticket Reporting

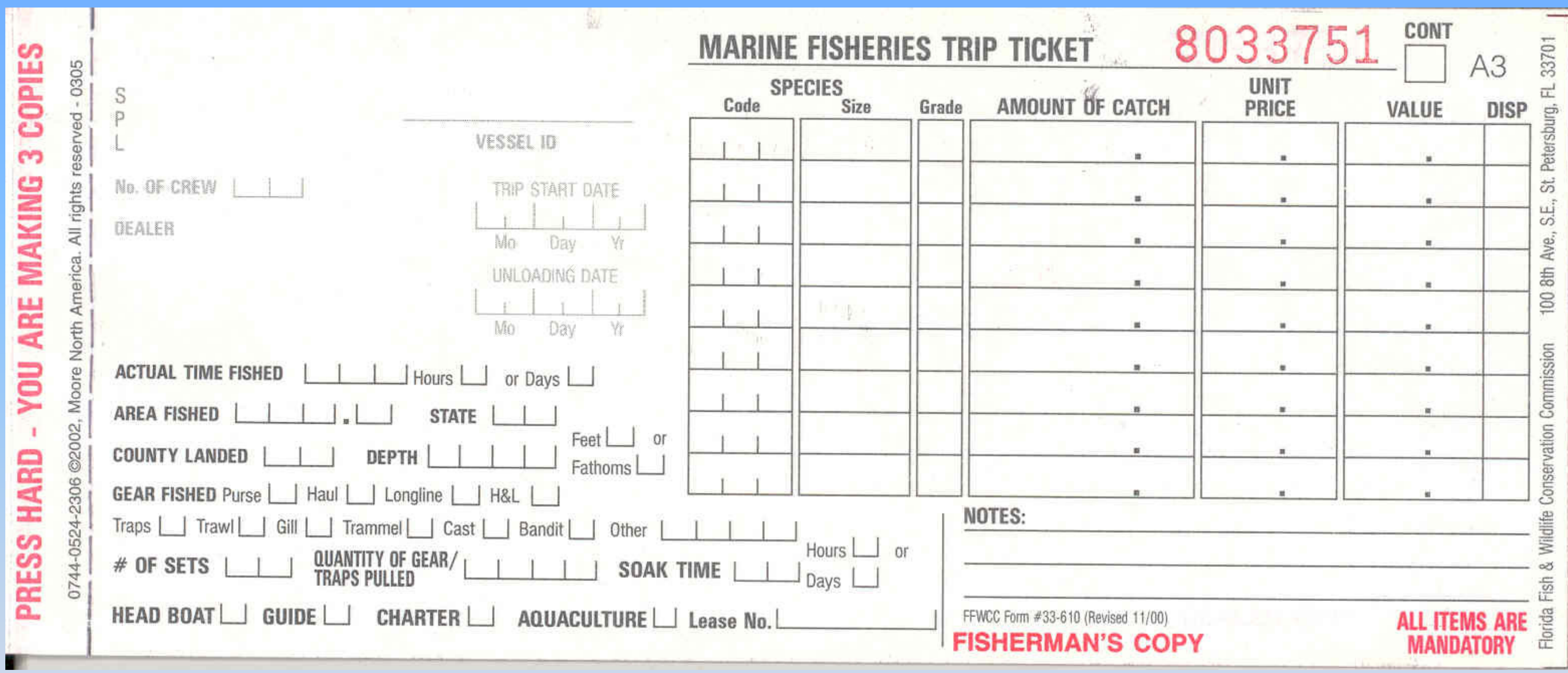
- Electronic started via diskette in late ‘80s
- First program developed in early 90’s
- Current program (Bluefin Data) started in 2003
- By the numbers (2013)
    - Electronic tickets: 156,745 (70%)
    - Electronic dealers: 419 (30%)
    - Total dealers: 996
    - About 5% of dealers did both paper and electronic


Historical Penaeid Shrimp Harvest by Coast in Florida
Pounds (thousands)
60000
50000
40000
30000
20000
10000
0
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
GOM
SA


Florida Penaeid Shrimp Harvest by Coast from Trip Tickets
Pounds (thousands)
Trips (thousands)
30000
25000
20000
15000
10000
5000
0
35
30
25
20
15
10
5
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
GOM - Sum of Pounds
SA - Sum of Pounds
GOM - Sum of Trips
SA - Sum of Trips


Number of Licenses in the Florida SA Penaeid Shrimp Fishery
1000
900
800
700
600
500
400
300
200
100
0
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013


Florida South Atlantic Penaeid Shrimp Harvest by Species
Pounds (thousands)
7000
6000
5000
4000
3000
2000
1000
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
SHRIMP, WHITE
SHRIMP, BAIT
SHRIMP, BROWN
SHRIMP, OTHER
SHRIMP, PINK



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MARINE FISHERIES TRIP TICKET 8033751 CONT A3

S
P
L

VESSEL ID

No. OF CREW

DEALER

TRIP START DATE Mo Day Yr

UNLOADING DATE Mo Day Yr

SPECIES Code	Size	Grade	AMOUNT OF CATCH	UNIT PRICE	VALUE	DISP

ACTUAL TIME FISHED Hours or Days

AREA FISHED . STATE

COUNTY LANDED DEPTH Feet or Fathoms

GEAR FISHED Purse Haul Longline H&L

Traps Trawl Gill Trammel Cast Bandit Other

OF SETS QUANTITY OF GEAR/ TRAPS PULLED SOAK TIME Hours or Days

HEAD BOAT GUIDE CHARTER AQUACULTURE Lease No.

NOTES:

FFWCC Form #33-610 (Revised 11/00)

FISHERMAN'S COPY

ALL ITEMS ARE MANDATORY

Florida Fish & Wildlife Conservation Commission 100 8th Ave., S.E., St. Petersburg, FL 33701

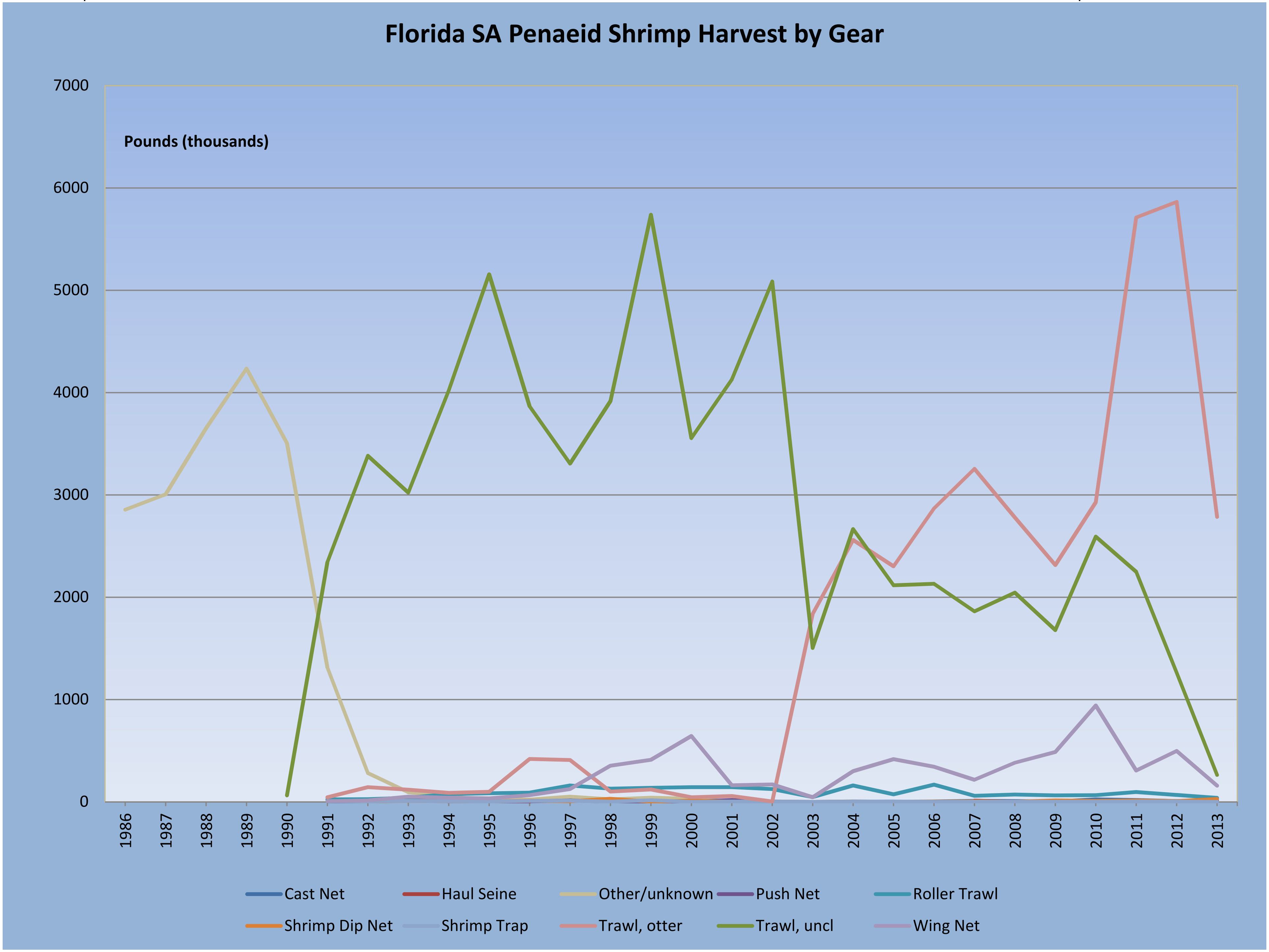
Florida Fish and Wildlife Conservation Commission
Marine Fisheries Trip Ticket Gear Codes

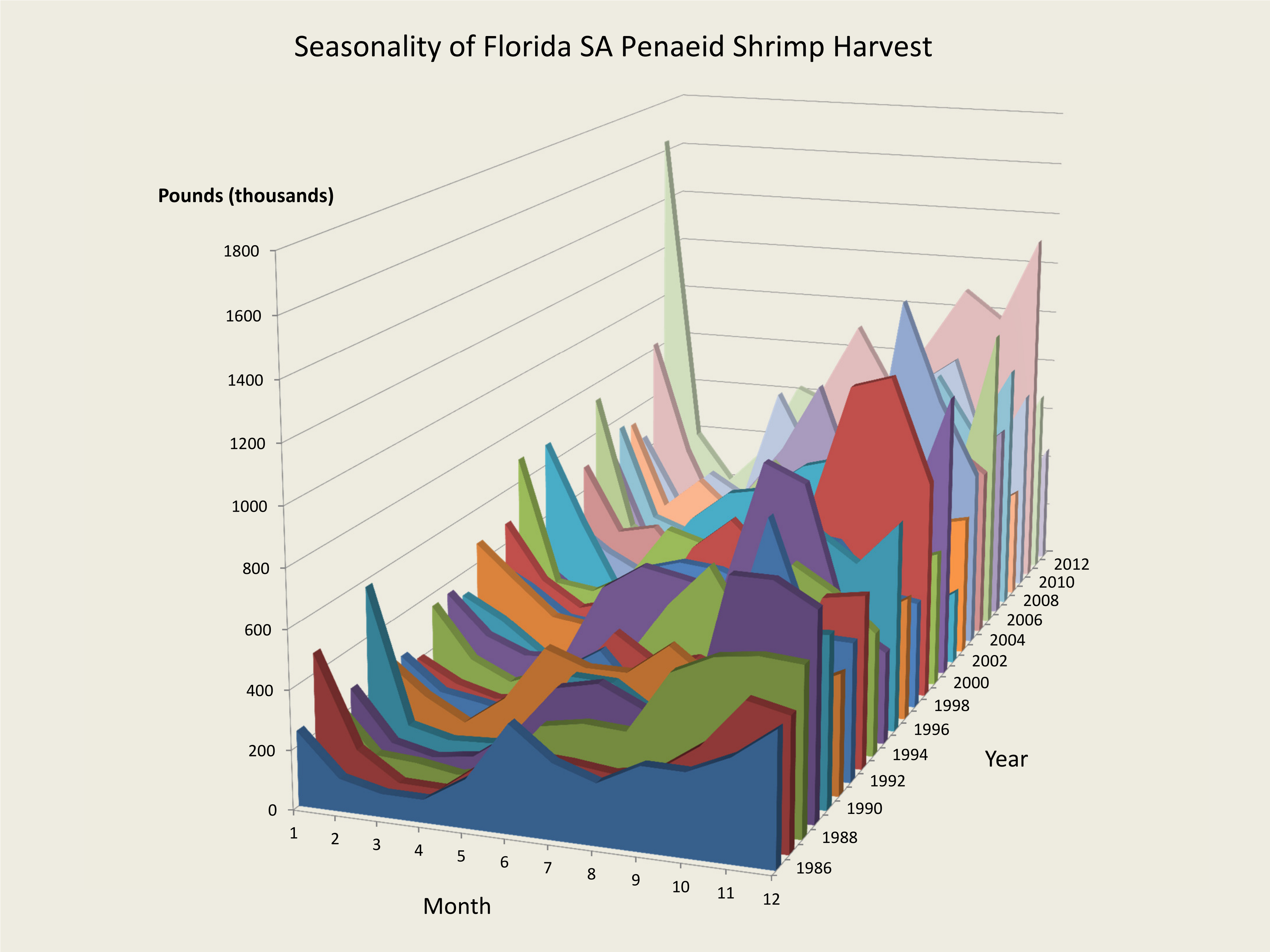
Revised 7/09/2012

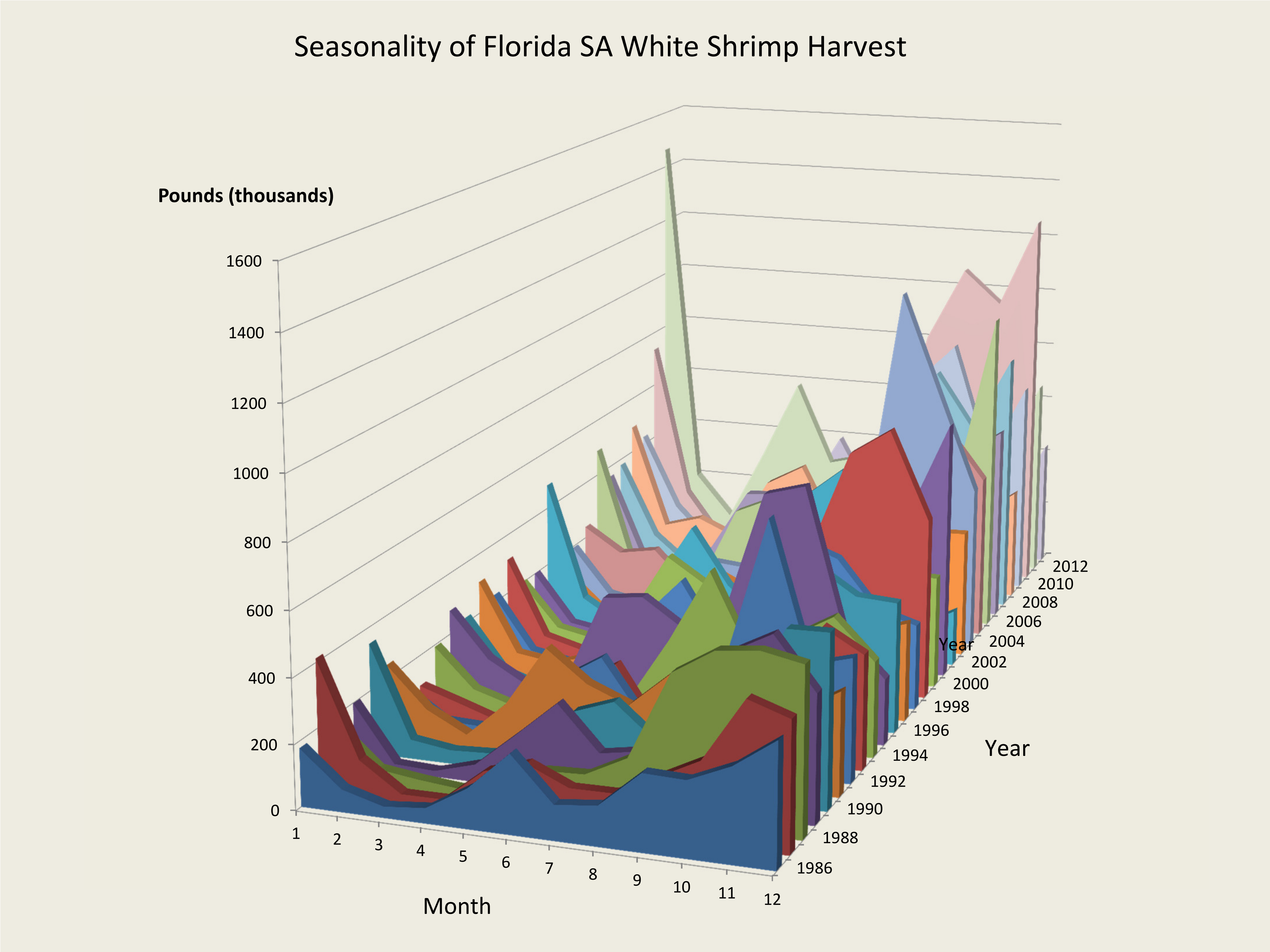
Gear Code	Description	Most often used for:
	Trawls	
1900	Trawl, Beam	Food Shrimp
2001	Trawl, Single	Food Shrimp
2002	Trawl, Double	Food Shrimp
2003	Trawl, Twin	Food Shrimp
2004	Trawl, Roller	Fish, Shrimp
2005	Trawl, Roller Frame	Bait Shrimp
2006	Trawl, uncl.	
2007	Trawl, Quad Rig	Food Shrimp
2009	Trawl, Skimmer	Food Shrimp
	Nets	
200	Seine, Beach/Haul	Fish
1450	Seine, Purse/Rib	Bait Fish
1455	Seine, Purse/Tarp	Fish
1650	**Pound Net**	**Menhaden, tunas**
1750	Lampara Net	Bait Fish (Ballyhoo)
1890	Butterfly (Wing) Net	Shrimp
4700	Gill Net, uncl.	Fish
4750	Gill Net, Run-around	Fish
4760	Gill Net, Stab	Fish
4770	Gill Net, Sink	Fish
4780	Gill Net, Drift	Shark
5300	Trammel Net, uncl.	Fish
5350	Trammel, Run-around	Fish
5360	Trammel, Stab	Fish
7250	Push Net	Shrimp
7350	Cast Net	Fish, Bait Fish
	Traps	
3300	Trap, Blue Crab	
3330	Trap, Stone Crab	
3450	Trap, Fish	
3550	Trap, Lobster	
3700	Trap, Shrimp	
3860	Trap, other	
	Hook & Line	
6100	Hook & Line, uncl.	
6110	Rod And Reel	
6120	Hand Reel	
	Hook & Line (cont.)	
6130	Electric Reel	
6200	**Troll Lines**	
6210	**Troll Lines, Manual**	
6220	**Troll Lines, Hydraulic**	
6230	**Troll Lines, Electric**	
6240	**Troll Lines, Hand**	
6301	Head Boat	
6302	Guide Boat	
6303	Charter Boat	
6570	Green-stick line	
6740	Long Line, uncl.	
6750	Long Line, Surface/Midwater	
6760	Long Line, Bottom	
6770	Bouy Drop Line	
6800	Trot Line	Catfish
6850	Crab Line	
	Hand Gears	
7600	Gig/Spear	Fish
8400	Tongs	Oysters
8405	Hand (Hogging)	Oysters
9250	Sponge Hook	Sponges
9355	Other Tropicals	
9430	Chemical, Quinaldine	Tropicals
9431	Chemical, other	Tropicals
9432	Hand Net	Tropicals, Lobsters, Hoop Net
9433	Scuba	Tropicals, Lobsters
9434	Snorkel	Tropicals, Lobsters
9435	Bully Net	Lobsters
9436	Shrimp Dip Net	Shrimp
9437	Hand Gear	Tropicals
9550	Rake, Shovel, Pitchfork	Clams
9551	Hand Gear	Clams
	Other Gears	
8300	Dredge	Scallops, Clams
9901	Retail Bait	
9999	Other Gears	
9944	Tournament	
9955	Aquaculture	Clams, Oysters, Live Rock

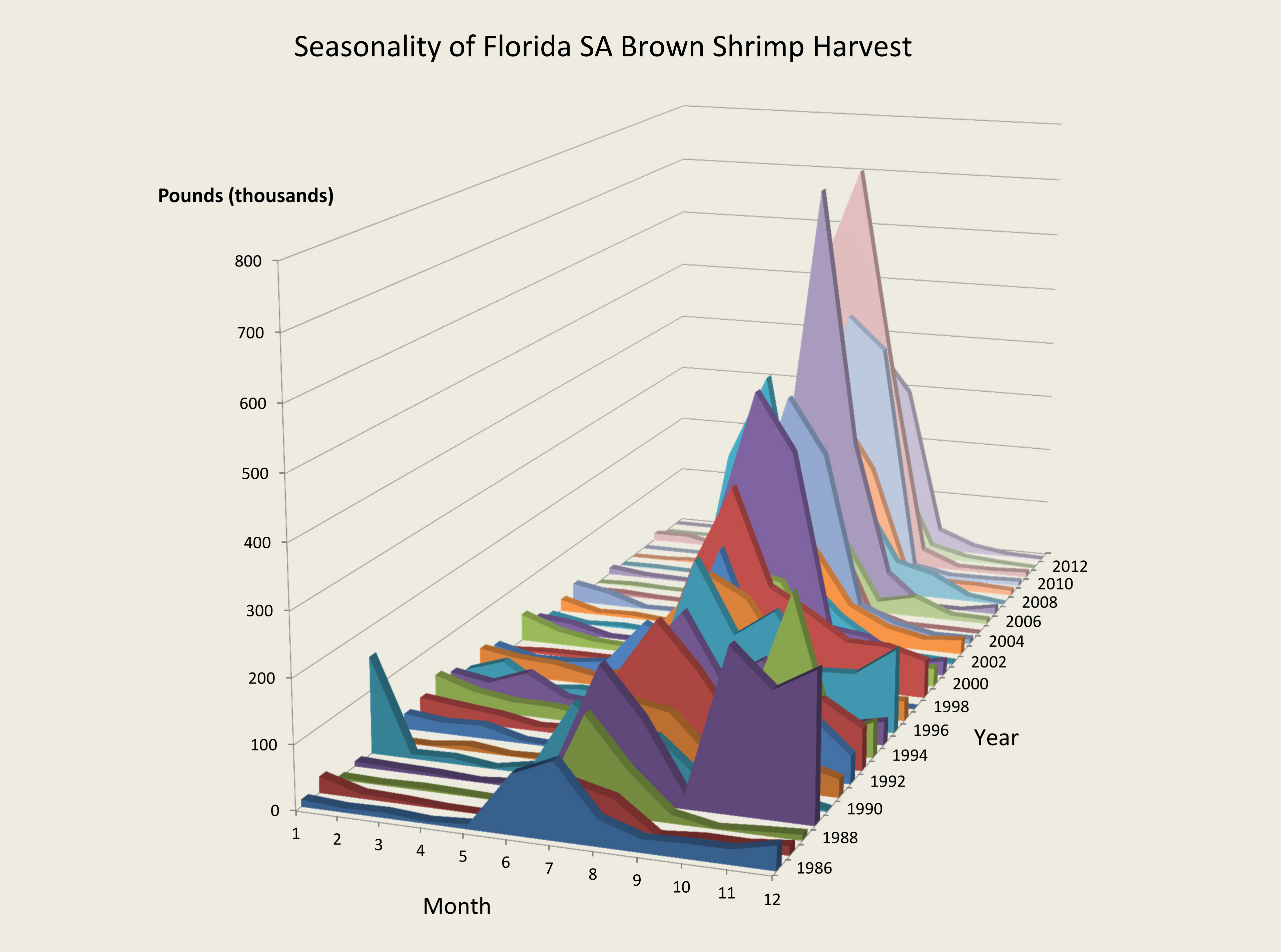
File: GEARS.XLS

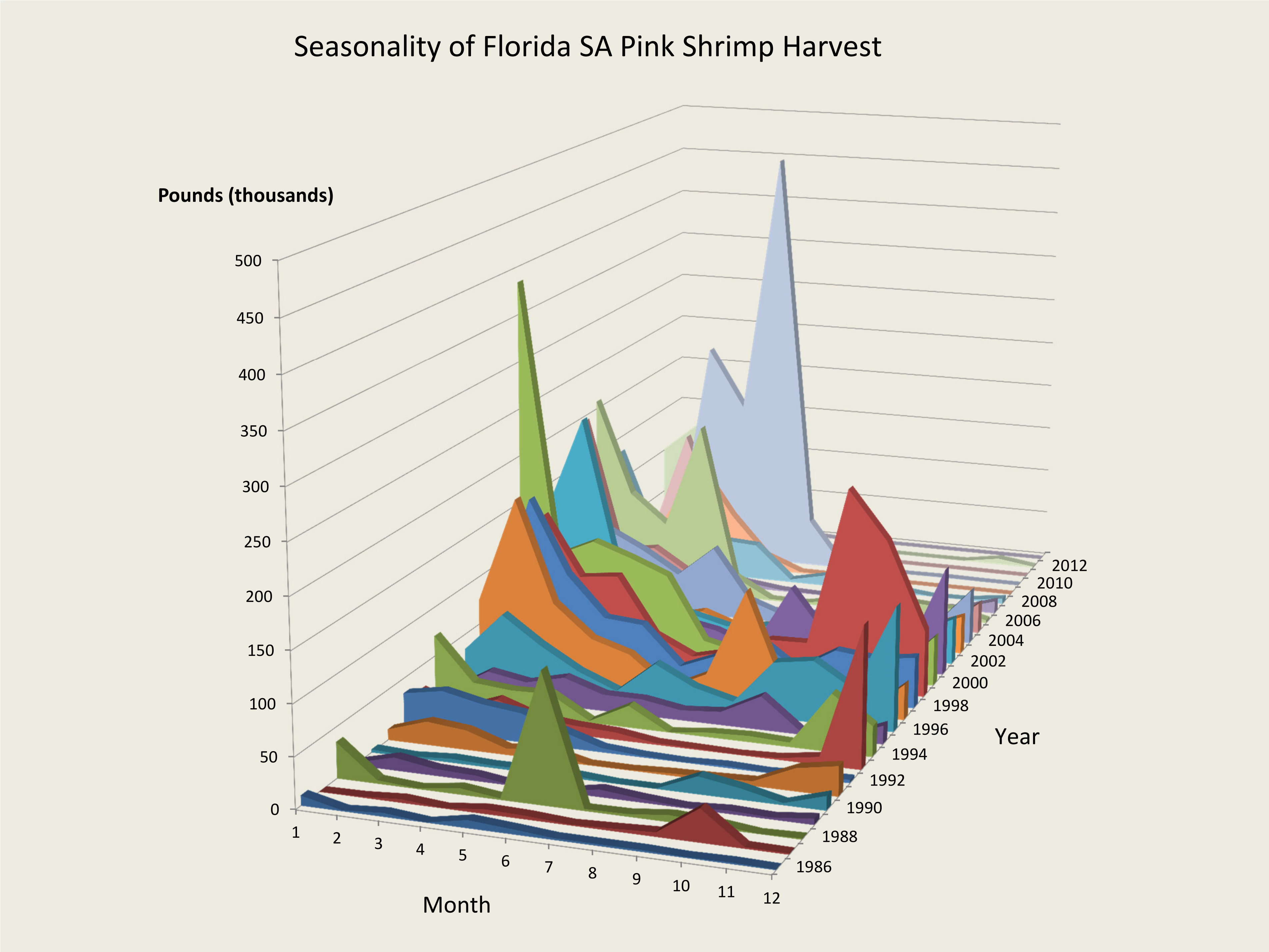
New gears in bold text

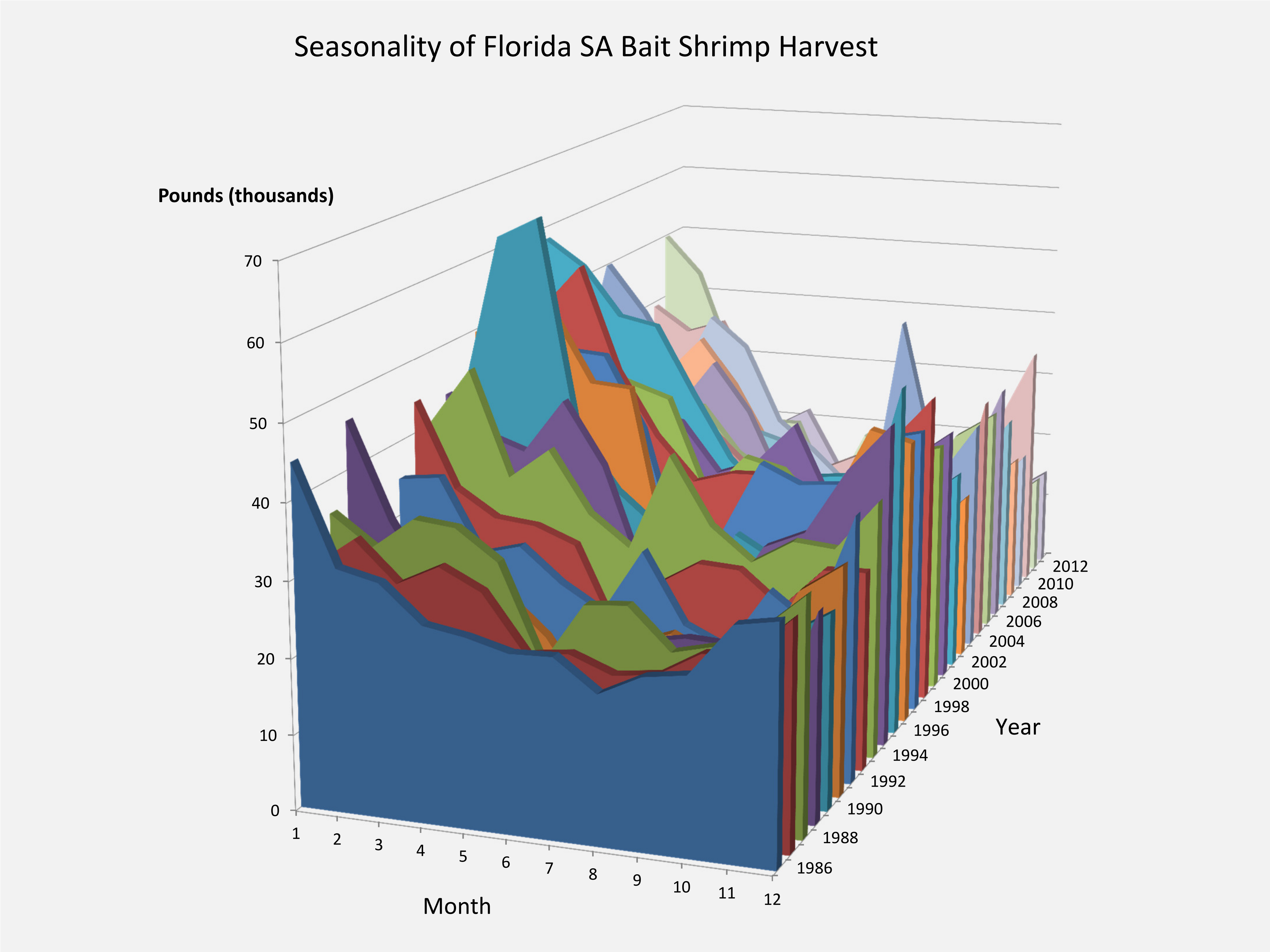

Florida SA Penaeid Shrimp Harvest by Gear
Pounds (thousands)
7000
6000
5000
4000
3000
2000
1000
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Cast Net
Haul Seine
Other/unknown
Push Net
Roller Trawl
Shrimp Dip Net
Shrimp Trap
Trawl, otter
Trawl, uncl
Wing Net

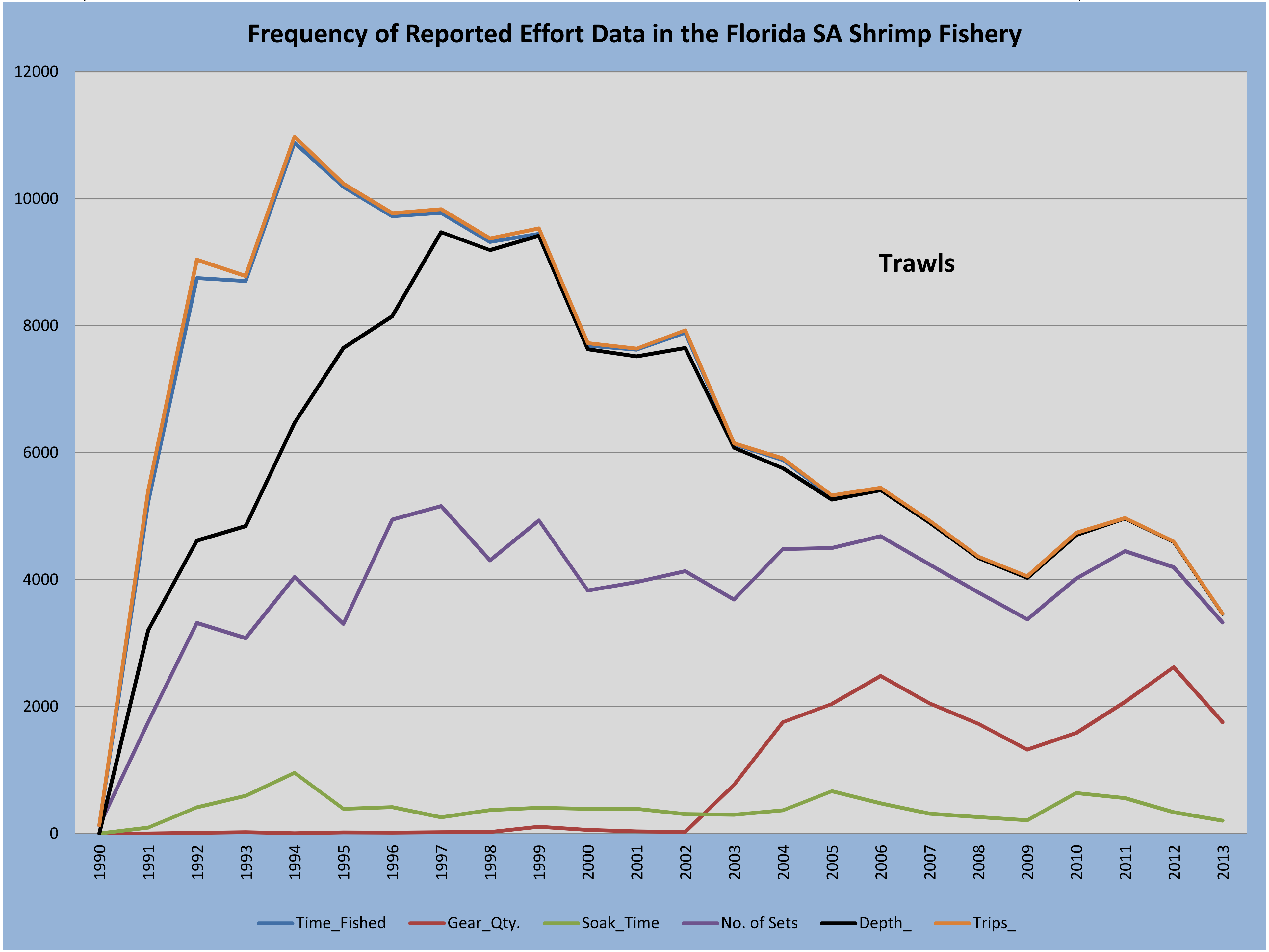

Seasonality of Florida SA Penaeid Shrimp Harvest
Pounds (thousands)
1800
1600
1400
1200
1000
800
600
400
200
0
1
2
3
4
5
6
7
8
9
10
11
12
Month
Year
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012

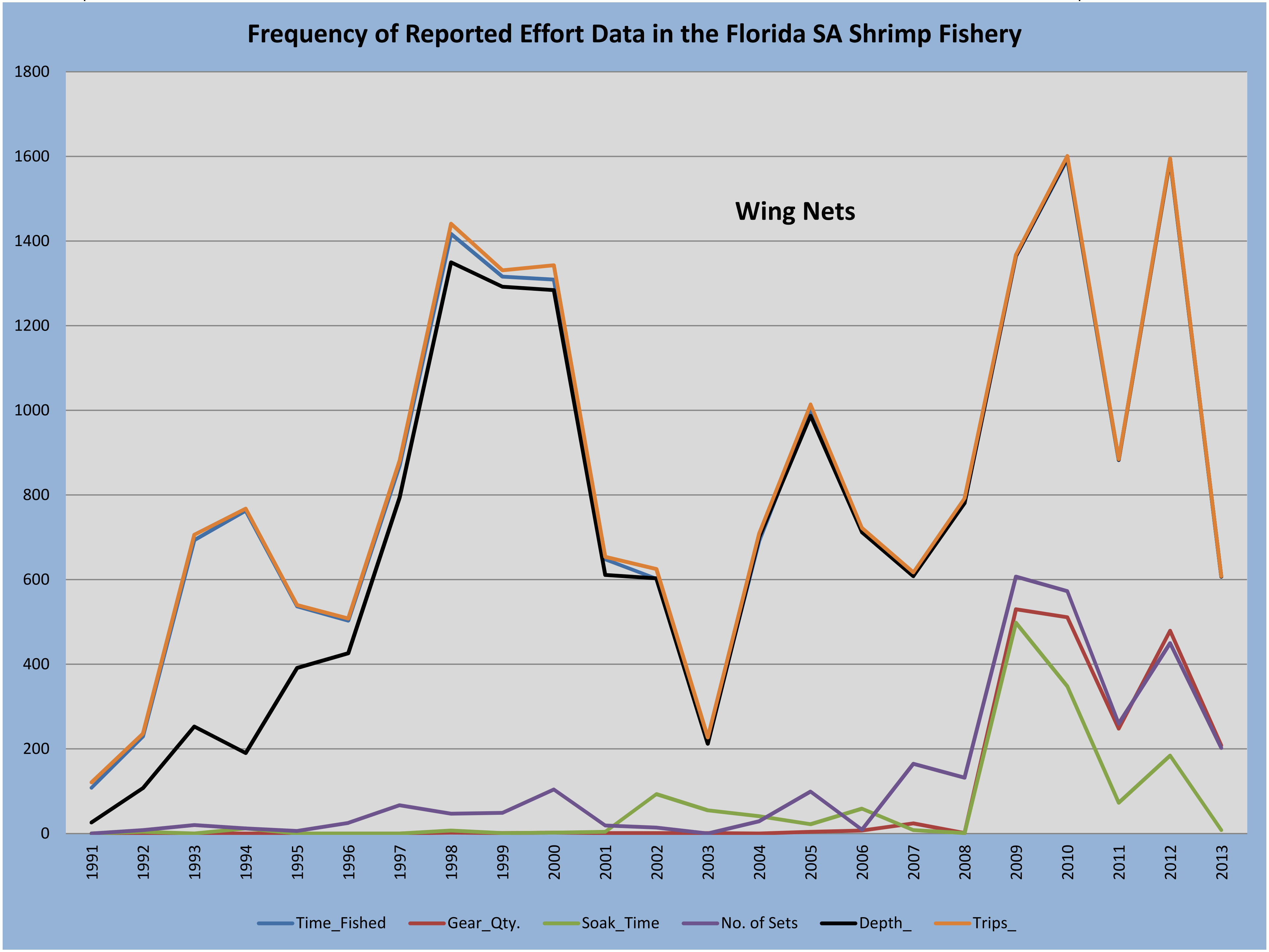

Seasonality of Florida SA White Shrimp Harvest
Pounds (thousands)
0
200
400
600
800
1000
1200
1400
1600
Month
1
2
3
4
5
6
7
8
9
10
11
12
Year
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Year


Seasonality of Florida SA Brown Shrimp Harvest
Pounds (thousands)
800
700
600
500
400
300
200
100
0
1
2
3
4
5
6
7
8
9
10
11
12
Month
2012
2010
2008
2006
2004
2002
2000
1998
1996
1994
1992
1990
1988
1986
Year

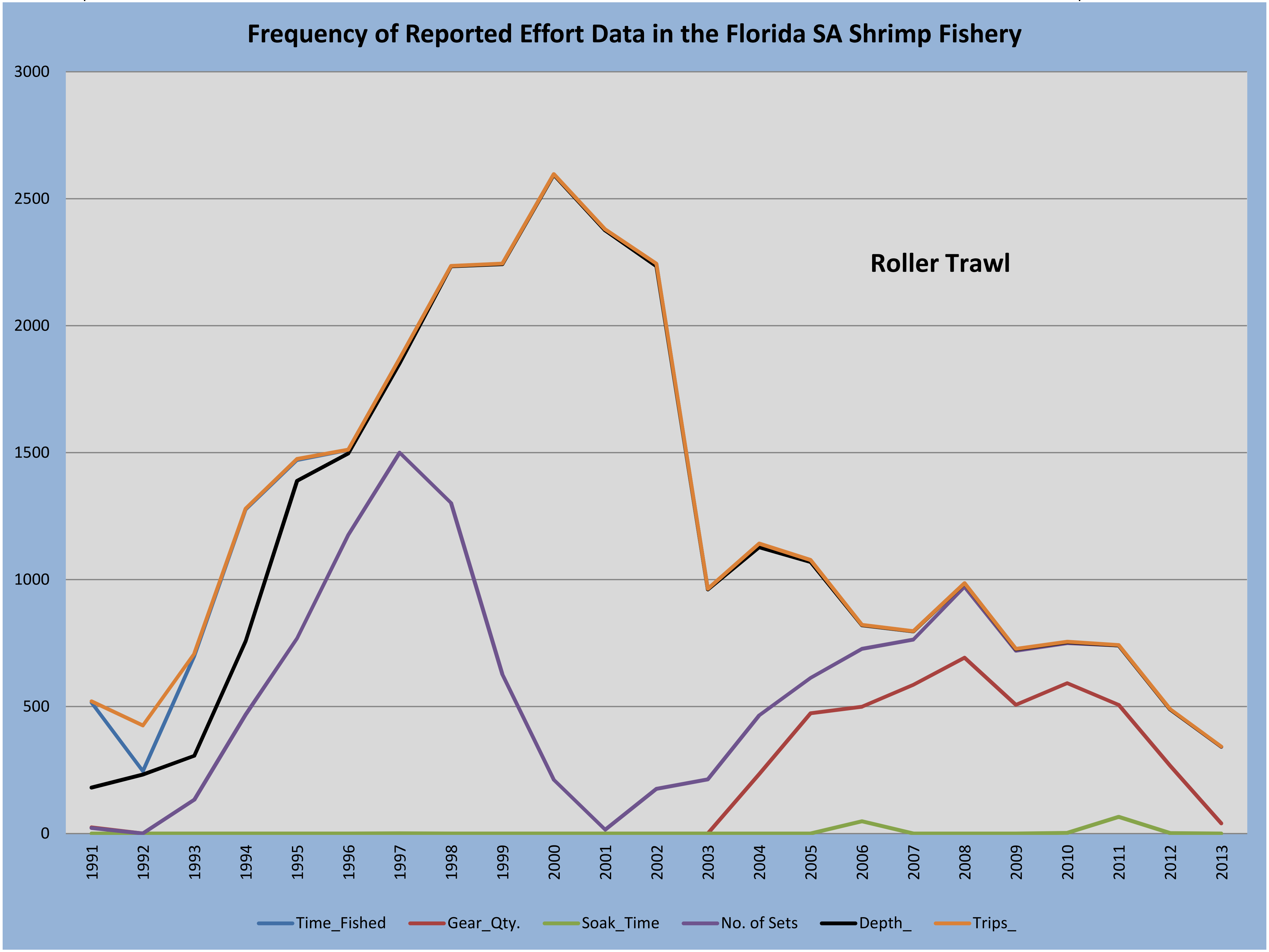

Seasonality of Florida SA Pink Shrimp Harvest
Pounds (thousands)
500
450
400
350
300
250
200
150
100
50
0
1
2
3
4
5
6
7
8
9
10
11
12
Month
2012
2010
2008
2006
2004
2002
2000
1998
1996
1994
1992
1990
1988
1986
Year

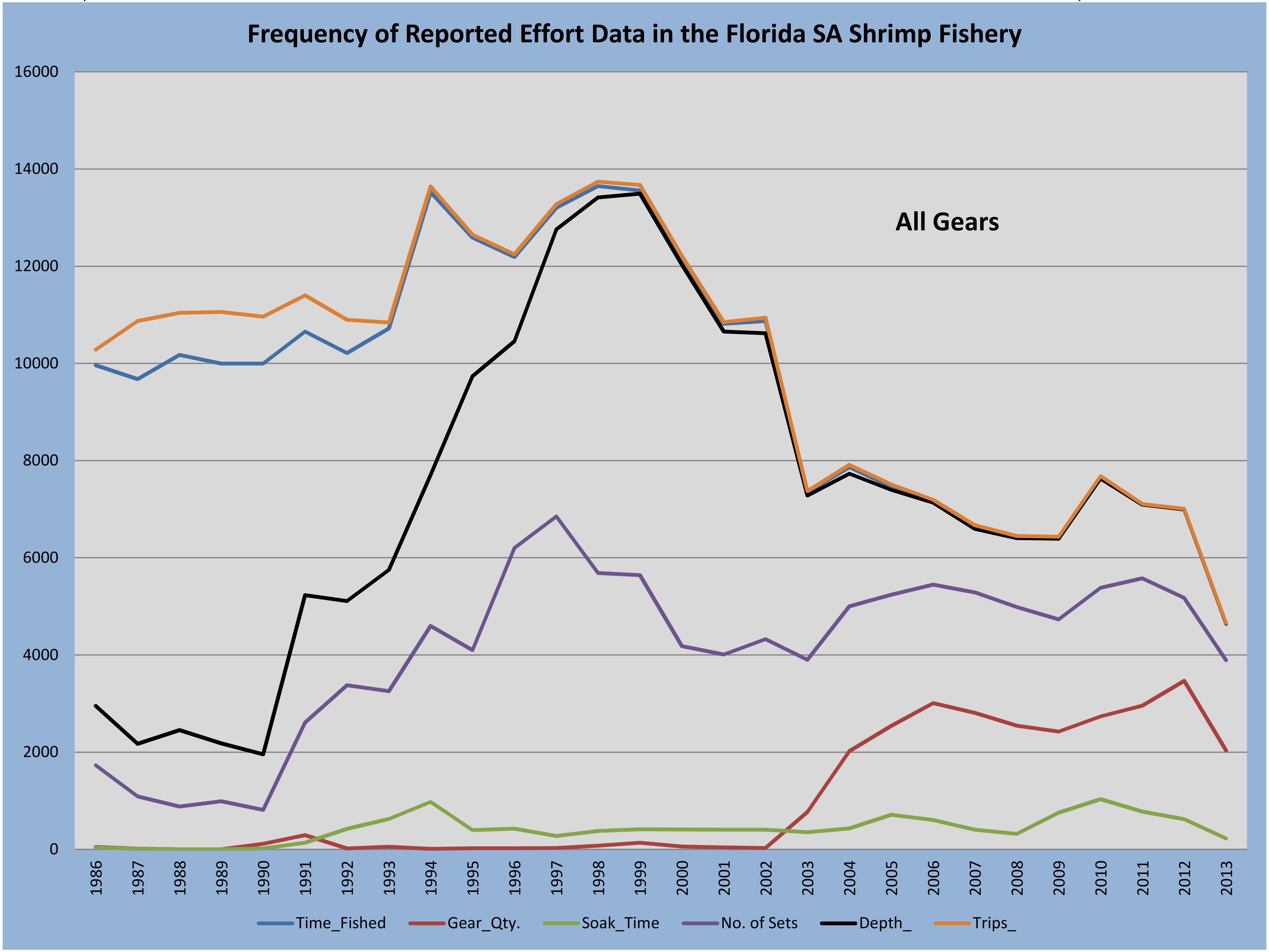

Seasonality of Florida SA Bait Shrimp Harvest
Pounds (thousands)
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
12
Month
2012
2010
2008
2006
2004
2002
2000
1998
1996
1994
1992
1990
1988
1986
Year

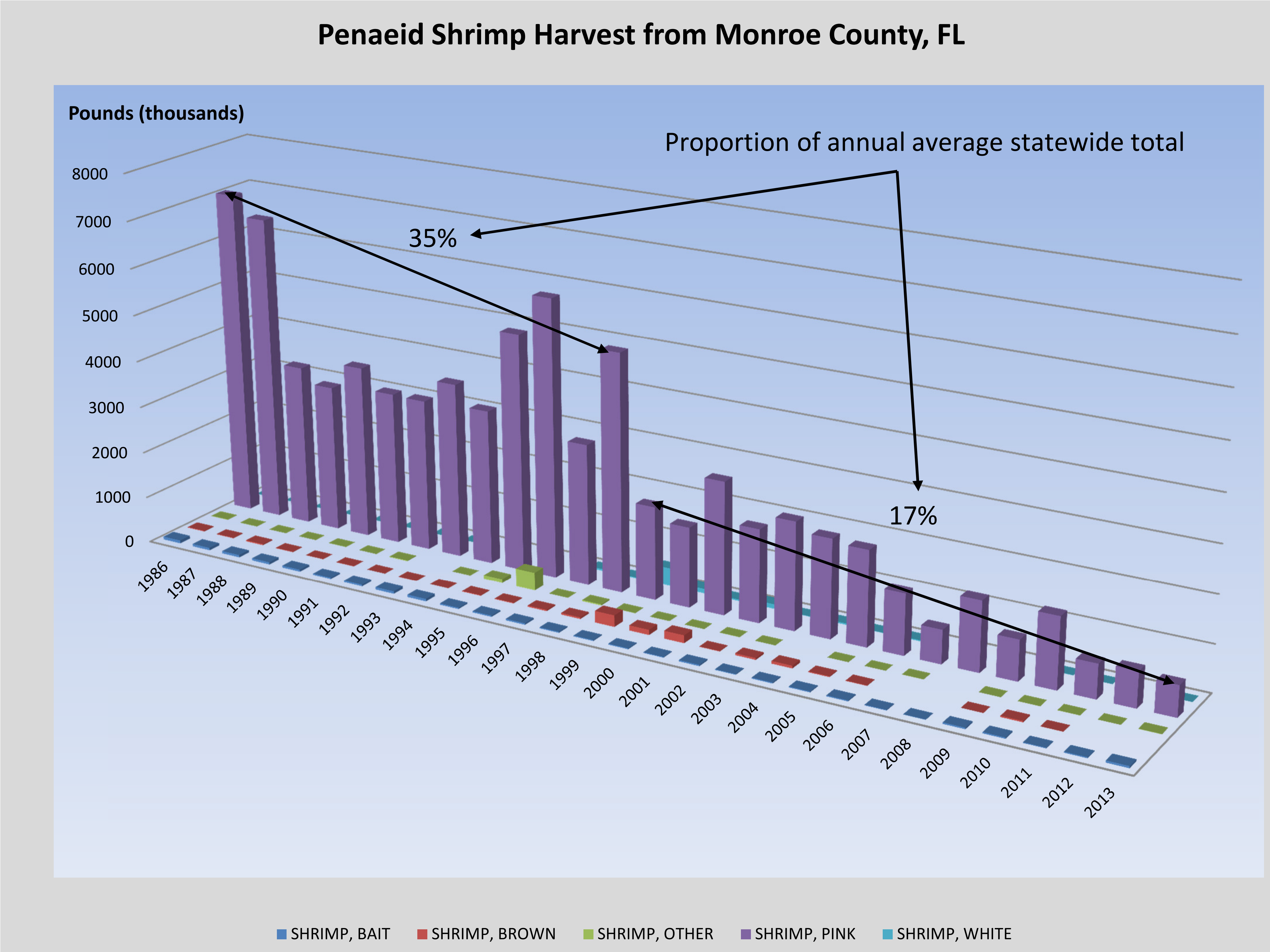

Frequency of Reported Effort Data in the Florida SA Shrimp Fishery
Trawls
12000
10000
8000
6000
4000
2000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Time_Fished
Gear_Qty.
Soak_Time
No. of Sets
Depth_
Trips_

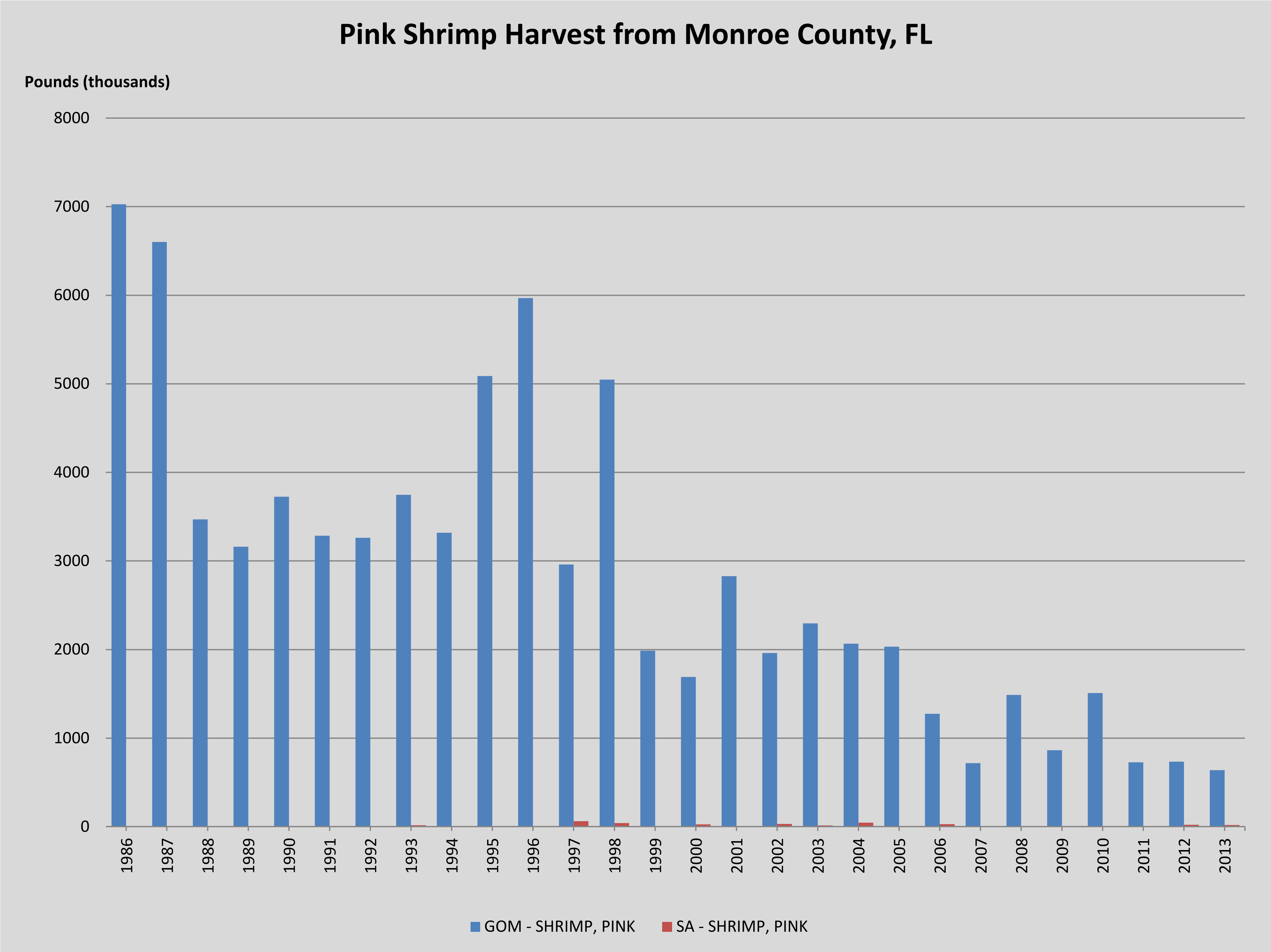


Frequency of Reported Effort Data in the Florida SA Shrimp Fishery
Wing Nets
1800
1600
1400
1200
1000
800
600
400
200
0
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Time_Fished
Gear_Qty.
Soak_Time
No. of Sets
Depth_
Trips_


Frequency of Reported Effort Data in the Florida SA Shrimp Fishery
Roller Trawl
3000
2500
2000
1500
1000
500
0
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Time_Fished
Gear_Qty.
Soak_Time
No. of Sets
Depth_
Trips_


Frequency of Reported Effort Data in the Florida SA Shrimp Fishery
All Gears
16000
14000
12000
10000
8000
6000
4000
2000
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Time_Fished
Gear_Qty.
Soak_Time
No. of Sets
Depth_
Trips_


Penaeid Shrimp Harvest from Monroe County, FL
Pounds (thousands)
Proportion of annual average statewide total
35%
17%
0
1000
2000
3000
4000
5000
6000
7000
8000
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
SHRIMP, BAIT
SHRIMP, BROWN
SHRIMP, OTHER
SHRIMP, PINK
SHRIMP, WHITE


Pink Shrimp Harvest from Monroe County, FL
Pounds (thousands)
8000
7000
6000
5000
4000
3000
2000
1000
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
GOM - SHRIMP, PINK
SA - SHRIMP, PINK

NOAA FISHERIES

Southeast Regional Office

Southeast Region Federal Shrimp Management Overview

July 22, 2014

Federally Managed Shrimp Fisheries in the Southeast

- South Atlantic Penaeid Shrimp
- South Atlantic Rock Shrimp
- Gulf of Mexico Penaeid Shrimp
- Gulf of Mexico Royal Red Shrimp

Federal Shrimp Permits

- **Gulf Shrimp Moratorium Permit:** Limited access permit. (1,488)
- **Gulf Royal Red Shrimp Permit:** Limited access permit, acts like an endorsement to the Gulf shrimp moratorium permit. (294)
- **South Atlantic Penaeid Shrimp Permit:** Open access permit. (498)
- **Rock Shrimp South Atlantic EEZ Permit:** Limited access permit, allows commercial harvest of rock shrimp in federal waters of the South Atlantic region. (acts like an endorsement to the South Atlantic Penaeid Shrimp Permit). (105)
- **South Atlantic Rock Shrimp Carolinas Zone:** Open access permit, allows commercial rock shrimp harvest in federal waters only off the coasts of North Carolina and South Carolina. (acts like an endorsement to the South Atlantic Penaeid Shrimp Permit). (93)

NOAA FISHERIES

Current Federal Management Measures

- Reporting Requirements
- Permitting Requirements
- Gear Requirements
- Closed Areas
- Vessel Monitoring Systems
- Cold Weather Event Closures
- Annual Catch Limit for Gulf Royal Red
- Accountability Measures for Gulf Royal Red

NOAA FISHERIES

U.S. Department of Commerce | National Oceanic and Atmospheric Administration | NOAA Fisheries | Page 4

Annual Catch Limits/Quotas

- MSA National Standard 1 Guidelines require ACLs and accountability measures be established for all federally managed species unless they are considered an annual stock or they are ecosystem component species.
- In the South Atlantic, penaeid shrimp and rock shrimp are both considered annual stocks. Penaeid shrimp in the Gulf of Mexico are also considered annual stocks. Therefore, they do not have ACLs or accountability measures assigned to them.

Reporting Requirements: South Atlantic Shrimp Fisheries

- South Atlantic Penaeid Shrimp
  - Must provide information for any fishing trip, as requested by NMFS.
  - Must be postmarked no later than 7 days after the end of each fishing trip. If no fishing occurred during a calendar month, a report so stating must be submitted on one of the forms postmarked not later than 7 days after the end of that month. Information to be reported is indicated on the form and its accompanying instructions.

- South Atlantic Rock Shrimp
  - A dealer who has been issued a permit for rock shrimp, and who is selected must provide information on receipts of rock shrimp and prices paid on forms available from NMFS. The required information must be submitted at monthly intervals postmarked not later than 5 days after the end of each month.
  - As of **August 7, 2014**, dealers will have to report electronically on a weekly basis.

Observer and VMS Requirements South Atlantic

- VMS required on Rock Shrimp vessels.
- All federally permitted South Atlantic shrimp vessels must carry an observer if requested to do so.

South Atlantic Shrimp Area and Seasonal Closures

Penaeid shrimp cold weather closure:

- A state may request federal waters adjacent to state waters closed to penaeid shrimp fishing to also be closed to shrimp harvest if a water temperature at or below 9°C (48°F) has been recorded for seven consecutive days or more, or 80% reduction of white shrimp abundance.

NOAA FISHERIES

South Atlantic Shrimp Area and Seasonal Closures

Closed Areas to Protect Coral

- Oculina Bank
- Stetson-Miami Terrace
- Cape Lookout Lophelia Banks
- Blake Ridge Diapir
- Pourtales Terrace
- Savanna Lithotherm
- East Florida Lithotherm
- Cape Fear

NOAA FISHERIES

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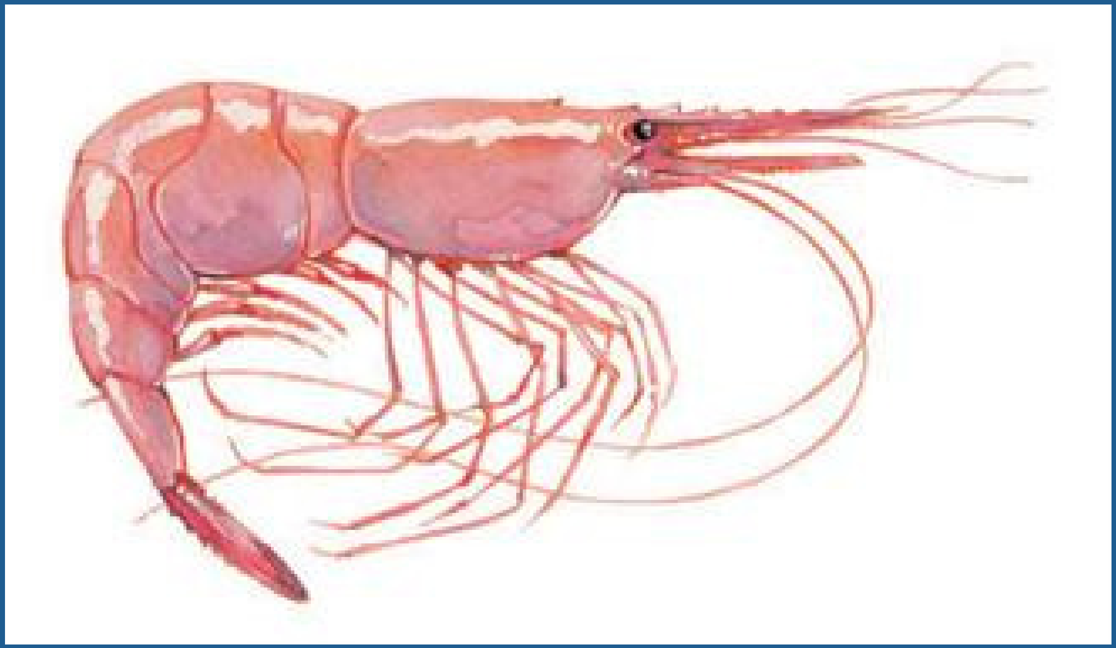
South Atlantic Shrimp BRD and TED Requirements

- On a shrimp trawler in the South Atlantic EEZ, each net that is rigged for fishing must have a BRD installed, which is certified or provisionally certified for the area in which the shrimp trawler is located, unless exempted(try nets and roller trawls).
- The regulations state which types of BRDs are certified.
- Most shrimp trawlers operating in the southeastern United States must have a NMFS-approved TED installed in each net that is rigged for fishing, to allow sea turtles to escape. There are some exceptions, which are found at 50 CFR 223.206-207.

Other Rock Shrimp Gear Requirement

The minimum mesh size for the cod end of a rock shrimp trawl net in the South Atlantic EEZ off Georgia and Florida is 1 7/8 inches (4.8 cm), stretched mesh. This minimum mesh size is required in at least the last 40 meshes forward of the cod end drawstring (tie-off rings), and smaller-mesh bag liners are not allowed. A vessel that has a trawl net on board that does not meet these requirements may not possess a rock shrimp in or from the South Atlantic EEZ off Georgia and Florida.

THE END



NOAA FISHERIES

U.S. Department of Commerce | National Oceanic and Atmospheric Administration | NOAA Fisheries | Page 12

U.S. Gulf of Mexico and South Atlantic Penaeid and Rock Shrimp Fisheries Observer Programs

NOAA Fisheries Service
Galveston Laboratory
Elizabeth Scott-Denton

Shrimp Trawl Bycatch Observer Program




Objectives:

- Refine catch rate estimates of finfish and shrimp by area and season for use in stock assessments
- Bycatch Reduction Device (BRD) and Turtle Excluder Device (TED) evaluation. Estimate protected species bycatch

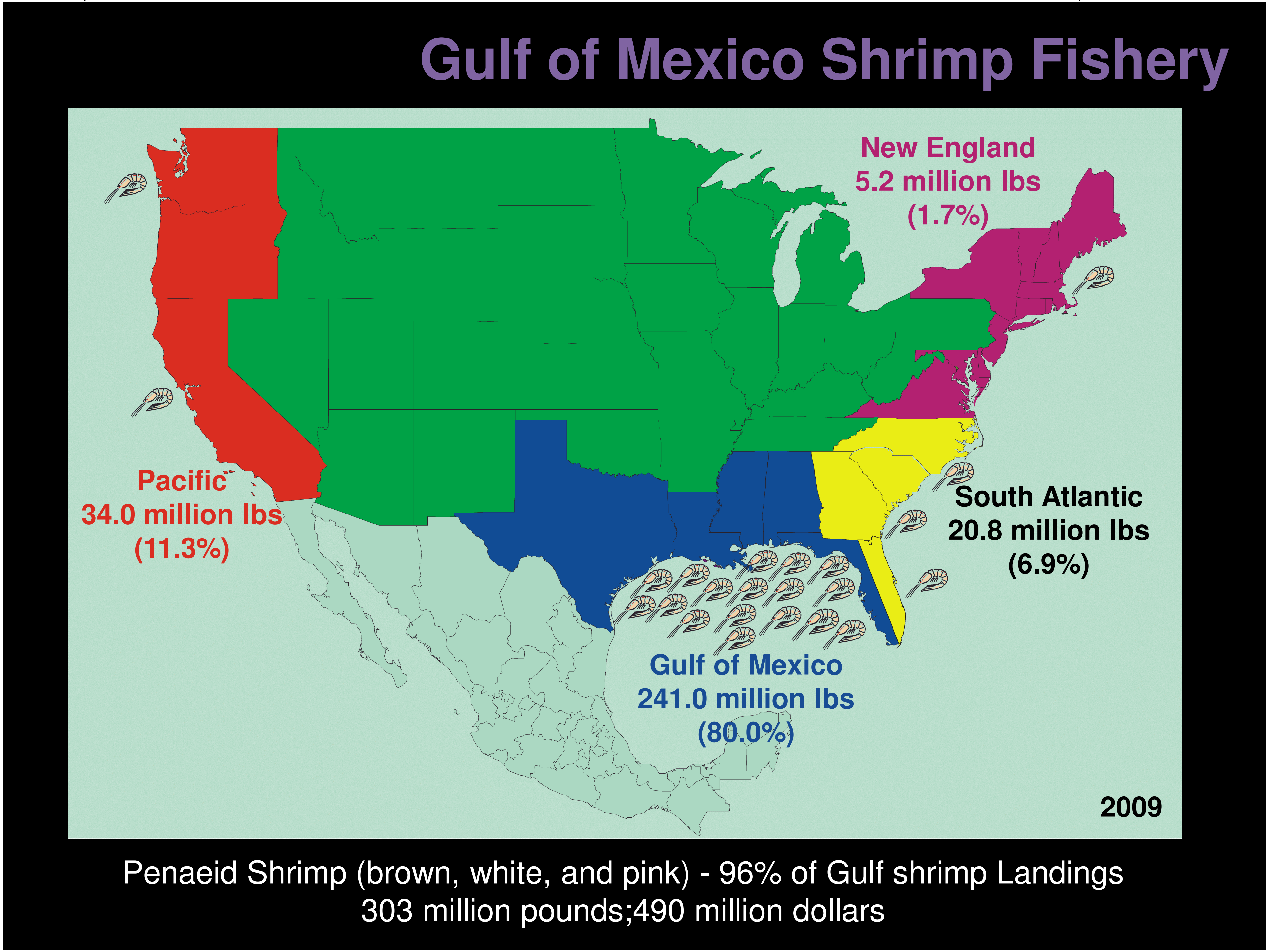
Since 1992:

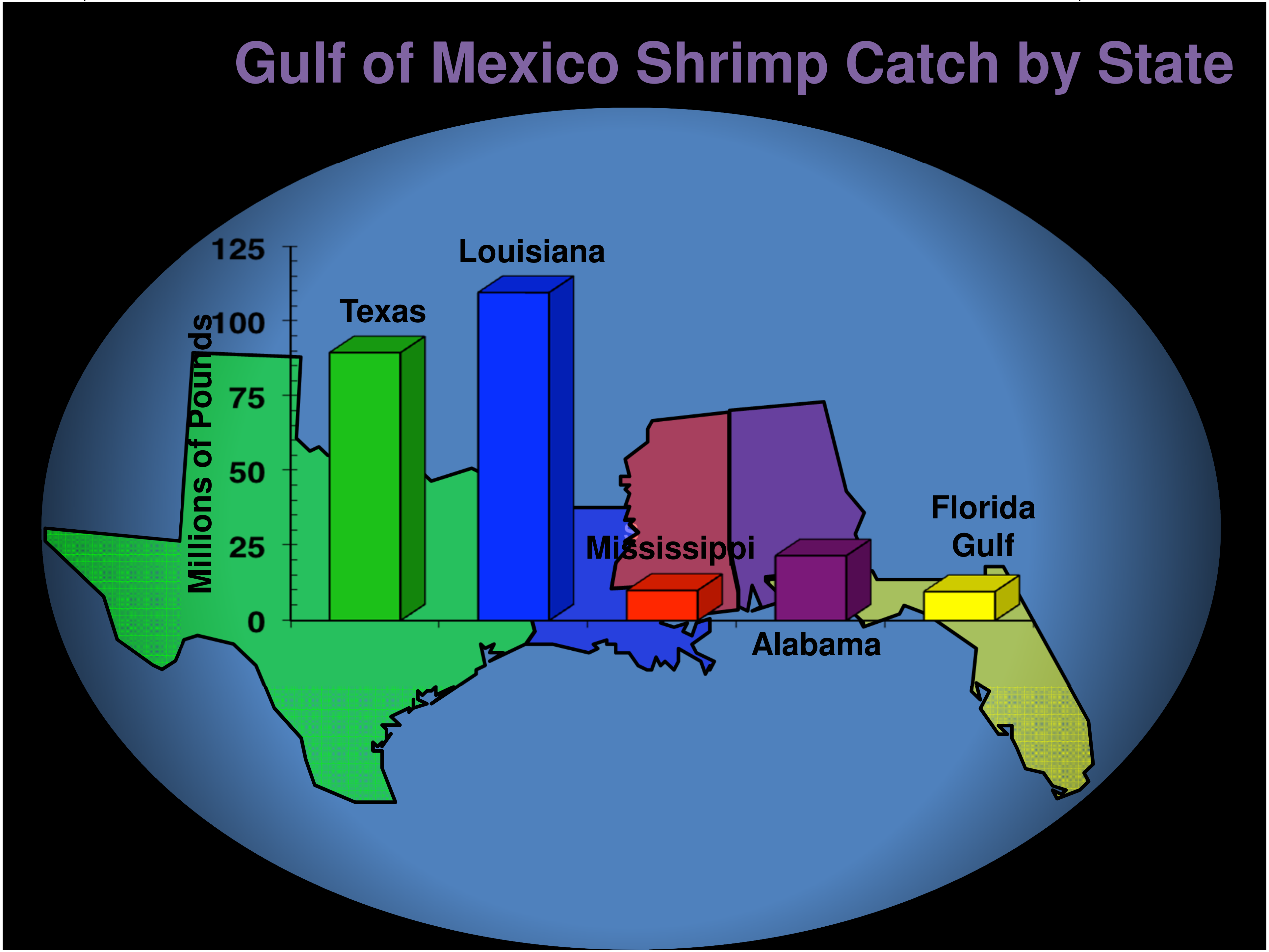
- Annual coverage approx. <1% to 2% of total shrimp effort
- Mandatory Coverage in 2007 (Gulf) and 2008 (SA)

Shrimp and Reef Bycatch Observer Programs - Management Interrelated

July 2006 (Reef)
July 2007 (Shrimp – Gulf, 2008 –SA)

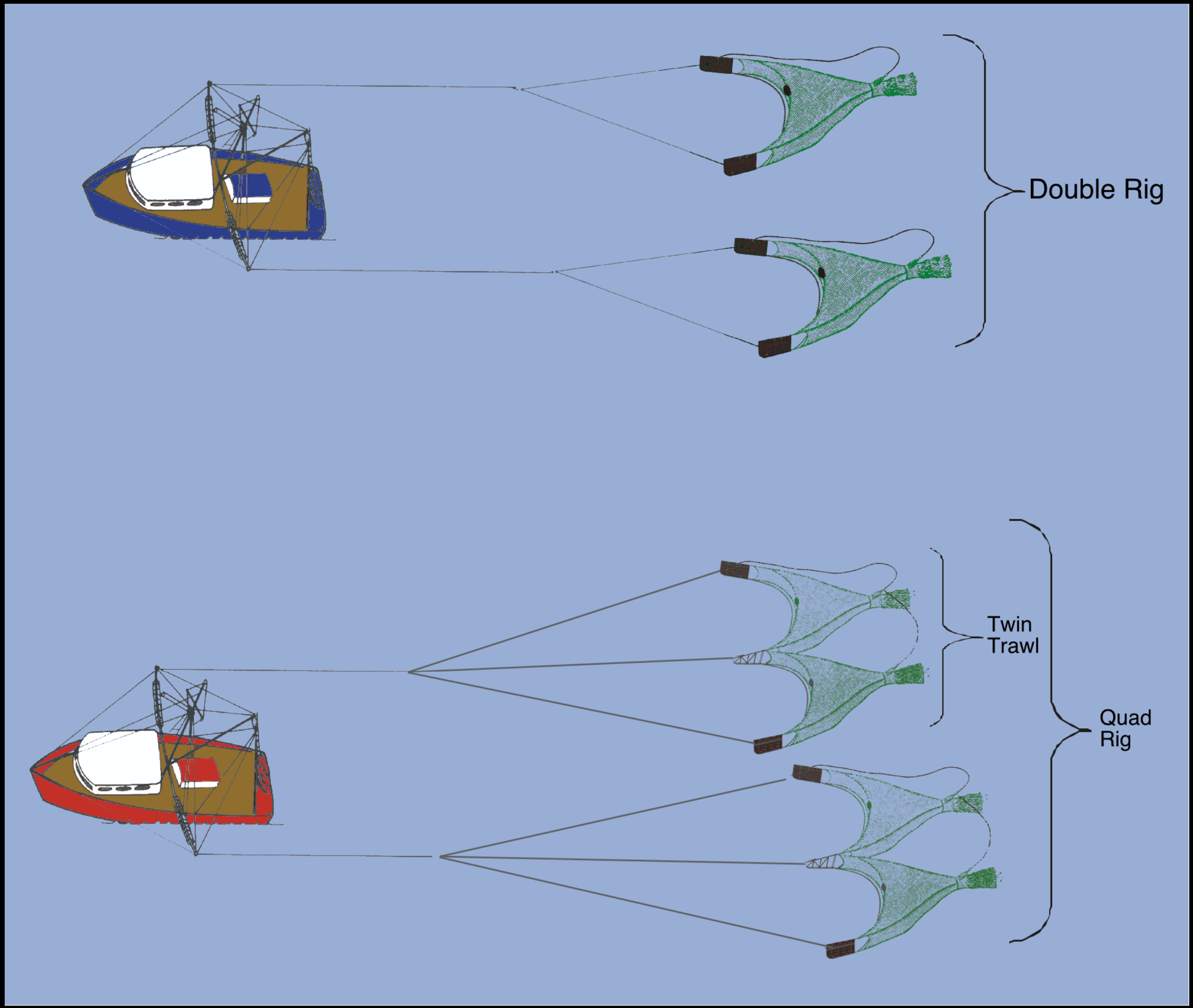
- Collect biological and gear data aboard commercial vessels in the US Gulf of Mexico and
  - mandatory ($25)
  - federal fishing permits
  - required to take an observer if selected
- Bycatch reduction
  - voluntary ($200)


Gulf of Mexico Shrimp Fishery
New England
5.2 million lbs
(1.7%)
Pacific
34.0 million lbs
(11.3%)
South Atlantic
20.8 million lbs
(6.9%)
Gulf of Mexico
241.0 million lbs
(80.0%)
2009
Penaeid Shrimp (brown, white, and pink) - 96% of Gulf shrimp Landings
303 million pounds;490 million dollars


Gulf of Mexico Shrimp Catch by State
125
100
75
50
25
0
Millions of Pounds
Texas
Louisiana
Mississippi
Alabama
Florida
Gulf

- Adult red snapper are taken in the directed fishery
- Juveniles taken as bycatch in the shrimp fishery
- Overfished; to end and rebuild reduce TAC
- Reduce shrimp effort 74% (2001-2003 benchmark) WG

Shrimp Trawl Net Configurations



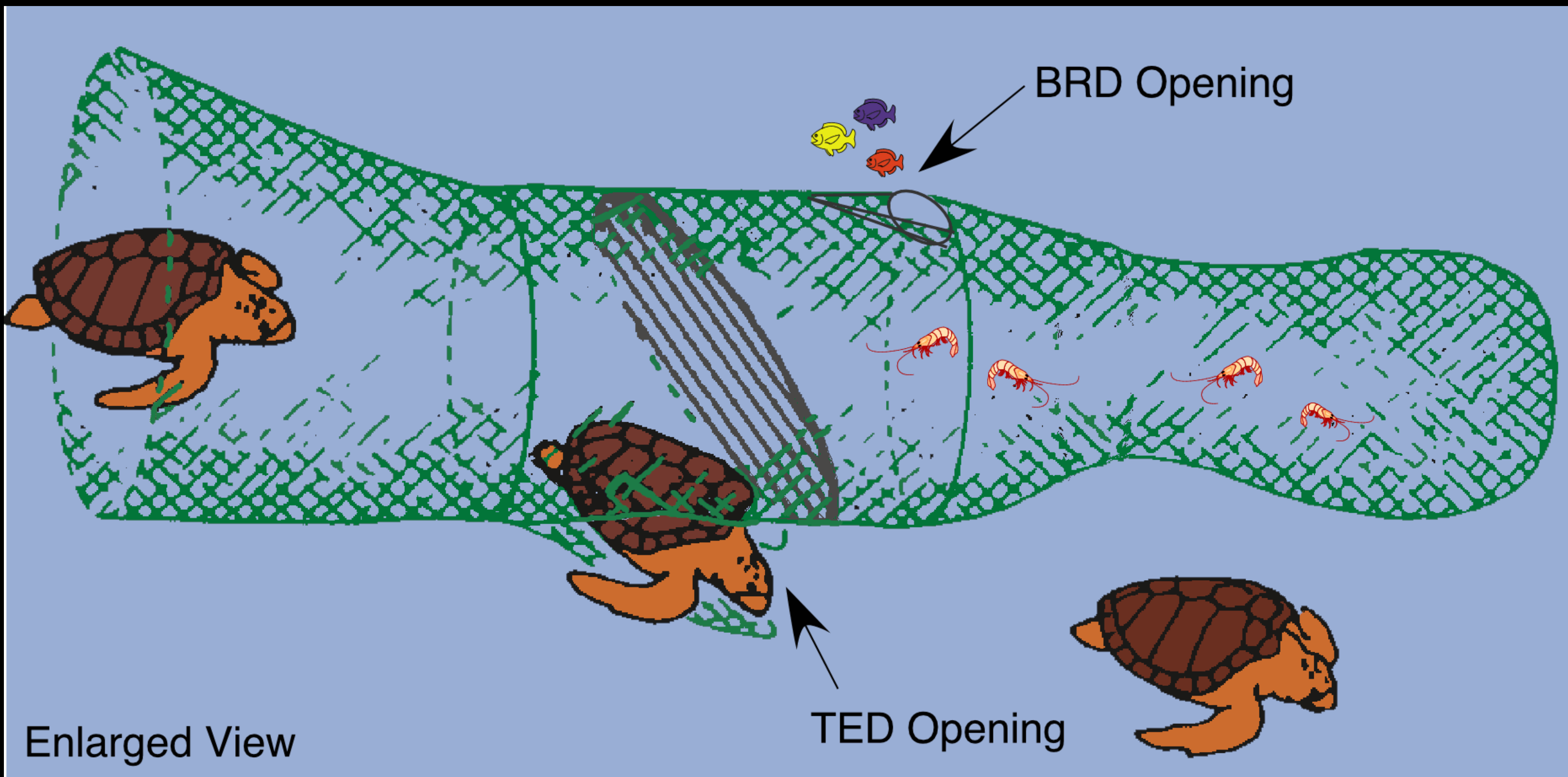
Bycatch Characterization

- Total weight of one randomly selected net
- Total shrimp, red snapper
- ~ 20% sample to species level
- **Project Codes: C and X**

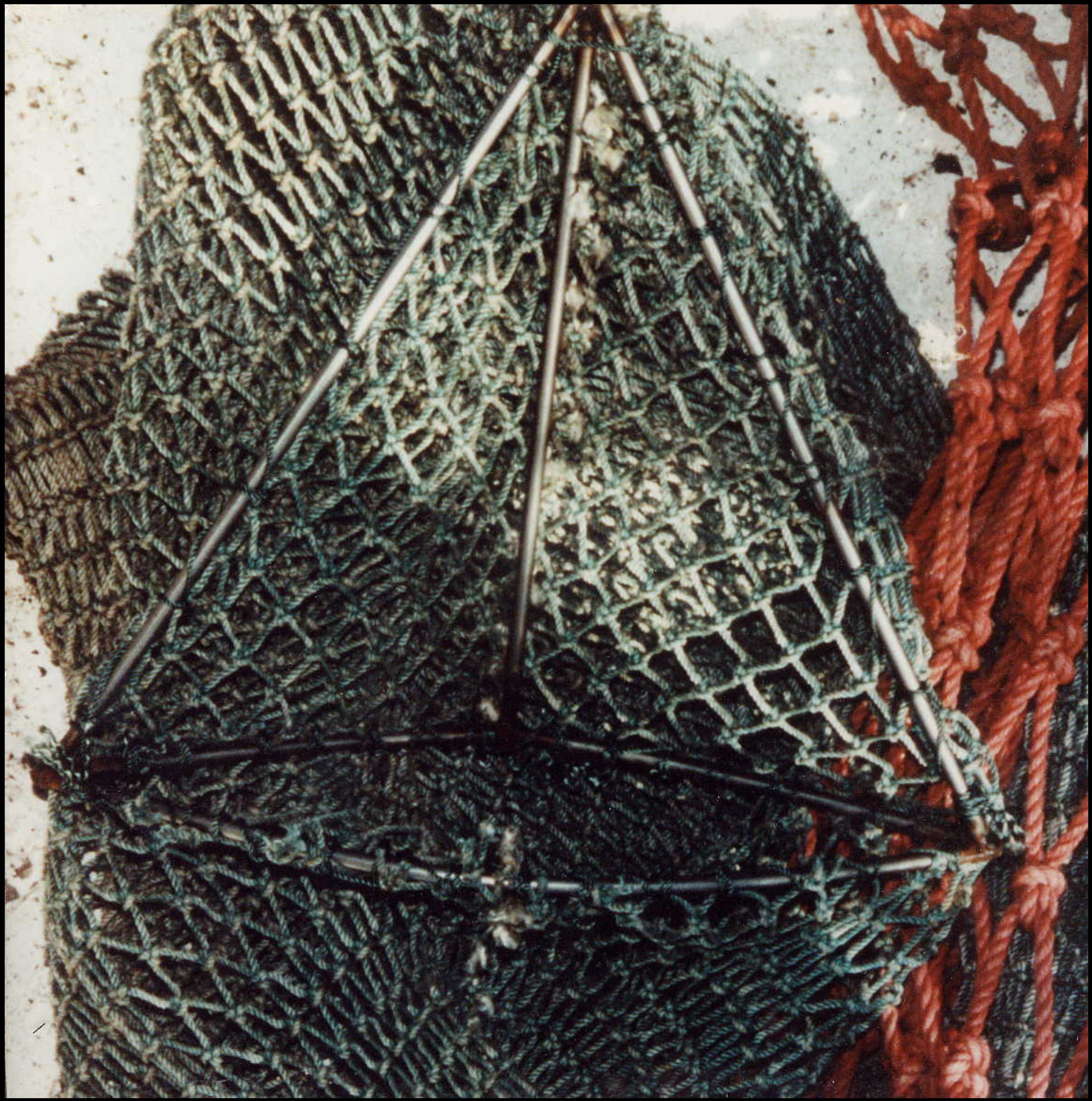
BRD / TED Evaluation and Mandatory Shrimp

- Two outboard nets (experimental vs. control)
- Total weight
- Total shrimp, red snapper
- Basket sample - species groupings
- **Project Codes: B, G, L, M, R, S, T, Y and Z (A, I, R, W)**

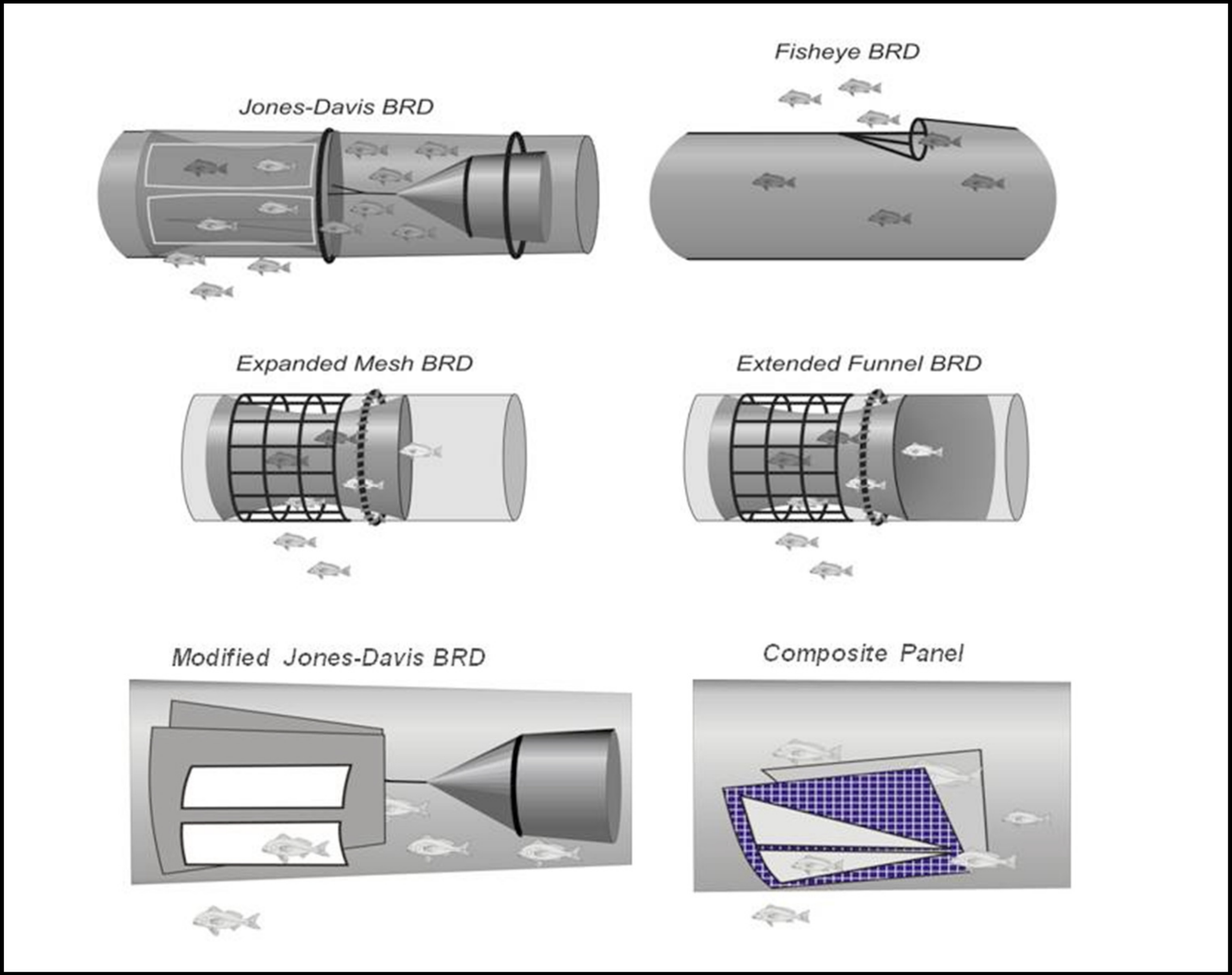
BRD / TED Configuration



Gulf Fisheye



Shrimp Trawl:
Amendment 10 – Voluntary Component



Expanded Mesh – South Atlantic Only

Shrimp Trawl Bycatch Observer Program

Delivery Model:

- NOAA Fisheries Galveston component
  - Between 6-45 contract observers depending on funding level

Cooperative Research:

- NOAA Fisheries Galveston (Org Code: G)
- Gulf & South Atlantic Fisheries Foundation, Inc. (Foundation) (Org Code: F and S)
- Texas Shrimp Association (Org Code: T)
- North Carolina Division of Marine Fisheries (Org Code: N)
- Georgia Department of Natural Resources (Org Code: D)

Shrimp Trawl Bycatch Mandatory Observer Program

Selected randomly – based on previous year of landings/effort (from NMFS data)

- Stratified by:
  - Area (states)
  - Depth
  - Season
    - January - April
    - May - August
    - September - December

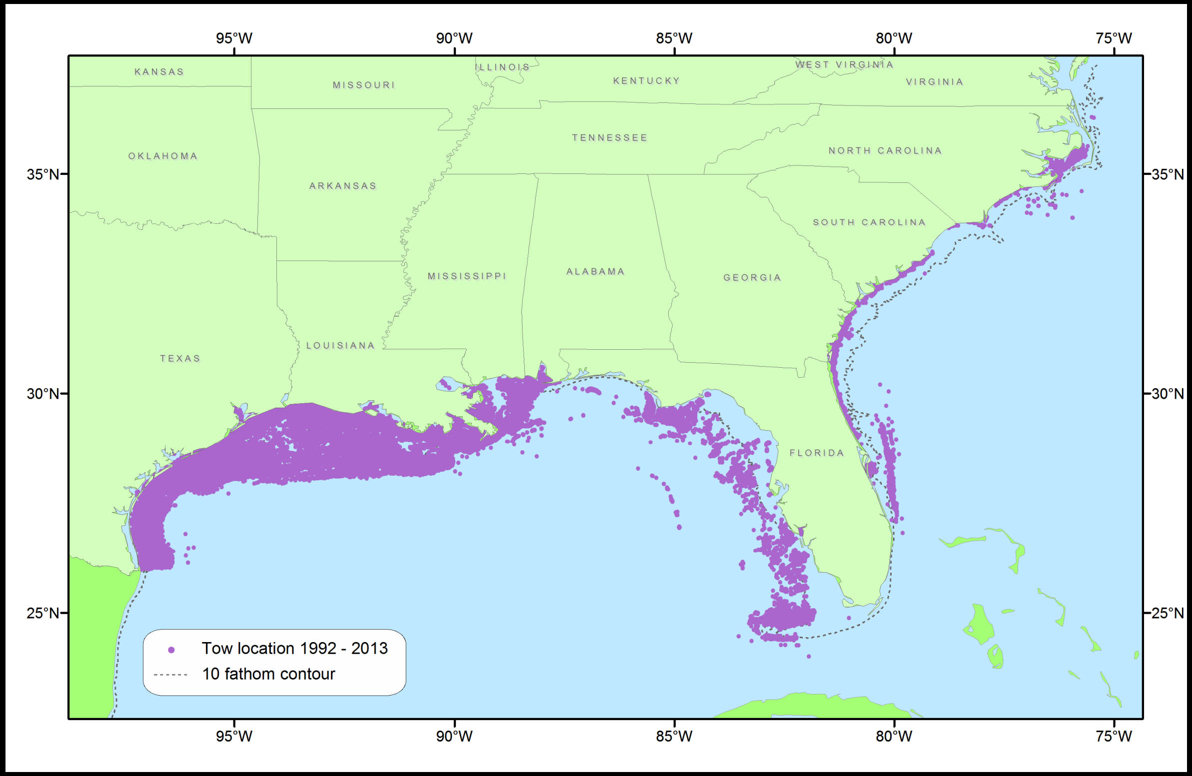
  - 1600 Sea days
    - 80% Gulf of Mexico
    - 20% South Atlantic

Shrimp and Reef Mandatory Observer Programs Selection Letters

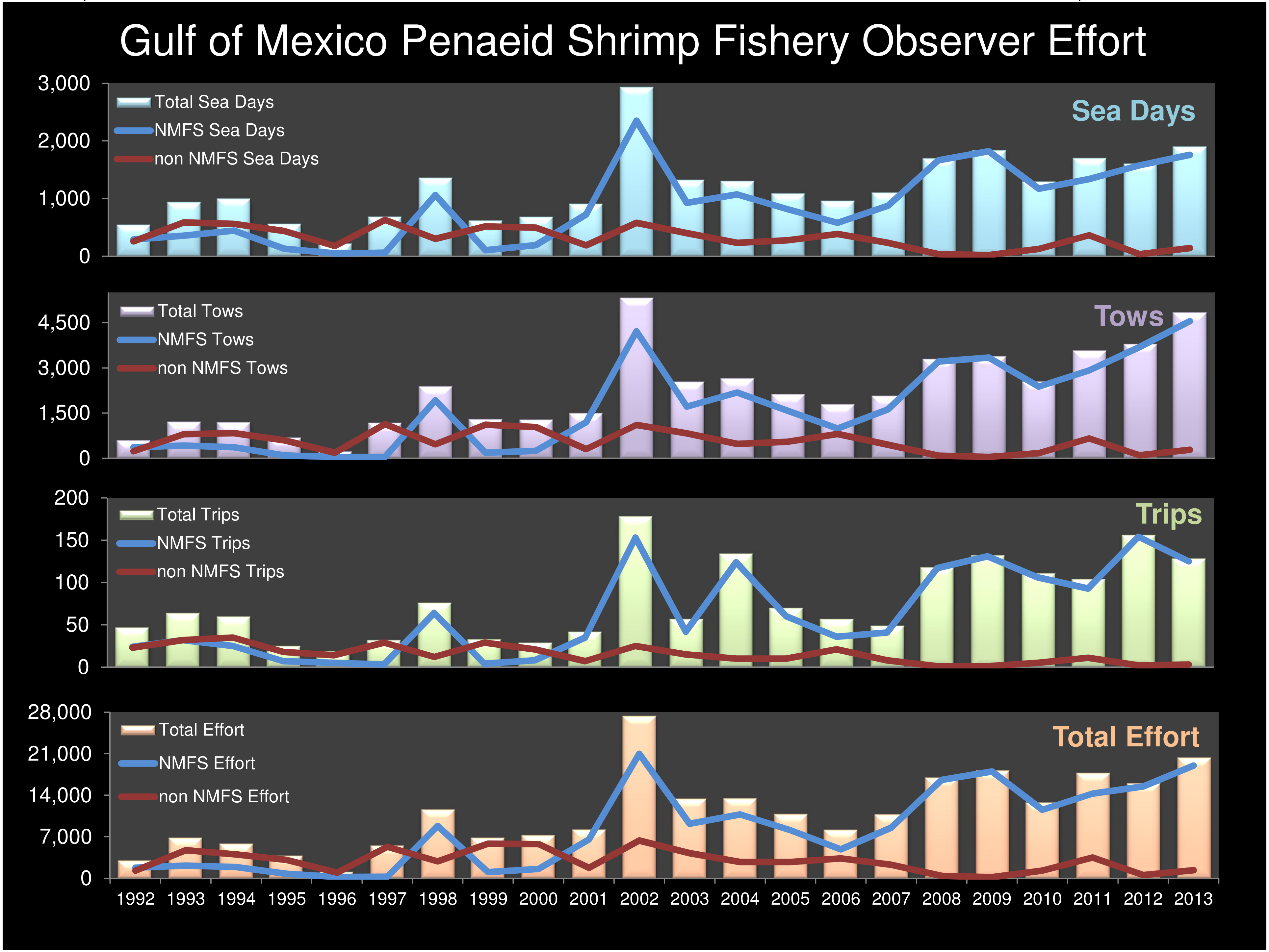
- Mailed 1 – 2 months prior to season
- Contain:
  - Authority
    - Magnuson-Stevens Act
    - Endangered Species Act
  - Requirements
    - e.g. Safety Decal
- Notify observer program staff 48 hours prior to each trip until requirements met
- Work with Industry
- OLE

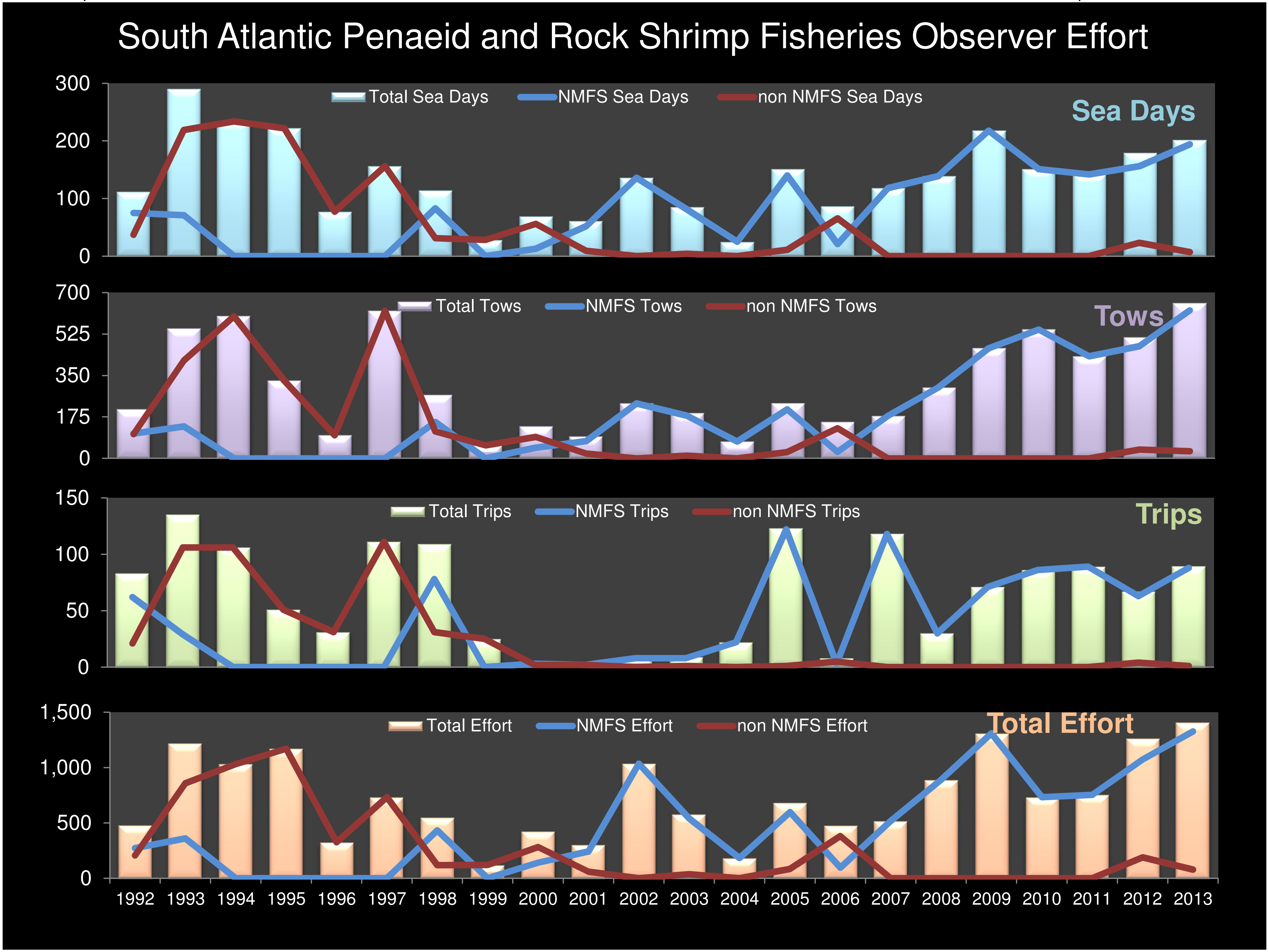

Commercial Fishing Vessel Safety
EXAMINATION
DATE ISSUED
EXPIRES
UNITED STATES COAST GUARD
1790
2007
2008
2009
2010
2011
VESSEL
Documented
Undocumented
LOCATION
Beyond Boundary Line
Inside Boundary Line
Inside
Outside
3 NM
12 NM
20 NM
50 NM
>100 NM
THIS VESSEL MEETS ALL USCG COMMERCIAL FISHING INDUSTRY VESSEL REGULATIONS
JAN
JUL
FEB
AUG
MAR
SEP
APR
OCT
MAY
NOV
JUN
DEC
NO.
CG-5587A (Rev. 6/06)
U.S. Department of Homeland Security

Shrimp Trawl Tow Locations 1992 - 2013



- 3,101 trips (1 to 62 days)
- More than 56,500 tows
- 29,262 sea days (more than 263,000 hours)
- Coverage less than 2% of annual directed effort; varies - funding


Gulf of Mexico Penaeid Shrimp Fishery Observer Effort
Sea Days
Total Sea Days
NMFS Sea Days
non NMFS Sea Days
3,000
2,000
1,000
0
Tows
Total Tows
NMFS Tows
non NMFS Tows
4,500
3,000
1,500
0
Trips
Total Trips
NMFS Trips
non NMFS Trips
200
150
100
50
0
Total Effort
Total Effort
NMFS Effort
non NMFS Effort
28,000
21,000
14,000
7,000
0
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013


South Atlantic Penaeid and Rock Shrimp Fisheries Observer Effort
Total Sea Days
NMFS Sea Days
non NMFS Sea Days
Sea Days
300
200
100
0
Total Tows
NMFS Tows
non NMFS Tows
Tows
700
525
350
175
0
Total Trips
NMFS Trips
non NMFS Trips
Trips
150
100
50
0
Total Effort
NMFS Effort
non NMFS Effort
Total Effort
1,500
1,000
500
0
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013

Shrimp Trawl Bycatch Observer Program

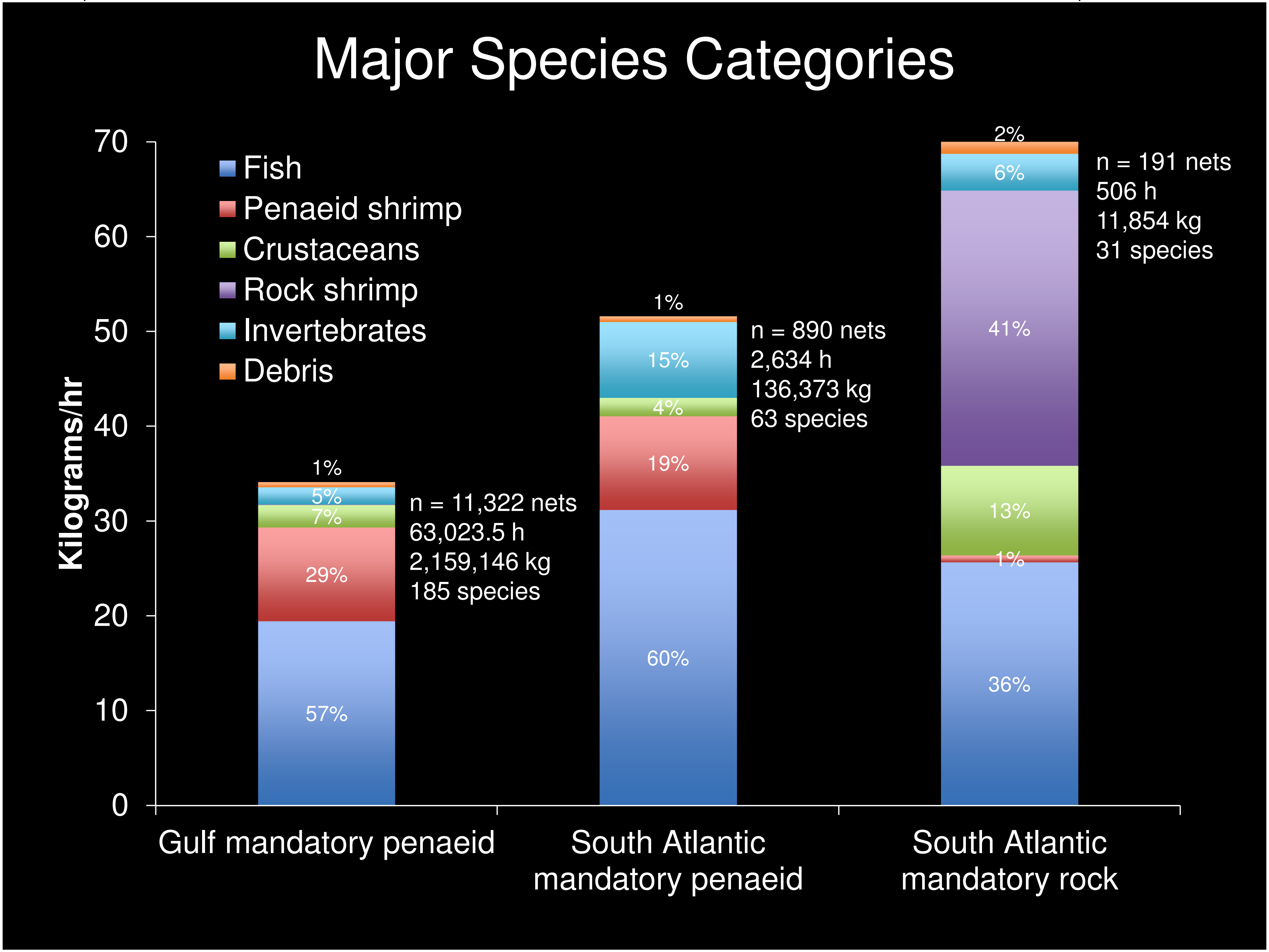
Vessels	1,500(Gulf); 500 (S. Atlantic) federal (~2000 Federal Vessels) Steel Hull/Freezer Capacity (Gulf) Wooden/Ice (SA)
Vessel Length	31 - 98 ft (Avg. = 74 ft) Gulf (Smaller 64 ft SA)
Crew	1 to 5
Trips	1-62 days •Avg. = 13.8 days (Gulf); •Avg. = 2.9 days (S. Atlantic)
Tow Depth	0.5 - 65 fms (Avg. = 16.4 fms) Gulf (4.8 SA) (34 Rock) (222 RR)
Tow Time	0.1 to 20.5 hrs •Gulf - 5.2 hours •South Atlantic - 2.8 hours

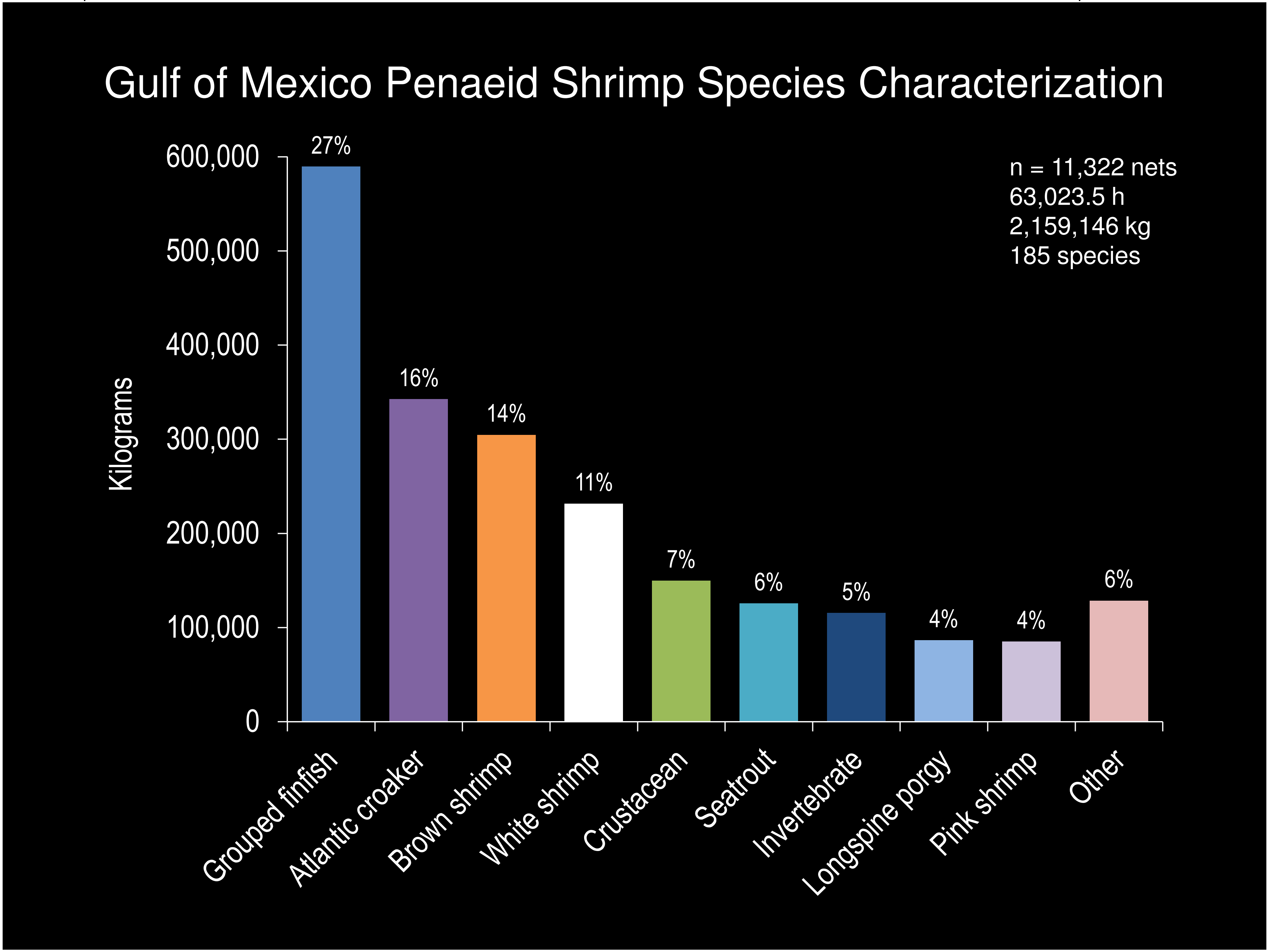
Net Characteristics

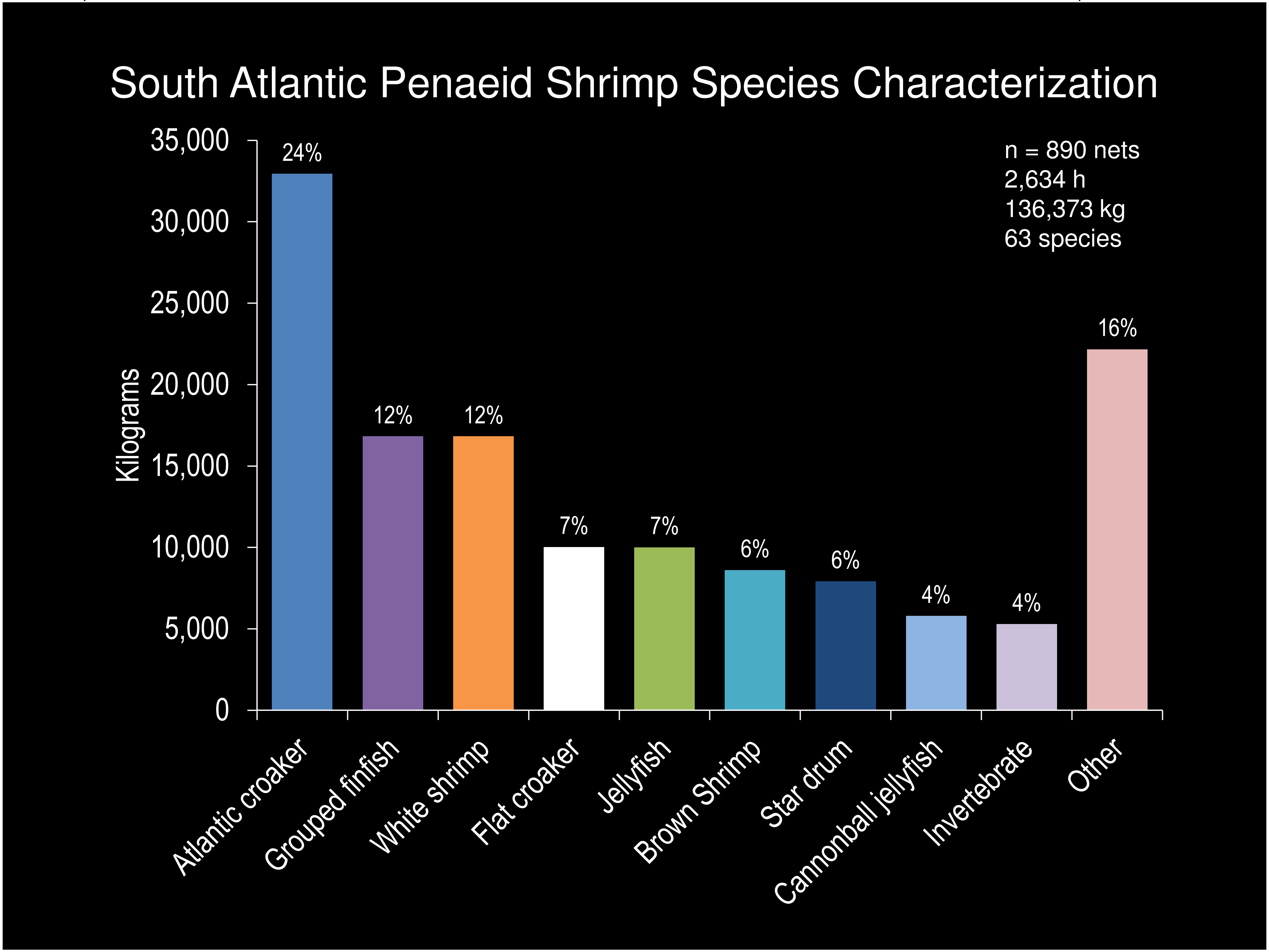
Item	Gulf mandatory penaeid	South Atlantic mandatory penaeid	South Atlantic mandatory rock
Main net headrope length (ft)	n=17,735	n=1,492	n=308
Mean	**50.5**	**52.3**	**52.5**
Range	14.0 - 74.5	33.4 - 70.0	35.0 - 61.0
s.d.	10.0	9.7	6.3
Try net headrope length (ft)	n = 5,565	n = 1,121	
Mean	**12.4**	**12.0**	
Range	8.3 - 16.3	10.0 - 14.0	
s.d.	1.8	0.6	

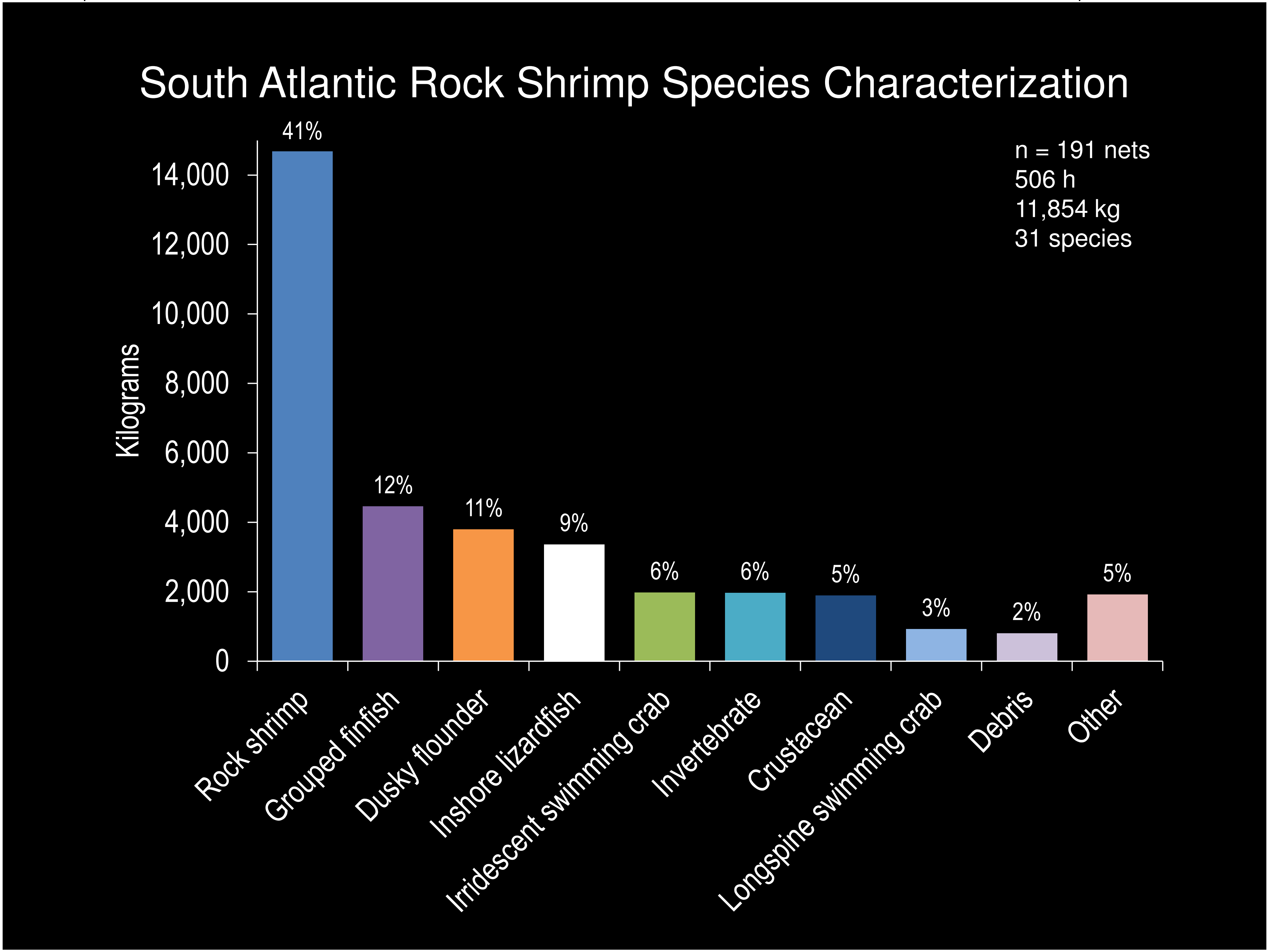
BRD / TED Characteristics

Item	Gulf mandatory penaeid		South Atlantic mandatory penaeid		South Atlantic mandatory rock	
BRD type (%)	Fisheye	**82**	Fisheye	**98**	Fisheye	**100**
	Composite panel	8.0	Unknown	2.2		
TED type (%)	Hard	**97**	Hard	**98**	Hard	**100**
TED design (%)	Curved bar	62.4	Curved bar	94.4	Curved bar	100.0
	Straight	30.7	Straight	3.1		
TED opening (%)	Bottom	**66**	Bottom	**90**	Bottom	**100**
TED funnel (%)	No	80.1	No	88.5	No	87.0
	Yes	16.2	Yes	7.9	Yes	13.0
TED angle (degrees)		n=17,208		n=1,496		n=308
Mean		**49**		**51**		**50**
Range		18.0 - 87.0		40.0 - 75.0		45.0 - 64.0
s.d.		8.7		5.5		6.3

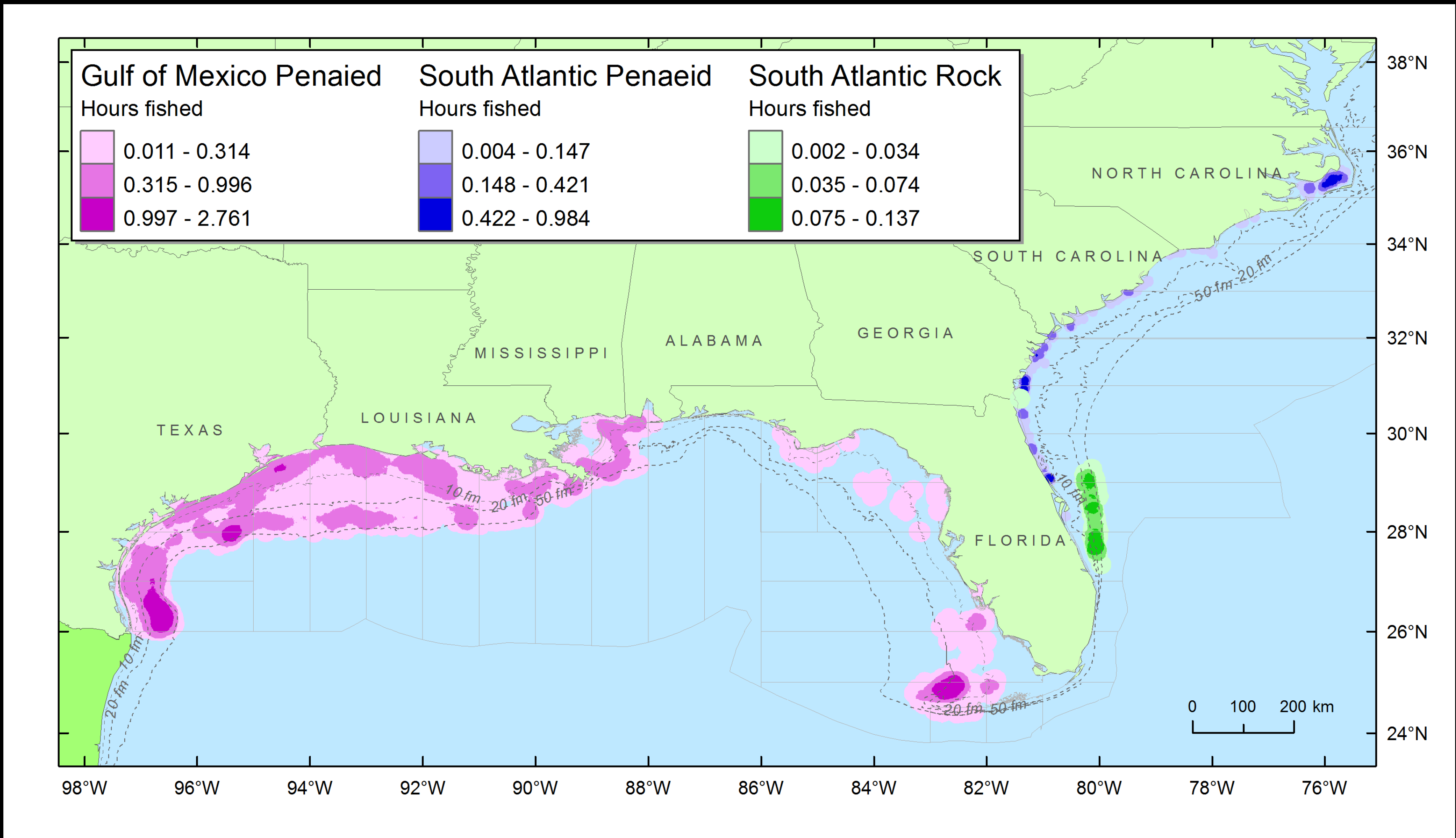

Major Species Categories
Kilograms/hr
70
60
50
40
30
20
10
0
Fish
Penaeid shrimp
Crustaceans
Rock shrimp
Invertebrates
Debris
1%
5%
7%
29%
57%
n = 11,322 nets
63,023.5 h
2,159,146 kg
185 species
1%
15%
4%
19%
60%
n = 890 nets
2,634 h
136,373 kg
63 species
2%
6%
41%
13%
1%
36%
n = 191 nets
506 h
11,854 kg
31 species
Gulf mandatory penaeid
South Atlantic mandatory penaeid
South Atlantic mandatory rock


Gulf of Mexico Penaeid Shrimp Species Characterization
n = 11,322 nets
63,023.5 h
2,159,146 kg
185 species
Kilograms
600,000
500,000
400,000
300,000
200,000
100,000
0
27%
16%
14%
11%
7%
6%
5%
4%
4%
6%
Grouped finfish
Atlantic croaker
Brown shrimp
White shrimp
Crustacean
Seatrout
Invertebrate
Longspine porgy
Pink shrimp
Other

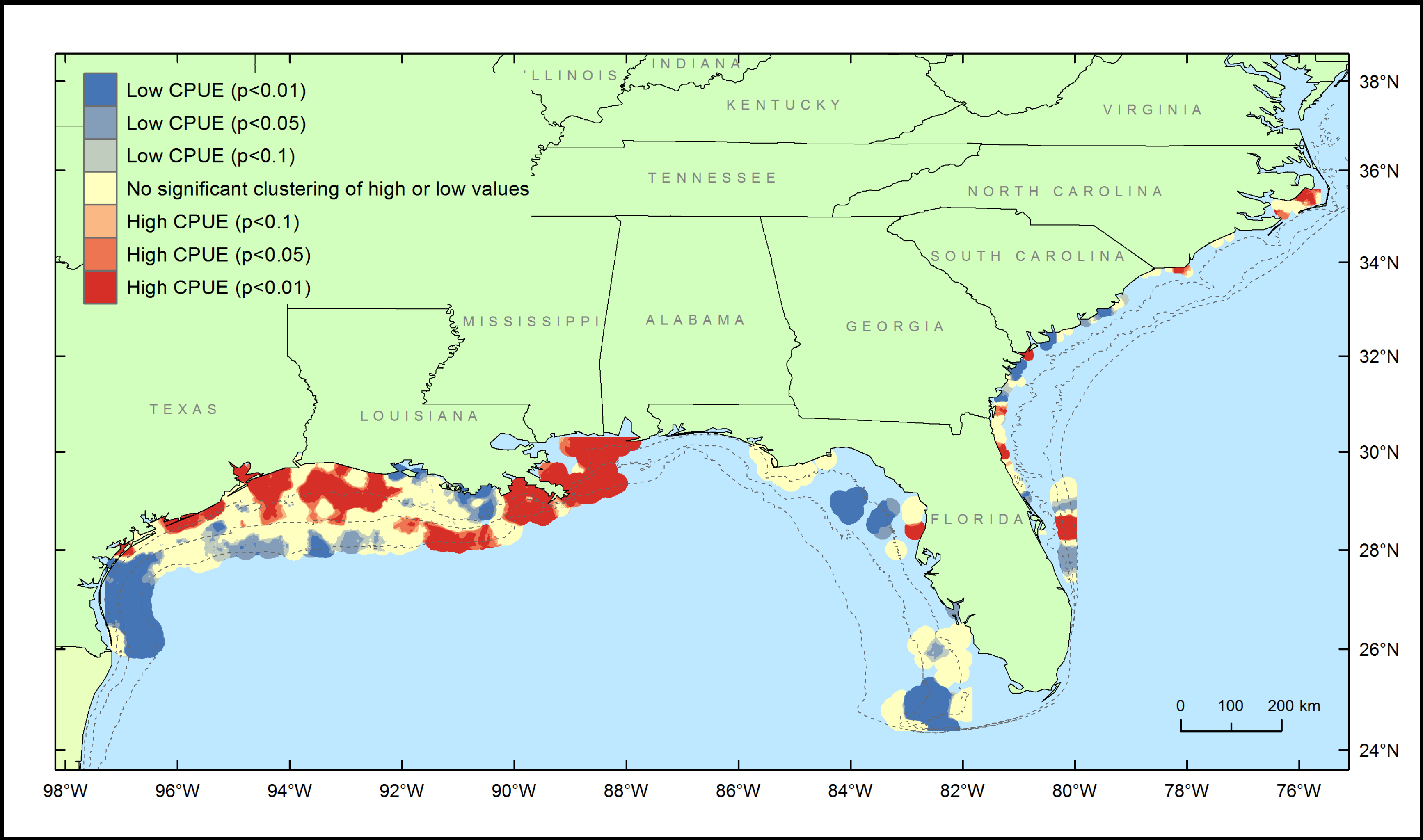

South Atlantic Penaeid Shrimp Species Characterization
n = 890 nets
2,634 h
136,373 kg
63 species
Kilograms
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
24%
12%
12%
7%
7%
6%
6%
4%
4%
16%
Atlantic croaker
Grouped finfish
White shrimp
Flat croaker
Jellyfish
Brown Shrimp
Star drum
Cannonball jellyfish
Invertebrate
Other


South Atlantic Rock Shrimp Species Characterization
n = 191 nets
506 h
11,854 kg
31 species
Kilograms
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
41%
12%
11%
9%
6%
6%
5%
3%
2%
5%
Rock shrimp
Grouped finfish
Dusky flounder
Inshore lizardfish
Irridescent swimming crab
Invertebrate
Crustacean
Longspine swimming crab
Debris
Other

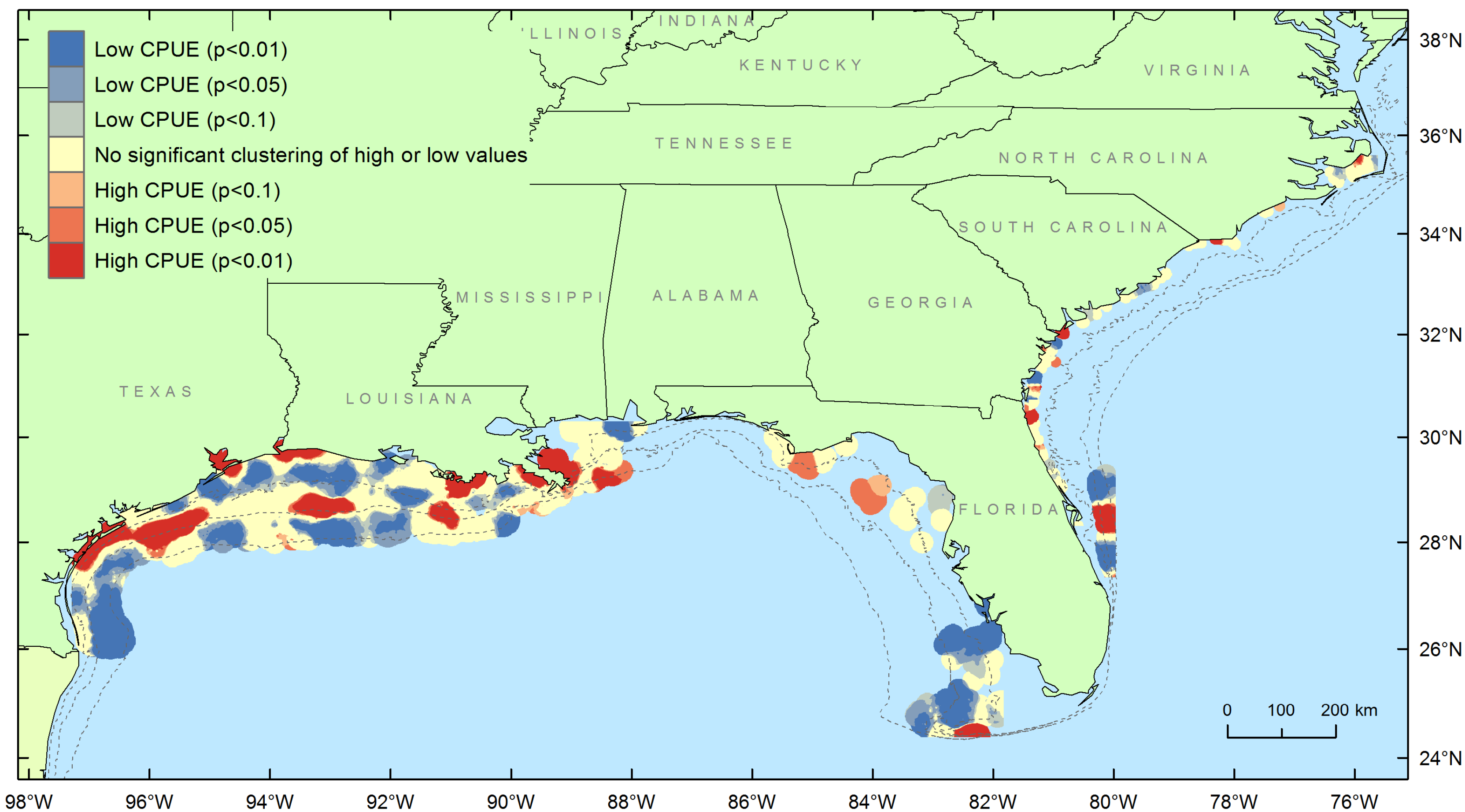
Density Surface Plot of Hours Towed
Mandatory Shrimp Observer Program 2007 - 2010



Discard Hot Spot Analysis



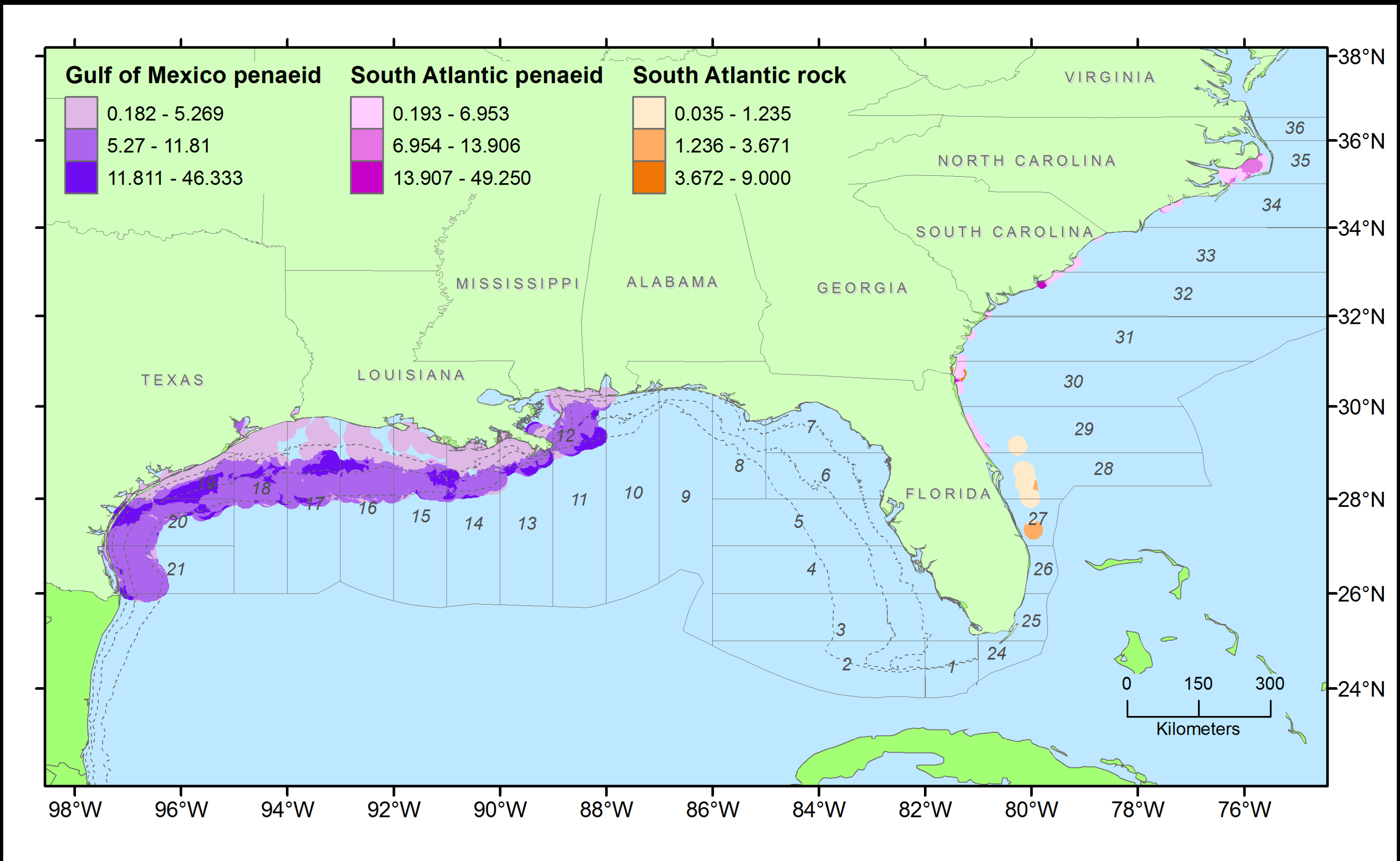
Shrimp Hot Spot Analysis



Brown Shrimp

(*Farfantepenaeus aztecus*)

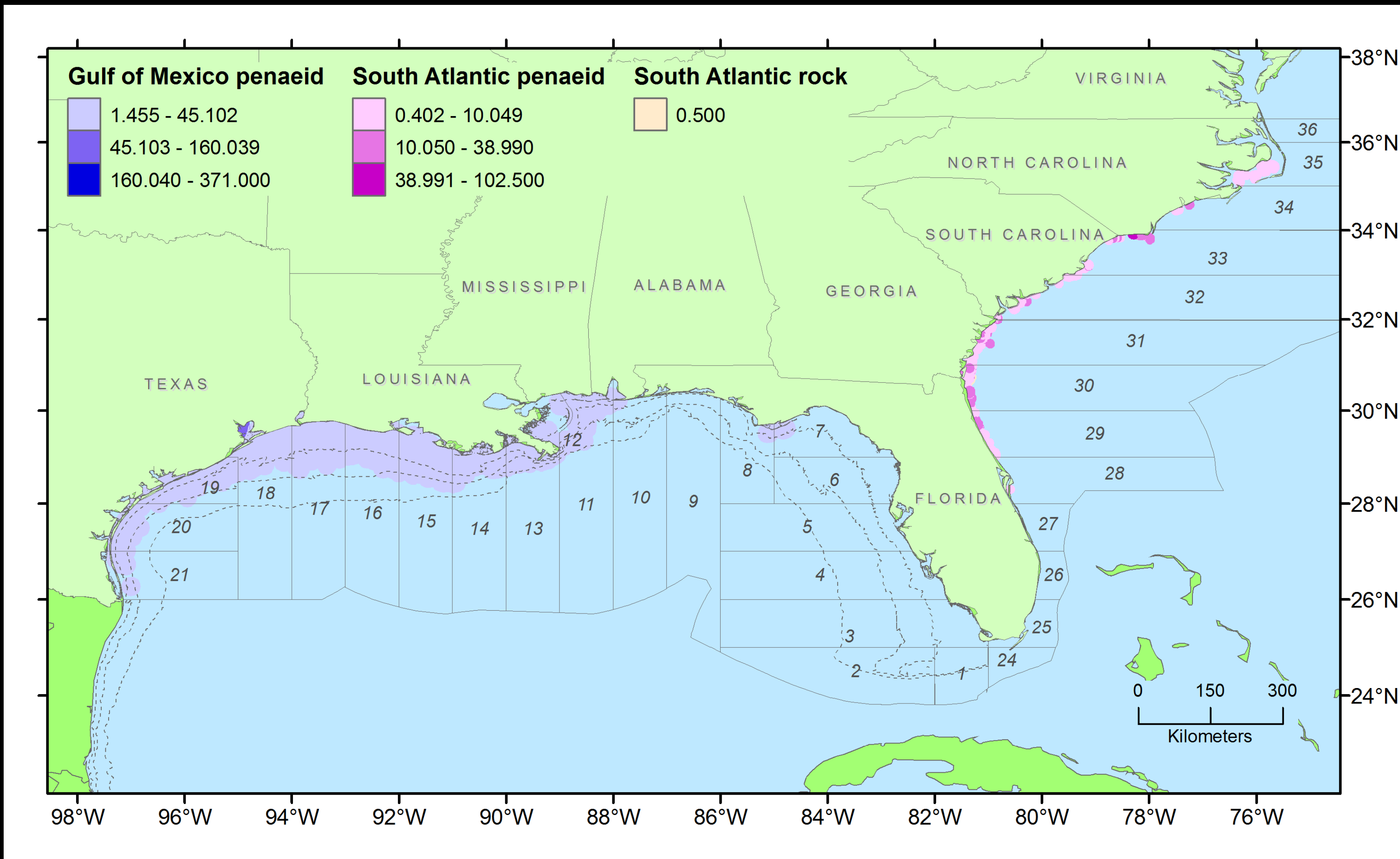
CPUE (kg/h)



White Shrimp

(*Litopenaeus setiferus*)

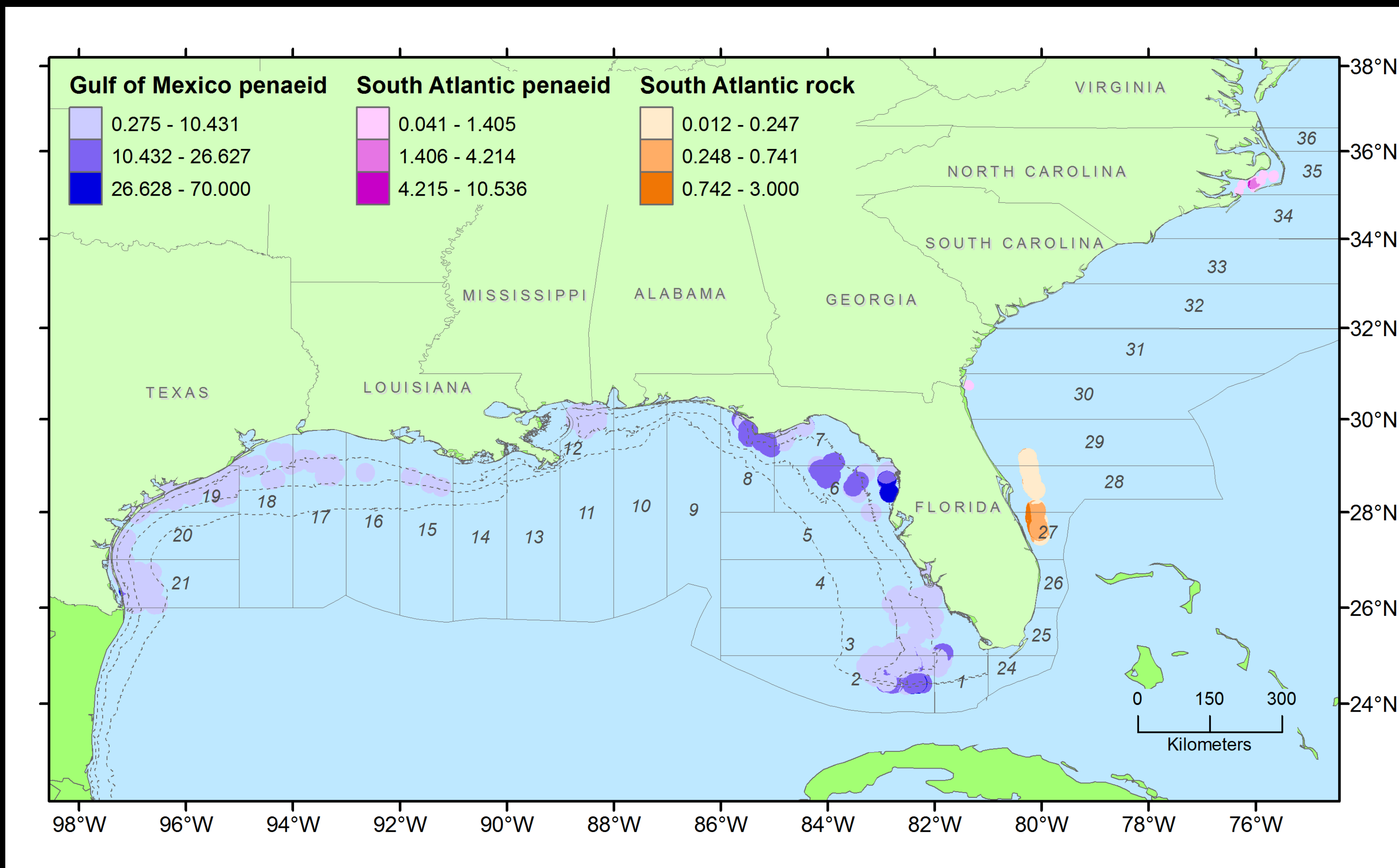
CPUE (kg/h)



Pink Shrimp

(*Farfantepenaeus duorarum*)

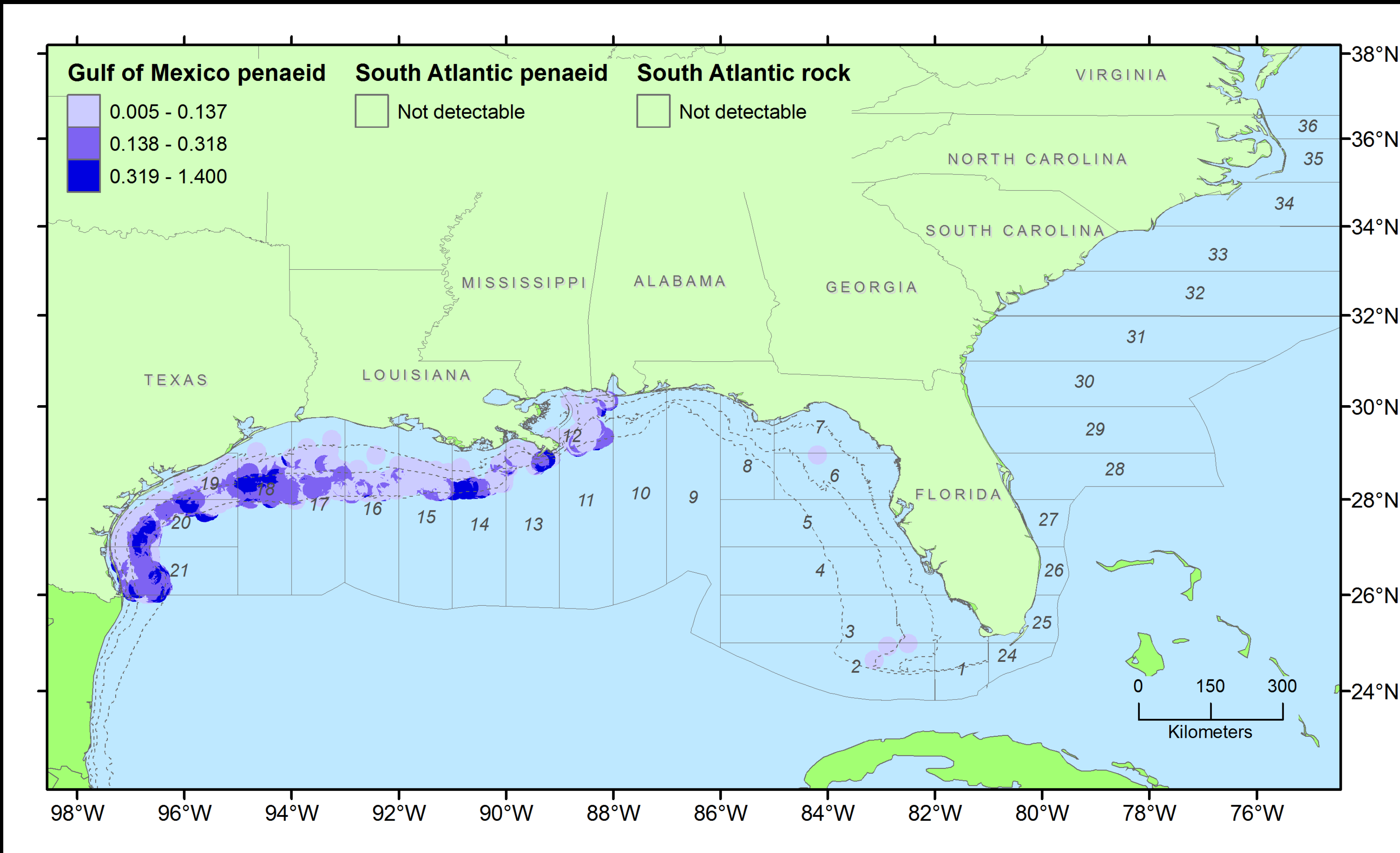
CPUE (kg/h)



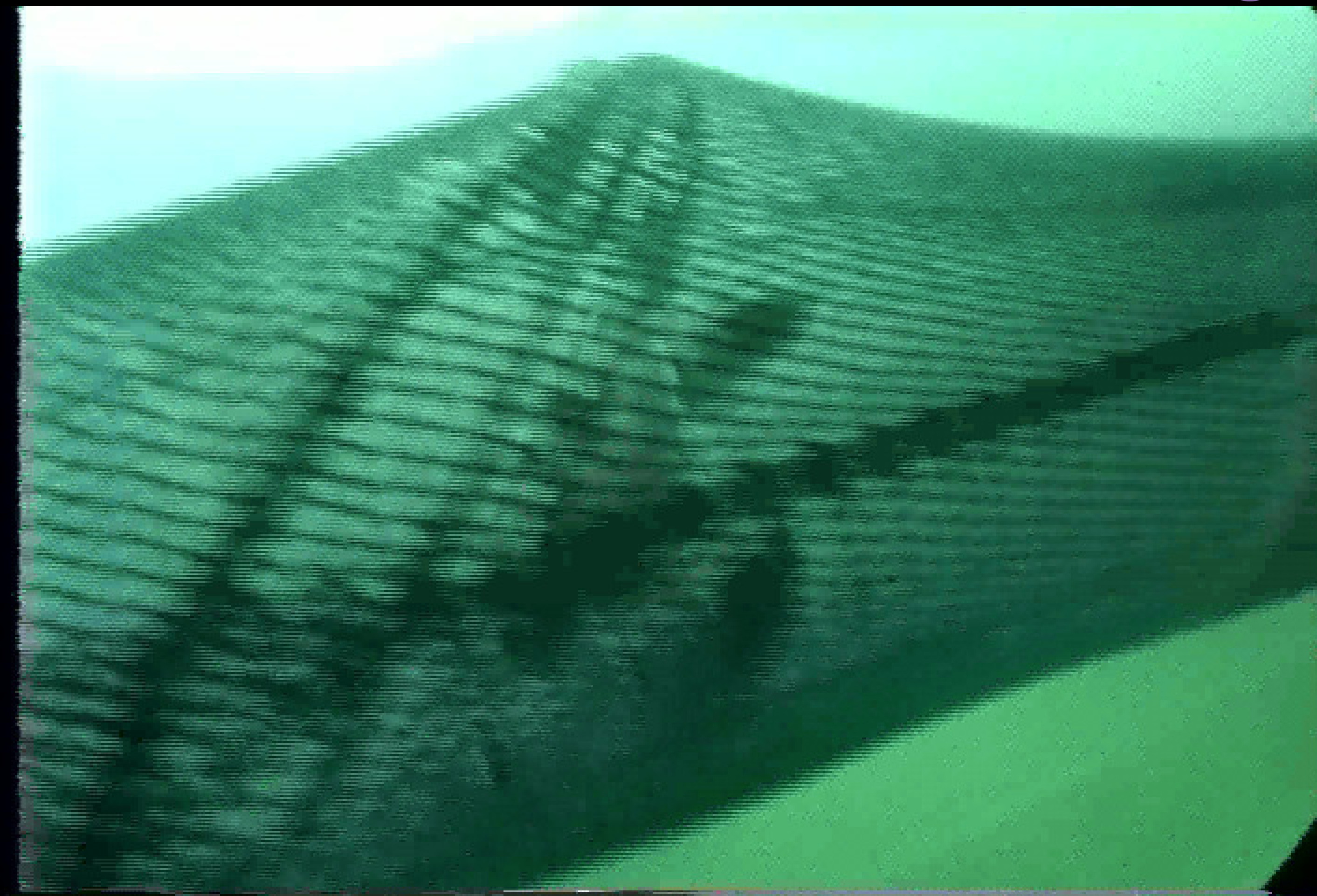
Red Snapper

(*Lutjanus campechanus*)

CPUE (kg/h)

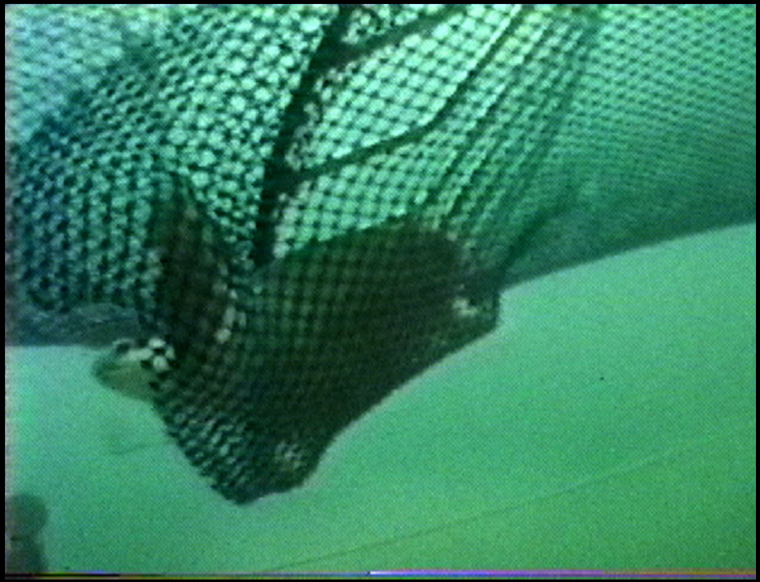


Observer Data: Streamline TED Investigations



- TED certification - Small turtle protocol
- Tested on commercial shrimp vessels with observers

Shrimp Trawl: Incidental Capture of Sea Turtles



ESA of 1973

NOAA Fisheries prepared several section 7 consultations effects of federal activities (federally-permitted fisheries) on endangered species

Several studies lead to TED requirements – 1987

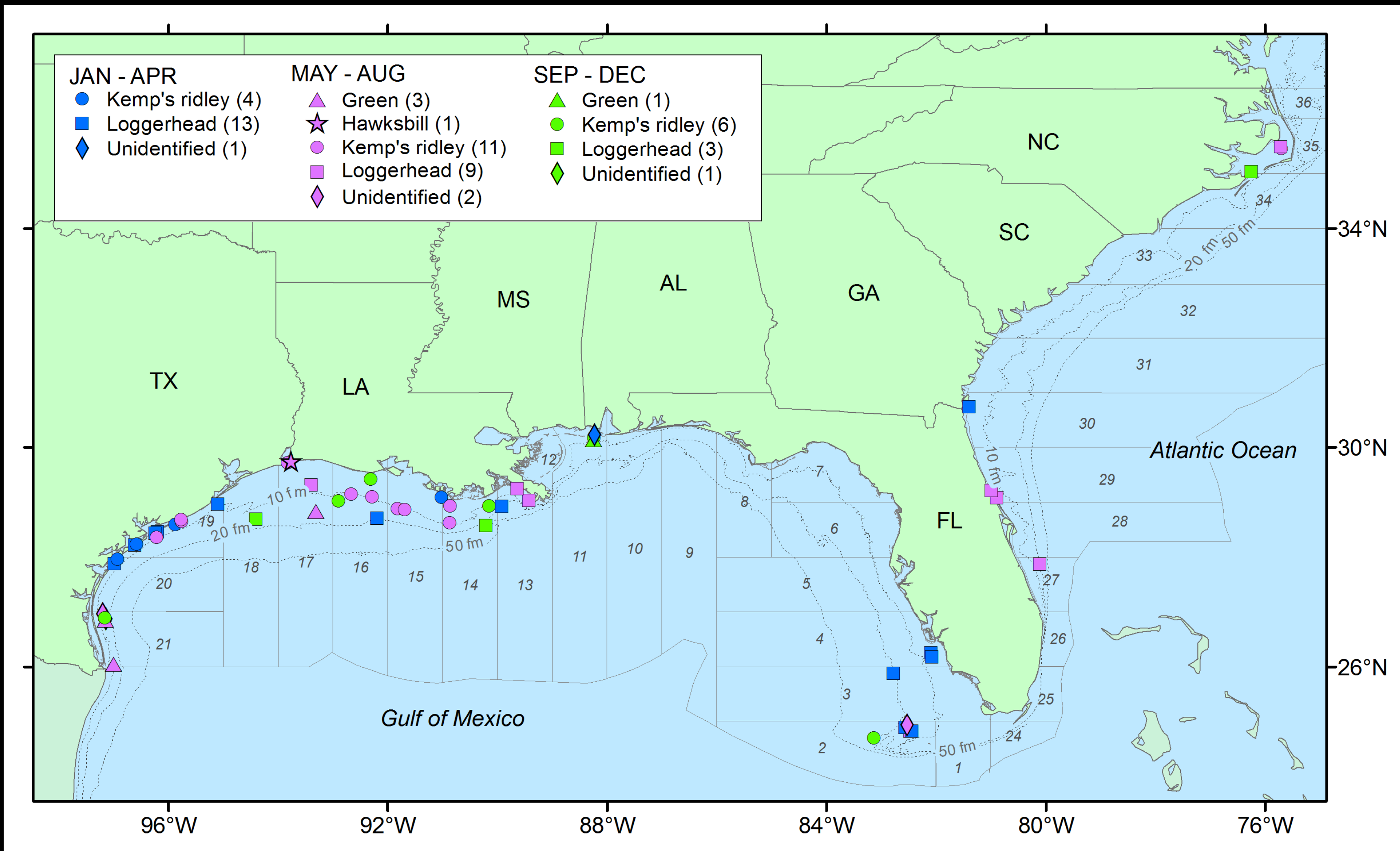
Congressional directives Alternative to TEDs project in 1997

subset of shrimp trawl observer program

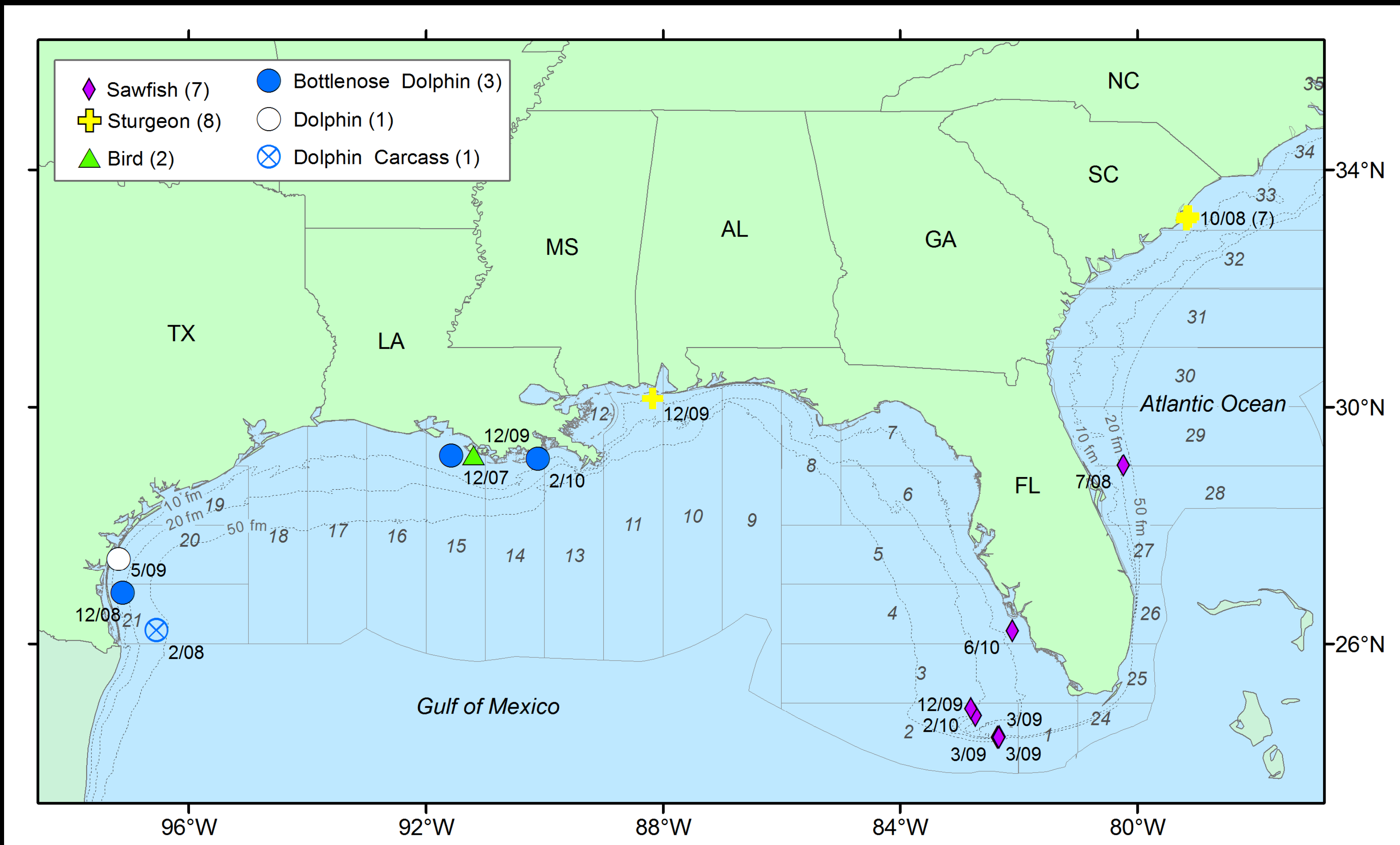
Shrimp Trawl: Sea Turtle Captures by Method of Capture

775

Sea Turtle Captures (54)



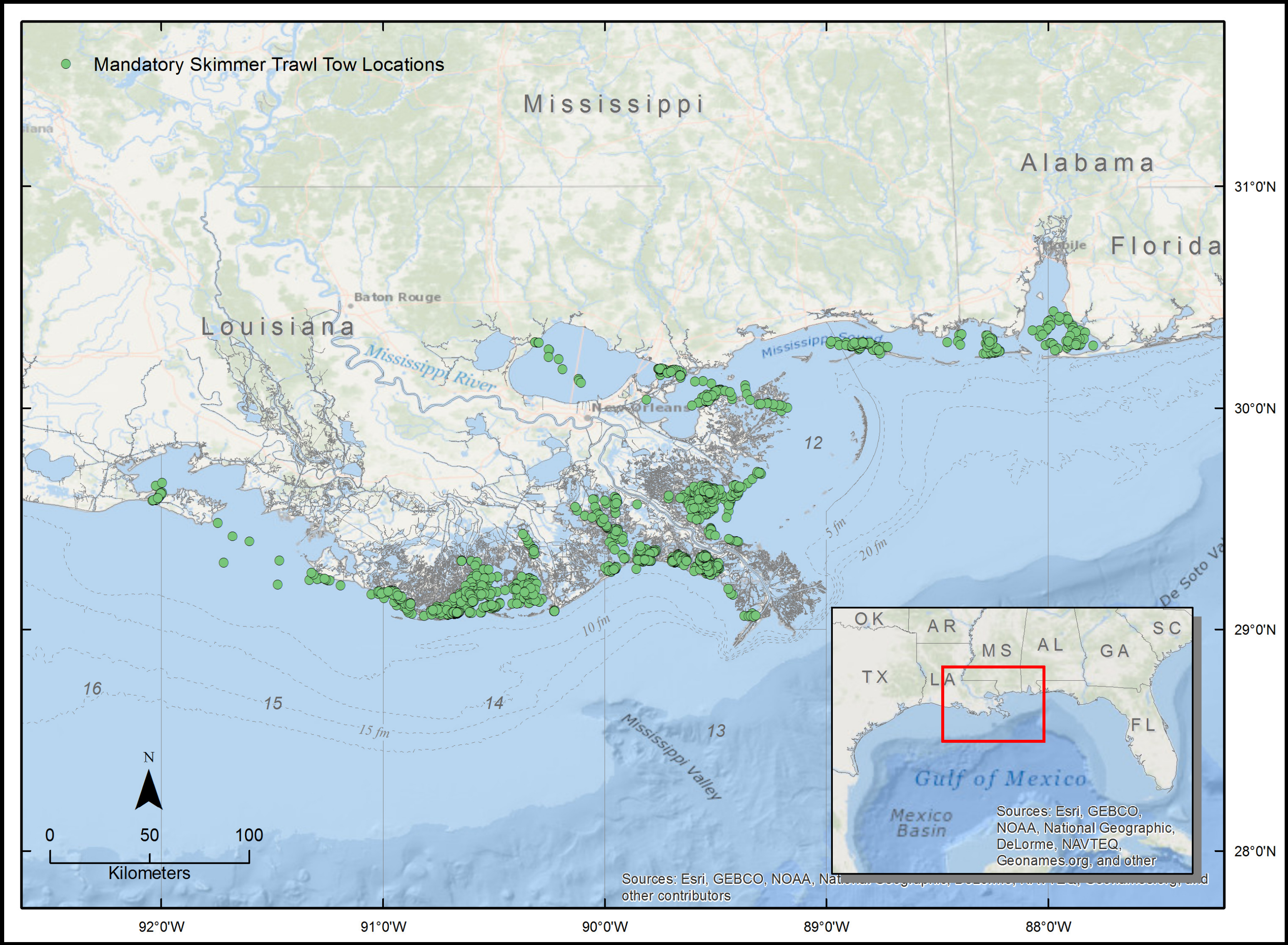
Protected Species Captures

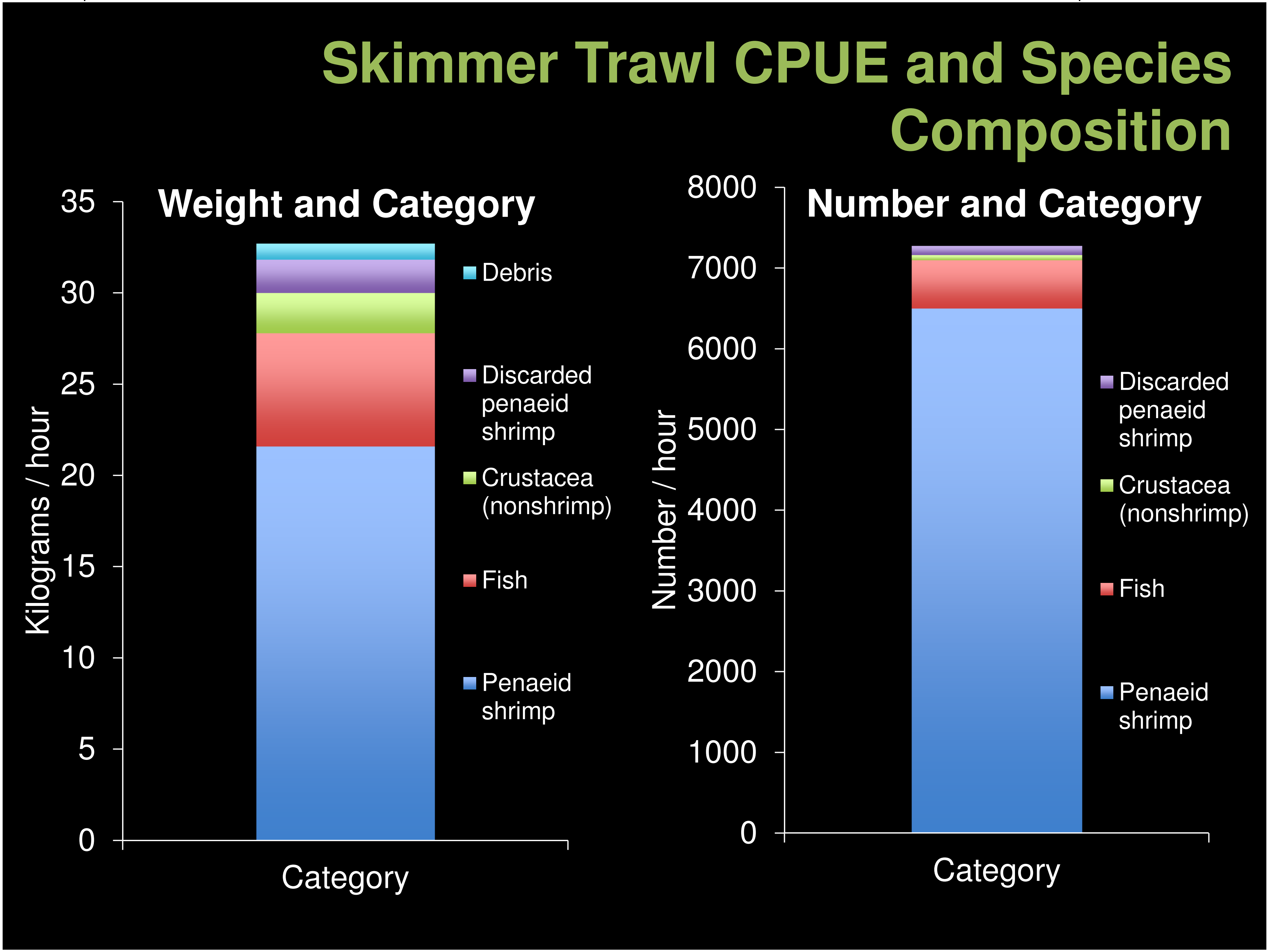


Gulf of Mexico Skimmer Trawl Fishery*

Dates	2004/2005; 2012-2014
Trips	93 trips 264 sea days
Vessel Length	26 - 61 ft (Avg. = 43 ft)
Hull Construction	Fiberglass
Tows	1871 tows
Depth	0.8 -2.3 fms (Avg. = 1.9 fms)
Tow Time	<0.5 – 4.0 hrs (Avg. = 1.0 hrs)

Skimmer Trawl Tow Locations 2012 - 2013




Skimmer Trawl CPUE and Species Composition
Weight and Category
Kilograms / hour
35
30
25
20
15
10
5
0
Category
Debris
Discarded penaeid shrimp
Crustacea (nonshrimp)
Fish
Penaeid shrimp
Number and Category
Number / hour
8000
7000
6000
5000
4000
3000
2000
1000
0
Category
Discarded penaeid shrimp
Crustacea (nonshrimp)
Fish
Penaeid shrimp

Special Programs (non-mandatory)

- Video monitoring (shrimp-bottom longline)
- Hook Timer (bottom longline)
- Otolith / gonad data collection
- Skimmer Trawl TED evaluation
- Shareholder's Alliance (Reef)
- Seafood Safety DWH : for-hire vessels

Future EM Research in the Southeast

- April 1, 2003, NOAA Fisheries listed the U.S. population of smalltooth sawfish, *Pristis pectinata*, as an endangered species under the Endangered Species Act (50 CFR 224)
- Smalltooth sawfish have been captured in the U.S. commercial shrimp fishery and resulting estimates of the rate of take have been calculated

U.S. Department of Commerce | National Oceanic and Atmospheric Administration | NOAA Fisheries

Source: Carlson and Scott-Denton, 2010

Future EM Research in the Southeast

- Relatively low observer coverage coupled with the rarity of smalltooth sawfish captures results in low reliability in the estimate of take
- To this end, EM technology is currently being advocated for monitoring smalltooth bycatch from the shrimp trawl fishery operating in US southwestern Florida waters
- Funding for this pilot is anticipated in the fall of 2013.

Source: Carlson and Scott-Denton, 2010

Appendix 3:

Shrimp Bycatch Estimation Method Presentations

Shrimp Fishery Bycatch Methods for Recent SEDAR Assessments: Challenges and Recommendations

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SEFSC

Xinsheng Zhang
E. Cortés, D. Courtney, E. Scott-Denton

SEDAR Shrimp Procedural Workshop
Charleston, SC, USA. July 22 - 24, 2014

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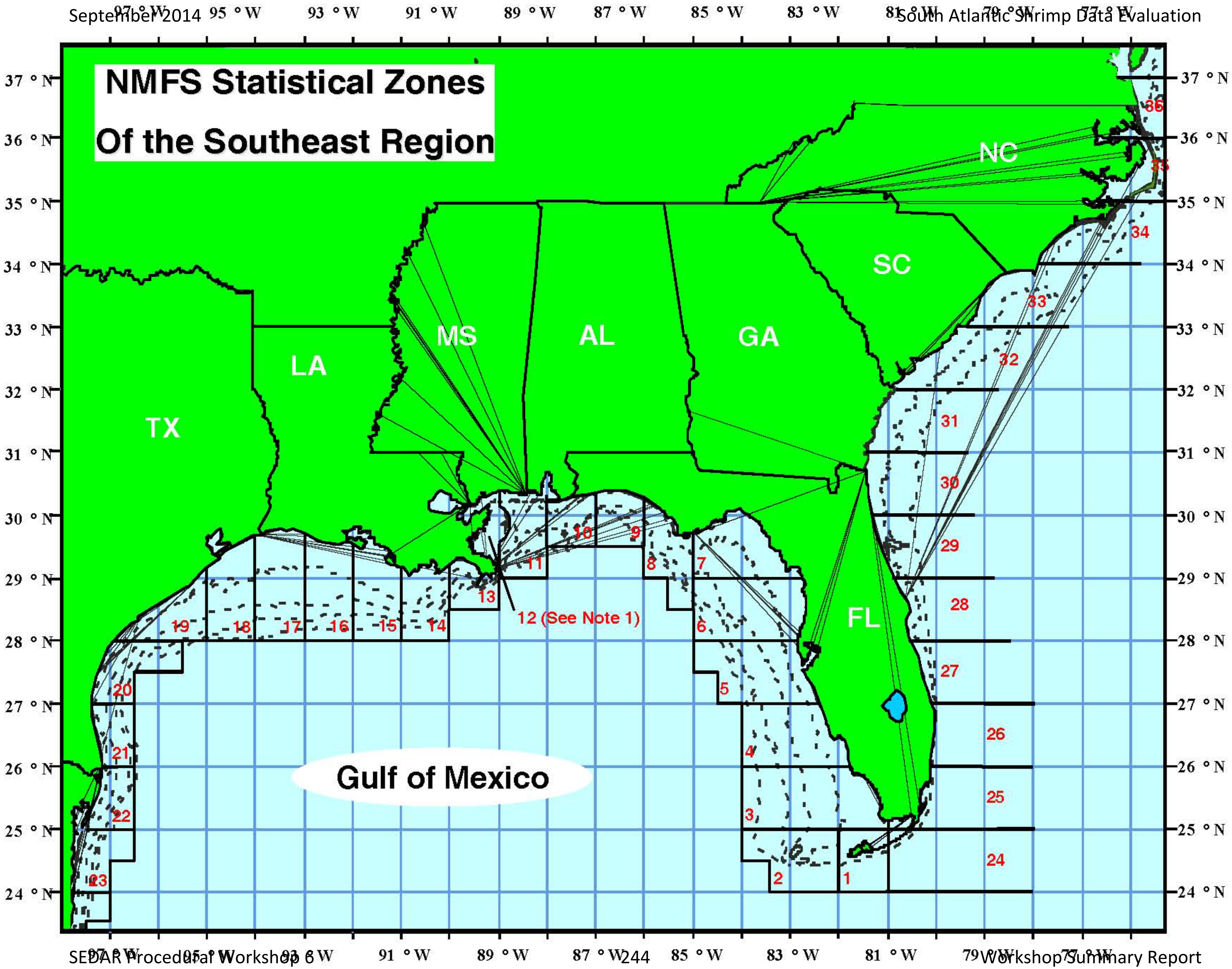
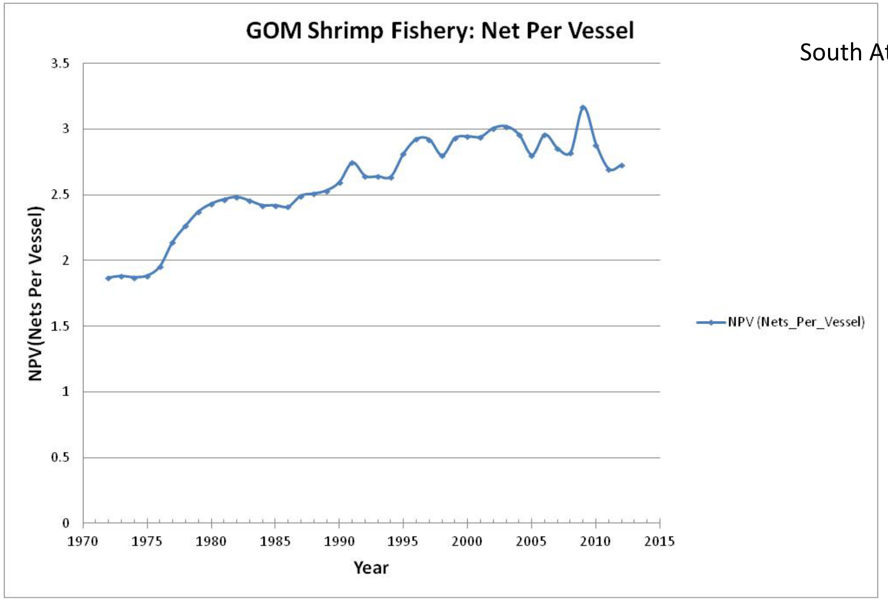
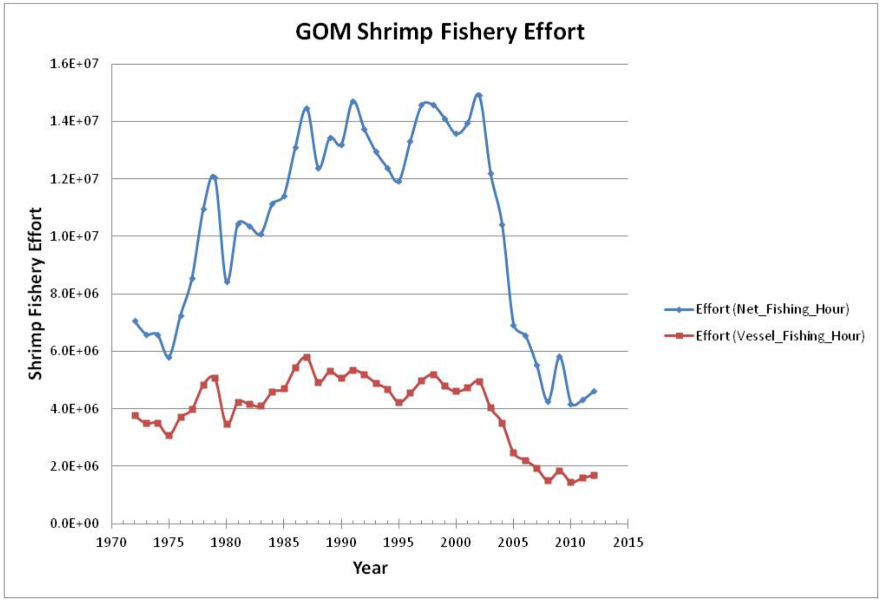
APPENDIX 11



Note 1 - Stat zone 12 expands east to include Chandeleur Islands





Shrimp Fishery Nets per Vessel Data (Jay Boulet & Dave Gloeckner) and Effort Data (Rick Hart & Jim Nance)

Shrimp Fishery Bycatch CPUE

To characterize and estimate shrimp fishery bycatch CPUE:

- A voluntary observer program for the commercial shrimp fishery operating in the U.S. Gulf of Mexico and South Atlantic was implemented in 1992.

- A mandatory observer program for the commercial shrimp fishery operating in the U.S. Gulf of Mexico was implemented in 2007. In June 2008, observer coverage expanded to include the South Atlantic penaeid and rock shrimp fisheries through Amendment 6 to the Shrimp Fishery Management Plan for the South Atlantic Region.

- Even though both the available bycatch data and commercial fleet representation through stratified selection have become much better since mandatory observer coverage of the shrimp fleet began in 2007, bycatch records for Gulf of Mexico sharks were extremely limited until January 2009.

There are NOT enough Observer data to reliably estimate shrimp fishery bycatch CPUE until mandatory observer coverage of shrimp fleet began in 2007 (sharks in 2009)

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Shrimp Bycatch Models

- Year/season/area/depth/dataset-specific shrimp bycatc CPUE was modeled with GLMs and coded with SAS and WinBUGS etc
- year, season, area, depth and *dataset* were treated as factors, and a local term was used to model perturbations from factors

$\ln(\mathrm{CPUE})_{[i,\, j,\, k,\, l,\, \text{obs or res}]} \sim \mathrm{year}_{[i]} + \mathrm{season}_{[j]} + \mathrm{area}_{[k]} + \mathrm{depth}_{[l]} + \mathrm{dataset}_{[\text{obs or res}]}$

$\mathrm{dataset}_{[obs]}$ = Observer data; $\mathrm{dataset}_{[res]}$ = Research data

Without any interaction effects, bycatch models basically ASSUMED that Observer CPUE and research CPUE follow the SAME global trend, but have DIFFERENT intercepts (i.e. Observer CPUE generally is much lower than research CPUE)

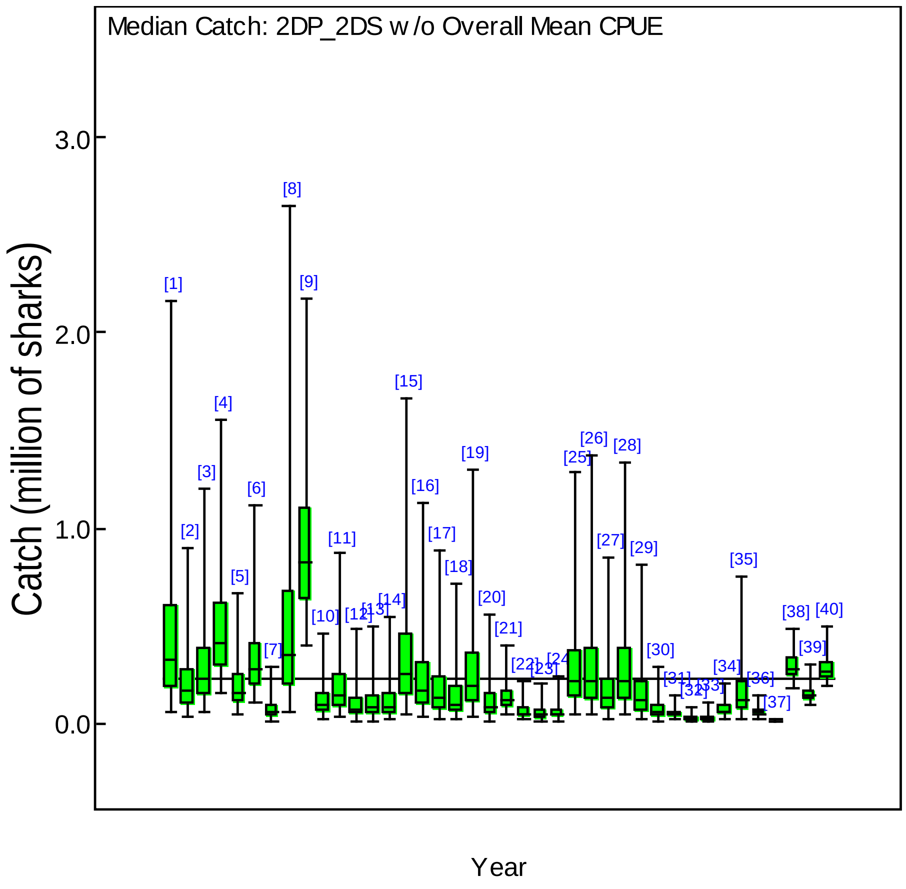
- Catch was assumed to follow a negative binomial distribution, which was modeled as a conjugate gamma-Poisson distribution due to computational issues

$\mathrm{lamb}_{[h]} \sim \mathrm{dgamma}(r, \mu\{\mathrm{yr}_{[h]}, \mathrm{seas}_{[h]}, \mathrm{ar}_{[h]}, \mathrm{dp}_{[h]}, \mathrm{ds}_{[h]}\});$ $\lambda_{[h]} = \mathrm{lamb}_{[h]} * \mathrm{hrsfishd}_{[h]};$ $\mathrm{catch}_{[h]} \sim \mathrm{dpois}(\lambda_{[h]})$

where r is the shape parameter & μ is the mean parameter ($\mu_{[i,\, j,\, k,\, l,\, m = 1 \text{ or } 2]} = r/\mathrm{cpue}_{[i,\, j,\, k,\, l,\, \text{obs or res}]}$)

$\mathrm{catch}_{[i,\, j,\, k,\, l]} = \mathrm{CPUE}_{[i,\, j,\, k,\, l,\, obs]} * \mathrm{npv}_{[i,\, j,\, k,\, l]} * \mathrm{effort}_{[i,\, j,\, k,\, l]}$

Estimates of Bonnethead Shark Bycatch and Variability with WinBUGS 1972-2011



Challenges for Shrimp Bycatch Estimation

The SEDAR 31 Panel noted that the annual bycatch of red snapper from the shrimp fishery was poorly estimated, having very large variances in all years. Accordingly, the panel decided to use the median of the annual median estimates from the Bayesian shrimp bycatch analysis (Linton 2012) to represent the 1972-2011 median shrimp bycatch. A similar approach was used in the SEDAR 28 assessments.

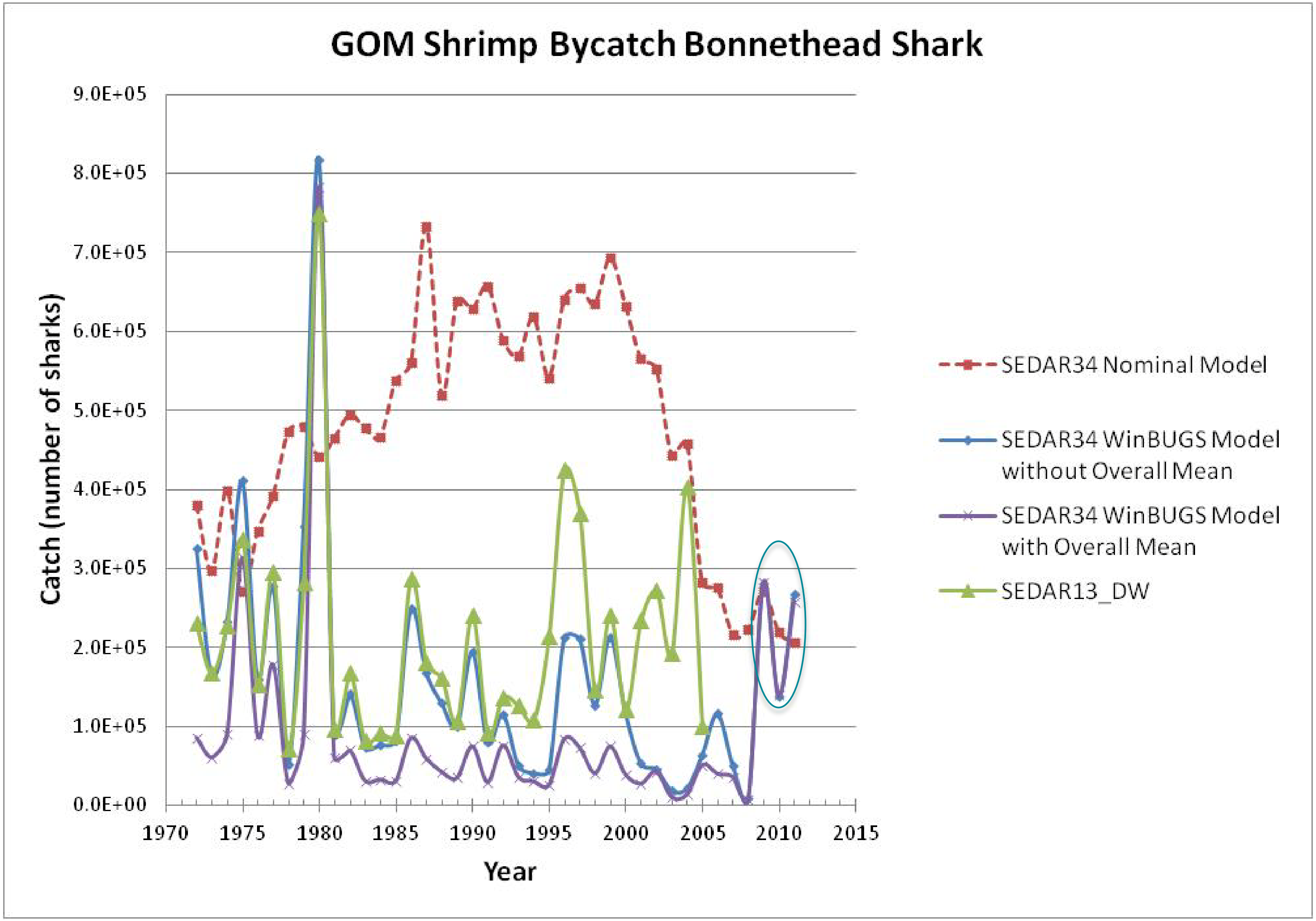
$$\ln(CPUE)_{[i,\,j,\,k,\,l,\,obs\text{ or }res]} \sim year_{[i]} + season_{[j]} + area_{[k]} + depth_{[l]} + dataset_{[obs\text{ or }res]}$$

$dataset_{[obs]}$ = Observer data; $dataset_{[res]}$ = Research data

$$catch_{[i,\,j,\,k,\,l]} = CPUE_{[i,\,j,\,k,\,l,\,obs]} * npv_{[i,\,j,\,k,\,l]} * effort_{[i,\,j,\,k,\,l]}$$

1. There are NOT enough Observer data to reliably estimate shrimp fishery bycatch CPUE for red snapper until mandatory observer coverage of shrimp fleet began in 2007 (sharks in 2009)
2. Observer CPUE < Research CPUE
3. Treat Observer and research data as a factor in the bycatch models may introduce biases for estimated Observer CPUE when bycatch CPUE could be estimated only based on Observer data during 2007-2011
4. Methods to estimate Observer CPUE when Observer data are unavailable

Shrimp Fishery Bycatch Models Comparisons



SEDAR 39 Smoothhound Sharks

Average Observed Bycatch CPUE Estimation (2009-2012)

Step 1:

$NZCT\_CPUE_{[yr,\ sea,\ ar,\ dp]} = \mathit{exp}\{\mathit{mean}[\mathit{ln}(NZCT\_CPUE_{[yr,\ sea,\ ar,\ dp,\ i]})] + 0.5*\mathit{var}[\mathit{ln}(NZCT\_CPUE_{[yr,\ sea,\ ar,\ dp,\ i]})]\}$

Step 2:

$CPUE_{[yr,\ sea,\ ar,\ dp]} = NZCT\_CPUE_{[yr,\ sea,\ ar,\ dp]}*Num\_of\_NZCT_{[yr,\ sea,\ ar,\ dp]}/Num\_of\_AT_{[yr,\ sea,\ ar,\ dp]}$

Step 3:

$2009\_2012\_Mean\_CPUE_{[sea,\ ar,\ dp]} = \mathit{mean}(CPUE_{[yr,\ sea,\ ar,\ dp]})$ where yr = 2009 – 2012

Step 3 (L-95%CI):

$L\_95\%CI\_2009\_2012\_Mean\_CPUE_{[sea,\ ar,\ dp]} =$

$2009\_2011\_Mean\_CPUE_{[sea,\ ar,\ dp]} - 1.96*SE\_of\_2009\_2011\_Mean\_CPUE_{[sea,\ ar,\ dp]}$

Step 3 (U-95%CI):

$U\_95\%CI\_2009\_2012\_Mean\_CPUE_{[sea,\ ar,\ dp]} =$

$2009\_2012\_Mean\_CPUE_{[sea,\ ar,\ dp]} + 1.96*SE\_of\_2009\_2012\_Mean\_CPUE_{[sea,\ ar,\ dp]}$

2009 CPUE (# of sharks per net-hour)

Year	Season	Area	Depth	Num_of_NZCT	Num_of_AT	NZCT_CPUE	CPUE
2009	1	1	1	2	137	1.2776	0.0187
2009	1	1	2	0	364	0.0000	0.0000
2009	1	2	1	0	35	0.0000	0.0000
2009	1	2	2	0	26	0.0000	0.0000
2009	1	3	1	0	71	0.0000	0.0000
2009	1	3	2	5	181	0.9314	0.0257
2009	1	4	1	0	107	0.0000	0.0000
2009	1	4	2	1	317	0.3047	0.0010
2009	2	1	1				
2009	2	1	2	0	62	0.0000	0.0000
2009	2	2	1	0	100	0.0000	0.0000
2009	2	2	2	0	33	0.0000	0.0000
2009	2	3	1	0	264	0.0000	0.0000
2009	2	3	2	3	190	2.3702	0.0374
2009	2	4	1	0	60	0.0000	0.0000
2009	2	4	2	1	416	2.0375	0.0049
2009	3	1	1				
2009	3	1	2	0	33	0.0000	0.0000
2009	3	2	1	0	64	0.0000	0.0000
2009	3	2	2	0	9	0.0000	0.0000
2009	3	3	1	0	75	0.0000	0.0000
2009	3	3	2	1	59	1.2319	0.0209
2009	3	4	1	0	158	0.0000	0.0000
2009	3	4	2	3	175	1.2421	0.0213
Total				16	2936		

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2010 CPUE (# of sharks per net-hour)

Year	Season	Area	Depth	Num_of_NZCT	Num_of_AT	NZCT_CPUE	CPUE
2010	1	1	1	0	115	0.0000	0.0000
2010	1	1	2	0	218	0.0000	0.0000
2010	1	2	1	0	63	0.0000	0.0000
2010	1	2	2	7	56	0.9728	0.1216
2010	1	3	1	1	56	0.1724	0.0031
2010	1	3	2	7	140	1.2358	0.0618
2010	1	4	1	8	220	0.8496	0.0309
2010	1	4	2	2	143	0.6301	0.0088
2010	2	1	1	0	73	0.0000	0.0000
2010	2	1	2	1	138	0.1923	0.0014
2010	2	2	1				
2010	2	2	2				
2010	2	3	1	0	147	0.0000	0.0000
2010	2	3	2	24	175	1.5221	0.2087
2010	2	4	1	0	208	0.0000	0.0000
2010	2	4	2	9	238	1.0176	0.0385
2010	3	1	1	0	28	0.0000	0.0000
2010	3	1	2	0	136	0.0000	0.0000
2010	3	2	1	0	78	0.0000	0.0000
2010	3	2	2	4	32	0.3708	0.0463
2010	3	3	1	0	218	0.0000	0.0000
2010	3	3	2	4	92	1.7540	0.0763
2010	3	4	1	0	11	0.0000	0.0000
2010	3	4	2	0	16	0.0000	0.0000
Total				67	2601		

2011 CPUE (# of sharks per net-hour)

Year	Season	Area	Depth	Num_of_NZCT	Num_of_AT	NZCT_CPUE	CPUE
2011	1	1	1	0	65	0.0000	0.0000
2011	1	1	2	0	229	0.0000	0.0000
2011	1	2	1	0	27	0.0000	0.0000
2011	1	2	2	0	8	0.0000	0.0000
2011	1	3	1	0	82	0.0000	0.0000
2011	1	3	2	10	123	0.1426	0.0116
2011	1	4	1	0	34	0.0000	0.0000
2011	1	4	2	5	28	0.1280	0.0229
2011	2	1	1	0	10	0.0000	0.0000
2011	2	1	2	0	190	0.0000	0.0000
2011	2	2	1	0	30	0.0000	0.0000
2011	2	2	2	6	27	5.0205	0.9655
2011	2	3	1	0	427	0.0000	0.0000
2011	2	3	2	16	194	0.3574	0.0295
2011	2	4	1	0	67	0.0000	0.0000
2011	2	4	2	1	224	1.0211	0.0046
2011	3	1	1				
2011	3	1	2				
2011	3	2	1	0	88	0.0000	0.0000
2011	3	2	2	0	7	0.0000	0.0000
2011	3	3	1	0	209	0.0000	0.0000
2011	3	3	2	30	343	0.4204	0.0368
2011	3	4	1	0	61	0.0000	0.0000
2011	3	4	2	23	397	0.3044	0.0176
Total				91	2870		

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2012 CPUE (# of sharks per net-hour)

Year	Season	Area	Depth	Num_of_NZCT	Num_of_AT	NZCT_CPUE	CPUE
2012	1	1	1	1	77	1.2221	0.0159
2012	1	1	2	0	118	0.0000	0.0000
2012	1	2	1	0	30	0.0000	0.0000
2012	1	2	2	2	14	3.2341	0.4620
2012	1	3	1	0	71	0.0000	0.0000
2012	1	3	2	9	182	0.8590	0.0425
2012	1	4	1	0	12	0.0000	0.0000
2012	1	4	2	2	26	0.5448	0.0419
2012	2	1	1	0	2	0.0000	0.0000
2012	2	1	2	0	112	0.0000	0.0000
2012	2	2	1	0	43	0.0000	0.0000
2012	2	2	2				
2012	2	3	1	1	308	2.2887	0.0074
2012	2	3	2	12	109	1.1645	0.1282
2012	2	4	1	0	24	0.0000	0.0000
2012	2	4	2	0	334	0.0000	0.0000
2012	3	1	1				
2012	3	1	2	0	115	0.0000	
2012	3	2	1	0	95	0.0000	0.0000
2012	3	2	2	2	94	1.8618	0.0396
2012	3	3	1	0	229	0.0000	0.0000
2012	3	3	2	13	248	1.0440	0.0547
2012	3	4	1	0	39	0.0000	0.0000
2012	3	4	2	14	875	0.8296	0.0133
Total				56	3157		

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2009-2012 Mean CPUE (# of sharks per net-hour)

Year	Season	Area	Depth	CPUE	N	L 95% CI CPUE	U 95% CI CPUE
2009-2012	1	1	1	0.0086	4	-0.0012	0.0185
2009-2012	1	1	2	0.0000	4	0.0000	0.0000
2009-2012	1	2	1	0.0000	4	0.0000	0.0000
2009-2012	1	2	2	0.1459	4	-0.0681	0.3599
2009-2012	1	3	1	0.0008	4	-0.0007	0.0023
2009-2012	1	3	2	0.0354	4	0.0142	0.0566
2009-2012	1	4	1	0.0077	4	-0.0074	0.0229
2009-2012	1	4	2	0.0186	4	0.0010	0.0362
2009-2012	2	1	1	0.0000	3	0.0000	0.0000
2009-2012	2	1	2	0.0003	4	-0.0003	0.0010
2009-2012	2	2	1	0.0000	3	0.0000	0.0000
2009-2012	2	2	2	0.1970	2	-0.1891	0.5832
2009-2012	2	3	1	0.0019	4	-0.0018	0.0055
2009-2012	2	3	2	0.1010	4	0.0180	0.1839
2009-2012	2	4	1	0.0000	4	0.0000	0.0000
2009-2012	2	4	2	0.0120	4	-0.0055	0.0294
2009-2012	3	1	1	0.0000	1	0.0000	0.0000
2009-2012	3	1	2	0.0000	2	0.0000	0.0000
2009-2012	3	2	1	0.0000	4	0.0000	0.0000
2009-2012	3	2	2	0.0215	4	-0.0030	0.0460
2009-2012	3	3	1	0.0000	4	0.0000	0.0000
2009-2012	3	3	2	0.0472	4	0.0238	0.0705
2009-2012	3	4	1	0.0000	4	0.0000	0.0000
2009-2012	3	4	2	0.0131	4	0.0039	0.0222
Mean				0.0255			

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SEDAR 39 Smoothhound Sharks

Total Annual Bycatch Calculations (2009-2012)

Step 4:

$Bycatch_{[yr,\ sea,\ ar,\ dp]} = 2009\_2012\_Mean\_CPUE_{[sea,\ ar,\ dp]} * EFFORT_{[yr,\ sea,\ ar,\ dp]} * NPV_{[yr]}$

Step 4 (L-95%CI)

$L\_95\%CI\_Bycatch_{[yr,\ sea,\ ar,\ dp]} = L\_95\%CI\_2009\_2012\_Mean\_CPUE_{[sea,\ ar,\ dp]} * EFFORT_{[yr,\ sea,\ ar,\ dp]} * NPV_{[yr]}$

Step 4 (U-95%CI):

$U\_95\%CI\_Bycatch_{[yr,\ sea,\ ar,\ dp]} = U\_95\%CI\_2009\_2012\_Mean\_CPUE_{[sea,\ ar,\ dp]} * EFFORT_{[yr,\ sea,\ ar,\ dp]} * NPV_{[yr]}$

Step 5:

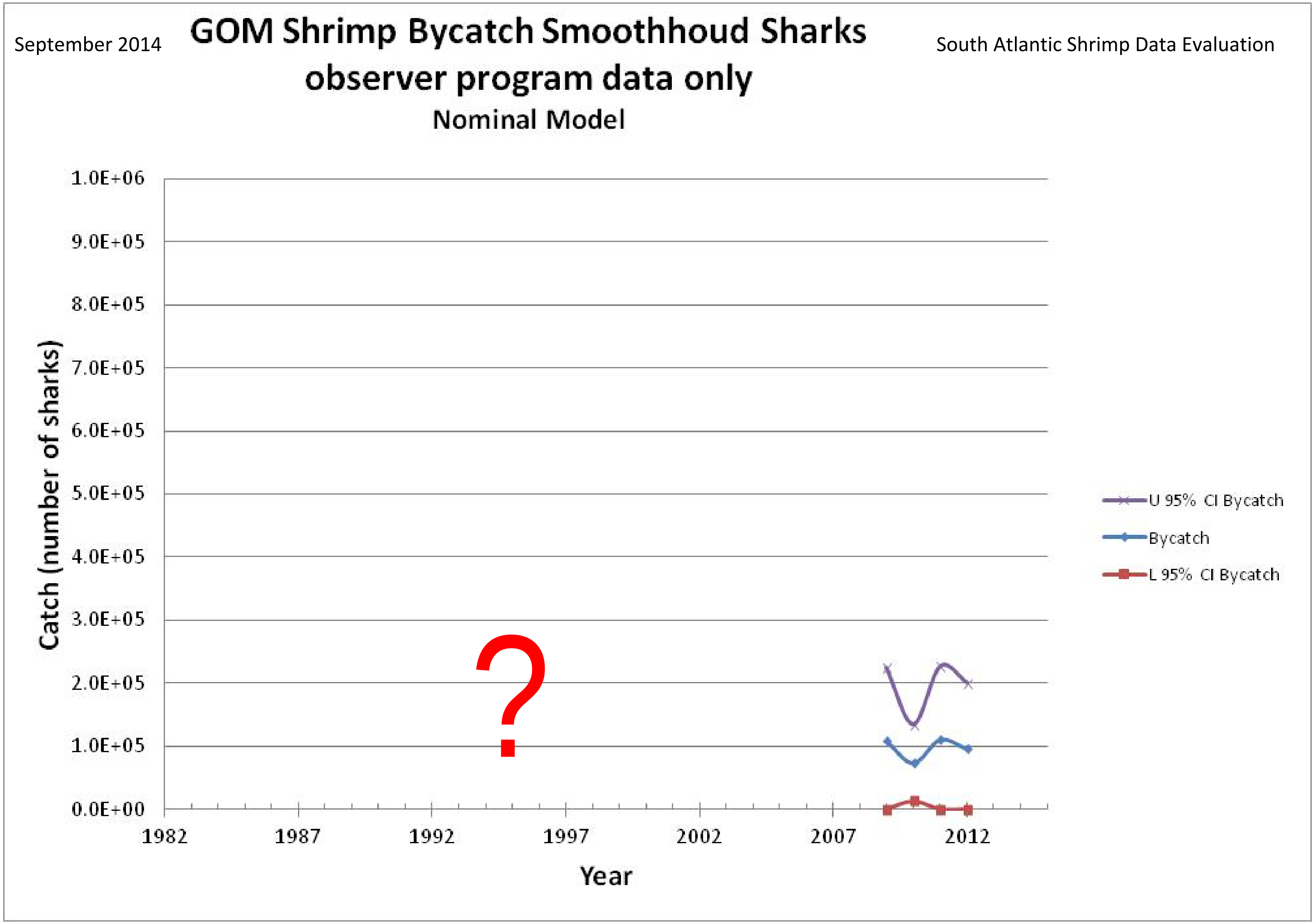
$Bycatch_{[yr]} = \mathit{sum}(Bycatch_{[yr,\ sea,\ ar,\ dp]})$

Step 5 (L-95%CI):

$L\_95\%CI\_Bycatch_{[yr]} = \mathit{sum}(L\_95\%CI\_Bycatch_{[yr,\ sea,\ ar,\ dp]})$

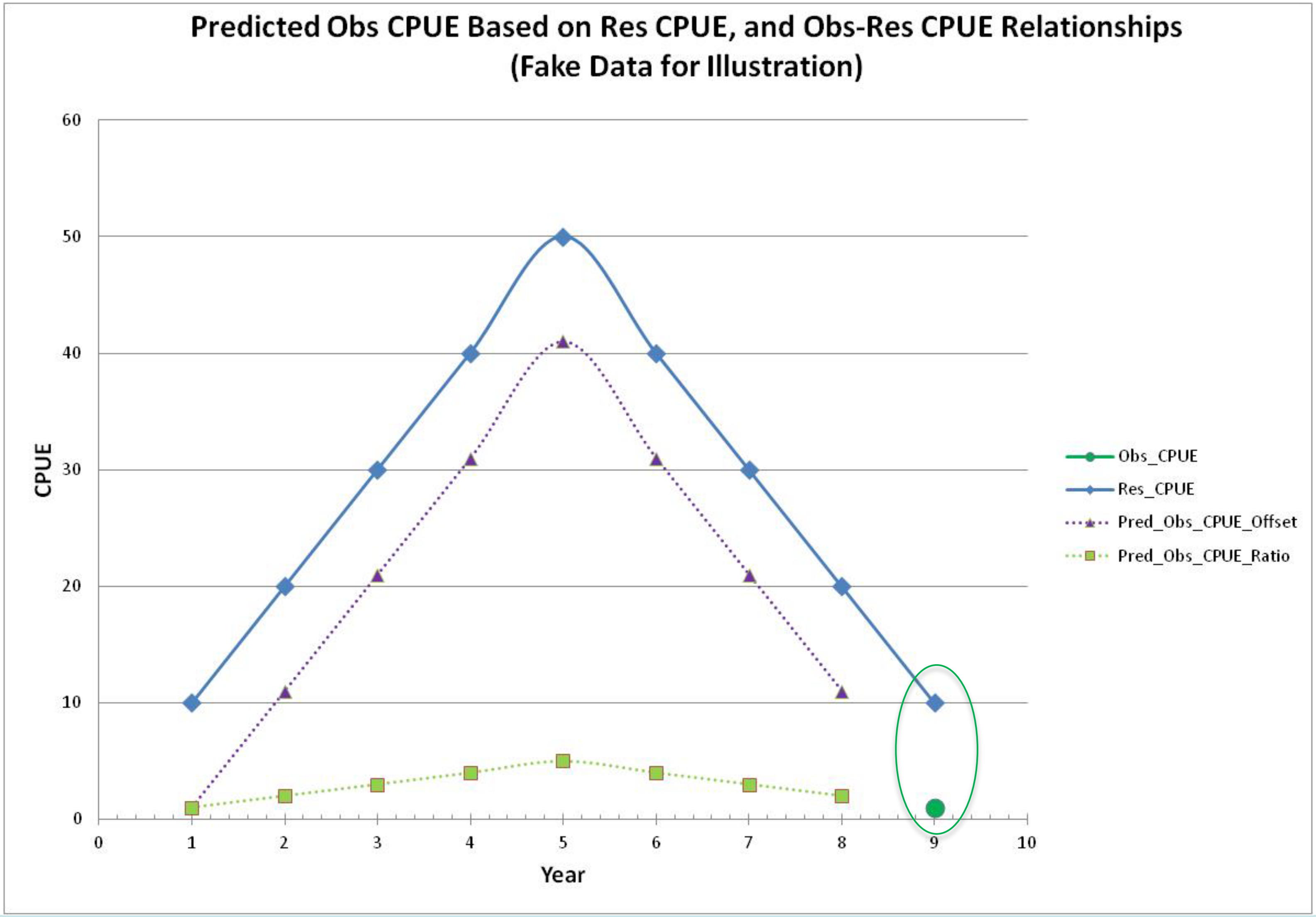
Step 5 (U-95%CI):

$U\_95\%CI\_Bycatch_{[yr]} = \mathit{sum}(U\_95\%CI\_Bycatch_{[yr,\ sea,\ ar,\ dp]})$



Nominal, traditional statistical and Bayesian statistical models can be used to estimate shrimp bycatch based on Observer data, shrimp effort and nets per vessel for 2009-2012 when observer data are available

How do we to estimate/reconstruct pre-2009 Observer CPUE when Observer data are unavailable or very limited? Our assumptions and methods have to be transparent!



Options and Recommendations

Option 1: using the mean 2009-2012 season/area/depth-specific Observer CPUE (approach reported in SEDAR 39-DW-05)

$Bycatch_{[yr, sea, ar, dp]}$ = $2009\_2012\_Mean\_CPUE_{[sea, ar, dp]}$ $*EFFORT_{[yr, sea, ar, dp]}$ $*NPV_{[yr]}$

$Bycatch_{[yr]}$ = *sum*($Bycatch_{[yr, sea, ar, dp]}$)

Option 2A: using the summer SEAMAP CPUE, and ratio of the mean 2009-2012 Observer CPUE and the mean 2009-2012 summer SEAMAP CPUE to scale the bycatch CPUE for 1982-2008

$Scaled\_CPUE_{[yr]}$ = (Mean_2009_2012_CPUE/Mean_2009_2012_SEAMAP_CUPE) $*SEAMAP\_CPUE_{[yr]}$

$Bycatch_{[yr]}$ = $Scaled\_CPUE_{[yr]}$ $*EFFORT_{[yr]}$ $*NPV_{[yr]}$ where year = 1982 - 2008

Option 2B (recommended): using a linear or nonlinear trend of the SEAMAP summer CPUE *vs.* year (to avoid the large inter-annual variability), and ratio of the mean 2009-2012 bycatch CPUE and the mean 2009-2012 SEAMAP summer CPUE to scale the bycatch CPUE for 1982-2008

$Pred\_SEAMAP\_CPUE_{[yr]}$ = linear or nonlinear regression of SEAMAP CPUE *vs.* Year

$Scaled\_CPUE_{[yr]}$ = (Mean_2009_2012_CPUE/Mean_2009_2012_SEAMAP_CUPE) $*Pred\_SEAMAP\_CPUE_{[yr]}$

$Bycatch_{[yr]}$ = $Scaled\_CPUE_{[yr]}$ $*EFFORT_{[yr]}$ $*NPV_{[yr]}$ where year = 1982 - 2008

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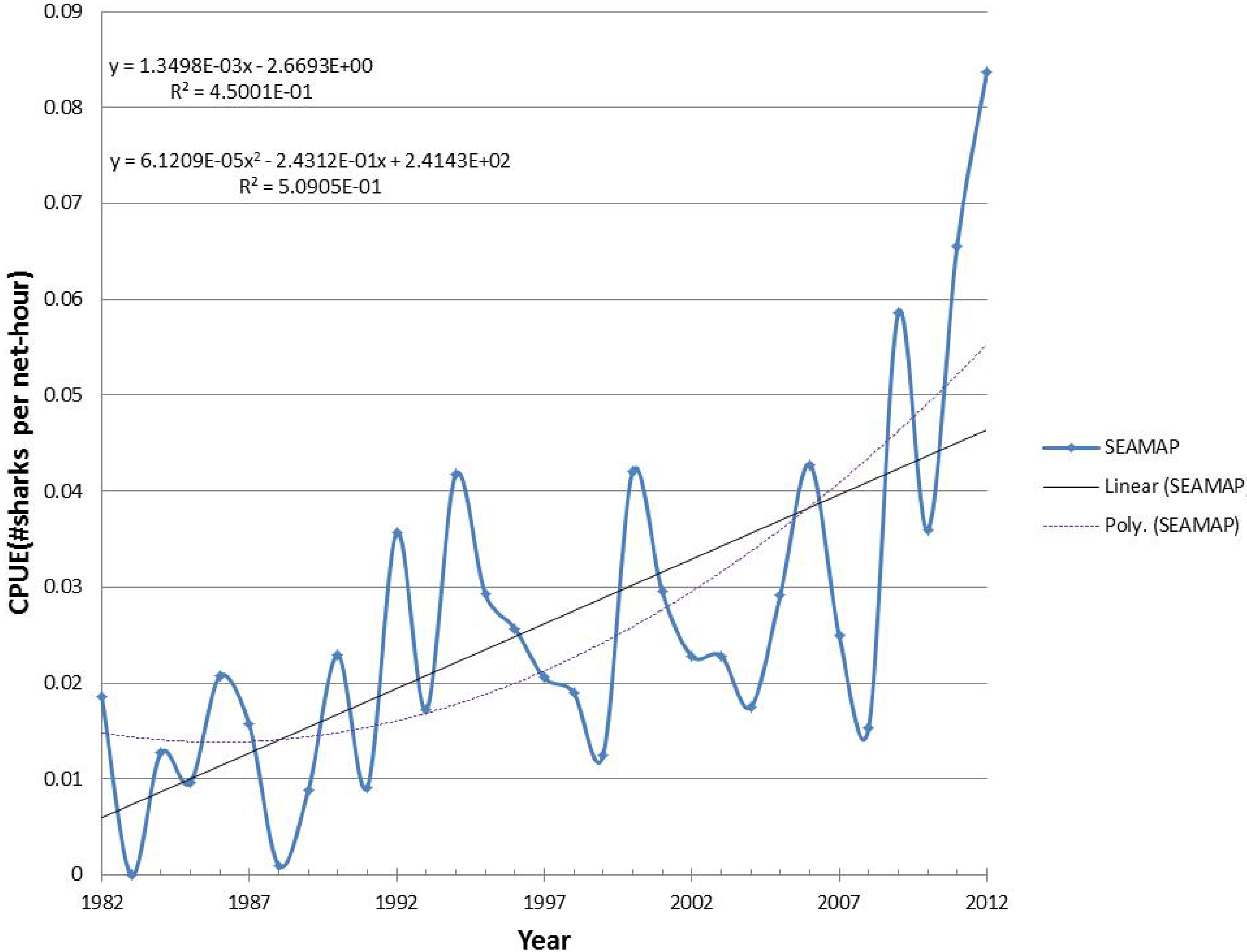
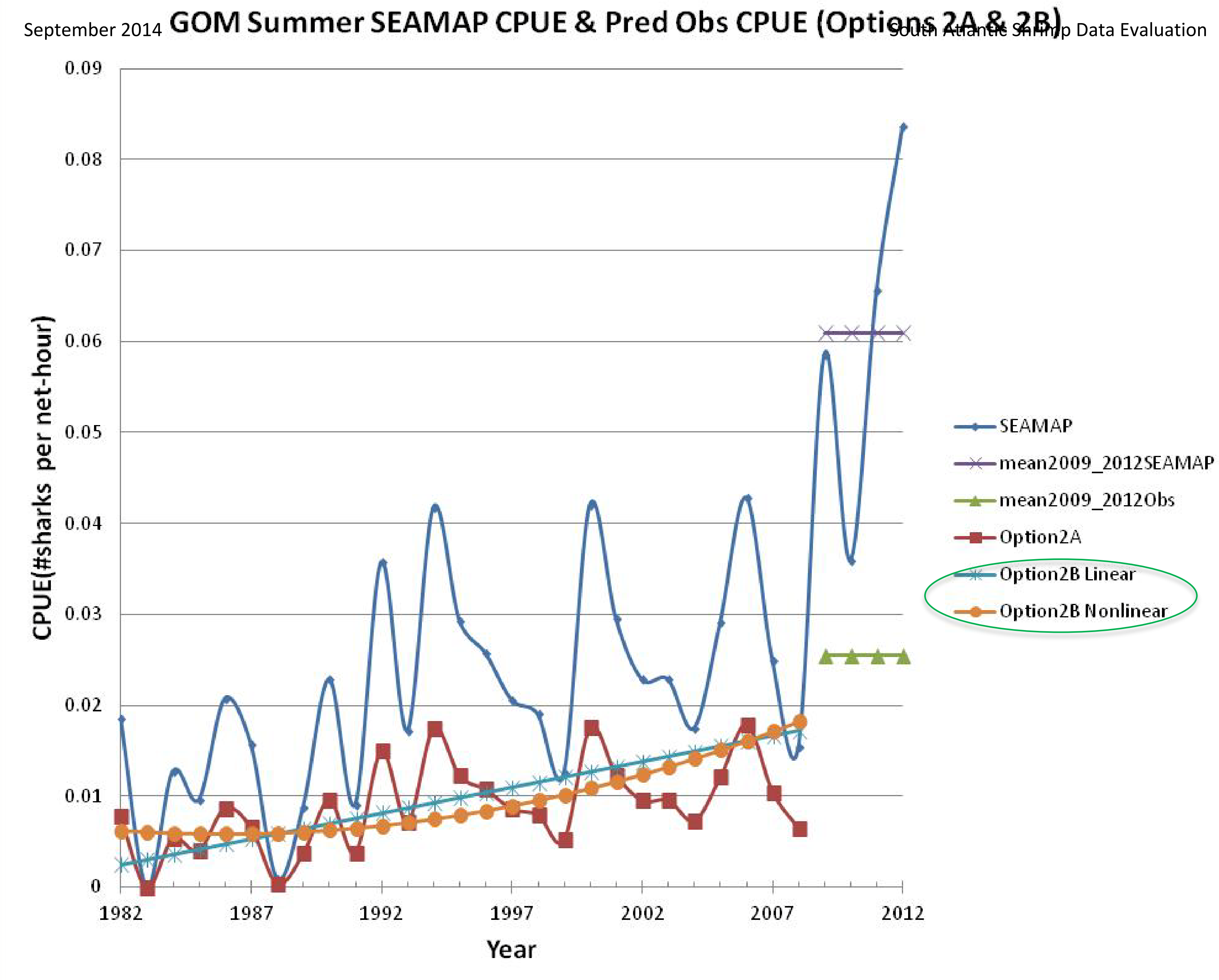
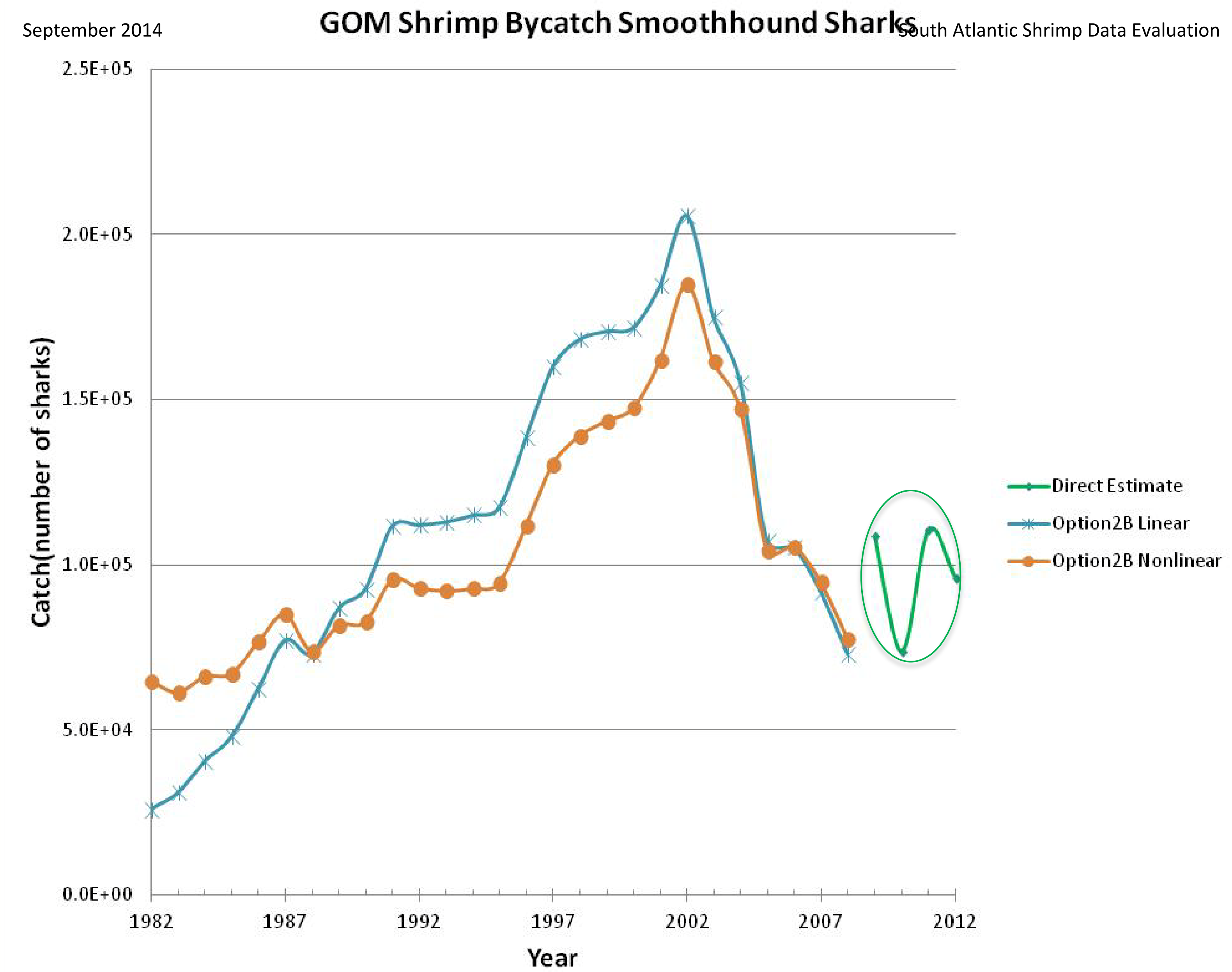
GOM SUMMER SEAMAP CPUE




GOM Summer SEAMAP CPUE & Pred Obs CPUE (Options 2A & 2B)
CPUE(#sharks per net-hour)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1982
1987
1992
1997
2002
2007
2012
Year
SEAMAP
mean2009_2012SEAMAP
mean2009_2012Obs
Option2A
Option2B Linear
Option2B Nonlinear


GOM Shrimp Bycatch Smoothhound Sharks
Catch(number of sharks)
2.5E+05
2.0E+05
1.5E+05
1.0E+05
5.0E+04
0.0E+00
1982
1987
1992
1997
2002
2007
2012
Year
Direct Estimate
Option2B Linear
Option2B Nonlinear

South Atlantic Shrimp Fishery Bycatch for Smoothhound Sharks

Option 1: Followed SEDAR 13 and SEDAR 34, based on the estimated GOM shrimp fishery bycatch and the ratio between South Atlantic and GOM average shrimp fishery trip length (0.141 or 0.032 adjusted with horizontal distribution overlap) from Observer program during 1992-2012

Option 2: based on the estimated GOM shrimp fishery bycatch and the ratio between South Atlantic and GOM (0.065 or 0.015 adjusted with horizontal distribution overlap) total shrimp fishery tow-hours from Observer program during 1992-2012

As South Atlantic shrimp fishery effort is much lower than GOM, shrimp bycatch is NOT expected to be a major part of fishing mortality. Therefore both options should provide acceptable first-order approximation of South Atlantic shrimp fishery bycatch. Given their very small magnitude, it may not need to consider South Atlantic shrimp fishery bycatch for smoothhound sharks.

Thank You

King Mackerel Discards in the Gulf of Mexico and South Atlantic Shrimp Fishery

Southeast Fisheries Science Center

SEDAR Shrimp Procedural Workshop

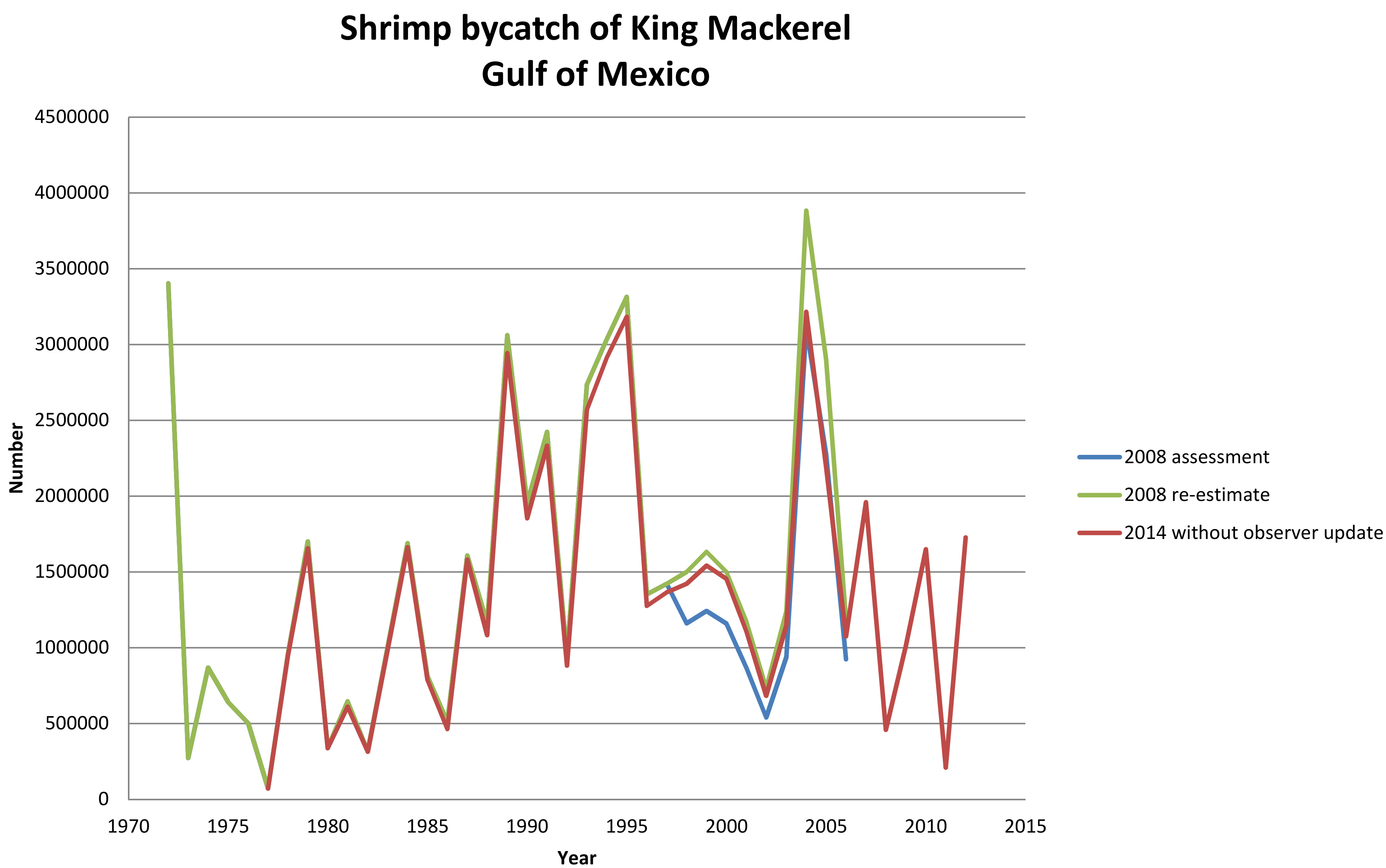
Charleston, SC, USA. July 22 - 24, 2014

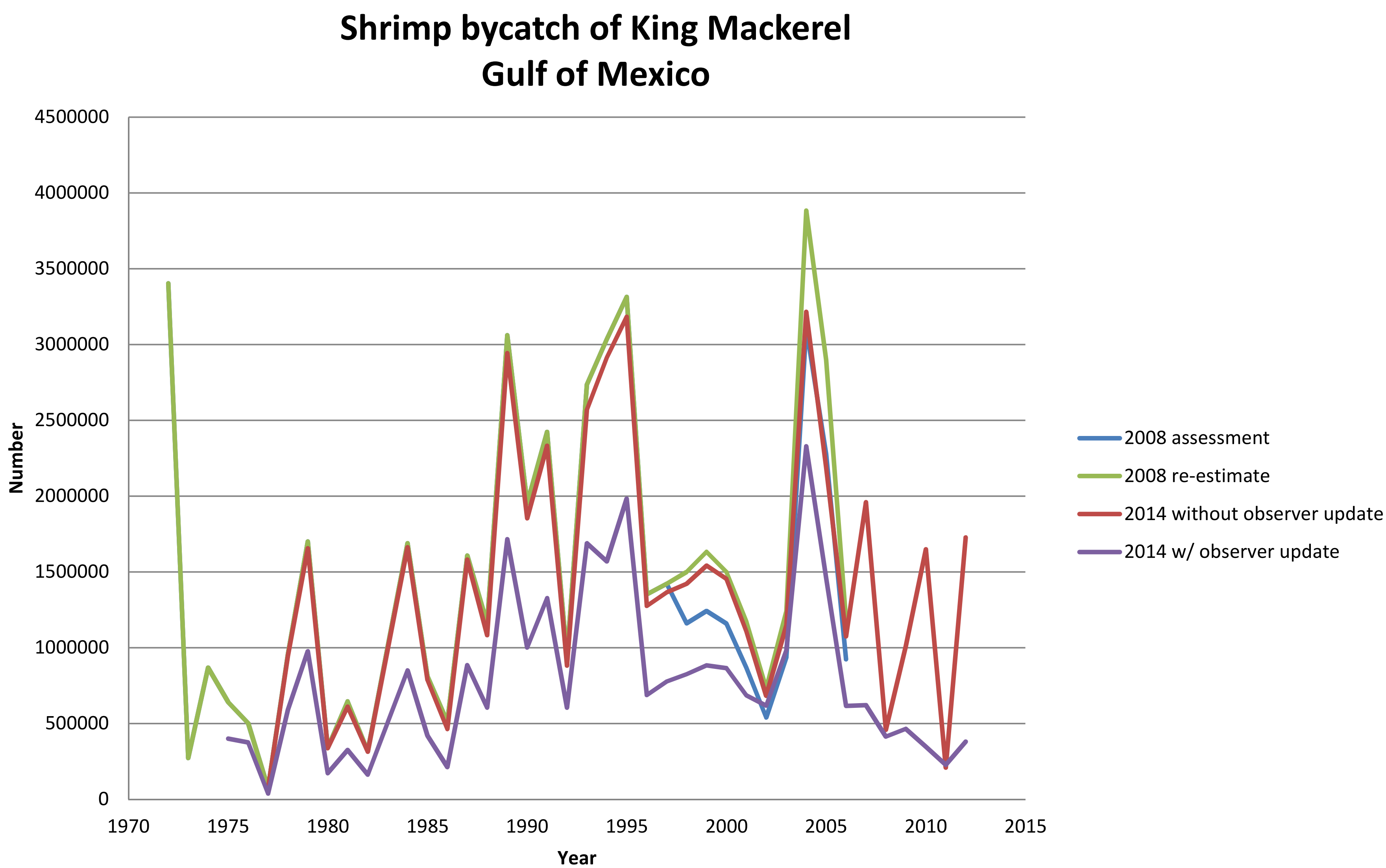
Jeff Isely and John Walter

- Gulf – Same as previous assessment
  - Observer data from 1972-2012, SEAMAP
  - Delta lognormal GLM scaled to effort (days)
  - presence/absence ~ year + season + area + depth + data source (BRD)
  - log(CPUE) ~ year + season + area + depth + data source (BRD)
  - Depth bin: 0-10 m; 10-30 m; 30+m
  - Season: Jan-Apr; May-Aug; Sep-Dec
- Atlantic – new (no discards in previous assessment)
  - Observer data 1989/90 – 2012/13 FY, SEAMAP
  - Delta lognormal GLM scaled to effort (hours)
  - presence/absence ~ year + state + depth + season (offset by hours towed) + data source (no BRD)
  - log(CPUE) ~ year + state + depth + season + data source (no BRD)
  - State: FL, GA, SC, NC
  - Predict on prediction grid of year, state, depth bin and season and multiply by effort on the same grid

Datasets to estimate shrimp discards

Data set	BRD	USE for KM	Gulf/SA	DSET	years	N trawls	Description
1	No	Yes	Gulf	SEAMAP	1972-2013	29403	CPUES.OREGON1 *SEAMAP Gulf trawl survey
2	No	Yes	SA	SEAMAP	1989-2013	7093	CPUES.SEAMAP_ATL * SEAMAP Atlantic trawl survey
3	No	Yes	Gulf	C	1972- 1985	1735	CPUES.OLDOBS1 *old observer data, assume no BRDs or TEDs, 1972- 1985
4	Yes	Yes	Gulf/SA	C	1992-1997	1042	CPUES.RRPCHAR1 *historical observer data, 1992-1997 all species
5	Yes	Yes	Gulf/SA	B	1992-1997	1776	CPUES.RRPEVAL1 *historical observer data, 1992-1997 paired with BRDS
6	No	No	Gulf/SA	DNU	1992-1997	133	CPUES.RRPONLY1 *historical observer data, 1992-1997 red snapper/shrimp only;
7	Yes	Yes	Gulf/SA	O	1992-1997	502	CPUES.RRPBRDS1 *historical observer data, 1992-1997 with BRD paired with EVAL
8	Yes	No	Gulf/SA	DNU	1992-1997	17	CPUES.RRPBNLY1 *historical observer data, 1992-1997 with BRD snapper/shrimp only;
9	No	Yes	Gulf	B	1998	76	CPUES.FDEVAL1 *BRD study, paired with BRDS, 1998
10	Yes	Yes	Gulf	C	1998	78	CPUES.FDBRDS1 *BRD study, paired with EVAL , 1998
11	Yes	No	Gulf	DNU	1998	1107	CPUES.FDBNLY1 *BRD study, with BRD snapper/shrimp only, 1998 ;
12	No	No	Gulf	DNU	1998	1224	CPUES.FDONLY1 *BRD study, ctrl side snapper/shrimp only, 1998 ;
13	No	No	Gulf	DNU	1997	6127	*CPUES.MOACO1 SIXTH SET NO BRD SNAPPER ONLY
14	No	No	Gulf	DNU	1998-2013	1260	*CPUES.MOAEO1 FIFTH SET EXPTL SIDE NO BRDS SNAPPER ONLY
15	Yes	Yes	Gulf/SA	B	1998-2013	28683	*CPUES.MOAEB1 MODERN OBSERVER THIRD SET A PROJECTS EXPTL SIDE (WITH BRD) SHOULD HAVE OTHER SPP
16	No	Yes	Gulf/SA	O	1998-2013	2185	*CPUES.MOACN1 MODERN OBSERVER THIRD SET A PROJECTS CTRL SIDE (WITH BRD) SHOULD HAVE OTHER SPP
17	No	No	Gulf	DNU	1998-2013	1784	*CPUES.MOECB1 *SECOND SET EFFORT PROJECT CONTROL DESIGNATION (BUT STILL HAVE BRDS) SNAPPER ONLY;
18	yes	NO	Gulf	DNU	1998-2013	962	*CPUES.MOEEB1 *FIRST SET: EFFORT PROJECT EXPTL DESIGNATION WITH BRDS SNAPPER ONLY;


Shrimp bycatch of King Mackerel
Gulf of Mexico
Number
Year
0
500000
1000000
1500000
2000000
2500000
3000000
3500000
4000000
4500000
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2008 assessment
2008 re-estimate
2014 without observer update



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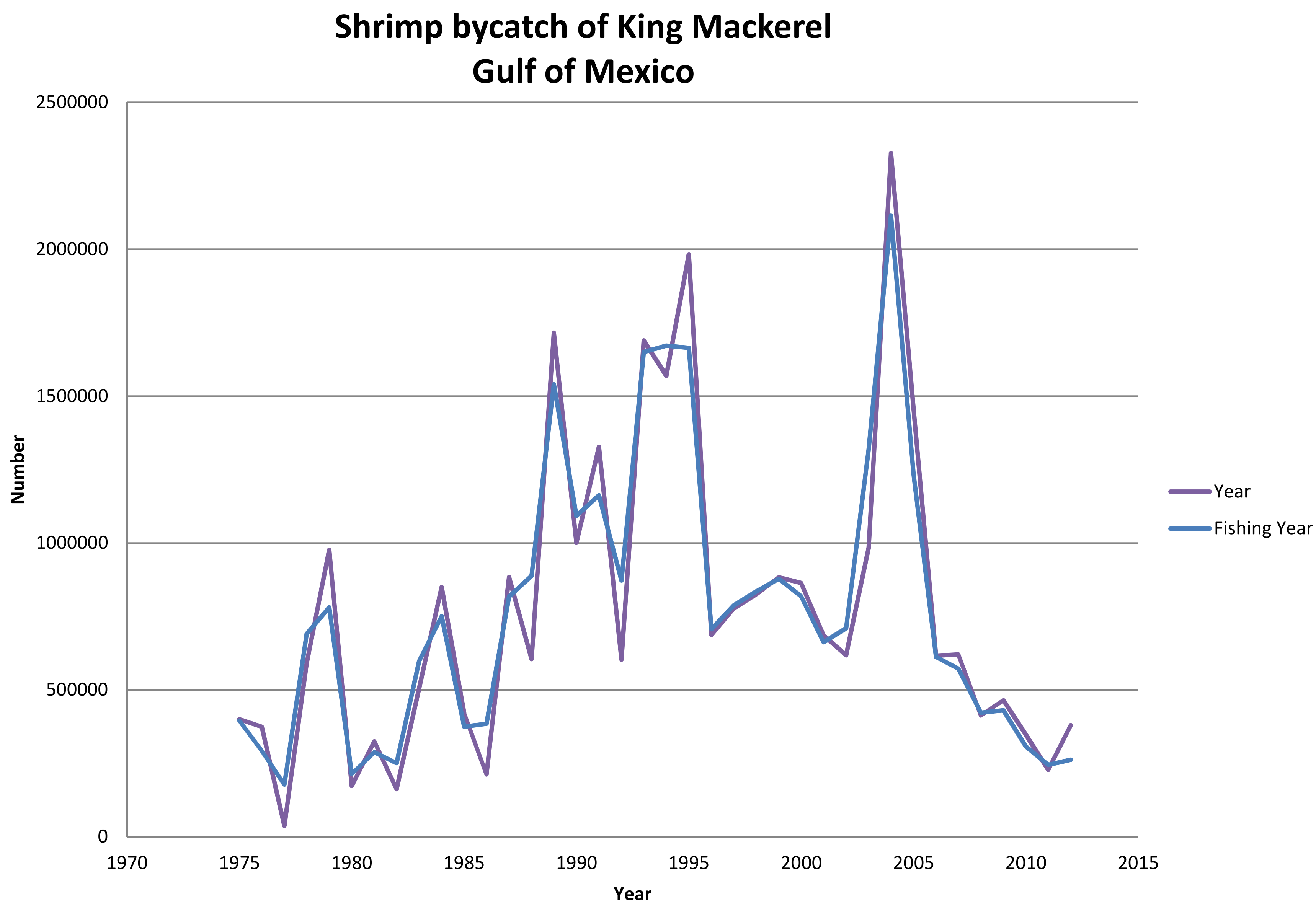
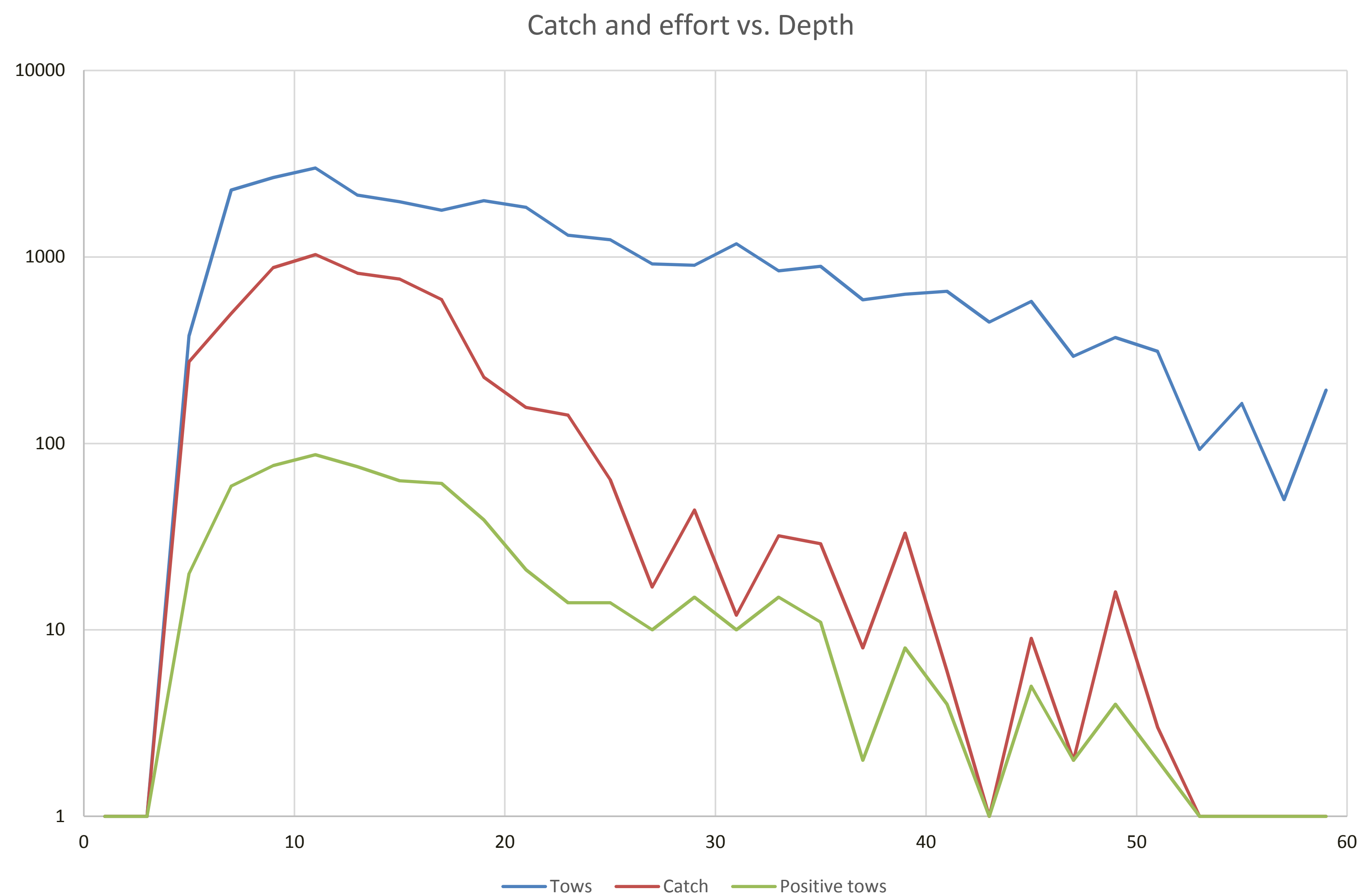
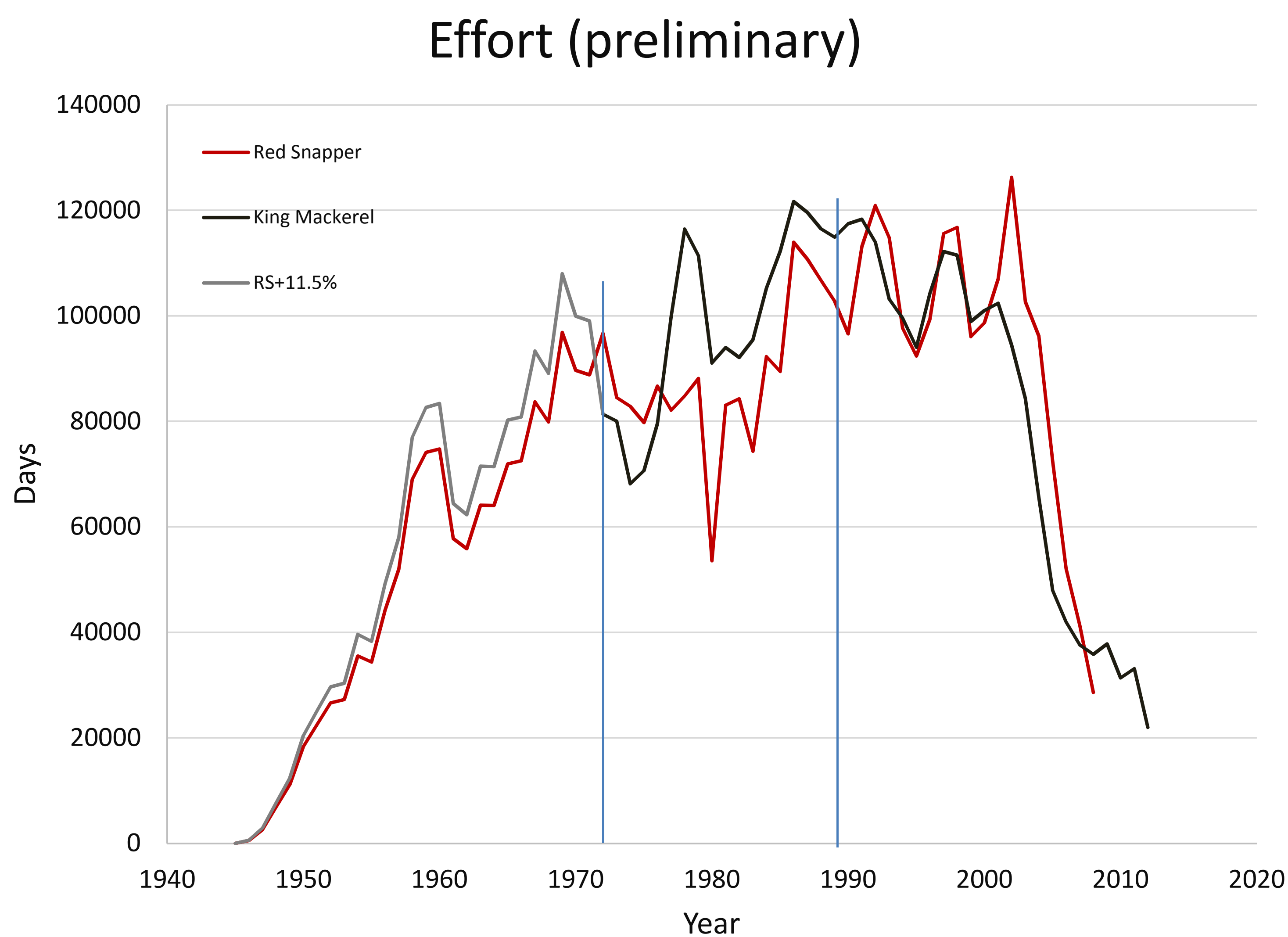
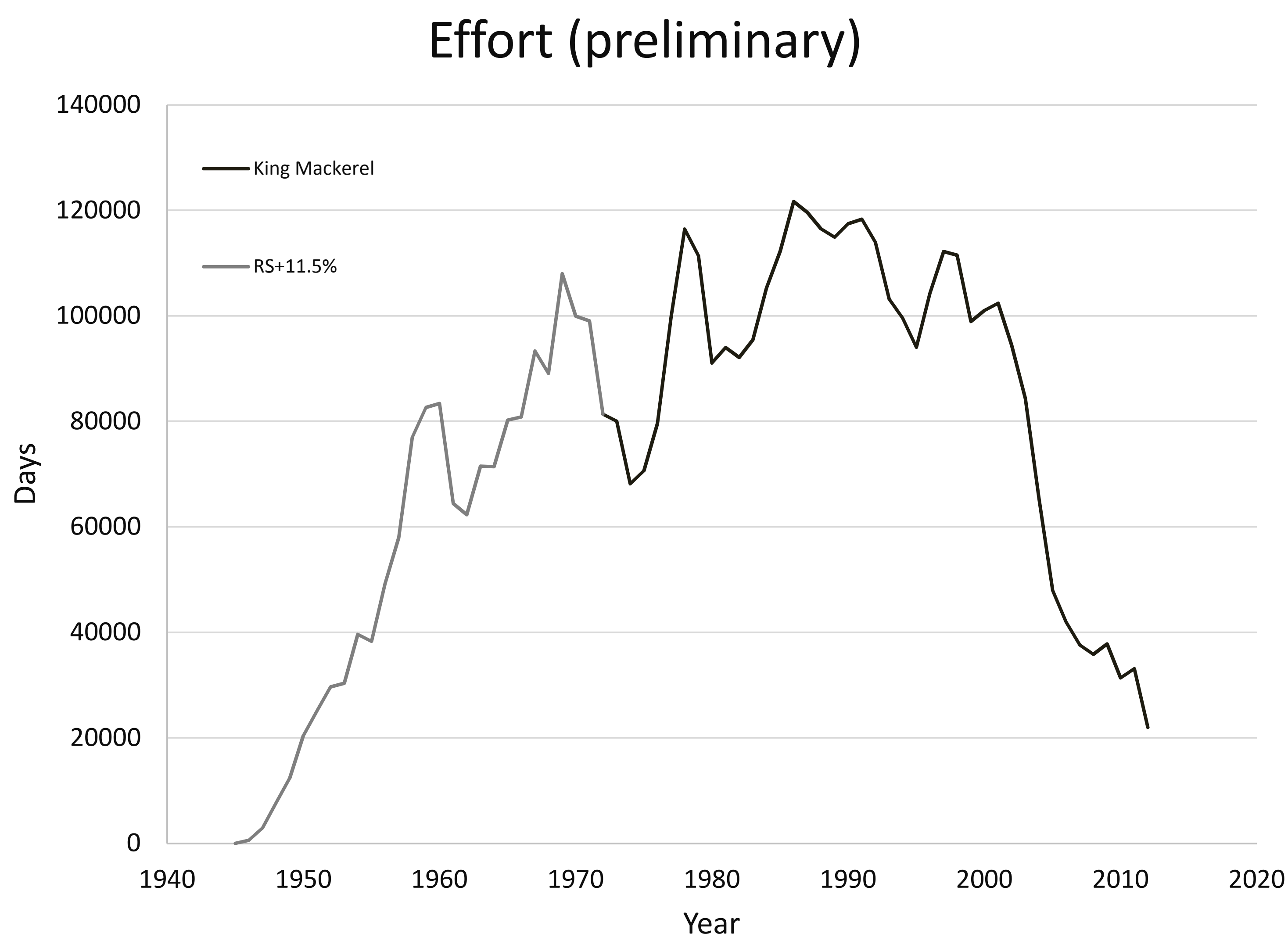
	2010				2014	
Year	Obs	Mean CPUE		Year	Obs	Mean CPUE
2001	606	0.024169		2001	606	0.024169
2002	1930	0.022659		2002	1930	0.061369
2003	795	0.006963		2003	795	0.026375
2004	1080	0.304528		2004	1080	0.323546
2005	459	0.342051		2005	458	0.332522
2006	32	0		2006	32	0
2007	14	0		2007	1391	0.058535
				2008	3138	0.103567
				2009	2910	0.041850
				2010	2576	0.034832
				2011	2772	0.031292
				2012	3035	0.051151


Shrimp bycatch of King Mackerel
Gulf of Mexico
2500000
2000000
1500000
1000000
500000
0
Number
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Year
Year
Fishing Year


Catch and effort vs. Depth
10000
1000
100
10
1
0
10
20
30
40
50
60
Tows
Catch
Positive tows

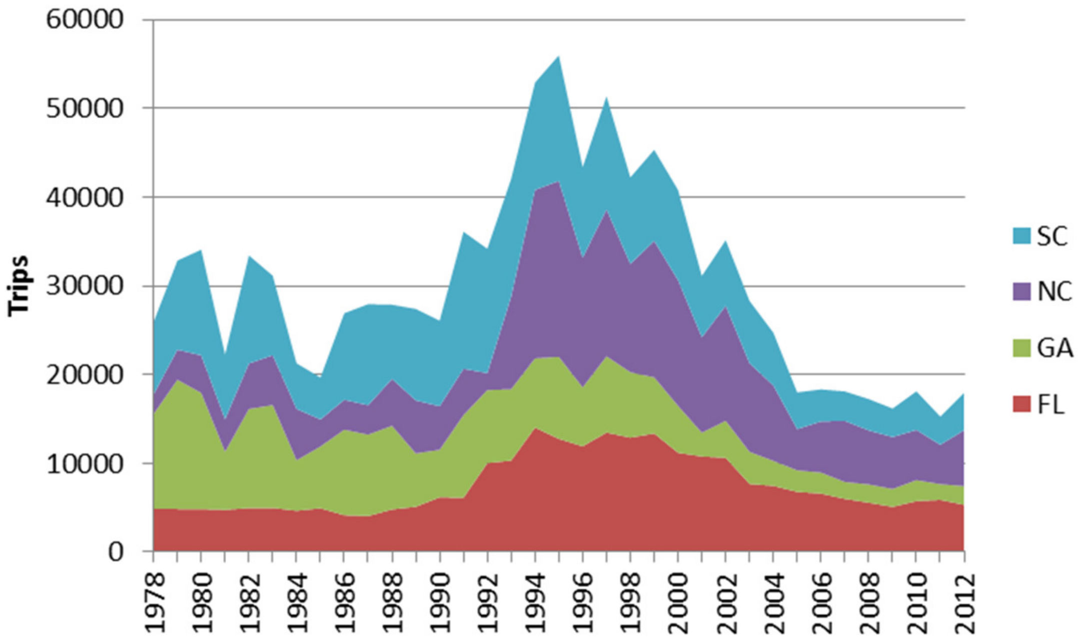


Effort (preliminary)
Red Snapper
King Mackerel
RS+11.5%
Days
Year
140000
120000
100000
80000
60000
40000
20000
0
1940
1950
1960
1970
1980
1990
2000
2010
2020


Effort (preliminary)
140000
120000
100000
80000
60000
40000
20000
0
Days
King Mackerel
RS+11.5%
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year

ATL shrimp effort estimation

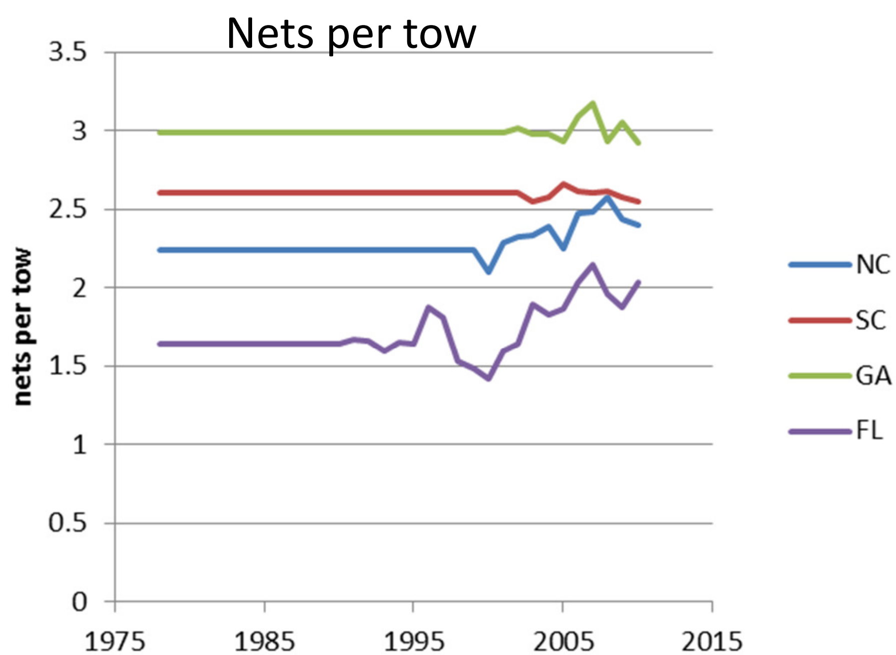
A 'trip' makes no assumption about the length of a trip

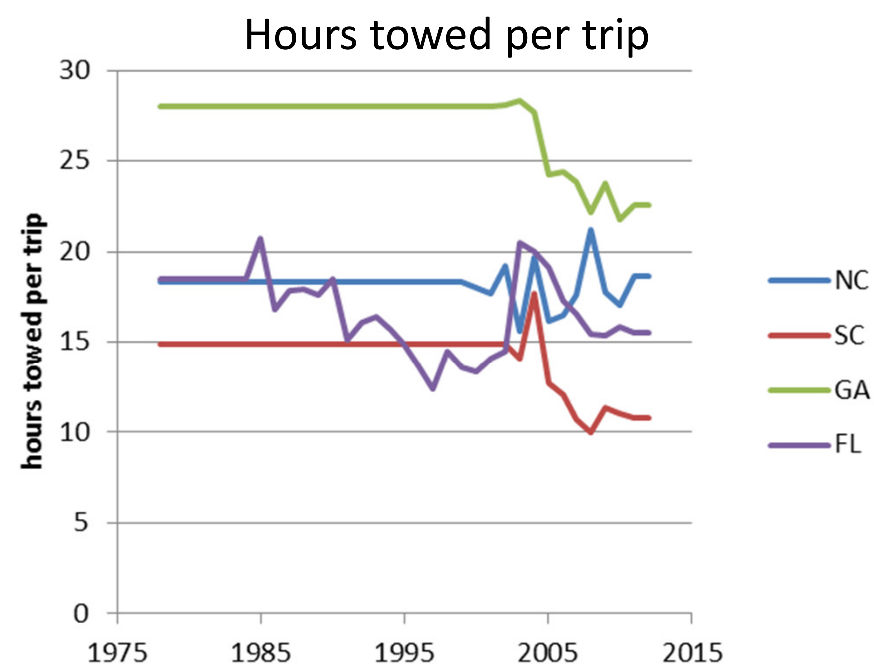


- Monthly, by state
- Duplicate trips removed, from SAS system (shrimp data set) and new trip ticket.
- Partitioned rock shrimp according to annual fraction of effort (usually ~1%); assigned to depth zone 30$^+$m.
- Then remainder of effort partitioned by depth zone according to observed fraction (98%, 0.016%, 0.001%), assumed constant over time.
- use hours towed and number of nets from SEDAR 28 AW02 (usually around 2.4 nets and 18 hours per trip but varies by state)
- Only "OTTER TRAWL BOTTOM, SHRIMP","SHRIMP TRAWL","OTTER TRAWLS“ used

SEDAR28AW2- state trip ticket data for nets and hours towed

Table 6. Average number of nets per vessel from state trip ticket programs (unshaded) and the 3- year average of the first 3 years of estimates applied when no data were available.





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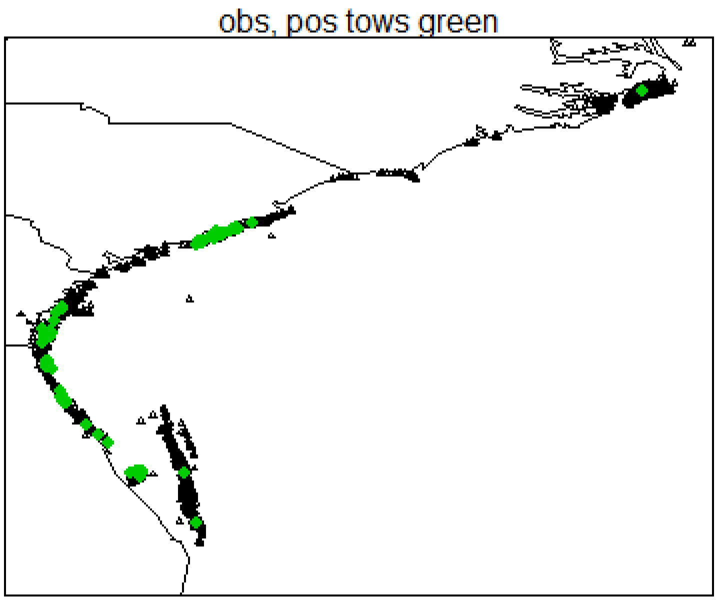
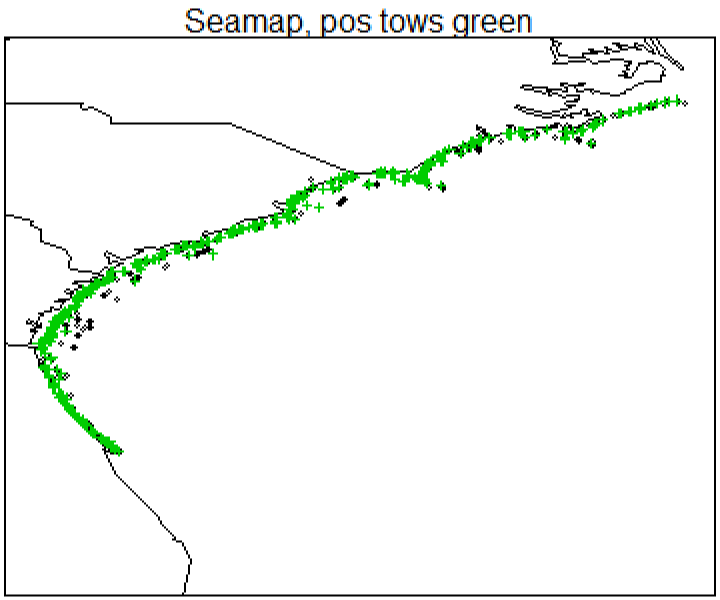
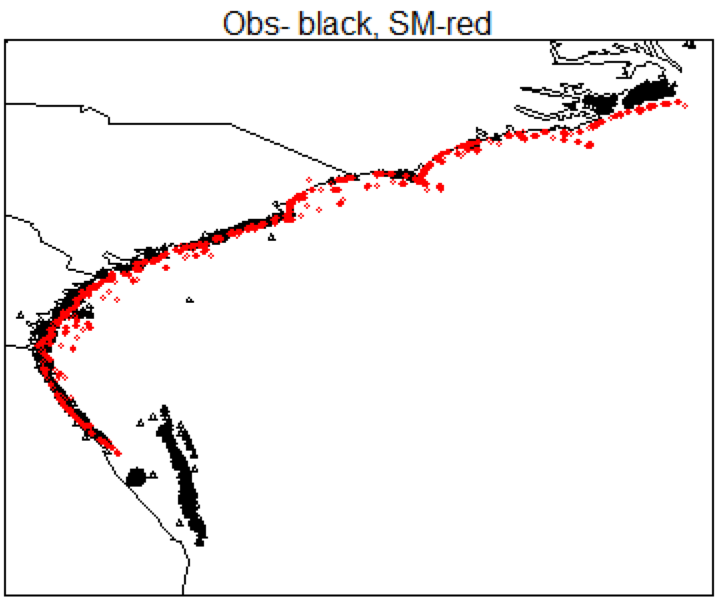






Locations jittered and are not exact

Spatial overlap looks ok

127 of 3002 observer tows, translating to 0.33 fish per net hour and 4.2 % positive tows

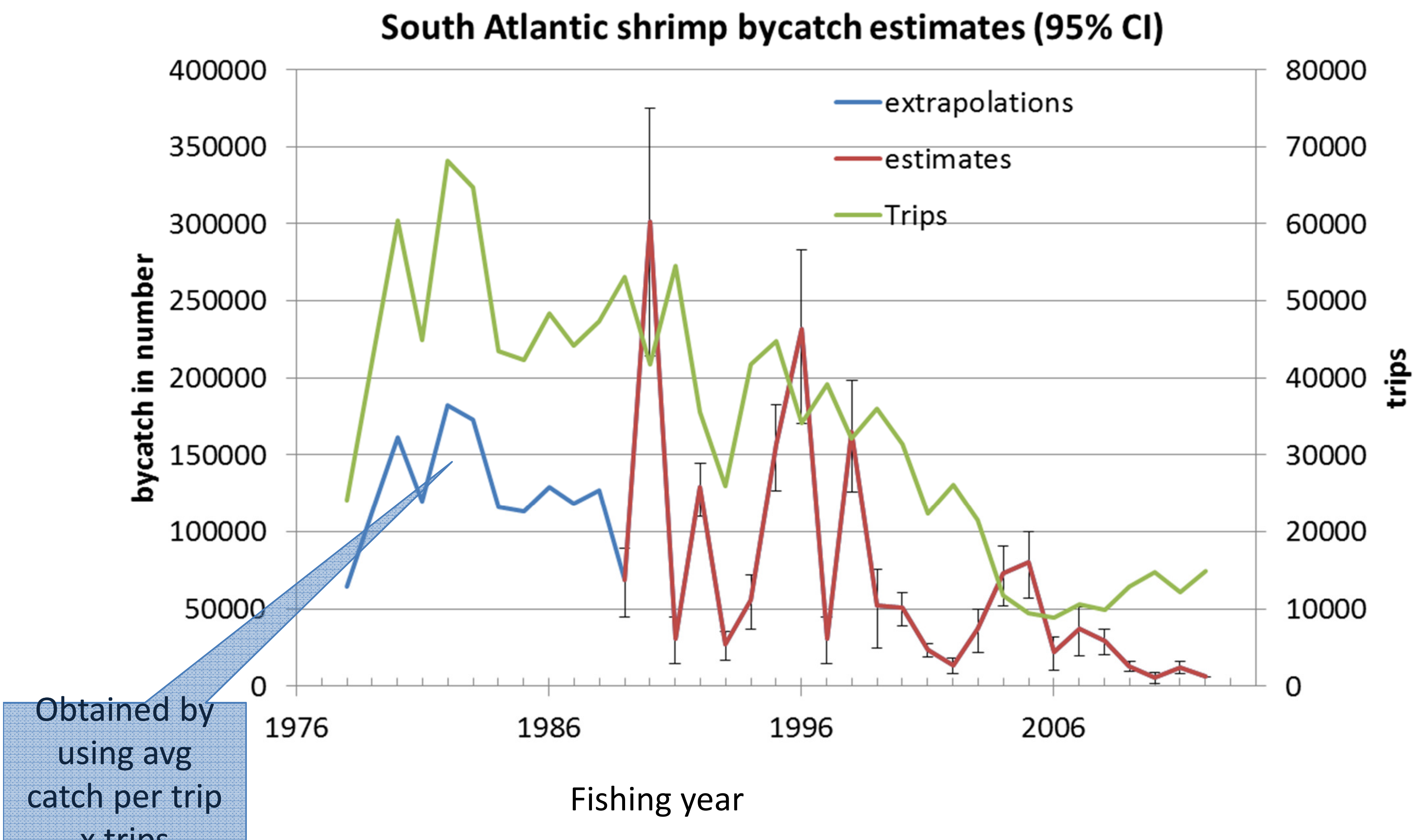
In SEAMAP, 3.4 fish per net hour and 21% positive tows

10 times higher catch rate for SEAMAP (mongoose, high opening, no BRD, 20 min tow)

ATL shrimp bycatch assumptions

- Depth distribution of effort constant over time
- Prior to 1989 FY, bycatch estimated from mean number per trip x number of trips
- For 2012-13 FY, 3 yr average effort for Season 1 used for first part of 2013.
- Effort for 1993 in NC interpolated from 1992 and 1994, by season.
- No BRD effect estimated, potentially could *borrow* Gulf BRD effect.

Atl bycatch estimates



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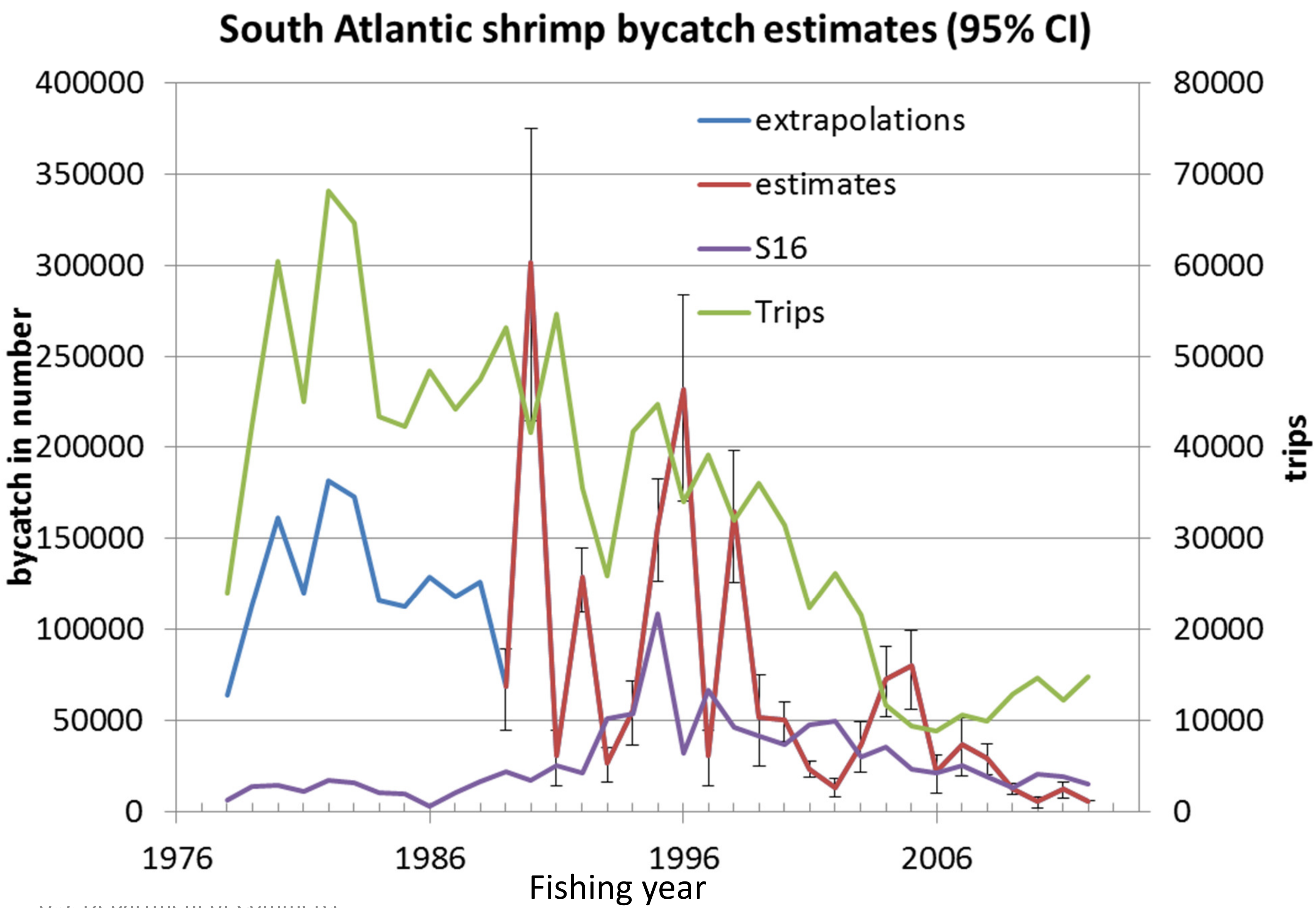
Atl bycatch estimates comparison with



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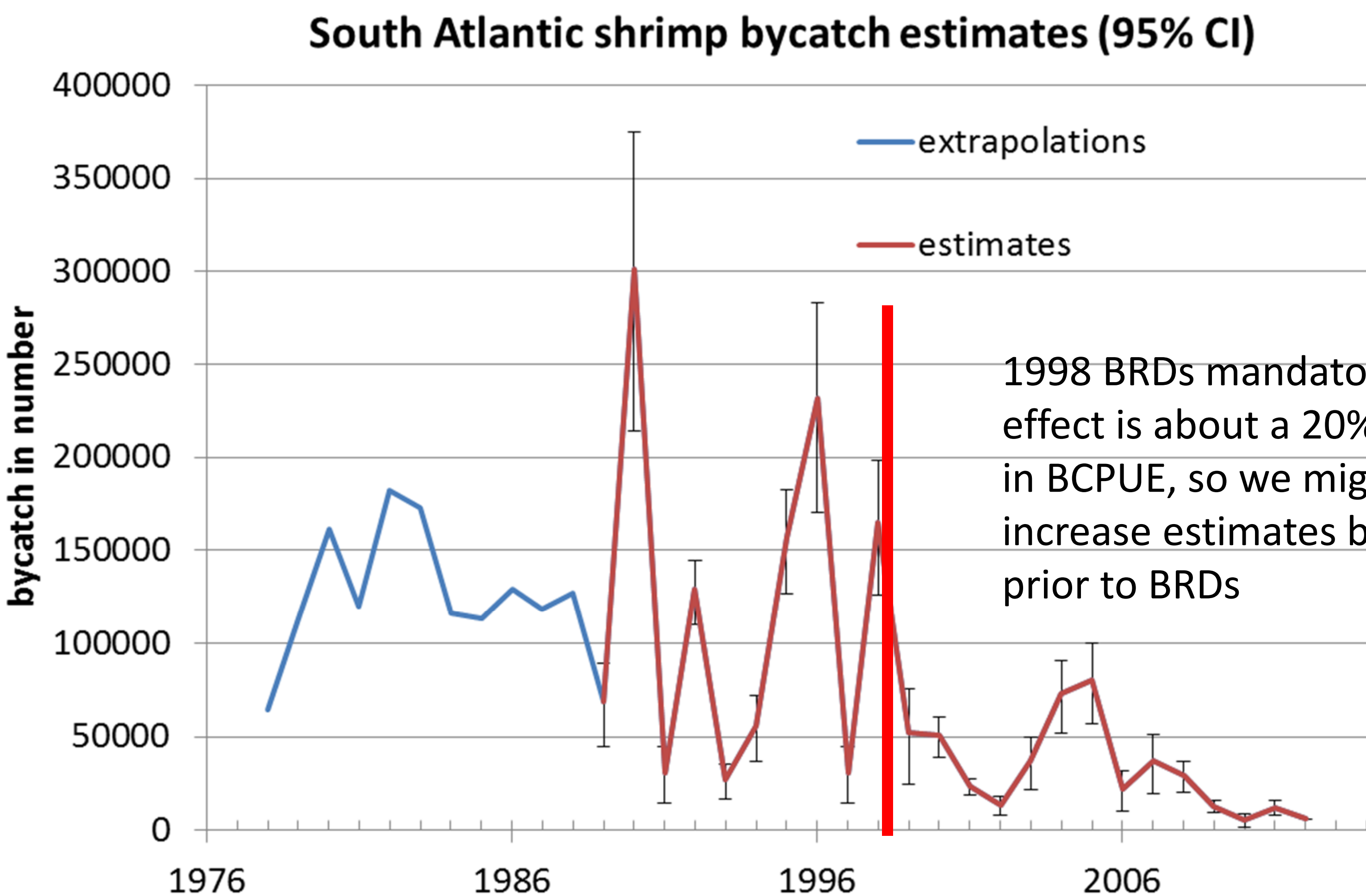
Atl bycatch estimates, incorporating BRD effect



1998 BRDs mandatory. BRD effect is about a 20% reduction in BCPUE, so we might increase estimates by 20% prior to BRDs

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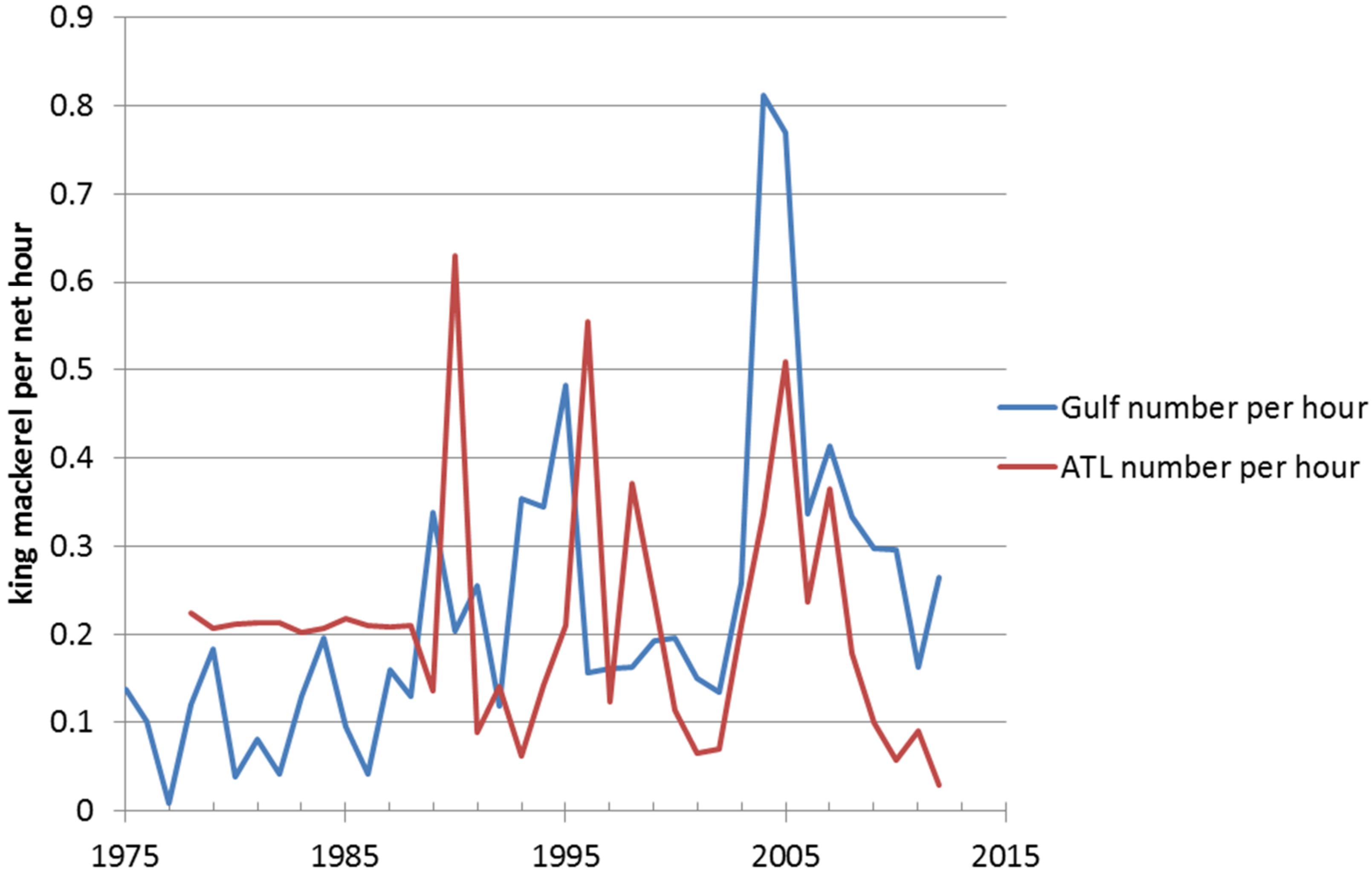
Gulf vs ATL commercial BCPUE



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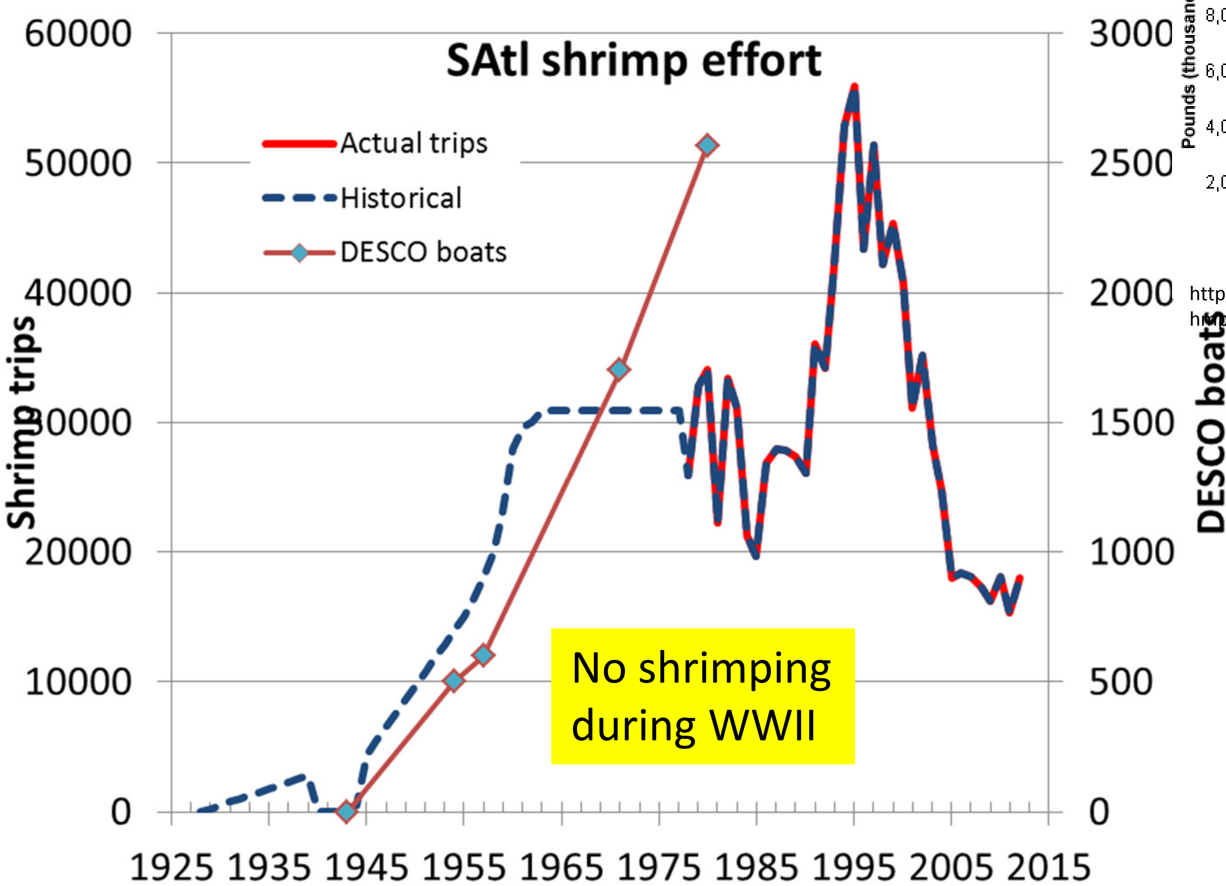
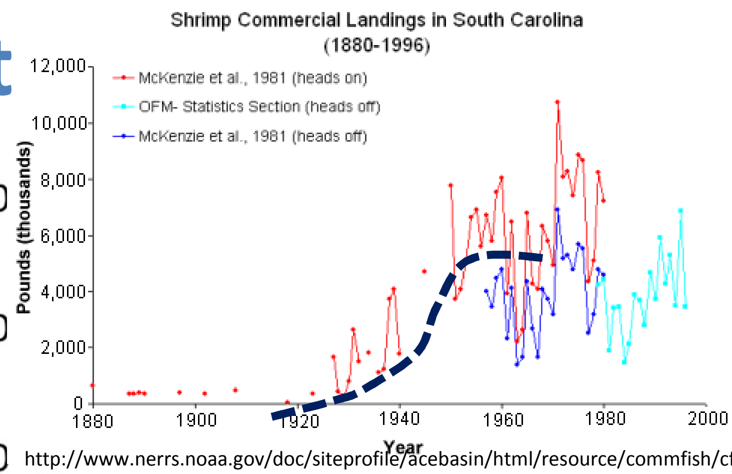
Historical shrimp fishing effort





http://www.nerrs.noaa.gov/doc/siteprofile/acebasin/html/resource/commfish/cfshmpfh.htm

- Start in 1929
- Ramp up to 1955
- No shrimping in WWII
- Rapid increase post-WWII (mimics trends in SC shrimp landings and DESCO boat building)
- Steady from ~1960-1975

http://www.staugustinelighthouse.org/LAMP/Hertiage_Boatbuilding/St_Augustine_Water%20_Craft/Shrimp_Trawler

South Atlantic data

	Tows				Percentage positive				CPUE			
year	BRD	no BRD	Rock shrimp	SEAMAP ATL	BRD	no BRD	Rock shrimp	SEAMAP ATL	BRD	no BRD	Rock shrimp	SEAMAP ATL
1989	-	-	-	265	-	-	-	23%	-	-	-	1.68
1990	-	-	-	274	-	-	-	39%	-	-	-	6.37
1991	-	-	-	269	-	-	-	21%	-	-	-	1.18
1992	-	-	-	277	-	-	-	17%	-	-	-	4.92
1993	-	-	-	277	-	-	-	17%	-	-	-	1.53
1994	-	-	-	277	-	-	-	19%	-	-	-	1.92
1995	-	-	-	277	-	-	-	26%	-	-	-	4.92
1996	-	-	-	277	-	-	-	35%	-	-	-	7.51
1997	-	-	-	277	-	-	-	19%	-	-	-	1.48
1998	-	-	-	276	-	-	-	25%	-	-	-	7.10
1999	-	-	-	277	-	-	-	30%	-	-	-	2.06
2000	-	-	-	277	-	-	-	21%	-	-	-	2.82
2001	30	12	15	306	13%	0%	0%	17%	0.53	0.00	0.00	2.37
2002	13	-	108	306	0%	-	1%	21%	0.00	-	0.01	1.43
2003	2	6	181	306	0%	0%	6%	25%	0.00	0.00	0.18	3.35
2004	-	-	-	306	-	-	-	24%	-	-	-	7.96
2005	159	-	-	306	23%	-	-	19%	2.82	-	-	5.44
2006	-	-	22	306	-	-	0%	20%	-	-	0.00	3.66
2007	138	-	-	306	14%	-	-	23%	0.77	-	-	3.65
2008	309	-	122	306	2%	-	0%	16%	0.14	-	0.00	5.18
2009	667	-	20	336	6%	-	0%	17%	0.47	-	0.00	2.04
2010	215	-	57	335	0%	-	2%	13%	0.00	-	0.11	0.94
2011	426	-	-	336	1%	-	-	12%	0.06	-	-	2.65
2012	558	2	-	336	0%	0%	-	14%	0.01	0.00	-	1.61
Totals / averages	2517	20	525	7091	6%	0%	1%	21%	0.48	0.00	0.04	3.49

2010 Atlantic Croaker Assessment

Linda Barker, SASC Chair
Laura Lee, Lead Analyst
Katie Drew, Analyst

Estimation of Shrimp Trawl Bycatch

- Ratio approach

Annual Croaker Bycatch	=	Annual Shrimp Landings	x	Croaker: Shrimp Ratio	-	Reported Croaker Landings from Shrimp Trawls

- Ratio from literature values
- Same approach used in the 2005 assessment, but updated with a more recent study

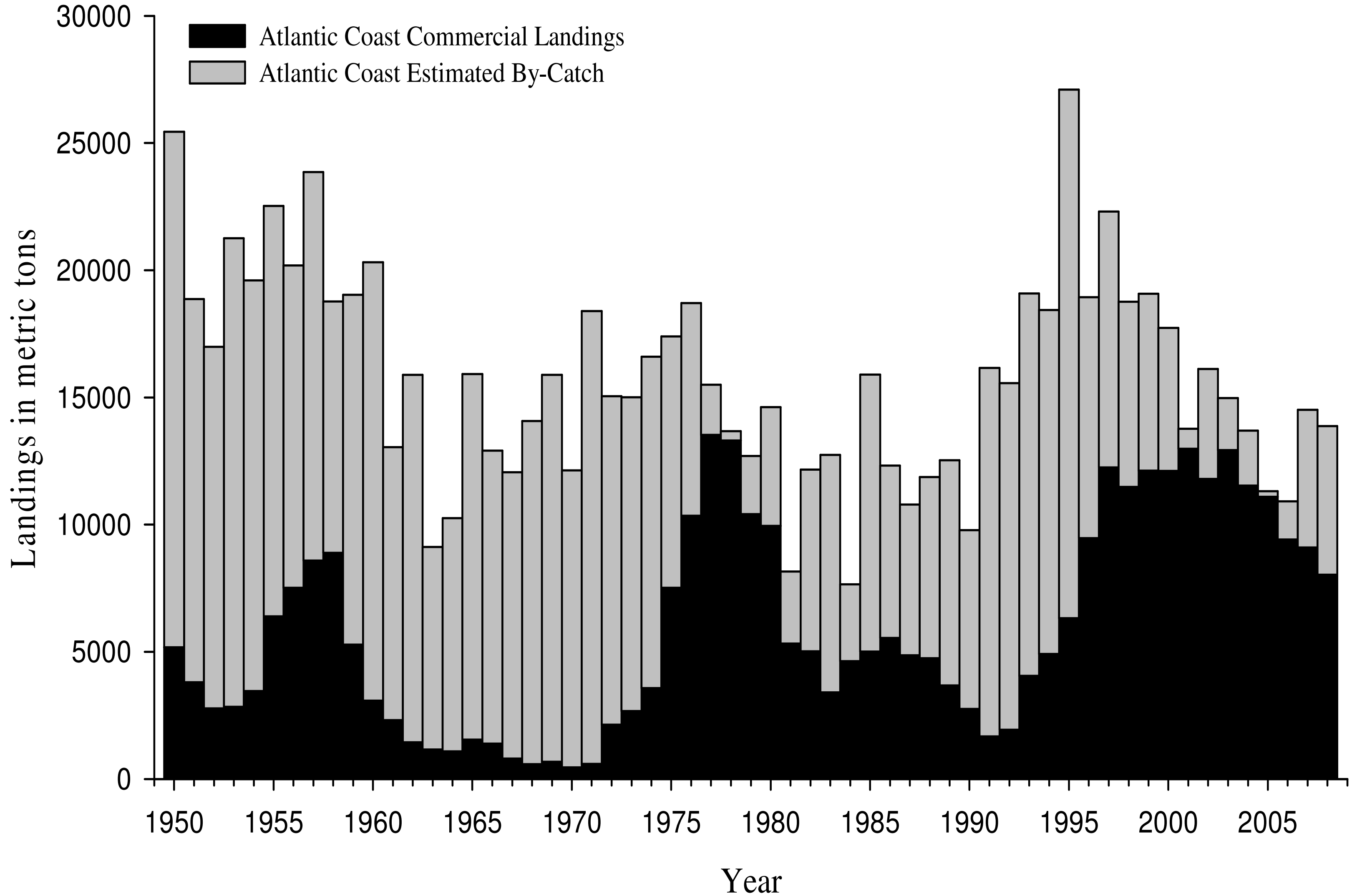
Estimation of Shrimp Trawl Bycatch

- **Wolff, M. 1972.** A study of North Carolina scrap fishery. NC Department of Natural and Economic Resources, Special Scientific Report 20, 29 pp.
- **Nance, J., E. Scott-Denton, E. Martinez, J. Watson, A. Shah, and D. Foster. 1997.** By-catch in the southeast shrimp trawl fishery. A data summary report, SFA Task N-10.03.
- **Brown, K. 2009.** Characterization of the near-shore commercial shrimp trawl fishery from Carteret County to Brunswick County, North Carolina. *In:* Documentation and reduction of by-catch in North Carolina fisheries. Completion Report for Interstate Fisheries Management Program Implementation for North Carolina. 34 pp.

Estimation of Shrimp Trawl Bycatch

- Croaker was ~25% of total bycatch by weight
- Ratios used
  - 1950-1991: Wolff (1972) 1.30 lbs croaker: 1 lb shrimp
  - 1992 – 1998: Nance et al (1997) 1.66 lbs croaker: 1 lb shrimp
  - 1999 – 2008: Brown (2009) 1.15 lbs croaker: 1 lb shrimp

Estimation of Shrimp Trawl Bycatch



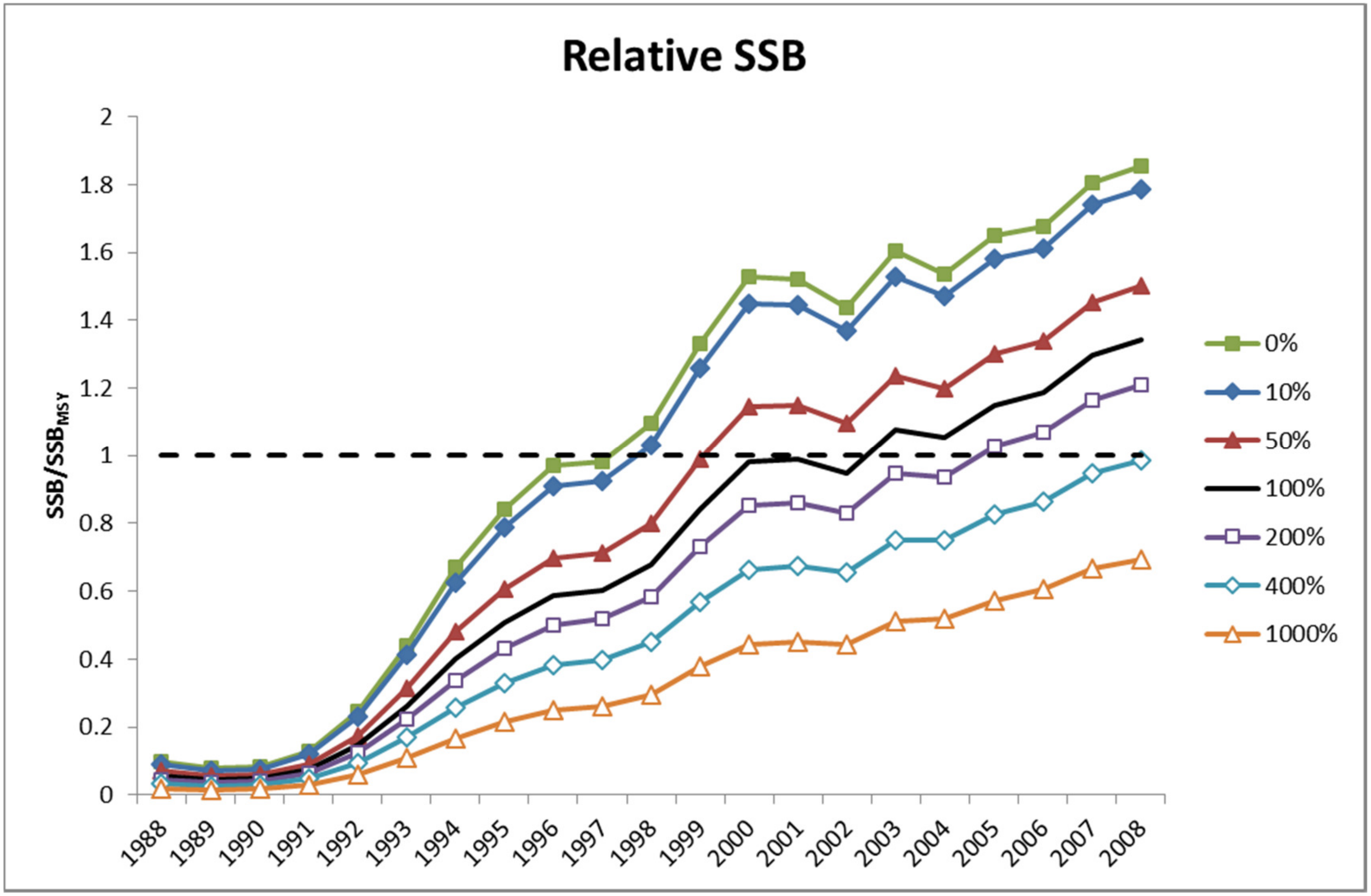
Estimation of Shrimp Trawl Bycatch

- Foster (2004) found that 99% of croaker bycatch was Age 0, so we fixed the selectivity pattern of the shrimp trawl fleet at 1 for age-0 and 0 for all other ages
- Due to the low confidence in estimates of bycatch, they were used as a sensitivity run

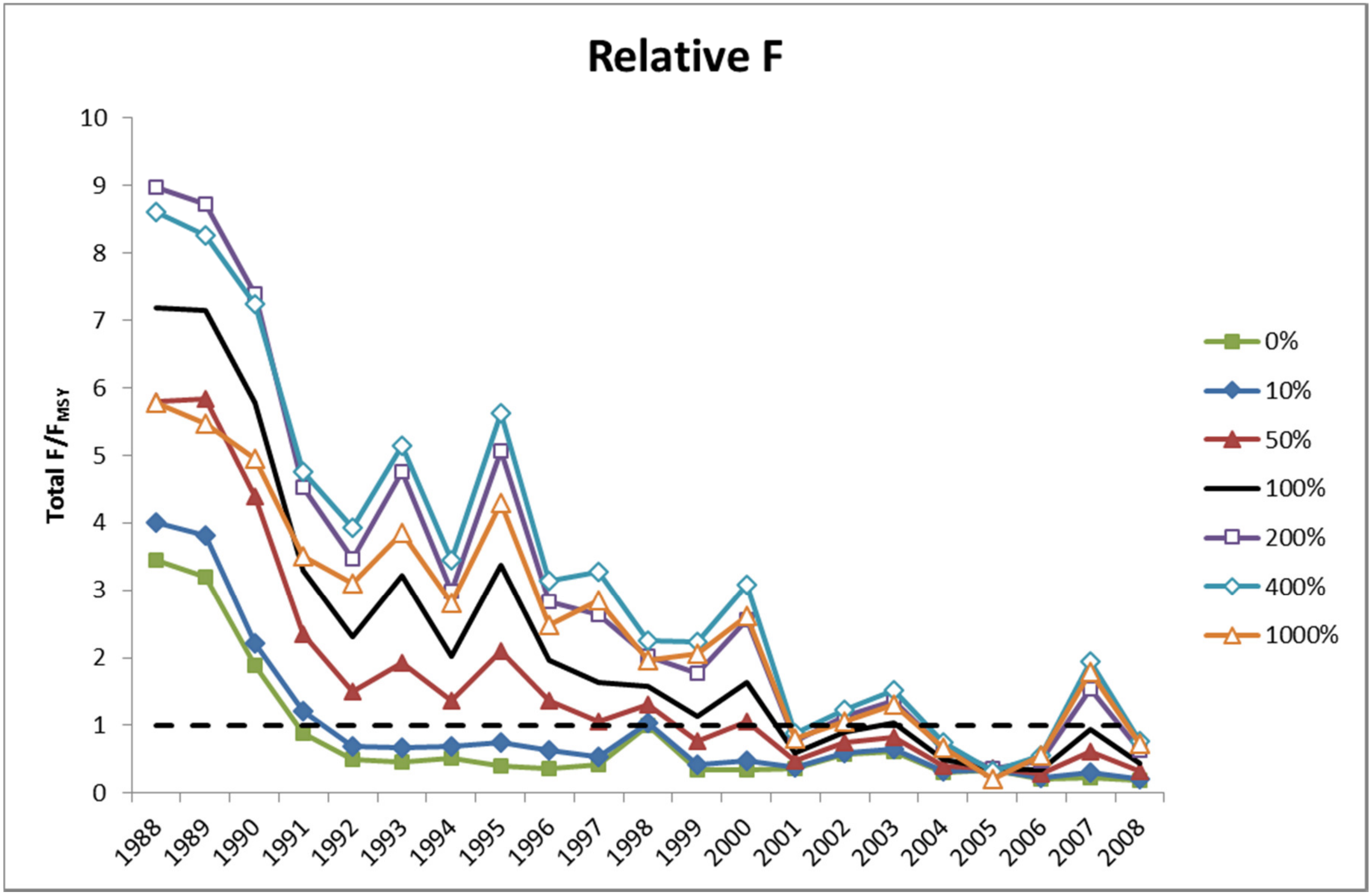
Impact on Assessment

- Estimates of SSB, abundance, and MSY-based reference points were sensitive to the level of shrimp trawl bycatch, but F was less sensitive
- Overfished status varied depending on level of shrimp trawl bycatch, but overfishing status was consistent (overfishing not occurring in terminal year)

Impact on Assessment



Impact on Assessment



Impact on Assessment

- Review panel did not accept estimates of shrimp trawl bycatch as best available data
- Review panel did not accept overfished status or estimates of SSB and abundance due to uncertainty caused by shrimp trawl bycatch estimates
- Review panel did accept “overfishing not occurring” status and estimates of F, since results were more robust to shrimp trawl bycatch uncertainty

Future Work

- Atlantic croaker will undergo another benchmark assessment in 2016 with spot
- Need to improve estimates of shrimp trawl bycatch for both species

Appendix 4:

Shrimp Stock Assessment Presentations

Stock Synthesis

Presented by Rick A. Hart

NOAA Fisheries, SEFSC

Based upon a Presentation Developed by

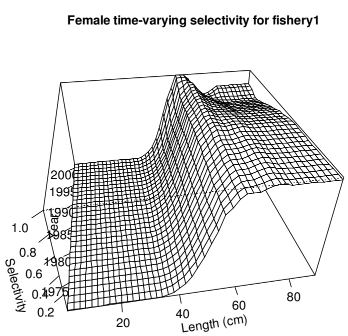
Richard Methot

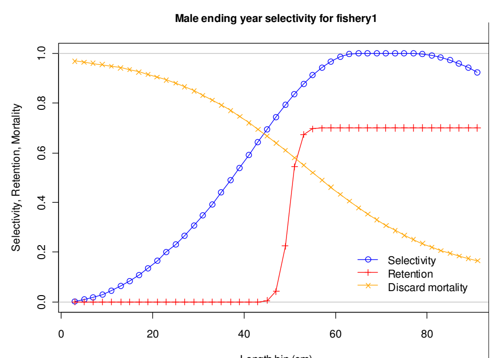
NOAA Fisheries

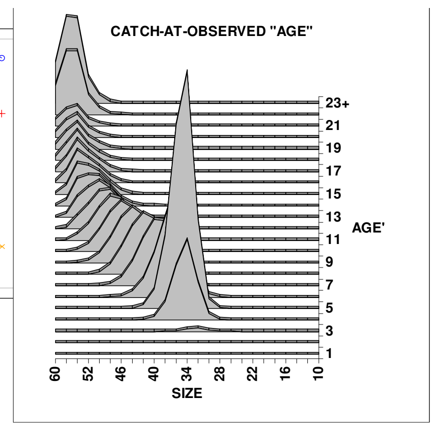
Office of Science & Technology

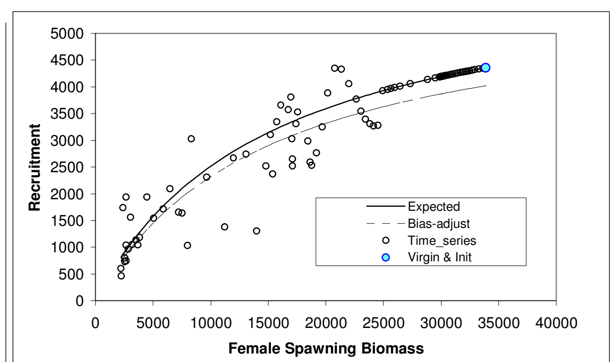
Seattle, WA

Synthesis: the collection of disparate parts into a cohesive whole









Why SS?

- Available data often incomplete, noisy
- Several diverse relevant kinds of data sometimes available, why pick just one?
- Estimation of productivity, mortality, selectivity is confounded and should be linked
- Good estimation of uncertainty requires modeling the relevant processes that created the data
- F is not always >>M
- Fishing is not only factor affecting fish stocks

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SS is an Integrated Analysis Model

- Population Model
  - Recruitment, mortality, growth
  - Age and size structured in SS
- Observation Model
  - Derive Expected Values for Data
- Likelihood-based Statistical Model
  - Quantify Goodness-of-Fit
- Algorithm to Search for Parameter Set that Maximizes the Likelihood
- Cast results in terms of management quantities
- Propagate uncertainty onto confidence for management quantities

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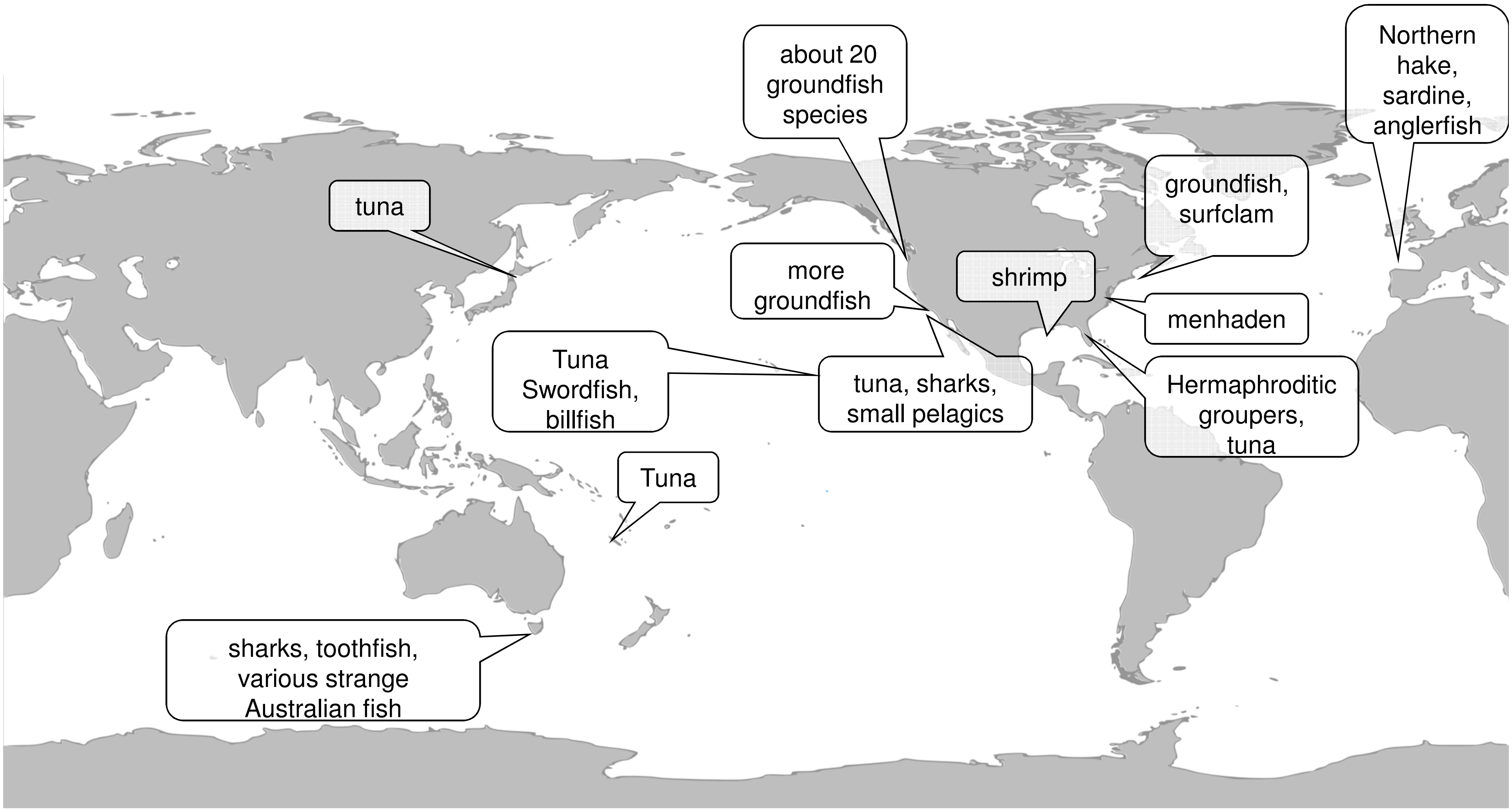
SS History – 2003 to present

- Generalized model coded in C++ with ADMB
- Merged and expanded features for age/size/area
- Target species: diverse
- Now SS3.24a (Feb2012), just call it "SS"
- 40 U.S. stocks have been assessed with SS

SS Around the World



Stock Synthesis Data

CATCH

- Retained catch

ABUNDANCE

- Fishery or survey CPUE or fishery effort

SPECIAL

- Discard (% or amount)
- Mean body weight
- Tag-recapture
- Stock composition

COMPOSITION DATA

- Age' composition
  - Across all lengths, or
  - Within length range
- Size composition
  - By biomass or numbers
  - Weight bins or length bins
- Mean length-at-age'
- Mean weight-at-age'

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SS Structure Examples

Simple

- 1 area
- 1 season
- 1 growth pattern
- 2 genders
- 1 sub-morph (null)
- So, only 2 N-at-age matrices are created

SS Structure Examples

Complex

- 3 areas
- 4 seasons, with recruitment in seasons 2 and 3
- 2 growth patterns (GP)
- 2 genders
- 5 sub-morphs
- Recruitment of GP1 in area 1 in season 2
- Recruitment of GP2 in area 3 in season 3
- Both GP movement to area 2 in season 4 and return to natal area in season 2.
- 60 N-at-age entities created – could max out computer memory: 2 GP*Birthseasons, 2 genders, 5 sub-morphs, 3 areas

NOTE: morph composition data type used with otolith micro-constituent data to inform %stock in mixing area 2

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Stock Synthesis Conclusions

- Flexible and evolving range of options for many population processes
- Integrates many sources of data
- Propagates uncertainty well
- Works well from very simple to very complex models
- Widely used

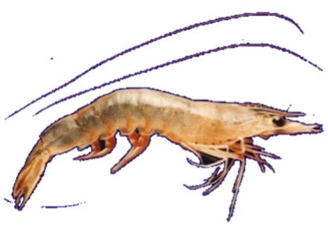
Stock Synthesis Conclusions, cont.

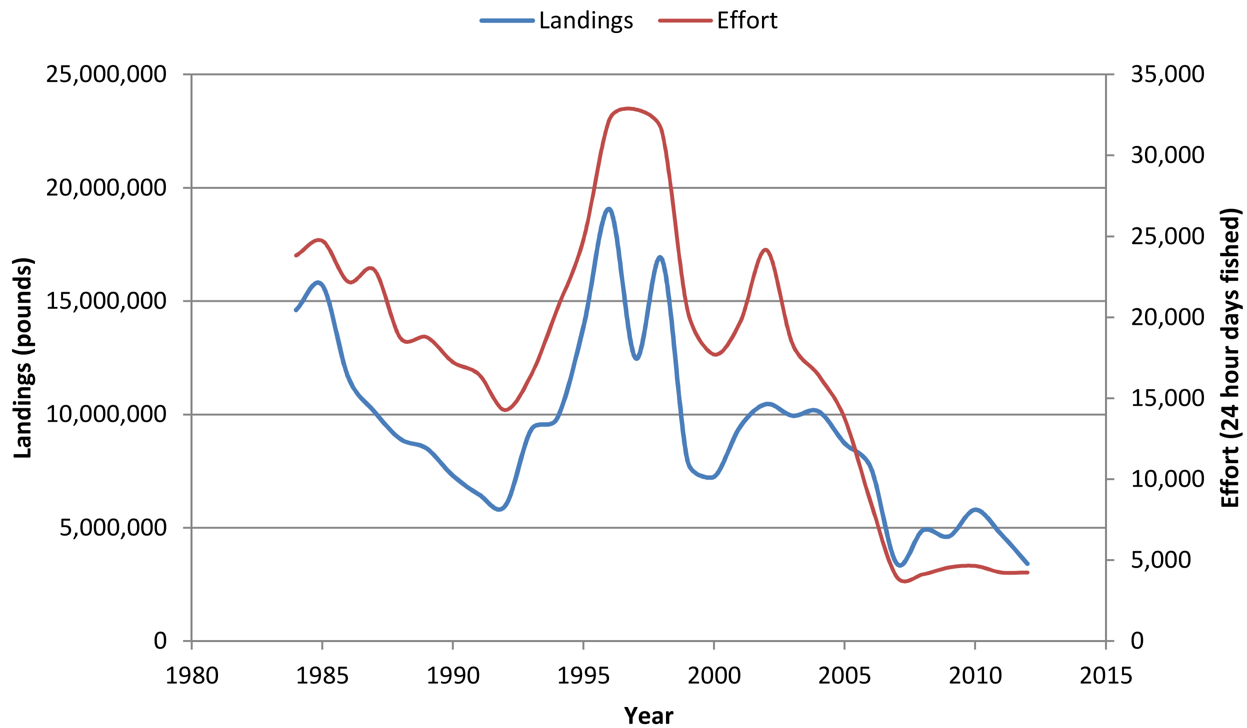
- Potential use for South Atlantic pink shrimp
  - Dependent upon "suitable" data availability

Stock Assessment of Pink Shrimp (*Farfantepenaeus duorarum*) in the U.S. Gulf of Mexico for 2012

October 2013

Rick A. Hart, Ph.D.
NOAA Fisheries Service
Southeast Fisheries Science Center
Galveston Laboratory
Galveston, TX USA





Pink Shrimp Landings and Effort US Waters Statistical Zones 1-11 1984-2012.

Model and Data Inputs
Catch Data

The Stock Synthesis model was developed using catch data from 1984-2012.

The model structure included 1 fleet:

- Commercial Shrimp Inshore and Offshore Catch Combined (statistical zones 1-11)
    - Directed fishing effort by year and month, i.e., effort for those trips where >90 percent of the catch were pink shrimp, used to calculate monthly CPUE; total catch; and catch by size, i.e., size composition data consisting of count of numbers of shrimp per pound (11 count categories).

And 2 indices of abundance:

- SEAMAP Summer Groundfish Trawls (Fisheries-independent; 1987-2012)
- SEAMAP Fall Groundfish Trawls (Fisheries-independent; 1987- 2012)

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Model and Data Inputs
Life History

Growth curve and other population level rates –

- Growth parameters k and linf derived and reported by Phares (1981), with variability around the growth curve set to a coefficient of variation (CV) of 0.07 which was the CV of the size distribution of the larger sized shrimp presented in Berry (1967).

Natural mortality rate (0.3 per month as previously used in the historical VPA).

Stock Synthesis estimated steepness in the spawner-recruit function and linf., with a starting size of 10 mm at age 1 month through age 20 months.

Model and Data Inputs
Fishery

Size Selectivity - A dome shaped (double normal) selectivity pattern with 4 estimated parameters was used, providing a good fit to the data.

- Assuming selectivity is affected by how the fishery is being executed, selectivity was tuned allowing the model to track changes in size composition data.

- In addition, months were modeled as years (340 “years”), therefore, selectivity was set to fluctuate in 12 “year” blocks beginning in July, which is the equivalent to an annual model with annual biological year fluctuations.

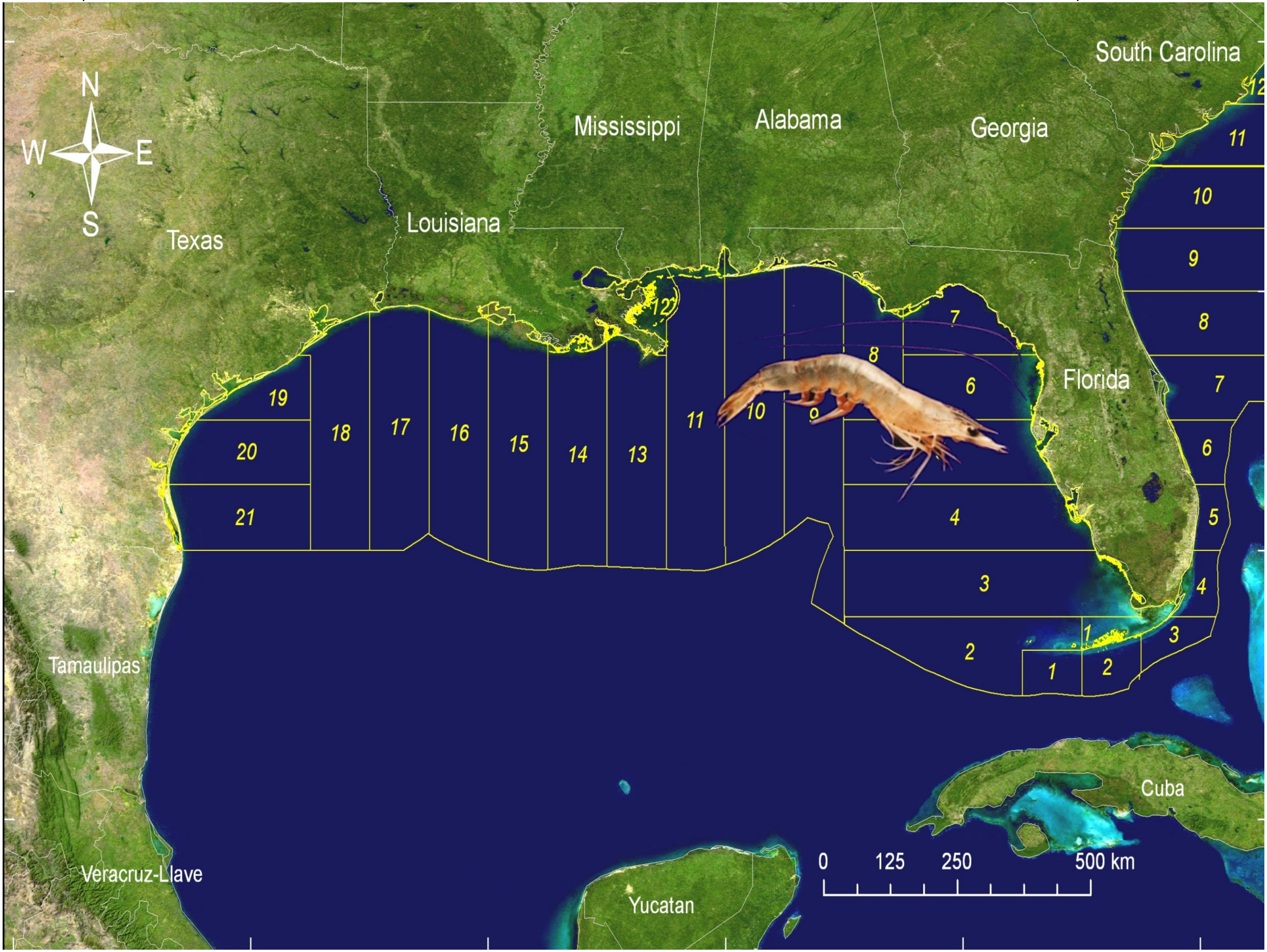
Catchability Q – Catchability was set as a random walk

- In this random walk setup, Q varied from January 2005 through October 2008. This is the time period when a large increase in CPUE is evident.

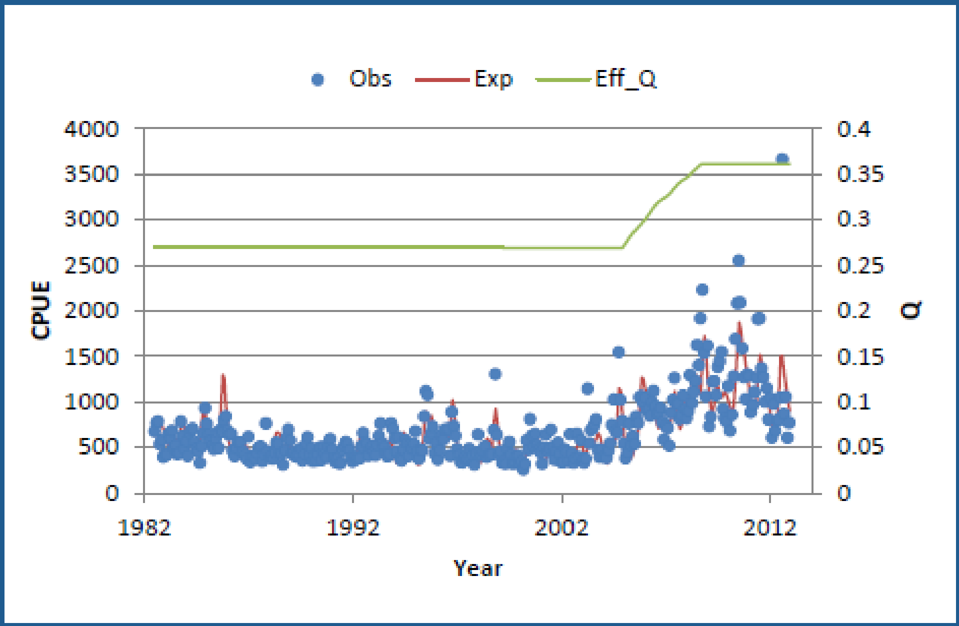
Model and Data Inputs
SEAMAP

SEAMAP Data – SEAMAP data collected by NOAA Fisheries research vessels and State Fisheries agencies were used in the Stock Synthesis model.

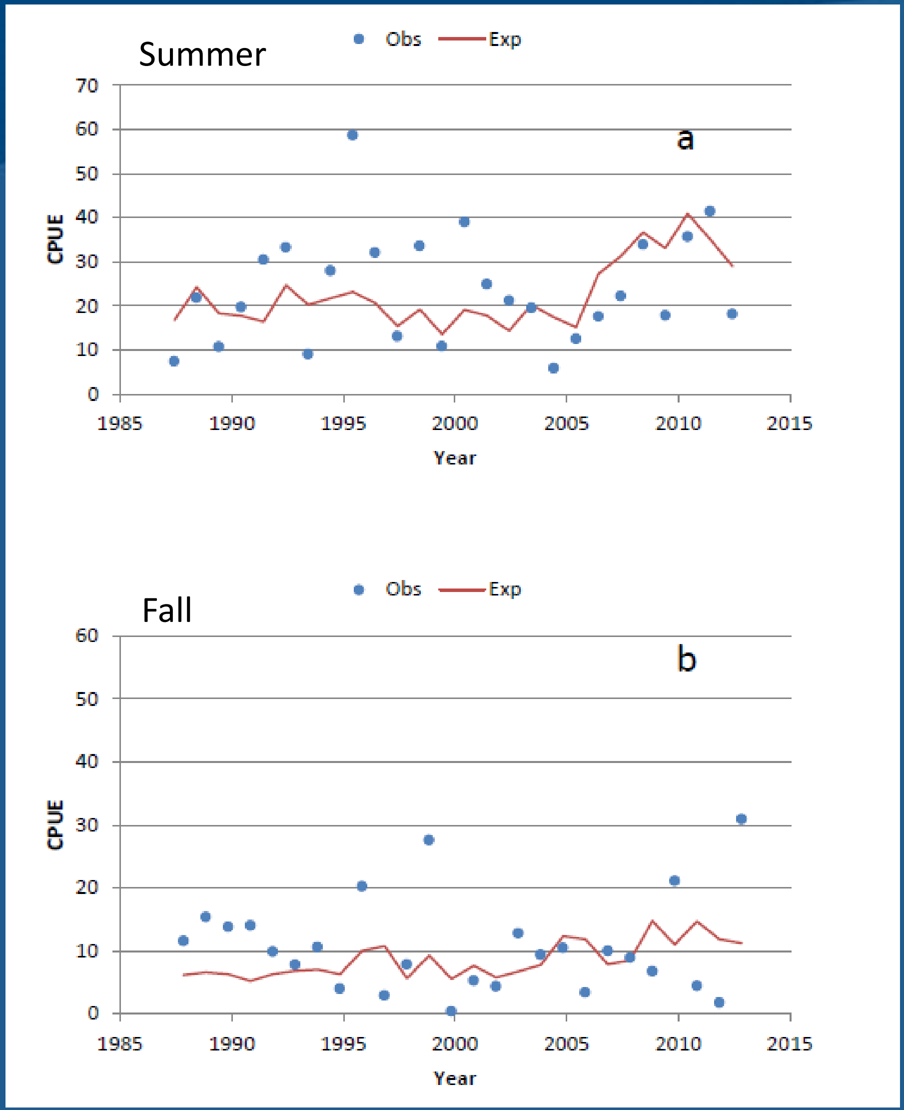
- SEAMAP sampling data input were collected from statistical zones 4-11.
- Sampling index data using the delta log normal index from 2008-2012 and nominal CPUE data from 1987-2012 were survey model inputs.
- Size compositions for pink shrimp collected and measured in 1987-2012 during summer and fall cruises were inputs.


N
W
E
S
South Carolina
Mississippi
Alabama
Georgia
Louisiana
Texas
Florida
Tamaulipas
Veracruz-Llave
Yucatan
Cuba
0 125 250 500 km
21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 4 3 2 1
1 2 3 4 5 6 7 8 9 10 11 12

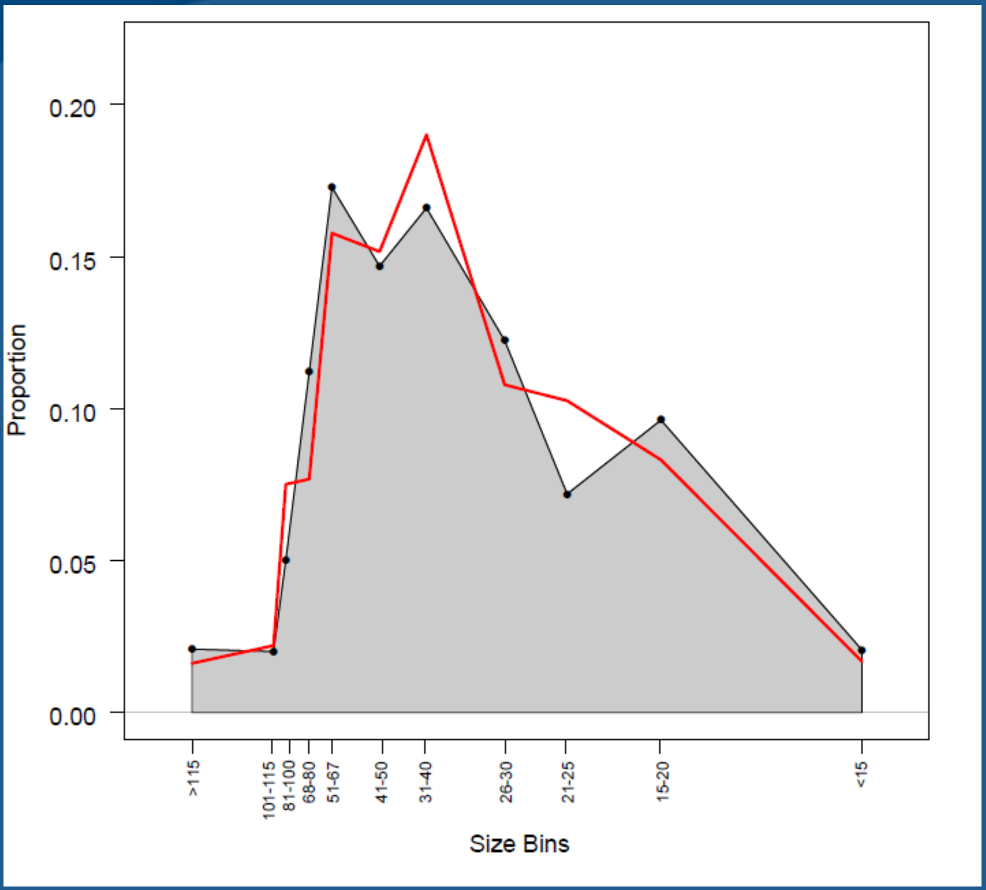
2012 Stock Synthesis Modeling Results



Pink shrimp model CPUE and Q fits, 1984-2012.



Pink shrimp SEAMAP Summer and Fall CPUE fits, 1987-2012.



Pink shrimp size composition fits for the commercial fishery aggregated across years, 1984-2012.

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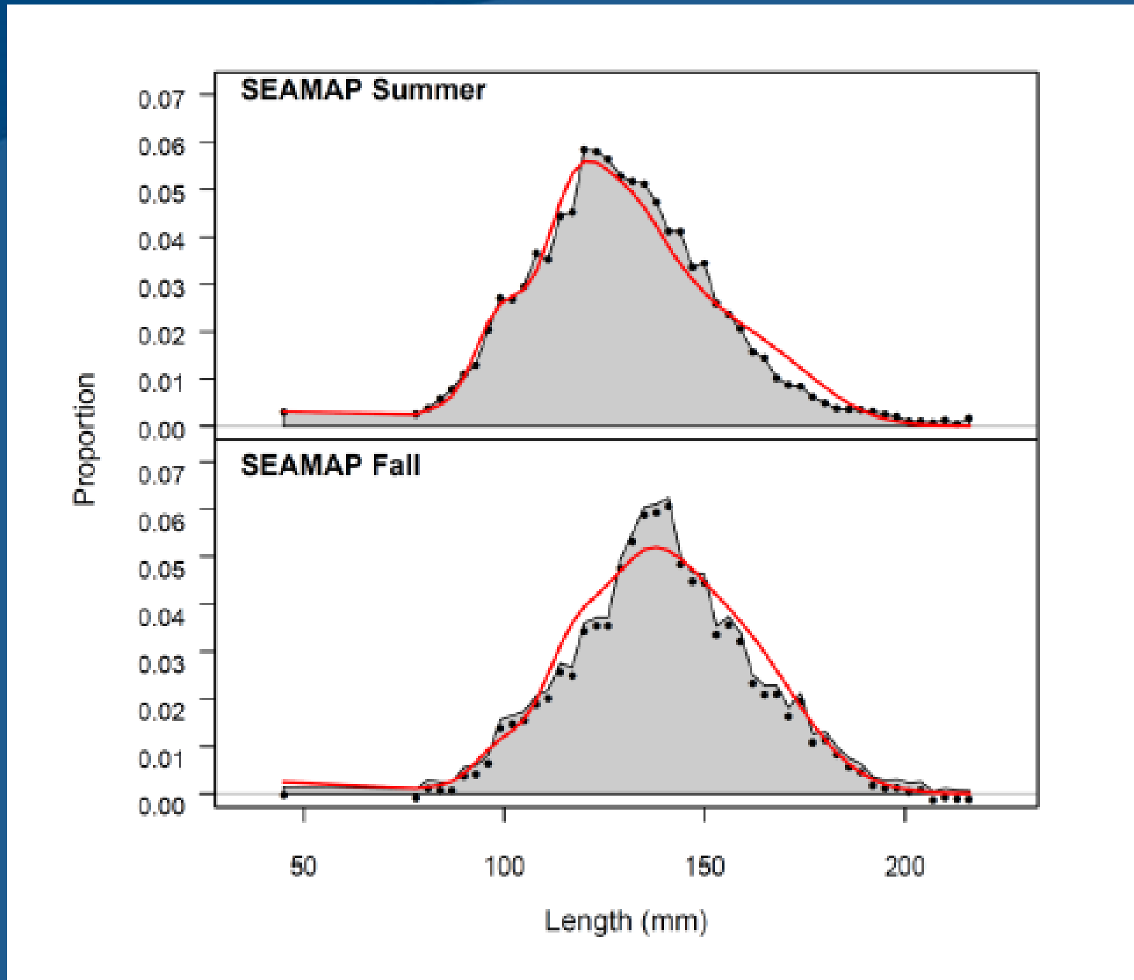

Pink shrimp size composition fits for the SEAMAP data aggregated across years, 1987-2012.

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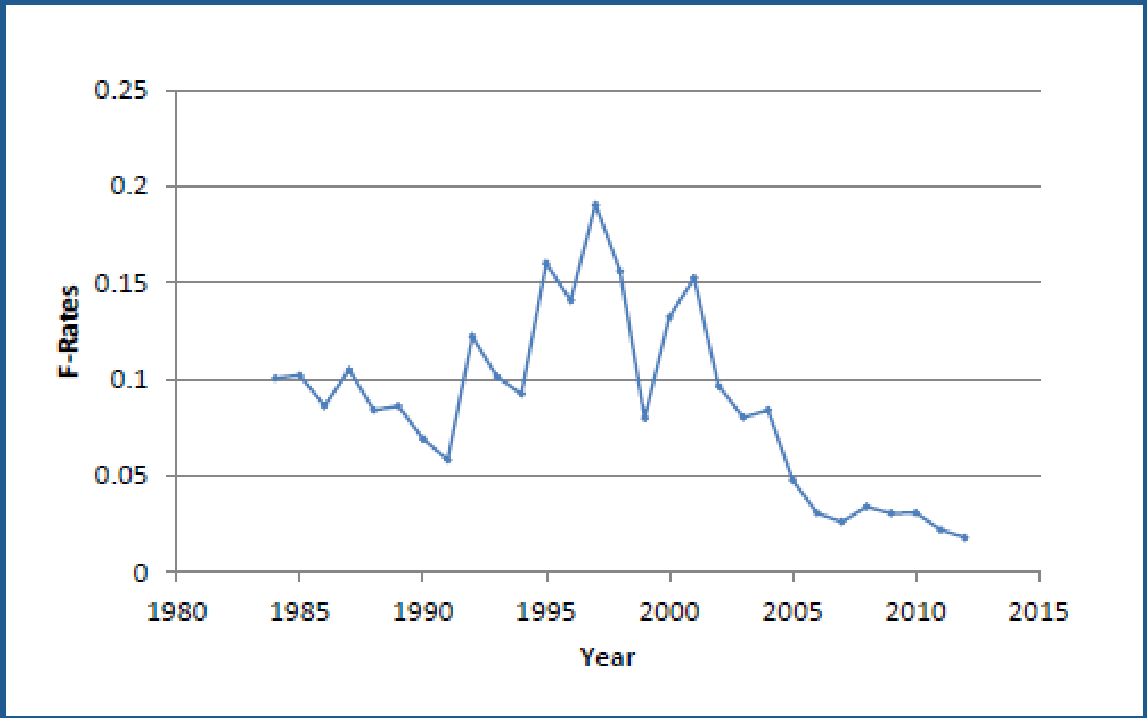
Assessment Model Outputs

- Fishing Rates (F) (Overfishing Levels)
- Spawning Biomass Estimates (Overfished Levels)
- Recruitment Estimates



Pink shrimp weighted apical F estimates across ages 1-19 months, 1984-2012.

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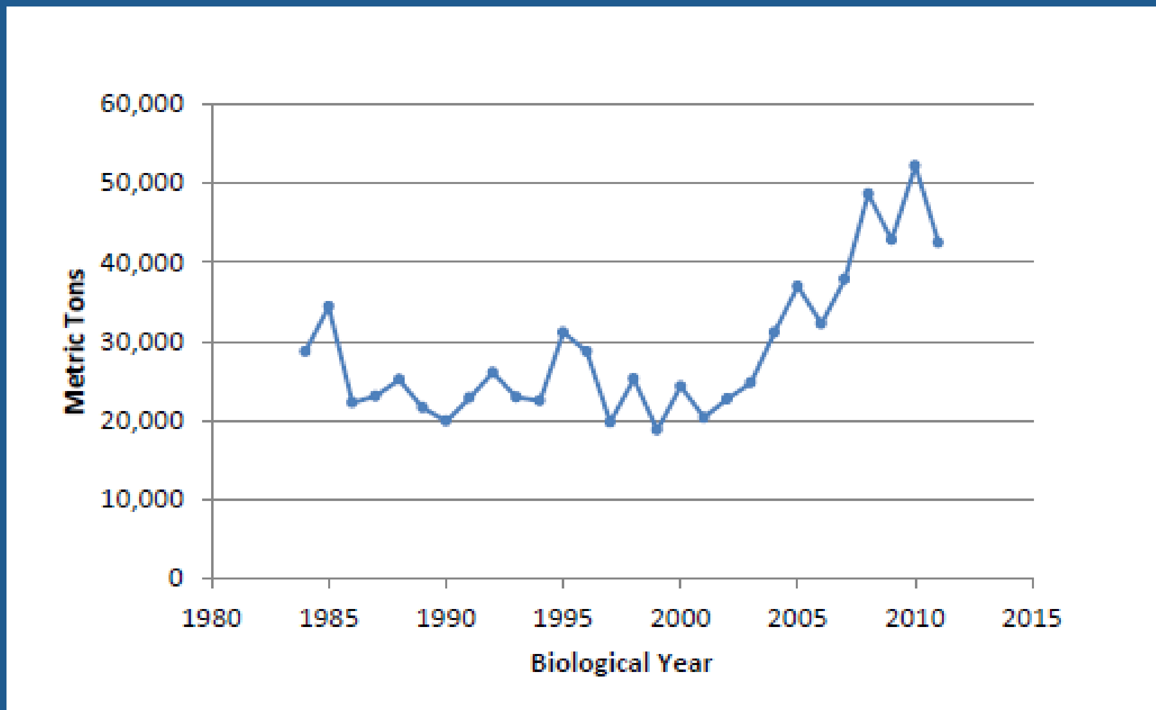
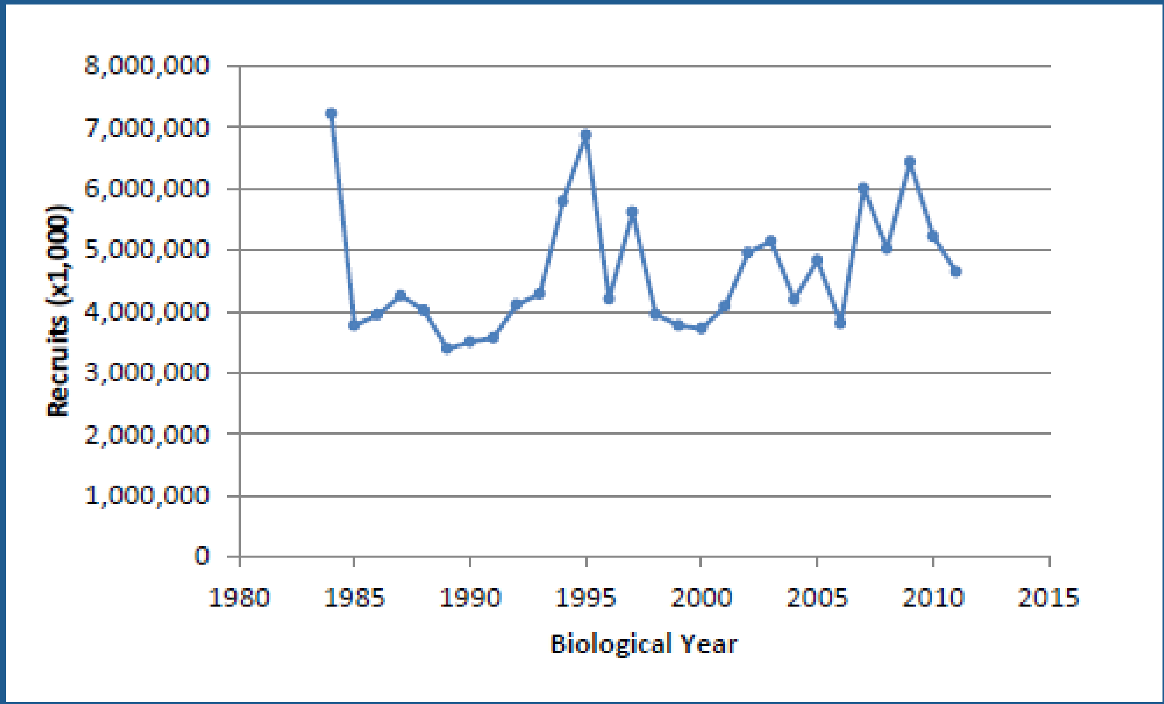


Pink shrimp spawning biomass estimates, 1984-2012.



Pink shrimp recruitment estimates, 1984-2012.

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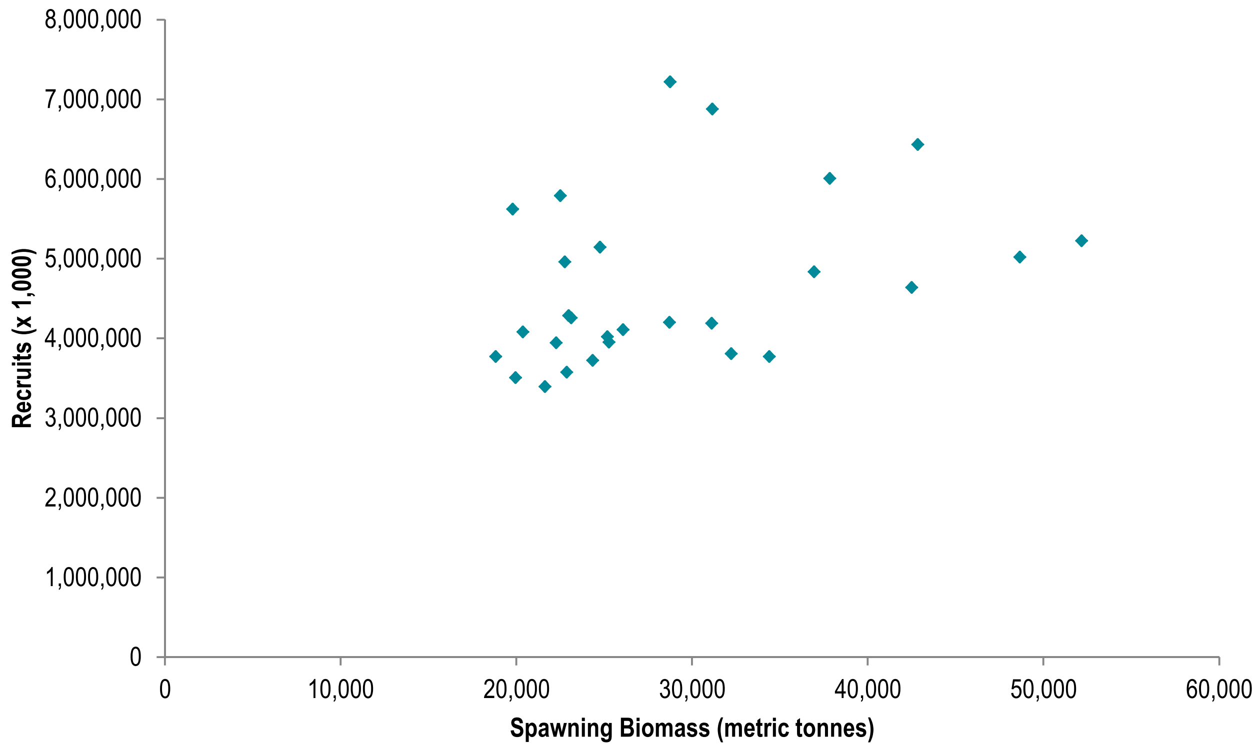

Pink shrimp biological year spawning biomass vs. recruitment.

Modeling Conclusions

- Pink shrimp assessment run in the Stock Synthesis model accepted by the SSC in June, 2012.
- Model is fitting CPUE and size selectivity well.
- Spawning biomass has been increasing. Within year recruitment cycles are evident, with peaks occurring in July of each year.
- Fishing mortality rates (F) have been declining in recent years.

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Acknowledgements

Drs. Richard Methot and James M. Nance
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and
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Assistance with data compilation and maps.

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2013 Northern Shrimp Stock Assessment

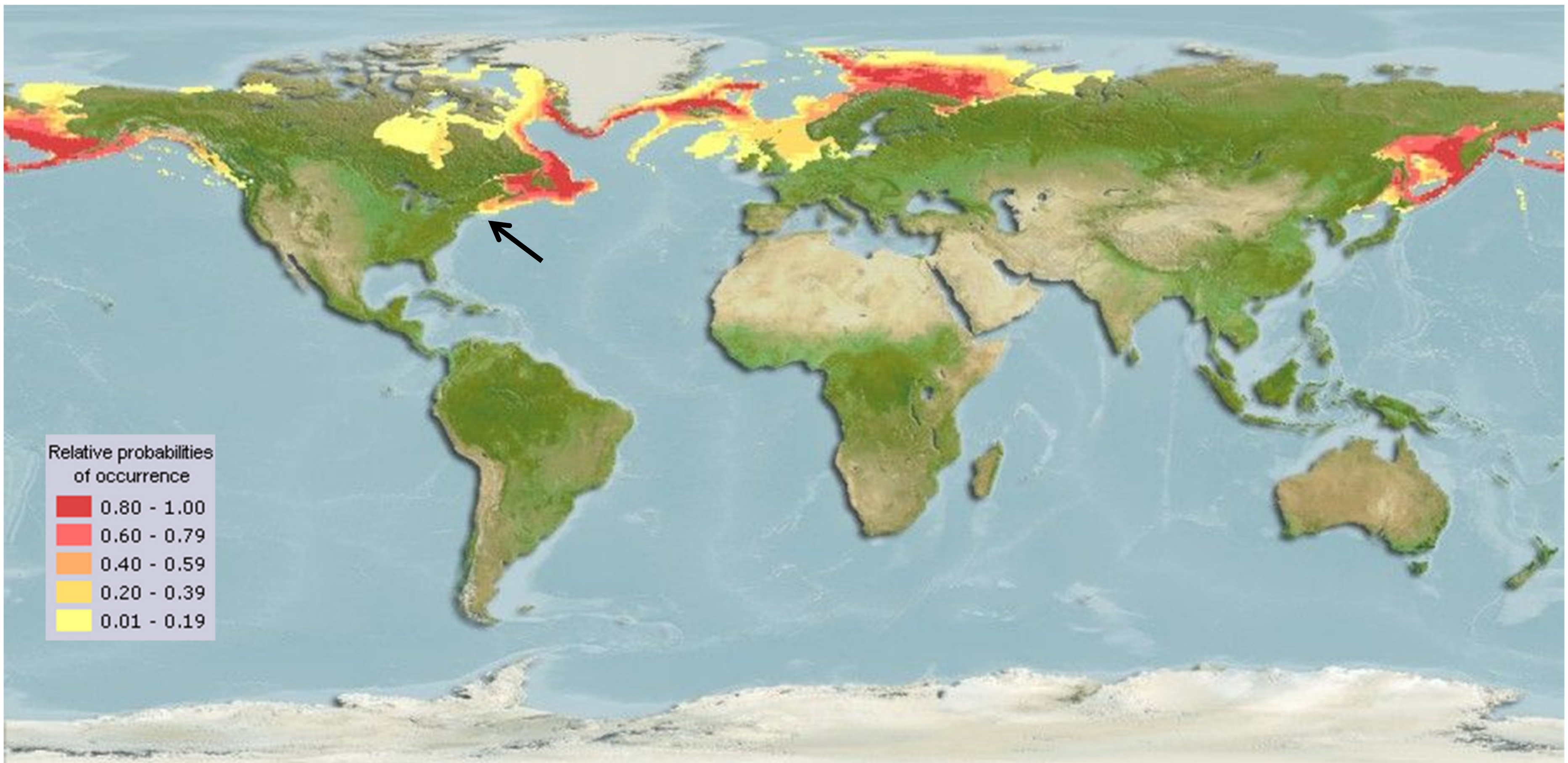
ASMFC Northern Shrimp Technical Committee

Kelly Whitmore, Chair (MA)
Jessica Carloni (NH)
Margaret Hunter (ME)
Anne Richards (NEFSC)
Katie Drew (ASMFC)
Marin Hawk (ASMFC)
With
Larry Jacobson (NEFSC)
Yong Chen and Jie Cao (University of Maine)

Gulf of Maine Northern Shrimp Biology

- N. shrimp occur at the southern-most extent of range in western Gulf of Maine; thought to be a discrete stock in GOM
- Prefer soft bottoms and cold basins; depths 90-180 m

(Figure C.4.1, page 99)

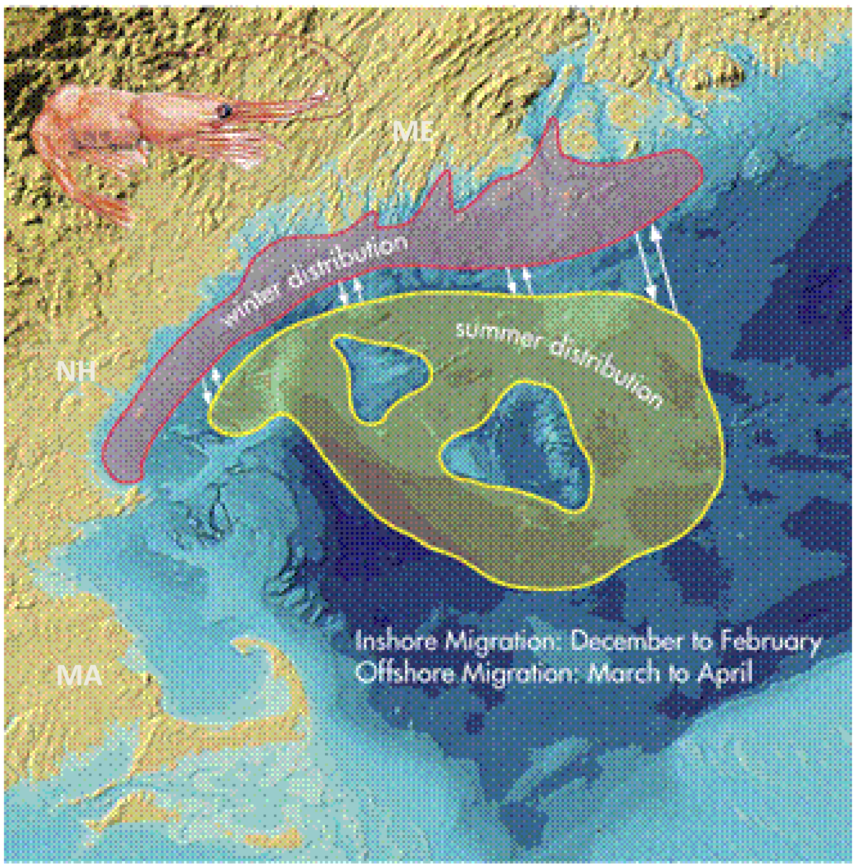


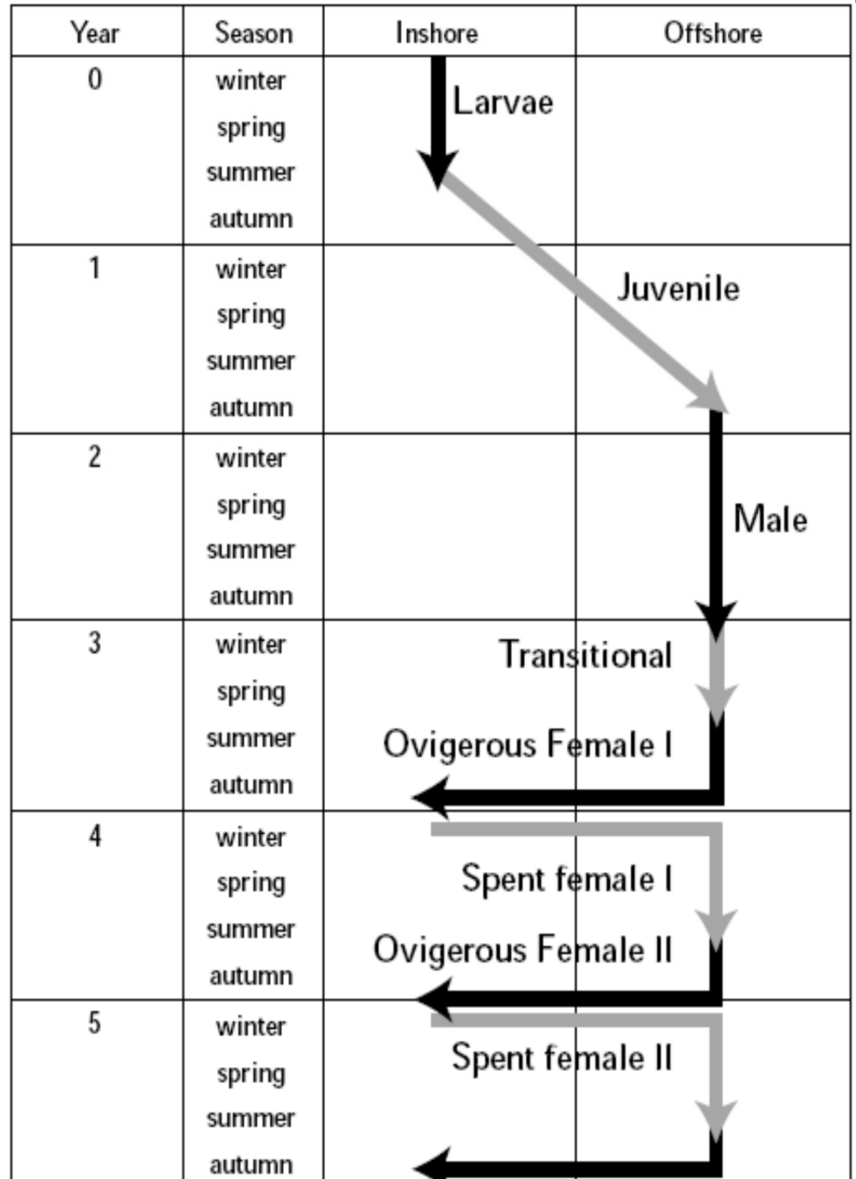
Gulf of Maine Northern Shrimp Biology

(Figure C.4.2, page 99)

Protandric hermaphrodites

- Larvae/juveniles stay inshore for about 1 year, then migrate offshore





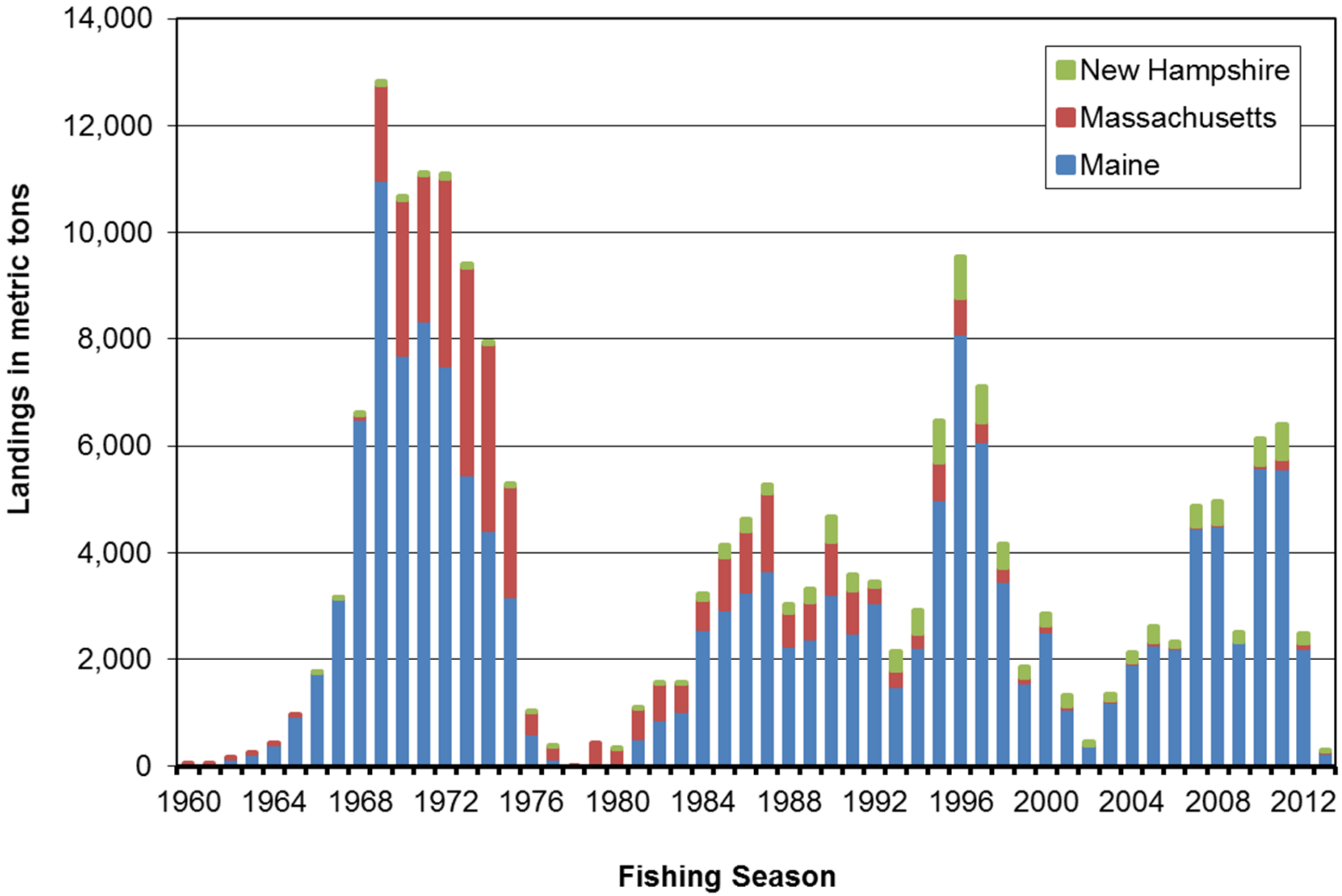
Gulf of Maine Northern Shrimp Biology

- Recruitment success is a function of both SSB and temperature: warmer spring water temperatures result in lower levels of recruitment

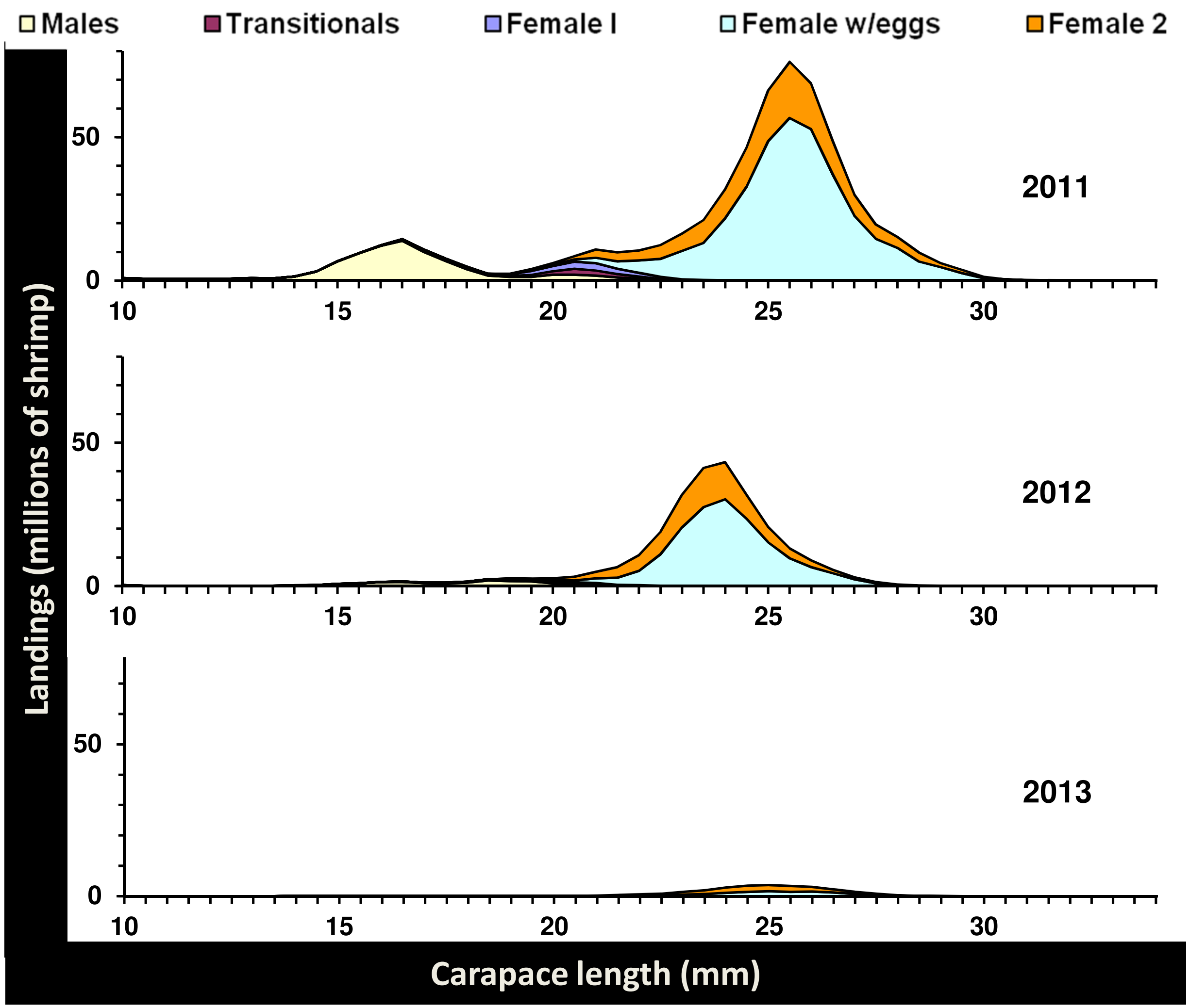
The Fishery

- Winter fishery targets the females when they move inshore to drop their eggs
- Stock collapsed in the mid 1970s; fishery was closed in 1978. Stock recovered, then declined in the late 1990s, recovered to very high levels in 2000’s, and recently experiencing record lows (2012/2013)
- Current fishery includes trawling and trapping (ME); trap landings averaged 5% of total landings past 3 years

Commercial Landings



Commercial Catch Composition



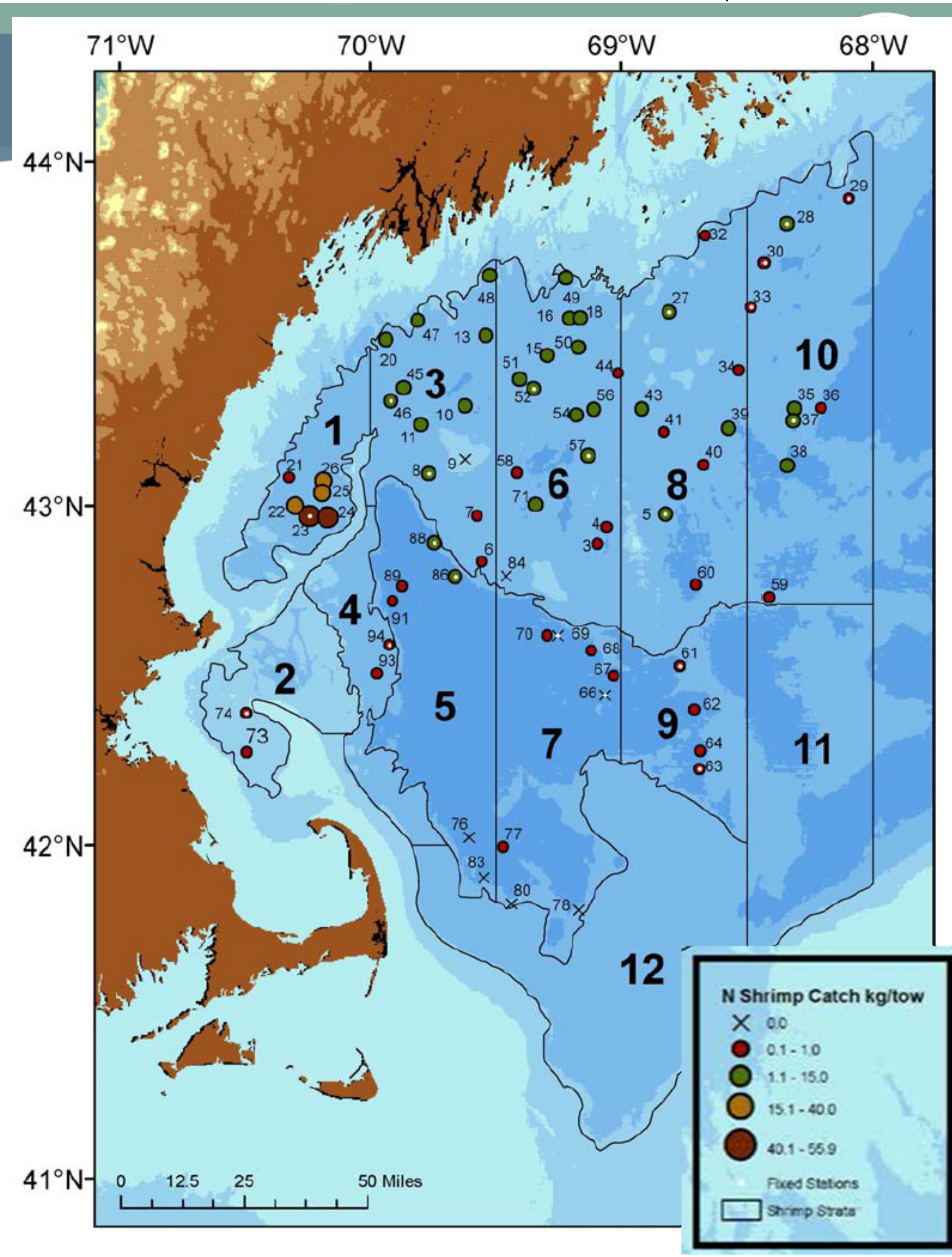
Indices of Abundance

- Primary: ASMFC Summer Survey (1984-2013)
- NEFSC Fall Bottom Trawl Survey (1968-2008, 2009-2012)
- State of Maine Summer Survey (1968-1983)

State-Federal (ASMFC) Summer Survey

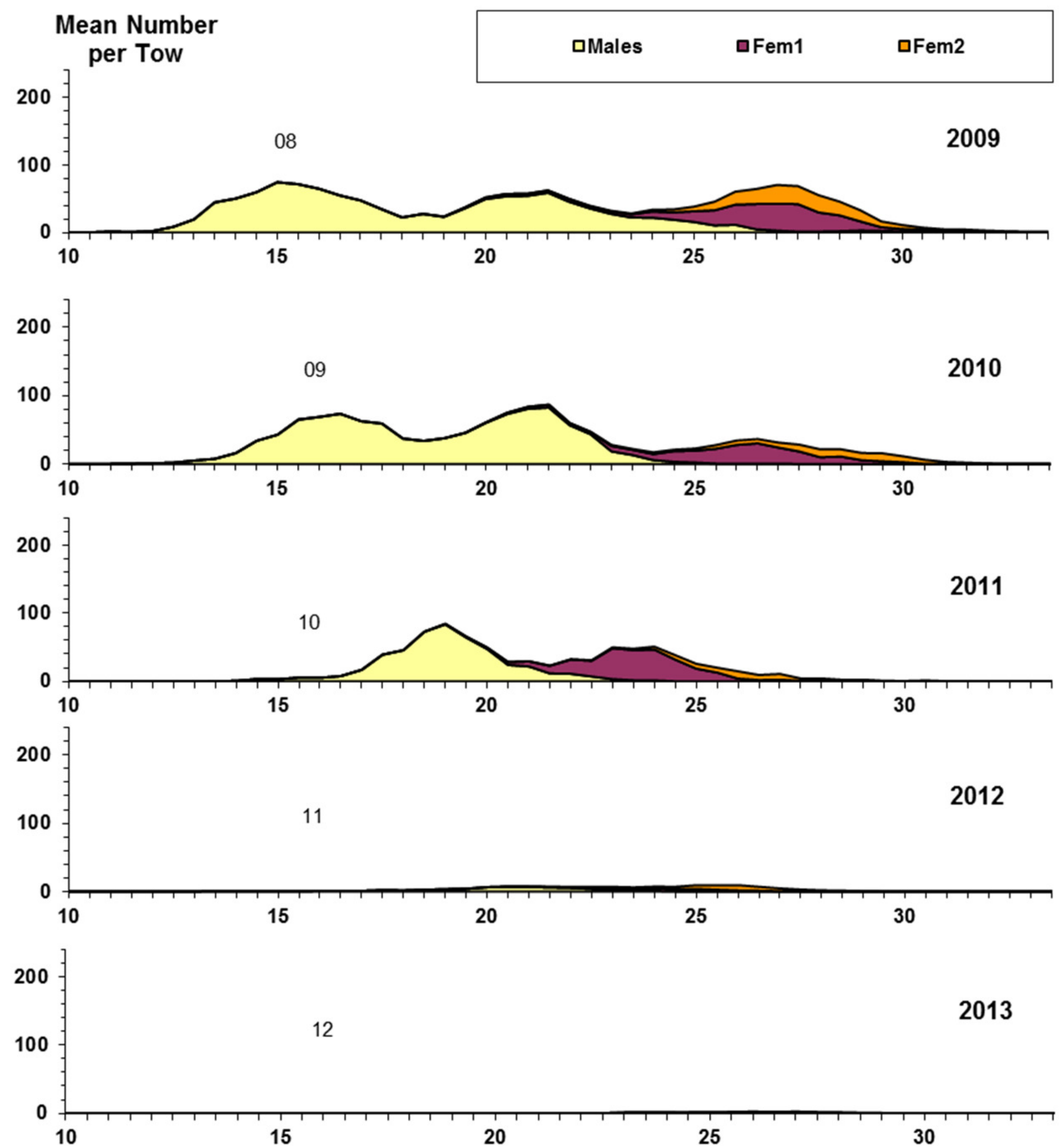
1984-2013

- Conducted offshore (>50m depth)
- July/August when adult stages aggregated offshore
- Stratified random sampling
- Gear designed for GOM
- Indices of abundance and biomass based on strata sampled most intensively and consistently (1,3,5,6,7 and 8)
- Highest catch rates from Strata 1,3,6, and 8

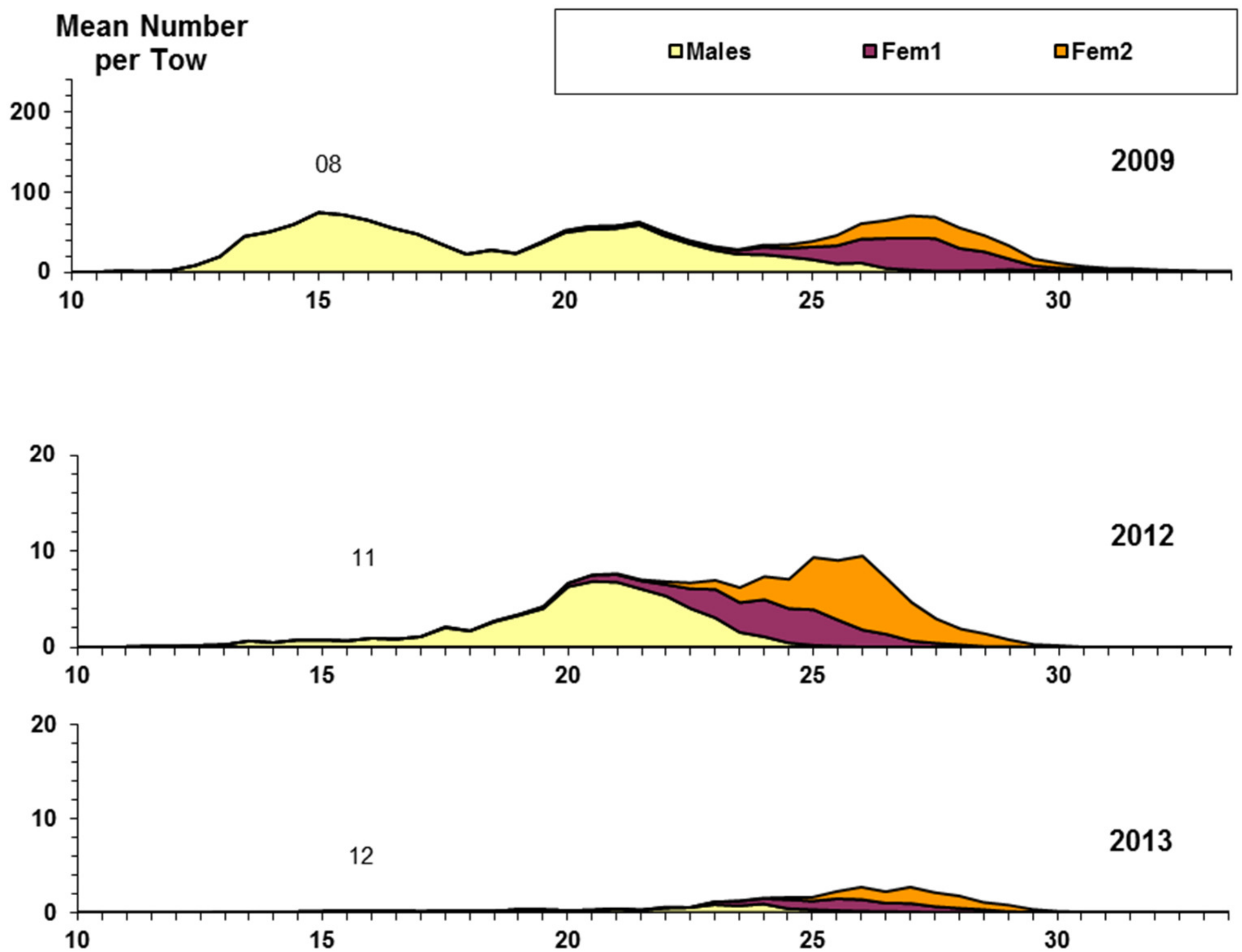


(Figure C5.11)

Index Composition



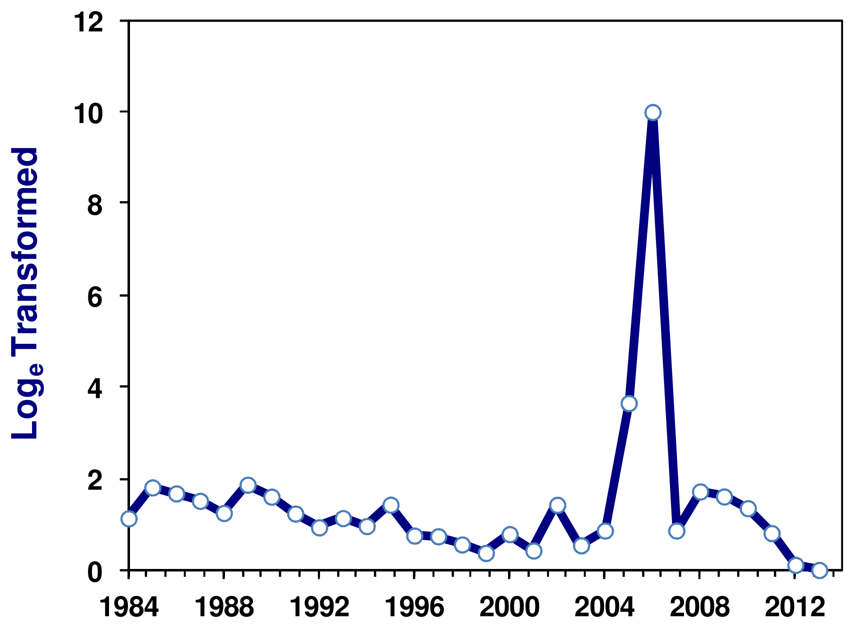
Index Composition



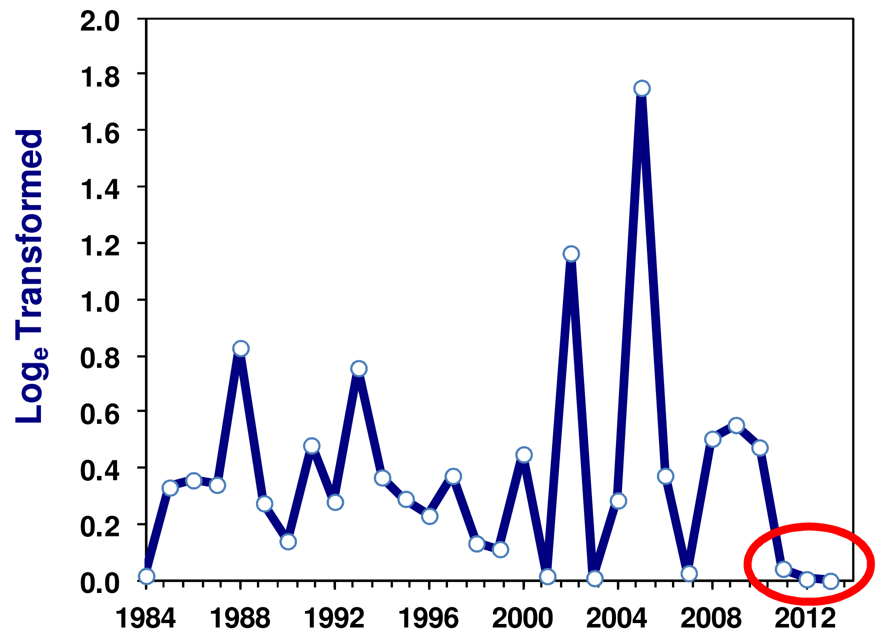
Indices of Abundance

- Total abundance and recruitment (age 1.5 yrs, based on length mode)

Total Abundance (Numbers per tow)



Recruitment Index (Numbers per tow)



Models Used

- Collie-Sissenwine (CSA)
  - Updated version of the NMFS Toolbox program
  - Recruit and post-recruit index from Summer Survey
  - Catch composition from port sampling
  - Allows use of total abundance indices as well (NEFSC trawl series)
  - Allows weighting of survey and catch data
  - Model approved by the 2007 SARC

Models Used

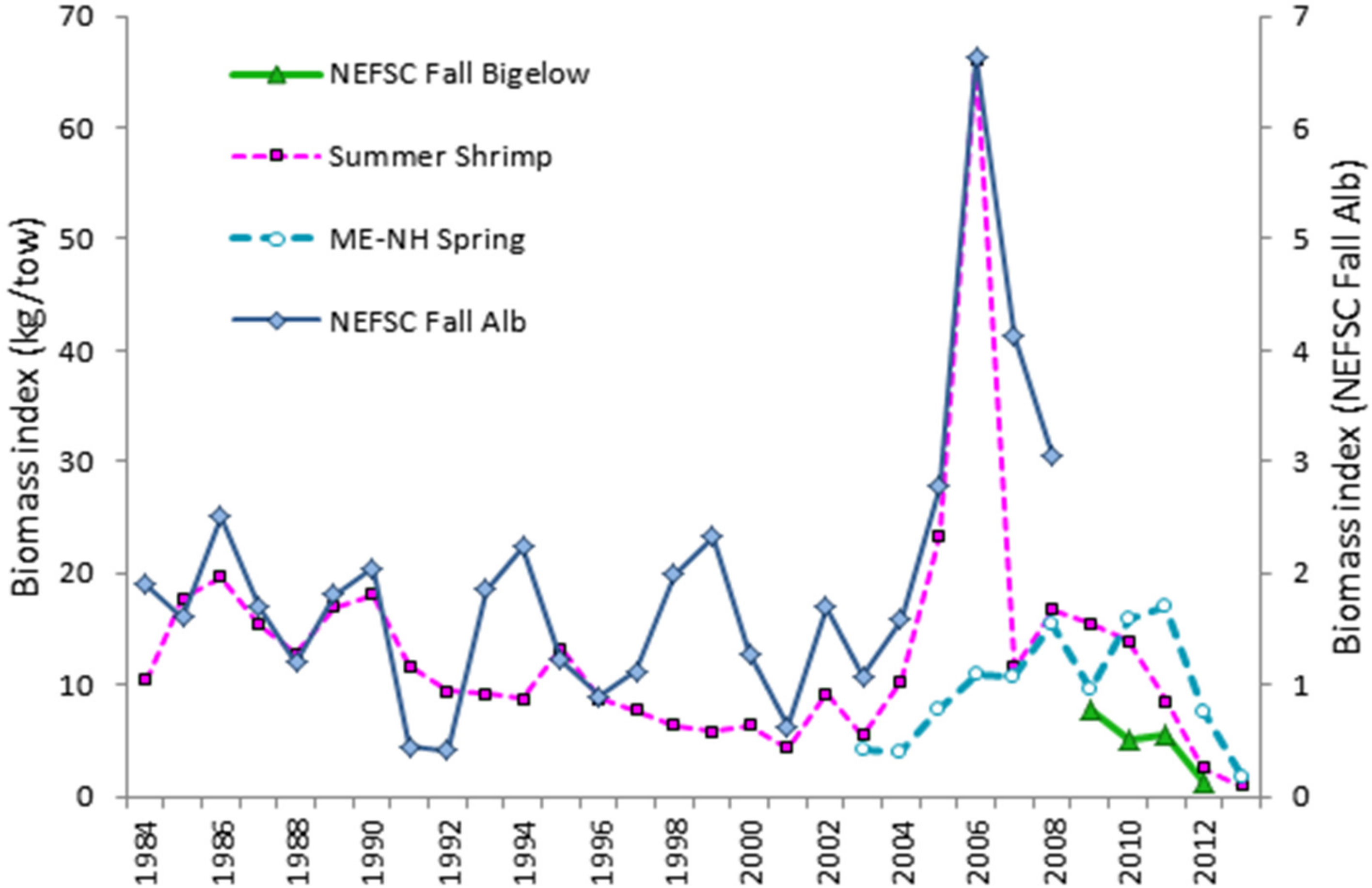
- University of Maine (UME) model
  - Length-structured model
  - Based on model developed for lobster
  - Growth transition matrix estimated internally for two stanzas
  - Fit to total catch and indices, length composition of catch and indices, proportion female in summer survey

Models Used

- Surplus production model (ASPIC)
  - NMFS Toolbox program
  - Can extend time-series back to 1968 (no length data of catch back that far)
  - Not preferred model because it doesn't respond well to the highly variable recruitment observed in N. shrimp
  - TC recommended it not be used in the future

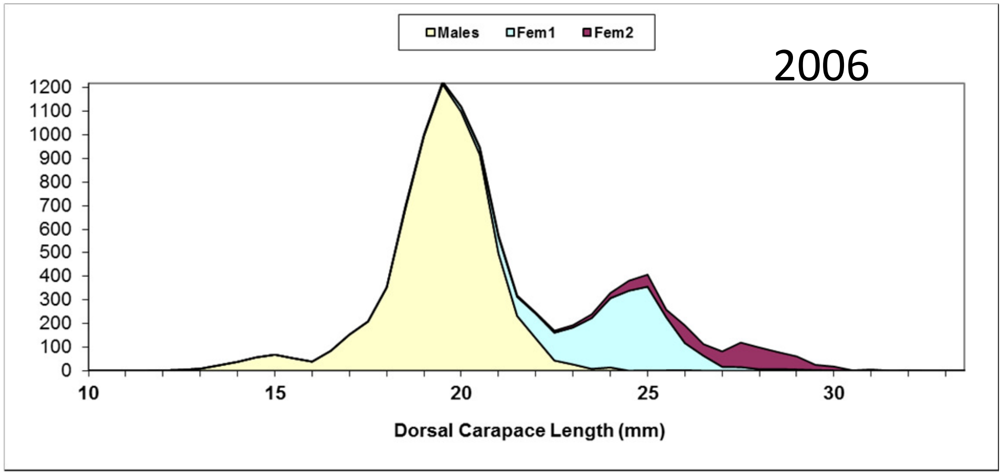
Data Input Issues

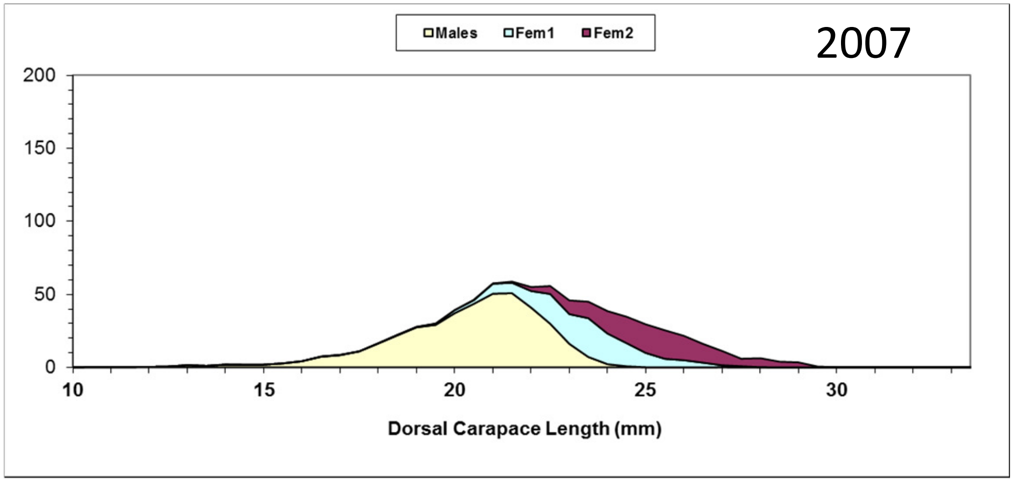
- 2006 was the highest year on record for the Summer Survey and the NEFSC trawl survey



Data Input Issues

- Increase was across all size classes, and 2007 was much lower again





Data Input Issues

- 2013 was the lowest value in the time-series
- All models struggled to fit that sudden increase and sharp decline
- Final overfishing status determination was different depending on whether the catch or the indices were weighted higher

Peer Review

- Panel endorsed length-structured models as the way to go for this species, and encouraged further development of the UME and CSA models
- HOWEVER, they did not accept the output of the assessment models for management use
- Agreed that stock biomass was at very low levels with little indication when they might recover, based on index and fishery indicators

Peer Review

- CSA Model
  - Too sensitive to weighting of data, inputs and lack of robustness regarding determination of stock status
  - Needs further development to incorporate other data types, including effort, catch rate and environmental drivers

Peer Review

- UME Model
  - – Struggled to fit length-composition data well
  - – Needs better information on growth within the model
  - – Needs to be better tested with simulation data

Peer Review

- ASPIC Model
  - Should not be used for management at this time, given the recent high variability in shrimp recruitment

Future Work

- Continue development of UME and CSA models
- Explore approaches to use index data to manage fishery before next benchmark assessment