Effort Response, Harvest, and Climate in the Gulf of Mexico Recreational Fishery

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Outline

- Policy Background
- Research Questions
- Model and Approach
- Data
- Results
- Discussion

Background

- ❑Policy proposals (FMP amendments)
- ❑Effects on the Recreational Sector
  - – Effort
  - – Landings/Harvest
  - – Value
- ❑Bioeconomic modeling

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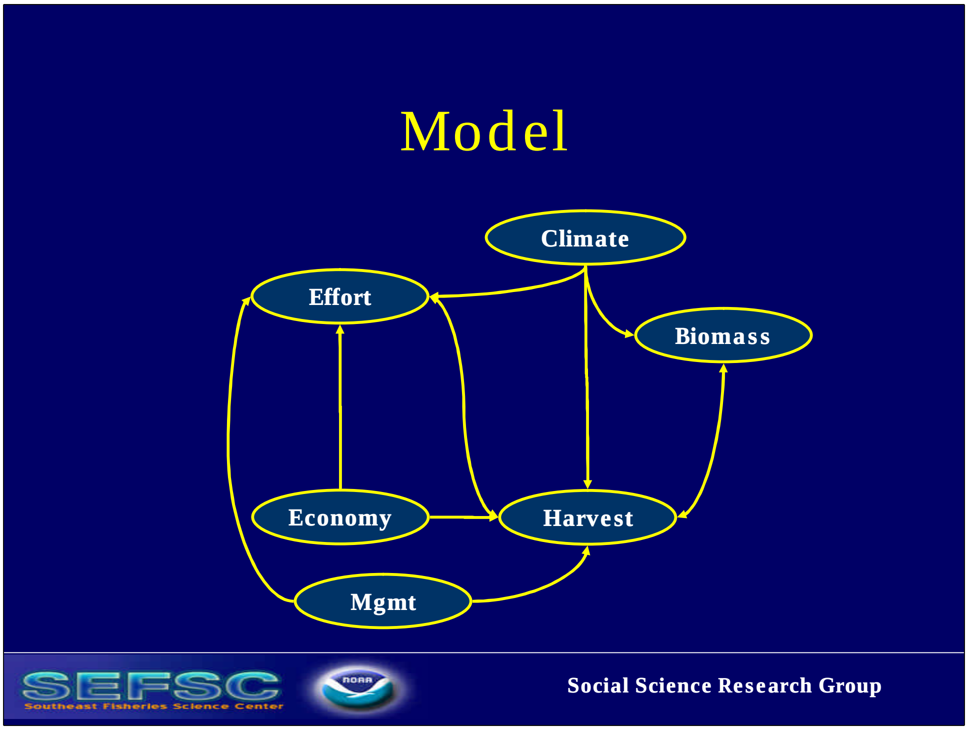
As directed by a Fishery Management Council (FMC) biologists conduct stock assessments to determine the fish stock status (OK, overfished, undergoing over-fishing, etc.). Based on the stock status the FMC proposes alternative amendments to a fishery management plan (FMP). There are typically policies proposed for the recreational fishing sector included among the proposed alternatives. NMFS economists are frequently asked to evaluate the effects of these proposals in terms of changes in effort, harvest, and value to the recreational anglers and for-hire industry. These evaluations require economic models to predict the aggregate effects over a long time horizon. There is very little published research on *applied* bioeconomic modeling of recreational fisheries. This research does not cover the range of variables that could influence how policy changes can effect angler behavior and, in turn, the aggregate policy affect.



We don’t consider biomass in this analysis.

Research Questions

- What are the time series properties of aggregate recreational fishing data?
- Do landings predict effort?
- How do the economy and climate affect aggregate recreational fishing?
- How do policies affect aggregate recreational fishing?

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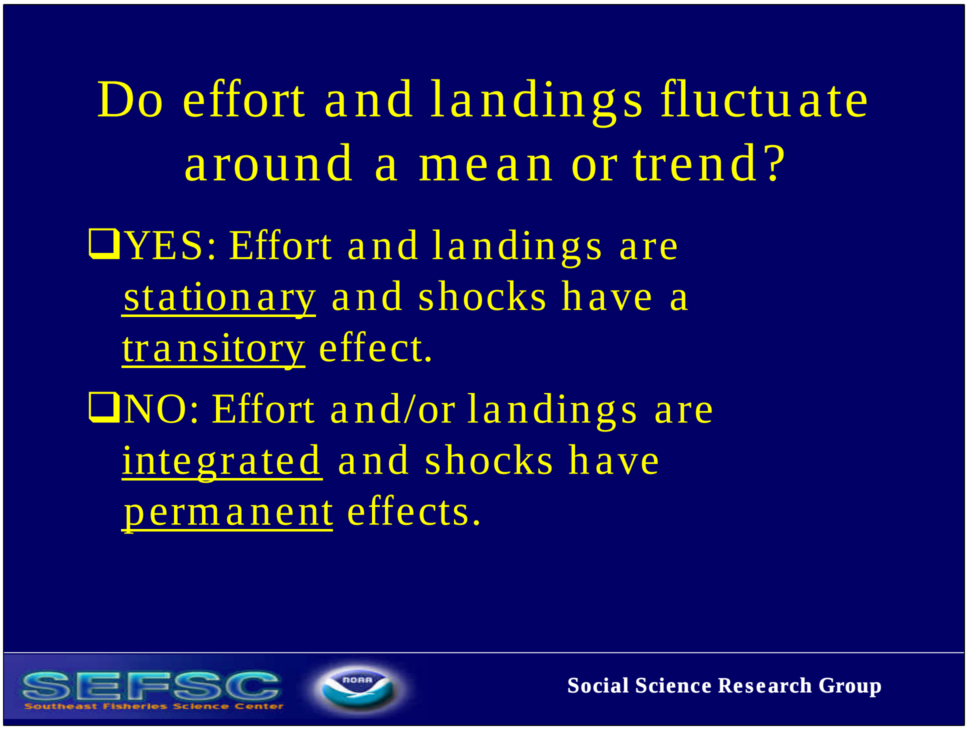
Vector Autoregression (VAR) Approach

- Endogenous Variables
  - Effort
  - Landings
- Exogenous Variables
  - Lags of endogenous variables
  - Climate indices
  - Economy index
  - Bag limits, minimum size limits, closures

Time Series Questions

- Do effort and landings fluctuate around a long run mean or trend?
- If not, is there a linear combination of effort and landings that does?



A series that must be differenced X times to become stationary is integrated of order X or I(X).

An I(1) series is a random walk.

Is there a stationary linear combination of effort and landings?

- NO: Effort and landings are independent integrated series.
- YES: Effort and landings are cointegrated and have a long-run linear equilibrium relationship.

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Following Engel and Granger (*Econometrica*, 1987), the long-run cointegrating equation between the series can be estimated via OLS. The residuals from the cointegrating equation track deviations from the long-run equilibrium. When included to a regression of effort and landings in differences, the cointegrating equation residuals form an error correction term that measures the short-run response to deviations from the long-run equilibrium.

VAR Identification

- Stationarity testing
  - Augmented Dickey-Fuller (ADF) tests
  - General-to-specific selection of autoregressive difference terms
- Cointegration testing
  - Residual based ADF tests
  - Johansen rank order test
- VAR lag-order selection
  - Corrected Akaike Information Criterion

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Fishery Data

- Gulf of Mexico: 1986 - 2003, bimonthly
- Private, charter, and head boats
  - MRFSS
  - Texas Parks and Wildlife
  - Head boat survey - Beaufort, NC
- Effort: trips or angler days
- Red snapper landings
- Bag and minimum size limits, closures

Red Snapper Regulations

Year	Size Limit	Daily Bag Limit	Season Length
1984	13	none	365
1990	13	7	365
1994	14	7	365
1995	15	5	365
1996	15	5	365
1997	15	5	330
1998	15	4	272
1999	15	4	240
2000	16	4	194

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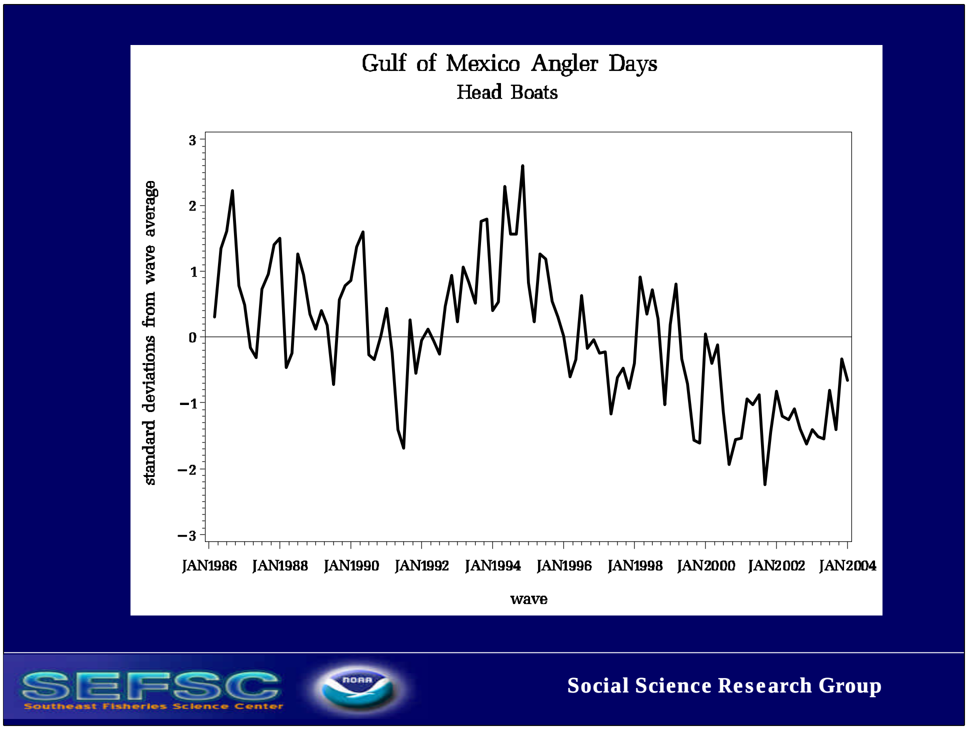
•Changes circled. Regulations have not changed since 2000.

•Prior to 1990, the bag limit was modeled as 99.

•The closed seasons were modeled as the percent of each wave that was closed, i.e., 0 indicates the wave is open to fishing and 1 indicates that the fishing was restricted for the full two months.

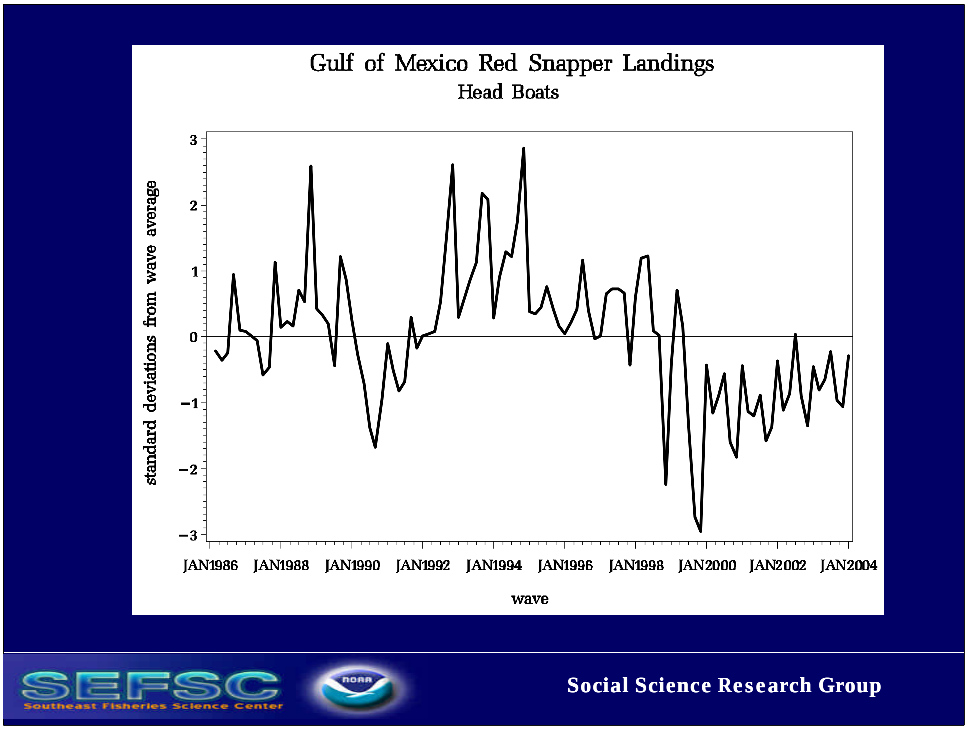
•Size and bag limits were transformed to annual changes (i.e., differenced six periods) prior to estimation.

•Closed seasons were transformed to wave changes (i.e., differenced one period) prior to estimation.

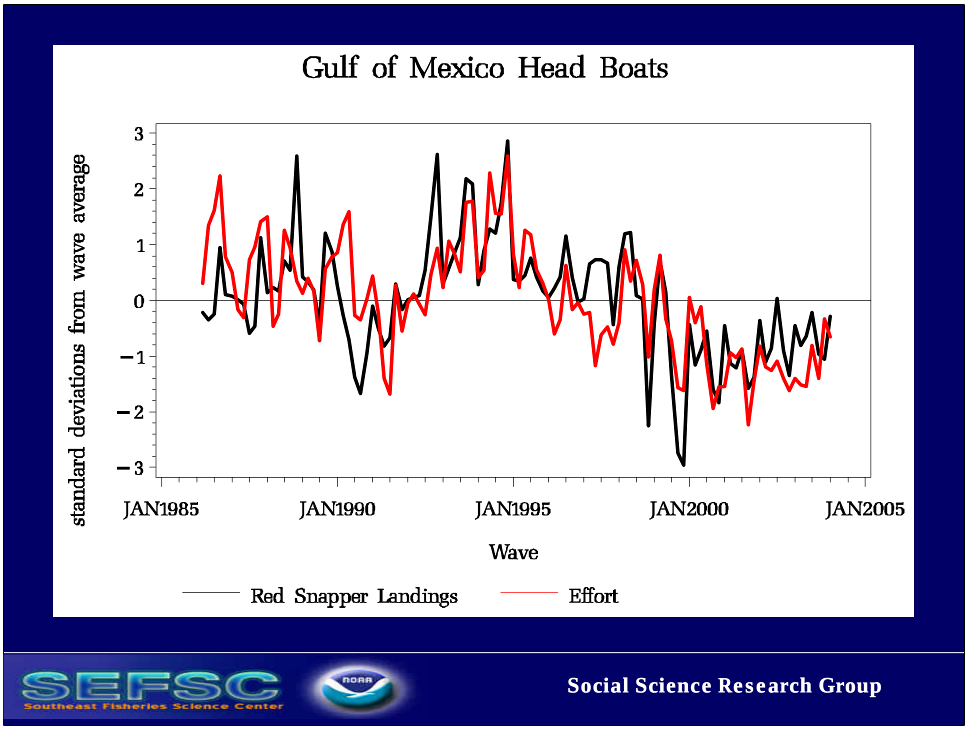


Each wave observation is expressed in terms of standard deviations from the mean level in that wave from 1986 to 2003. All means were normalized to zero. This transformation was conducted by subtracting the relevant wave average from each observation and then dividing the resultant series by it's standard deviation.

Head boat effort is integrated, I(1).

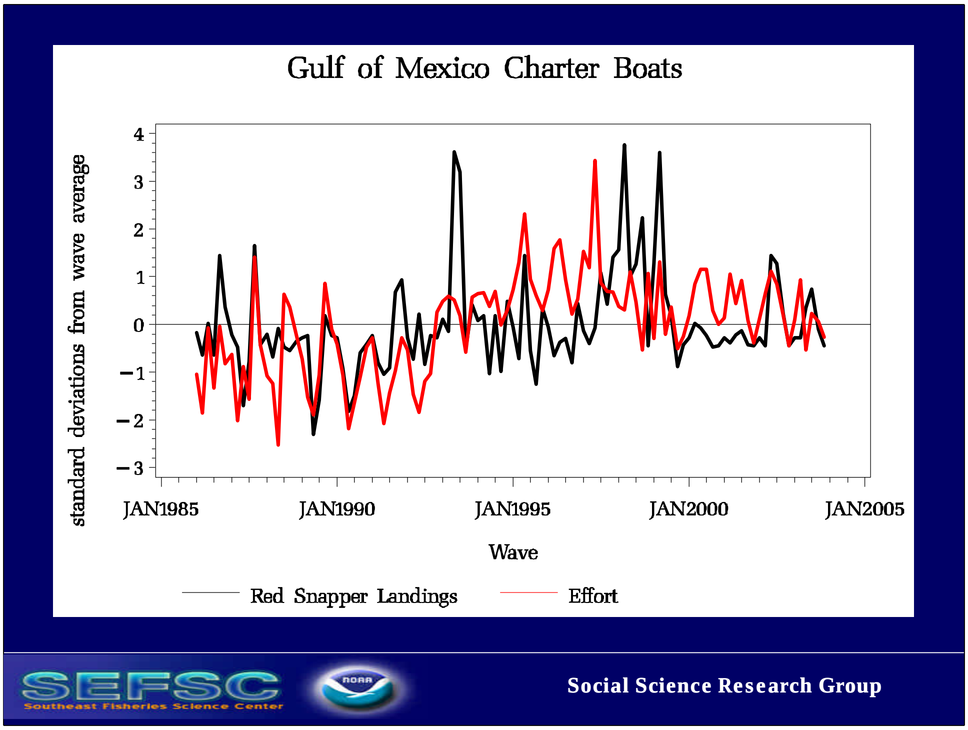


Red snapper landings is integrated, I(1).

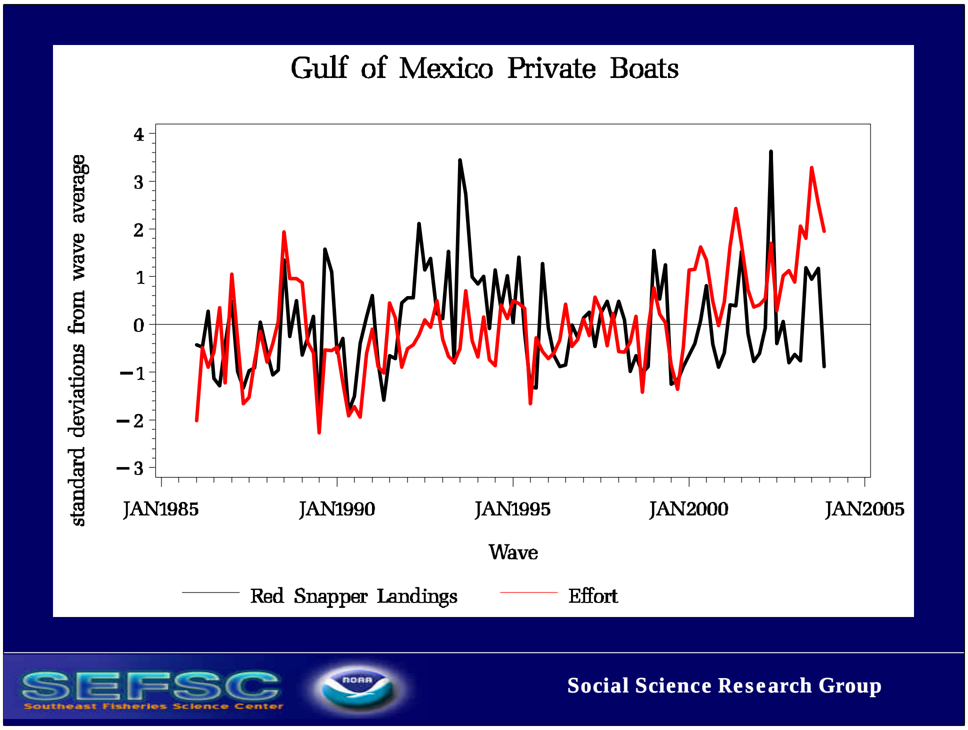


•Effort and landings are cointegrated. These series were differenced once prior to estimation.

•Five autoregressive lags of effort and landings are used in the VAR.



- Effort is integrated, I(1). This finding is robust to structural change, i.e., the change in the MRFSS effort estimation method in 1998. The series was differenced once prior to estimation.
- Red snapper landings is stationary, I(0).
- Cointegration is not applicable.
- Five autoregressive lags of effort and landings are used in the VAR.



- Effort is trend stationary, I(0). The trend was removed prior to estimation.
- Red snapper landings is stationary, I(0).
- Cointegration is not applicable.
- One autoregressive lag of effort and landings is used in the VAR.

Climate Data

- ENSO
  - Southern oscillation index (SOI)
  - NOAA Climate Prediction Center
- Bermuda High
  - Bermuda minus New Orleans sea level pressure
  - National Center for Atmospheric Research
- Storm/Hurricane Activity
  - Accumulated cyclone energy (ACE)
  - FIU International Hurricane Research Center

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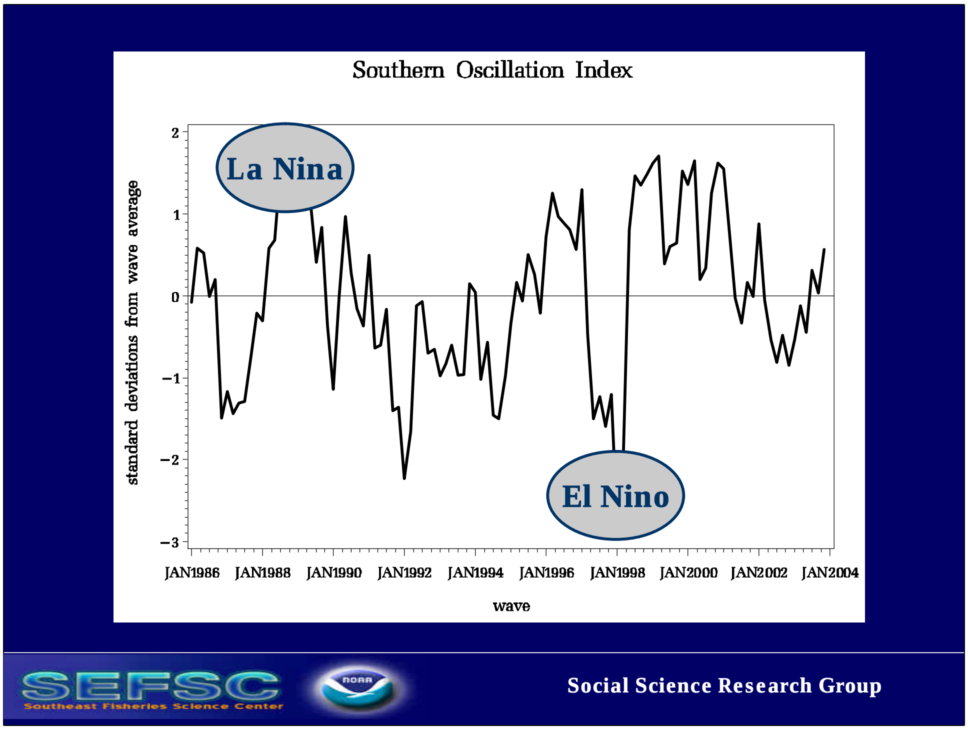
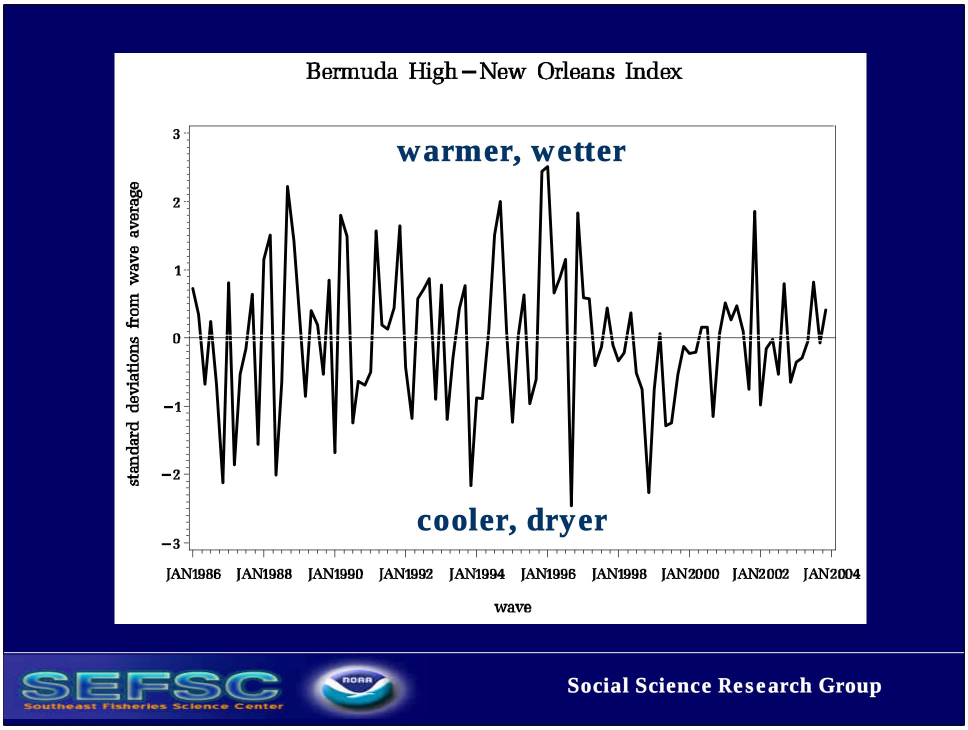


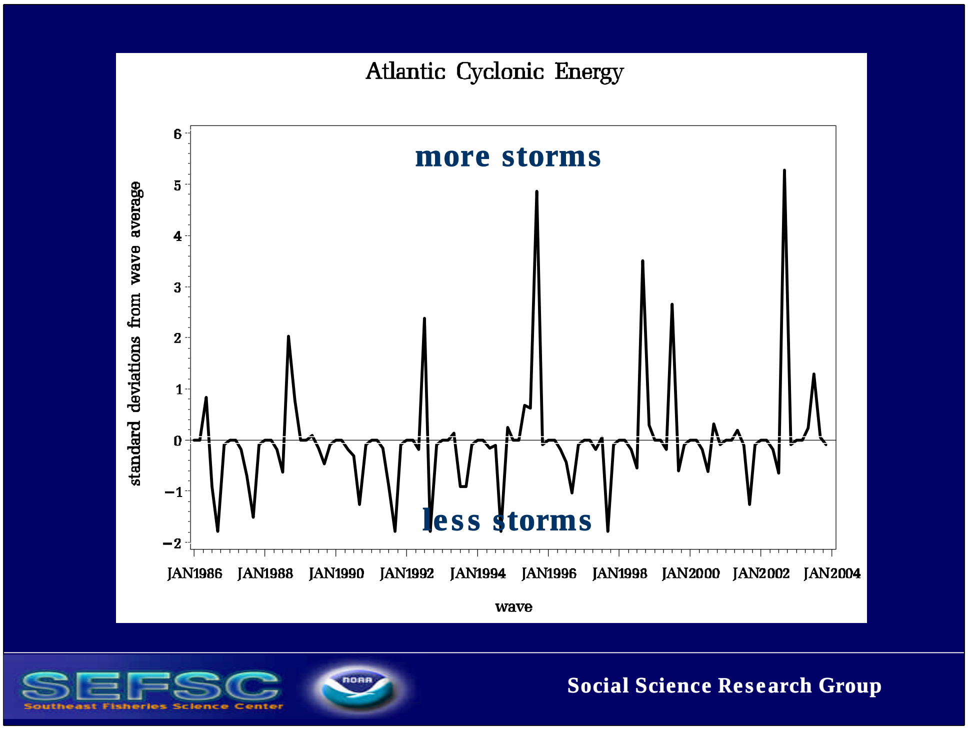
- El Nino winters are cooler and wetter in the Southeast.
- La Nina winters are warmer and dryer in the Southeast.
- The SOI is stationary, I(0)



•Positive deviations in the Bermuda high index are related to warmer and wetter springs in the Southeast.

•Negative deviations in the Bermuda high index are related to cooler and dryer springs in the Southeast.

•The Bermuda High index is stationary, I(0).



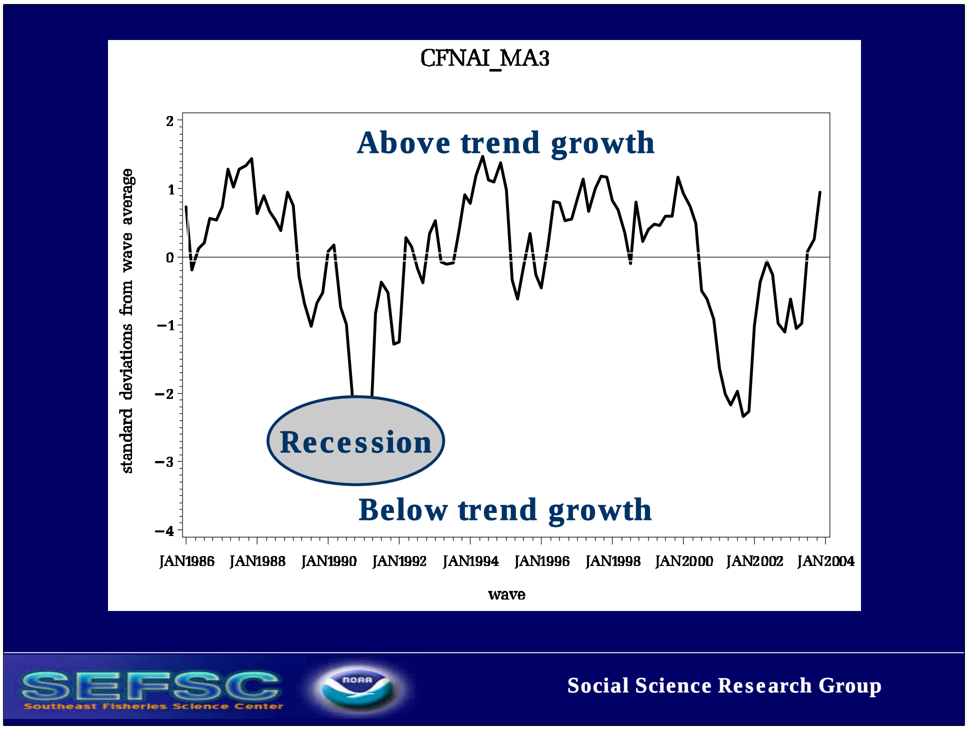
•Positive deviations in the ACE index are related to more hurricane and storm activity during the fall season in the Southeast.

•Negative deviations in the ACE index are related to less hurricane and storm activity during the fall season in the Southeast.

The ACE index is stationary, I(0).

Economy Index

- ❑Chicago Fed National Activity Index
- ❑Weighted average of 85 indicators of national economic activity
  - – Production and income
  - – Employment, unemployment, and hours
  - – Personal consumption and housing
  - – Sales, orders, and inventories



The three term moving average (MA3) version of the CFNAI is stationary, I(0).

Granger Causality

- Do landings predict effort even after controlling for past values of effort and the exogenous variables?
- Does effort predict landings even after controlling for past values of landings and the exogenous variables?
- Changes in effort Granger causes changes landings for head boats (not conversely).
- No Granger causality evident for other modes.

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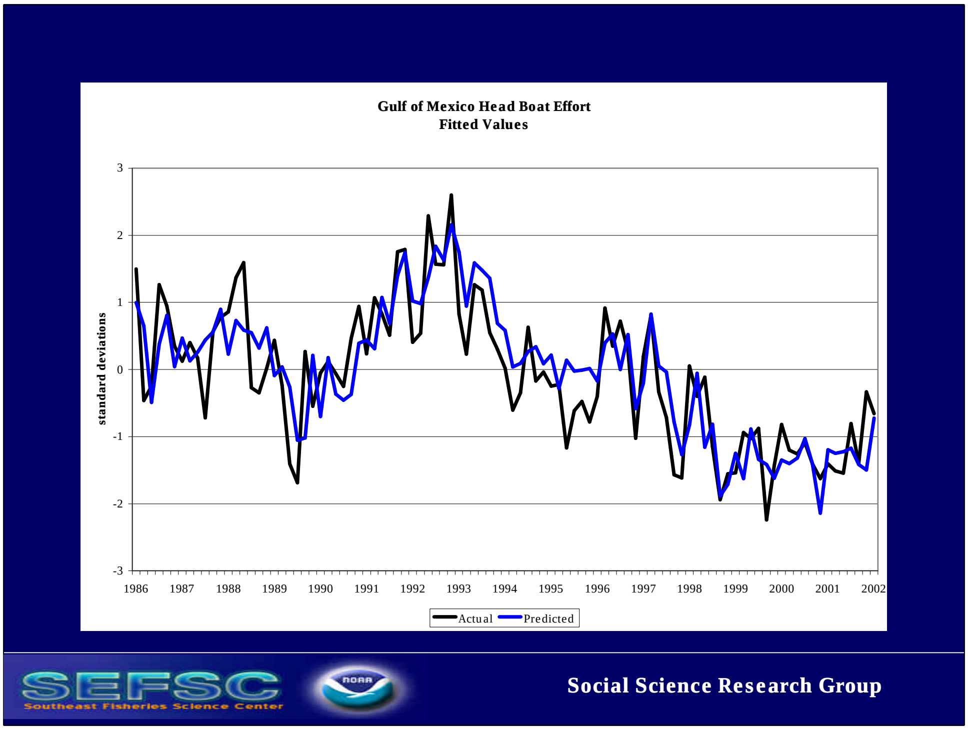
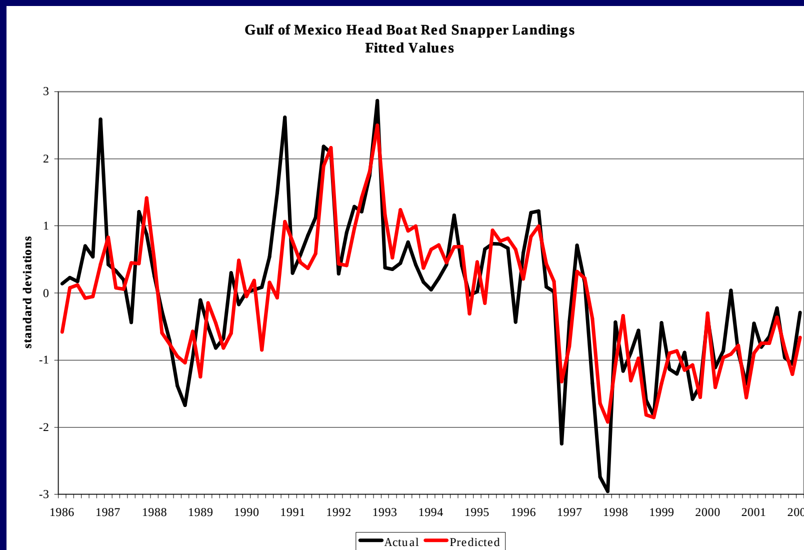
Wald tests reject the null hypothesis that effort lags are jointly equal to zero in the landings equation in the head boat model.



Only results for the head boat mode are shown in this graph and what follows. The complete set of results for the charter and private modes are presented in the related working paper.



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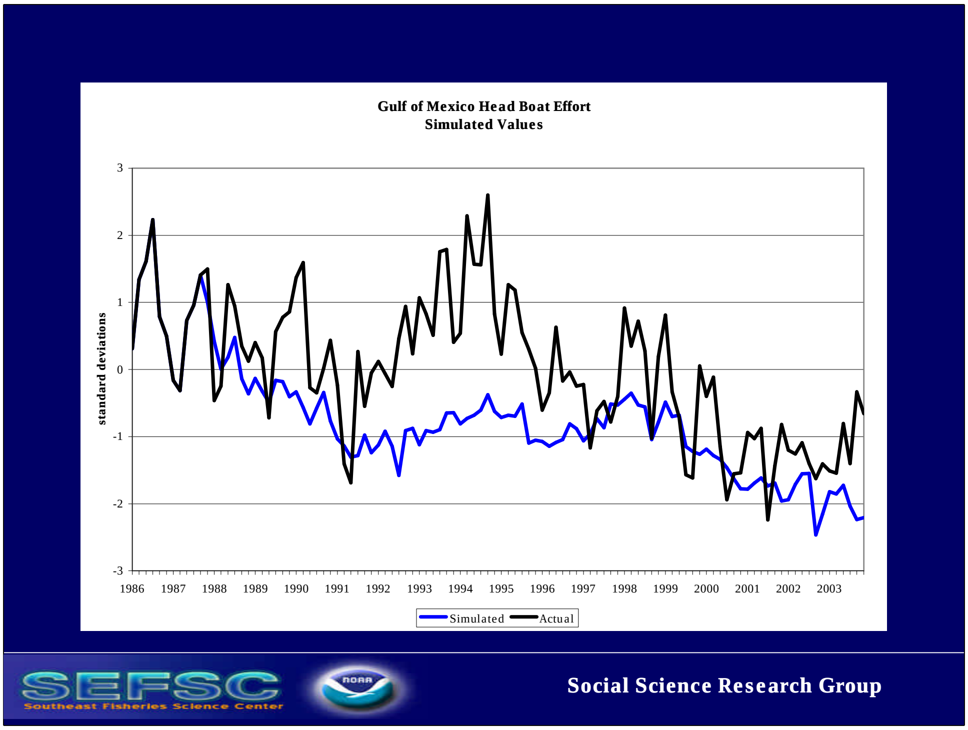
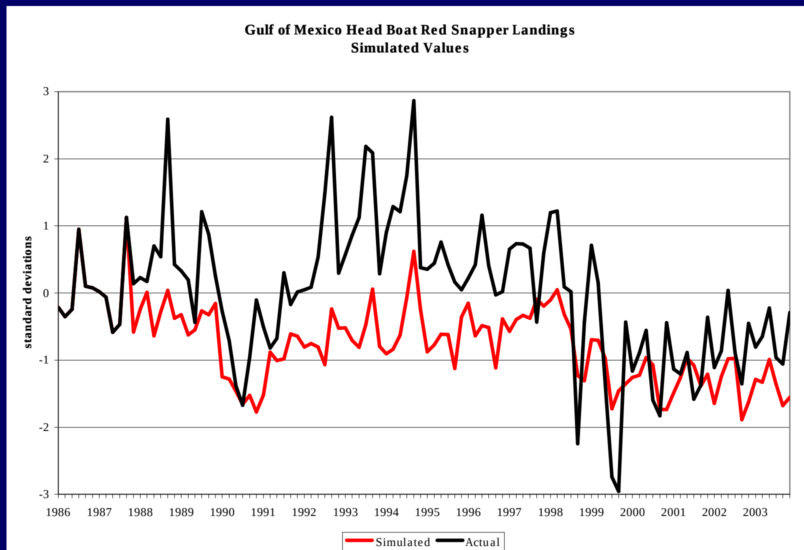


This data in this slide and the following slide were generated by initializing the model with effort and landings for waves 1986:2 – 6 as the first five lagged values and then simulating until 2003:6 using the actual values of the climate, economy, and regulation variables.



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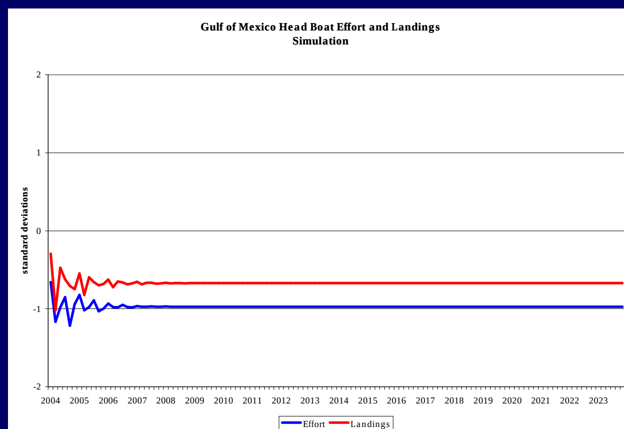
Equilibrium from 2004:1



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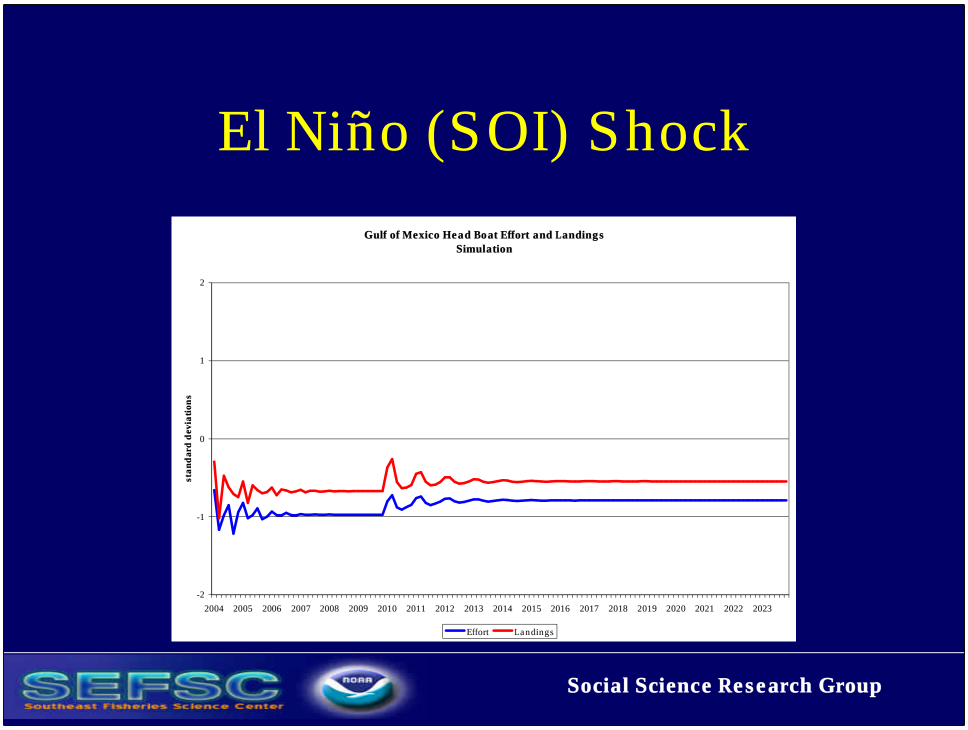
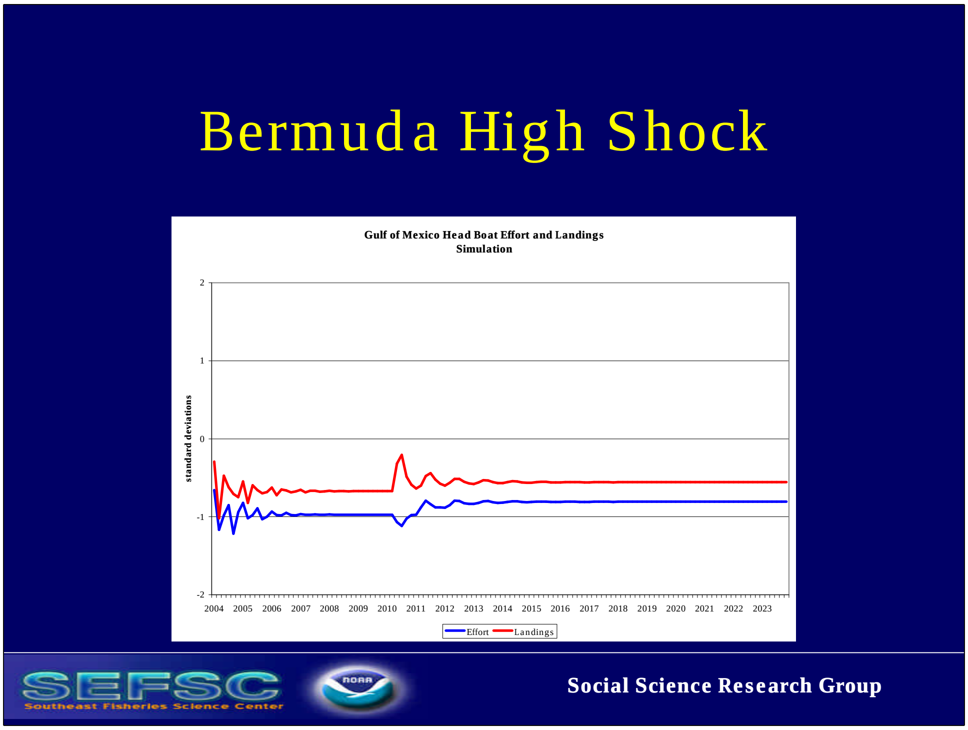
This data in this slide and the following slides were generated by initializing the model with effort and landings for waves 2003:2 – 6 as the first five lagged values and then simulating forward 20 years, setting the values of the climate and economy variables to their normalized mean (0) from 1986 to 2003. The regulations were fixed at the current levels.

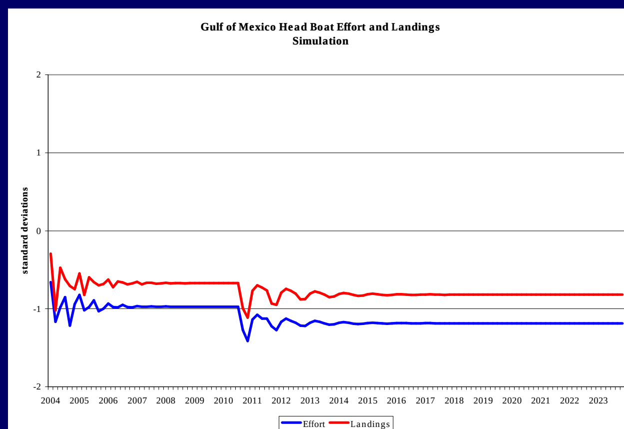


Two standard deviation decrease in the SOI for two waves (four months): 2009:6 and 2010:1. This corresponds with a cooler and wetter winter season in the Southeast.



Two standard deviation increase in the Bermuda high for two waves (four months): 2010:2 and 2010:3. This corresponds with a warmer and wetter spring season in the Southeast.

Hurricane (ACE) Shock



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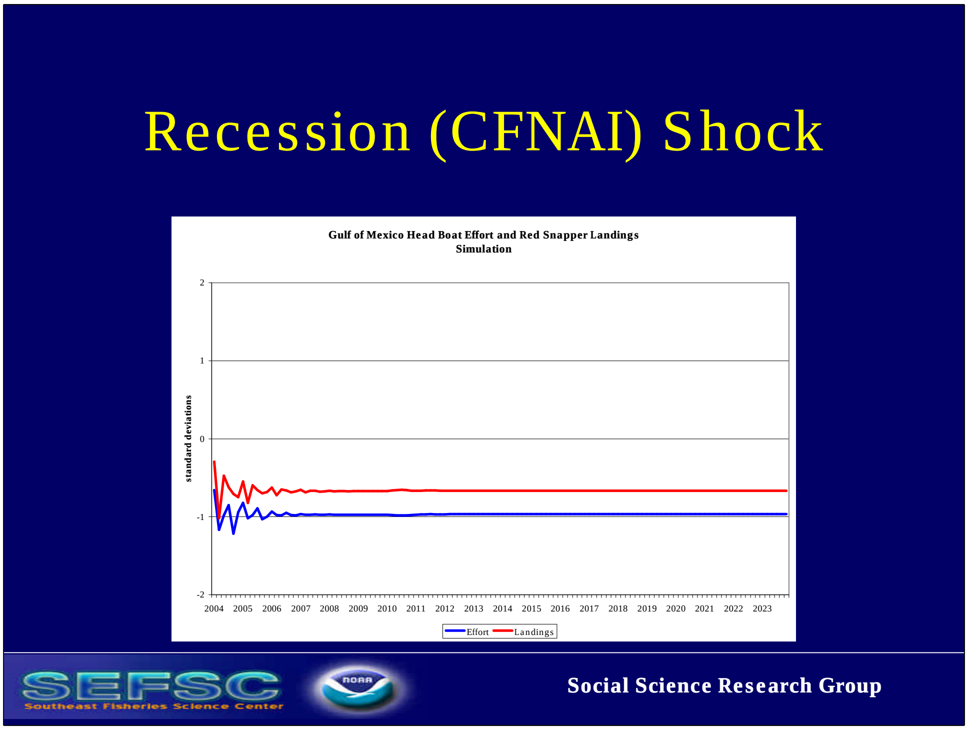
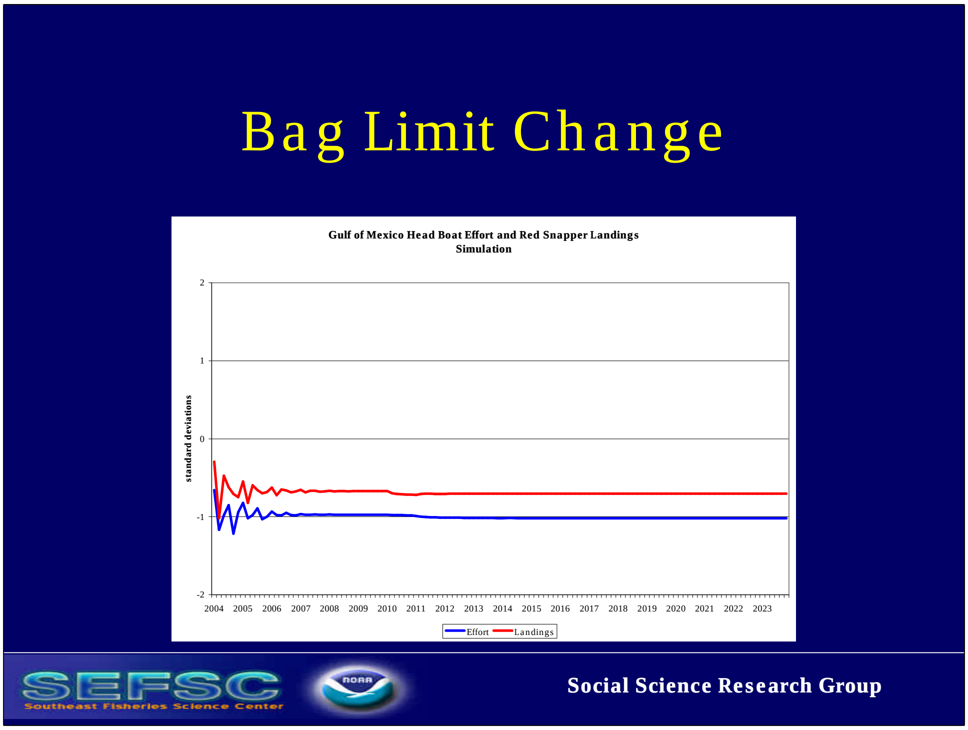
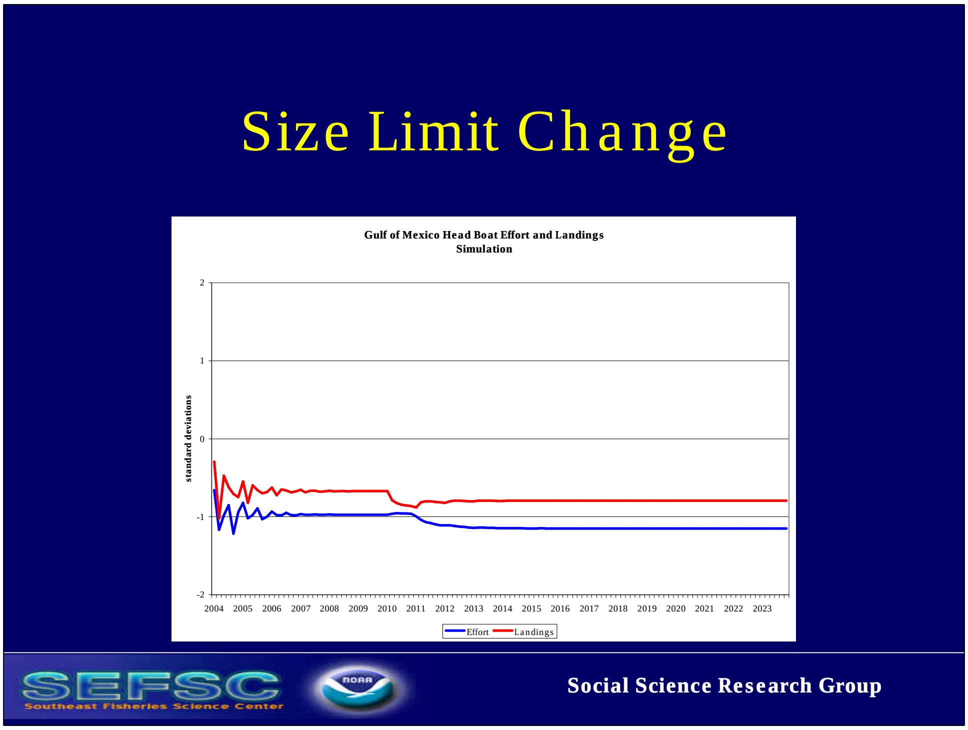
Two standard deviation increase in the ACE for two waves (four months): 2010:4 and 2010:5. This corresponds to more storms and hurricane activity during the fall season in the Southeast.



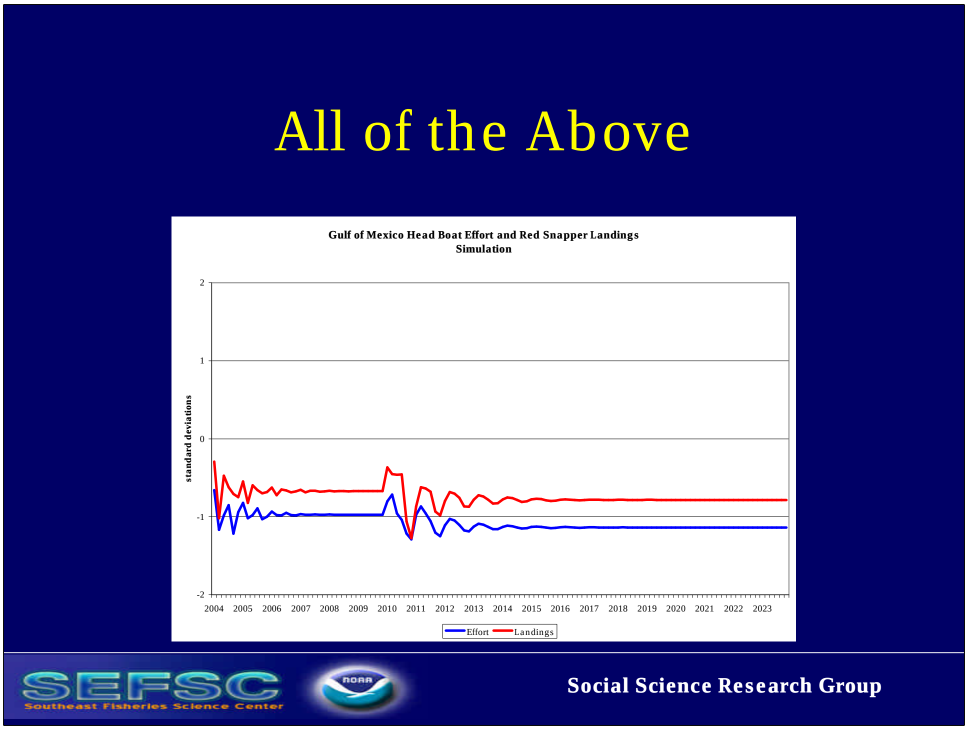
Three standard deviation decrease in the CFNAI_MA3 for four waves (eight months): 2010:1 and 2010:4. This corresponds with a recession in the U.S. economy.



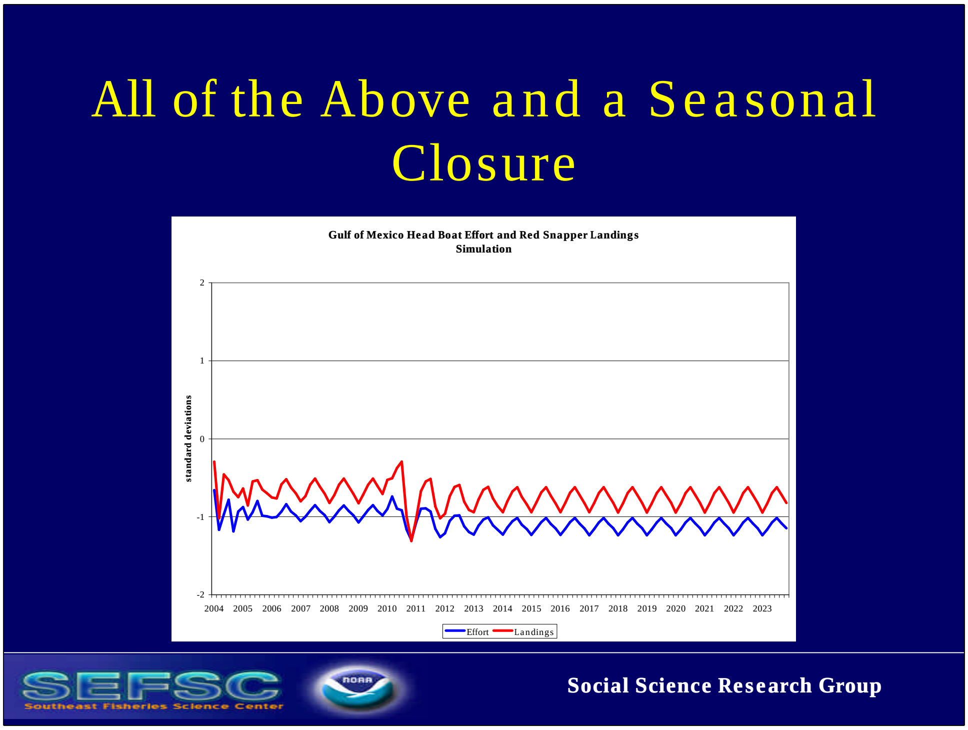
Decrease in the bag limit from four red snapper to one, beginning in wave one of 2010.



Increase in the red snapper minimum size limit from sixteen inches to nineteen, beginning in wave one of 2010.



All of the shocks in the previous slides combined.



All of the shocks in the previous slides combined with the current closed season, November1 through April20.

Discussion: General results

- Series are stationary, except:
  - Head boat effort and landings
  - Charter boat effort
- Climate signals are influential
- Economy index not influential
- Bag and size limits have mixed effectiveness

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Discussion: Interesting results

- El Niño contributes to more landings and effort
- Effort and red snapper landings are cointegrated in the head boat mode

Discussion: Future research

- Biomass and habitat indices
- Commercial landings
- Multiple species
- Micro data