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ROFFER'S OCEAN FISHING FORECASTING SERVICE, INC.

SECOORA and Fisheries Needs and Opportunities

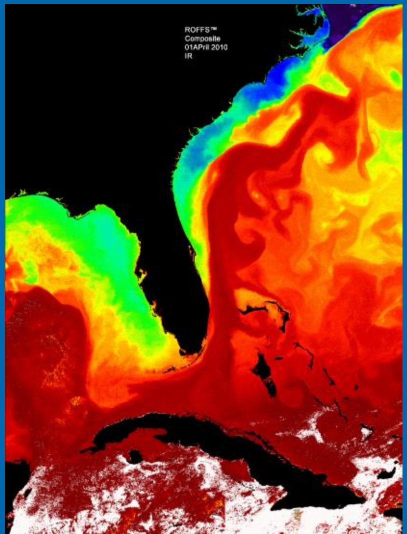
Mitchell A. Roffer (Ph.D.), President

Roffer's Ocean Fishing Forecasting Service, Inc.

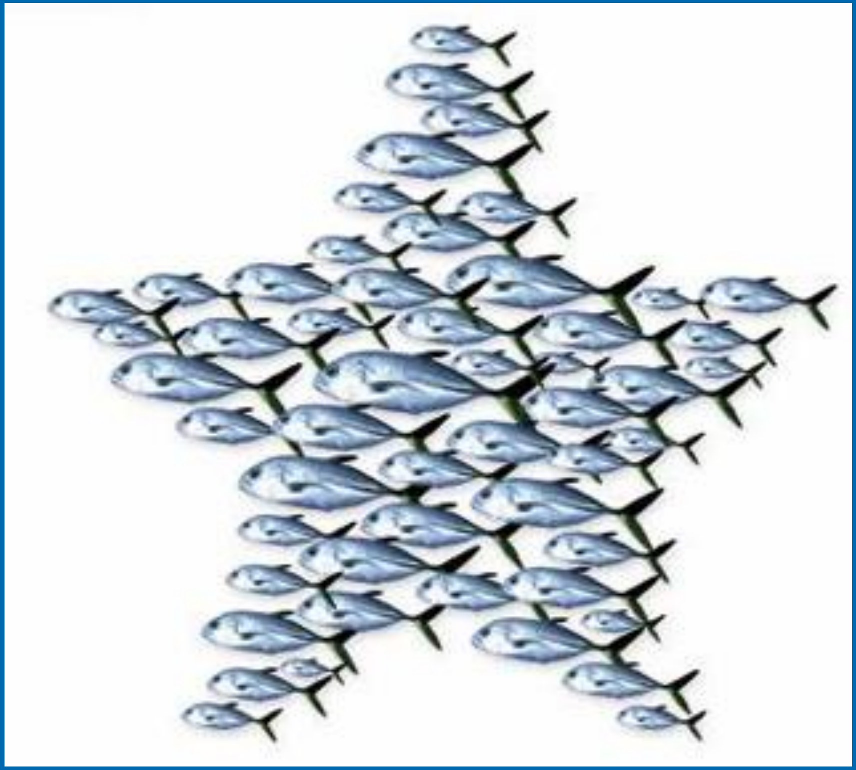
West Melbourne, Fl (WWW.ROFFS.COM)

With help from

Barbara Muhling (UM_CIMAS), Roger Pugliese (SAFMC), Marcel Reichert (SCDNR)



THANK YOU
SECOORA



WHAT IS ROFFS™

- FISHERIES OCEANOGRAPHERS THAT USE SATELLITE AND OTHER OCEANOGRAPHIC AND METEOROLOGICAL DATA TO PROVIDE DATA PRODUCTS FOR A VARIETY OF APPLICATIONS:
  - FISHERIES & AQUACULTURE
    - OPERATIONAL RECREATIONAL & COMMERCIAL FISHING
    - RESEARCH
      - DECISION MAKING TOOLS AND DATA FOR RESOURCE MANAGERS – IMPROVE/ENHANCE INFORMATION – STOCK ASSESSMENT
  - OIL & GAS INDUSTRY- SHIP ROUTING - MONITORING
  - HOMELAND SECURITY
    - SEARCH & RESCUE
    - HAZARDOUS MATERIALS ID & TRACKING
  - ENVIRONMENTAL PROTECTION
    - HAZARDOUS MATERIALS ID & TRACKING
    - ALGAE BLOOMS, E.G. RED TIDE
  - OTHER
    - LEGAL – FORENSIC OCEANOGRAPHY
    - ROUTING – SWIMMERS, BOARDERS, KAYAKERS, Other ?

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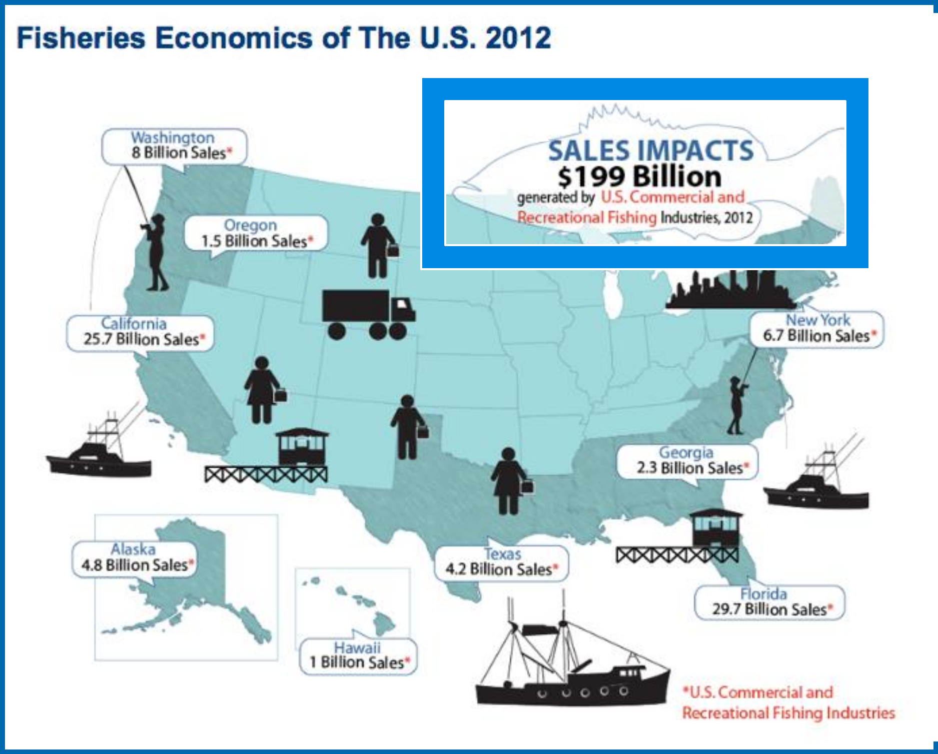
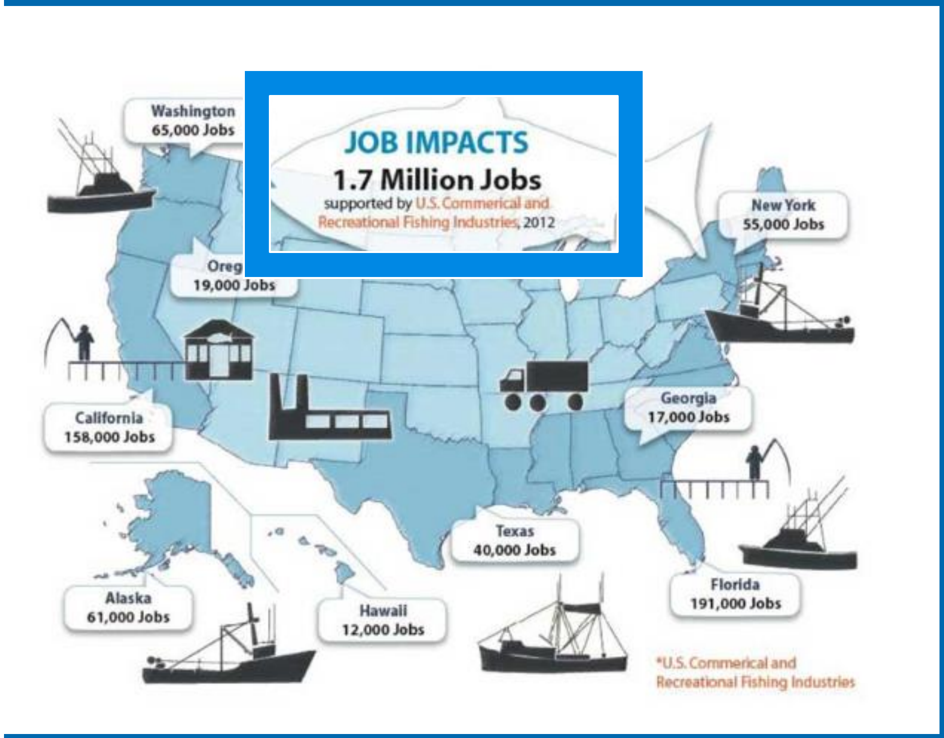
SEE WWW.ROFFS.COM

Why This Interest In Fisheries?

Money & Jobs & People





http://www.st.nmfs.noaa.gov/Assets/economics/documents/feus/2012/FEUS2012.pdf
http://www.st.nmfs.noaa.gov/economics/publications/feus/fisheries_economics_2012

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Food, Conservation & Ecosystem Health

See Appendix for more economic data

PURPOSE TODAY

Explore the Needs and Opportunities between SECOORA and the Fisheries Management Community.

1) South Atlantic Fishery Management Council
2) NOAA
   a) National Marine Fisheries Service
   b) National Marine Sanctuary Program
3) State Dept. Nat. Resources – Fish & Wildlife
4) U.S. National Park Service

5. U.S. Geological Service
6. Department of Interior
7. Office of Homeland Security
8. BOEM

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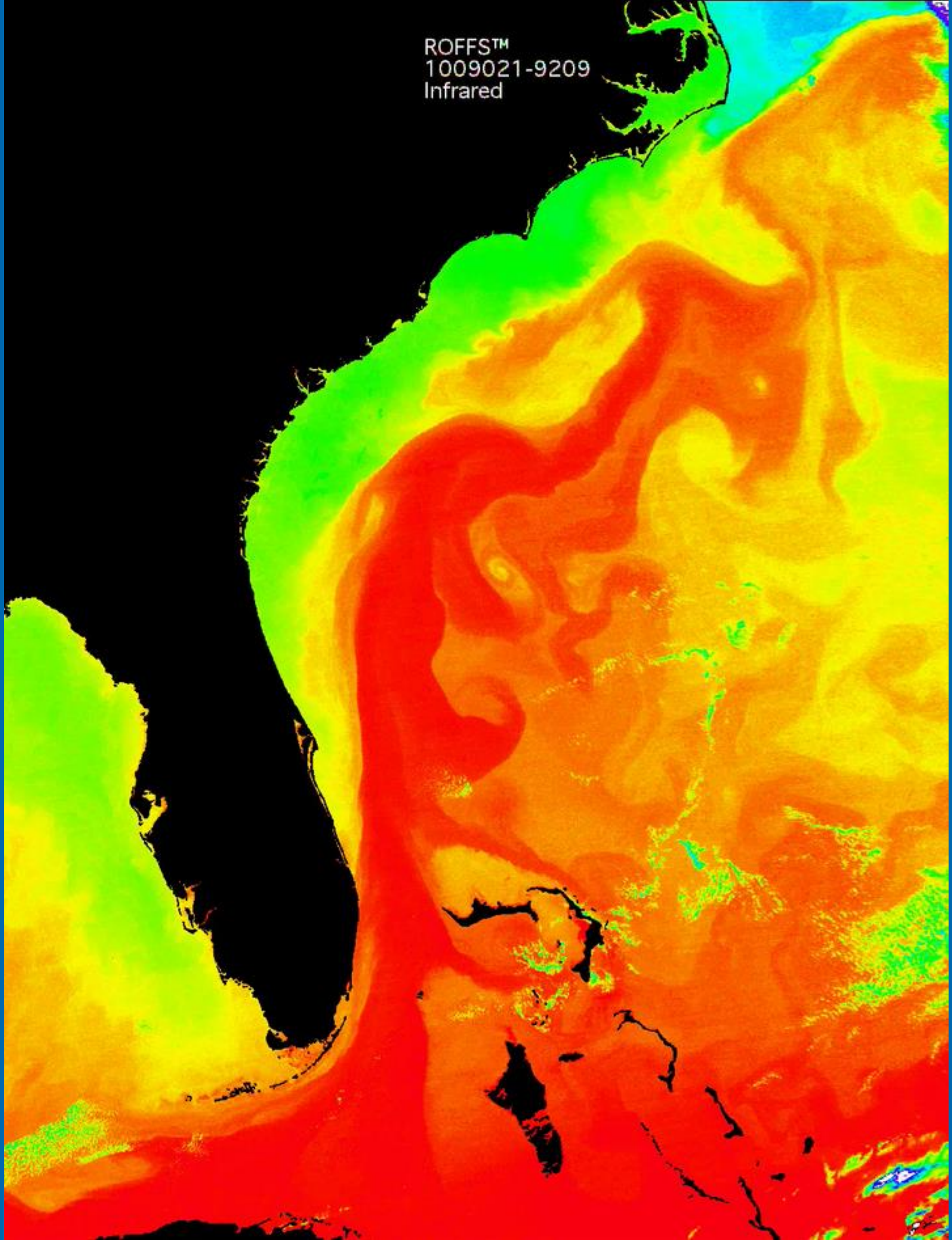


CONNECTIVITY
CONTINUITY
VARIABILITY

Inshore – Offshore
Regional

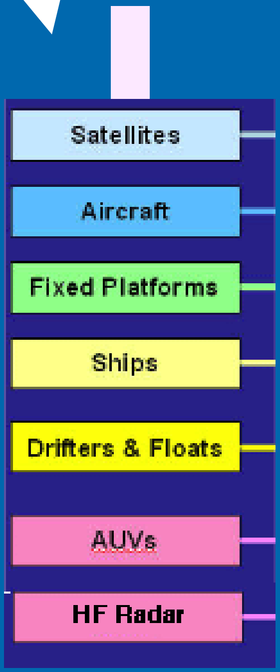
SURFACE CIRCULATION

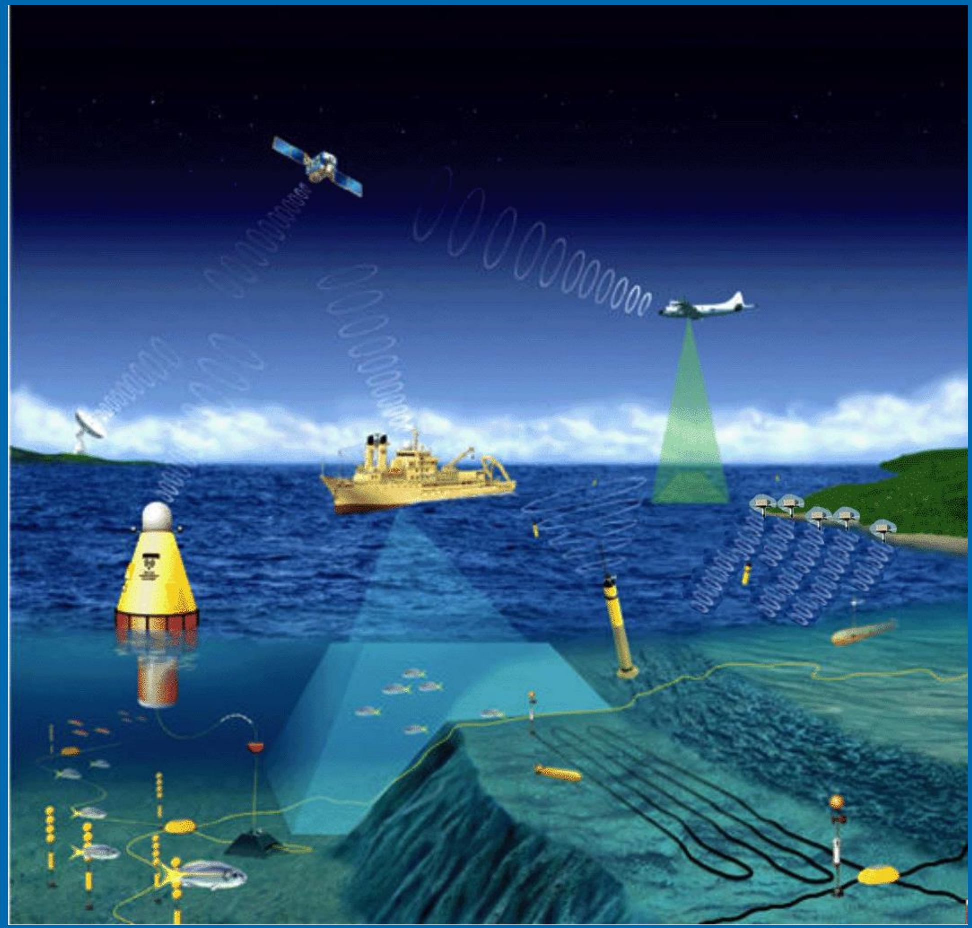
42 hrs. IR

SECOORA has Tools & Data & Expertise

"Integrated Ocean Observing System"

MAPPING - MONITORING - MODELING





Modified from http://ocean.us

Needs of Fisheries Management: Environmental Input

- **Fisheries are still largely managed under the assumption that oceanographic parameters do not change over time.**

In most stock assessments catchability (availability and vulnerability) is not quantified from varying environmental parameters.

Many functional (mechanistic) links between the ocean conditions and fish are not understood.

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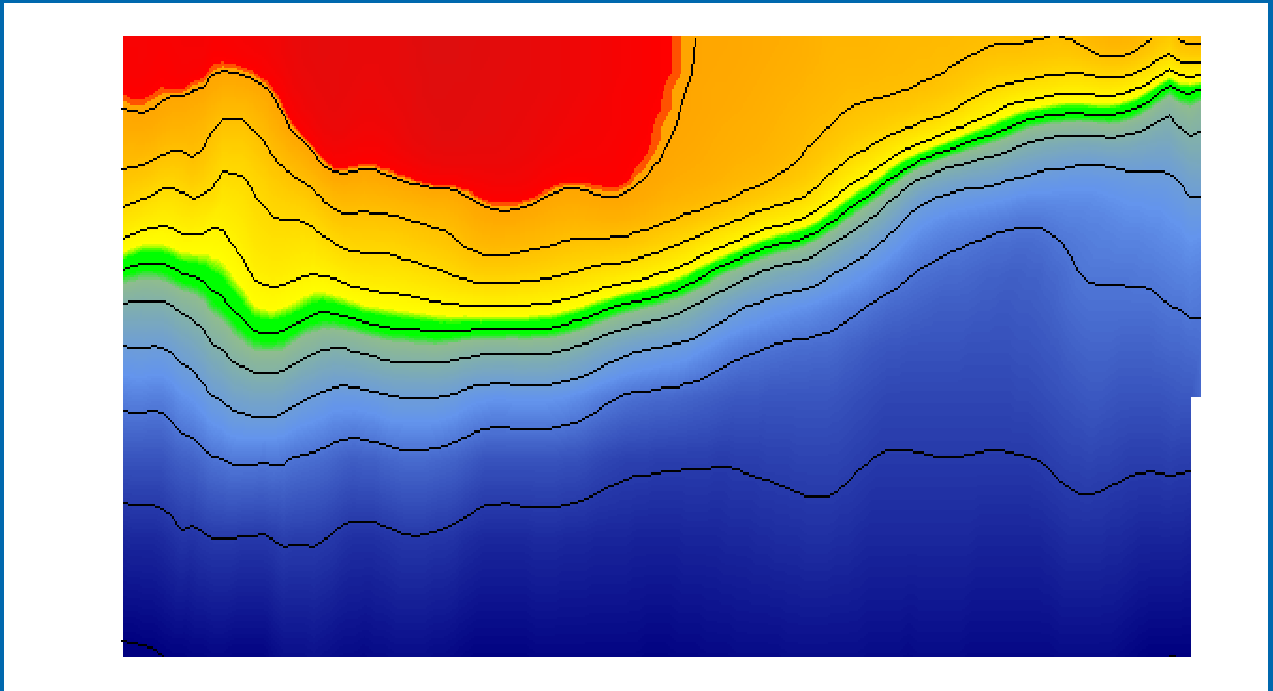
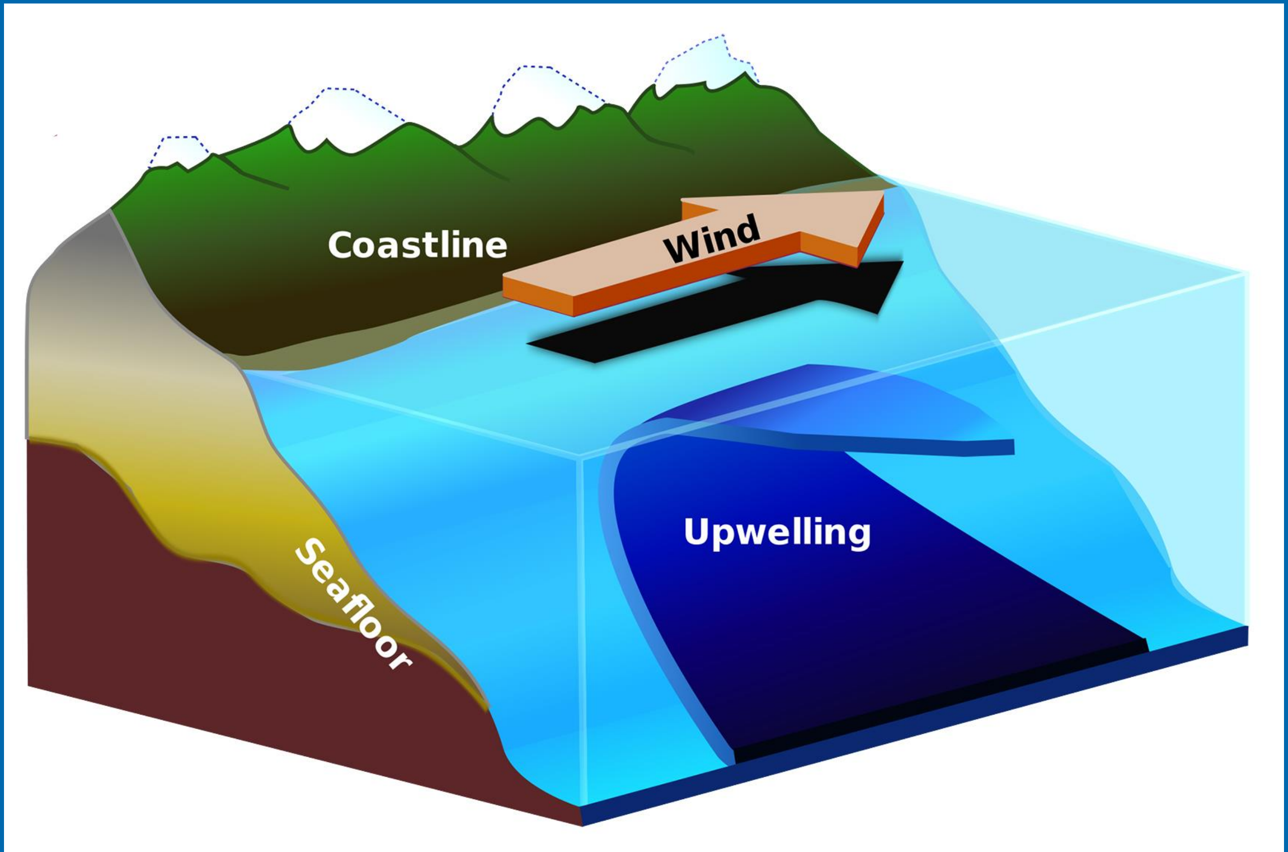
CATCHABILITY:
Where Is The Preferred Habitat?

- AVAILABILITY
  - ARE THEY WITHIN REACH?
- VULNERABILITY IN 3D
  - WILL YOU GEAR BE EFFECTIVE?



Classic ENSO & Catchability

Coastal and Other Upwellings Often Change Conditions Where Fish and Fisherman Occur



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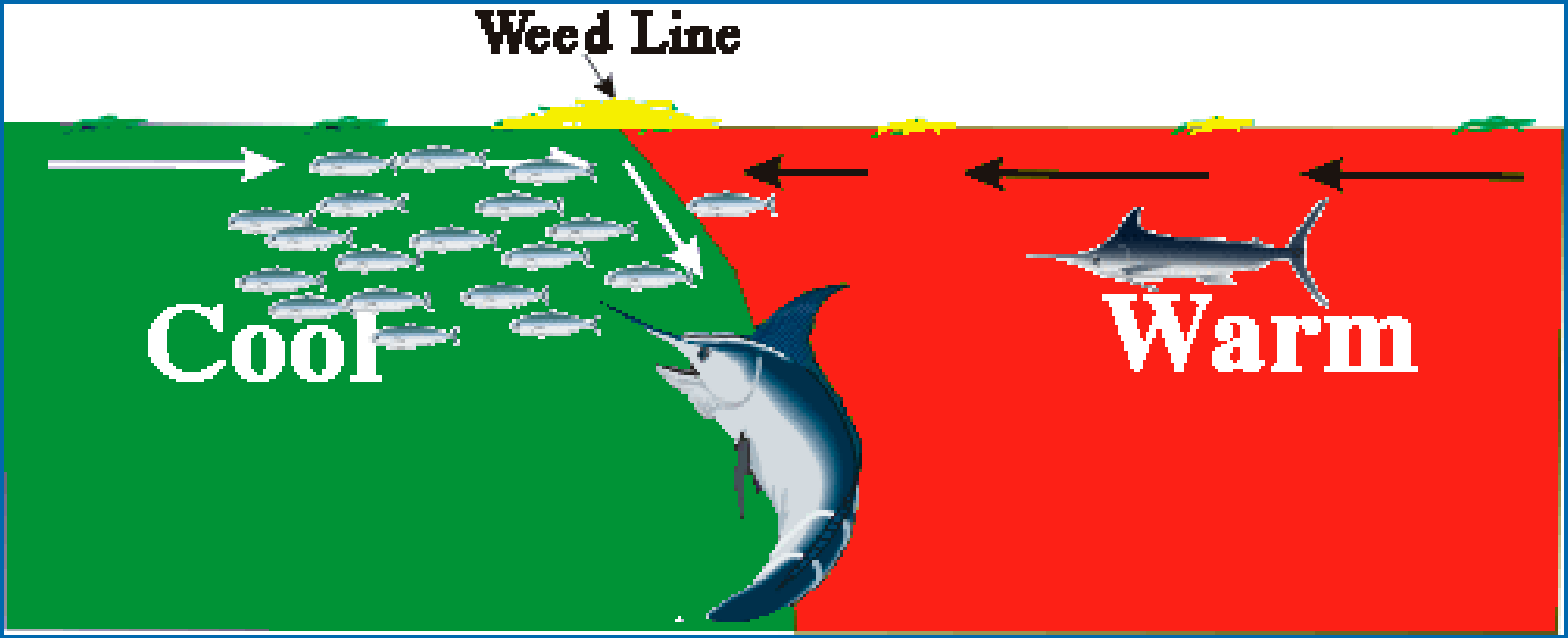
Coastal Upwelling- Ekman Transport

FISH CONCENTRATING MECHANISMS

OCEAN FRONTS AFFECTS CATCHABILITY



VARYING CONVERGENCE =VARYING CATCHABILITY

Strength, Persistence, Location

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SECOORA Can Help

- **Ecosystem Based Fisheries Management**

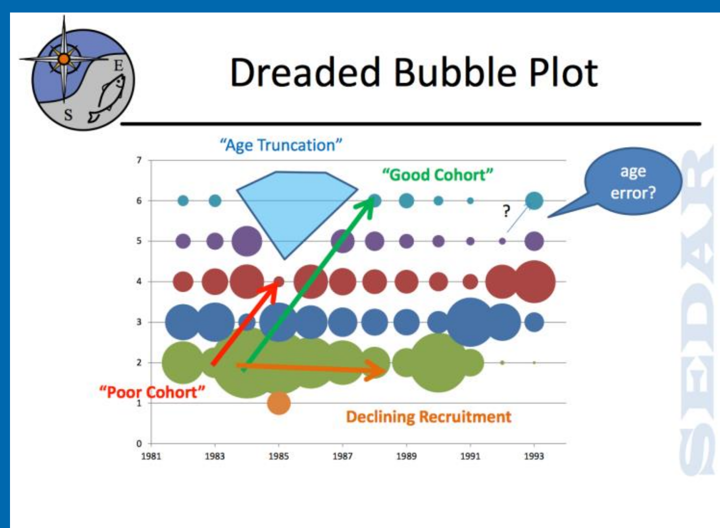
  1: Improved fisheries assessments;

  a. Catchability (availability and vulnerability)

  b. Recruitment (reproduction -> adults)

  2: Adaptive harvest management strategies;

  3: A better understanding of possible scenarios for future stock rebuilding under climate change.



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Biggest Management Need

Is Estimating Stock Abundance In a Varying Environment: SECOORA Can Help Resulting In

1) Improved adult spawning stock size estimates
2) Improved understanding of reproduction and recruitment processes.
   Includes location & timing spawning grounds, larval drift and these will change over time?
3) Understanding apparent changes in distribution.
4) Understanding varying fishing and natural mortality.
5) Using varying catchability in assessment calculations

Involves studying entire life cycle which is complicated by age/size/sex specific physiological requirements – behavior.
Involves finding functional relationships

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Introduction to Fisheries Data

- Fisheries Dependent
  - Landings
  - Statistical Surveys
- Complicated issues of fishery dependent data
  -Varying gear, varying techniques, varying management rules on size, amount, season, varying effort, economics (price too low, fish too far -> not fishing), efficiency of captain/crew, …..

Major Issue

- **Location of Catch**
  - Presently management in the southeast does not require fishermen to report the location of the effort and catch with resolutions that would facilitate the use of much of the high resolution environmental data often needed to determine relationships between the fish and the environment.
    - Other regions have vessel monitoring systems.

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Mitch and others think **This has got to change…….**

To Overcome Location Issue

- Cooperative fishing research programs
  - Range from official observers on ships to joint projects working on vessels.
- Use lower resolution catch data to achieve one's goals
  - a) Perhaps some recruitment studies
  - b) Large scale trends in catch
  - c) Other
    - **Use Fisheries Independent Data From Dedicated Research**

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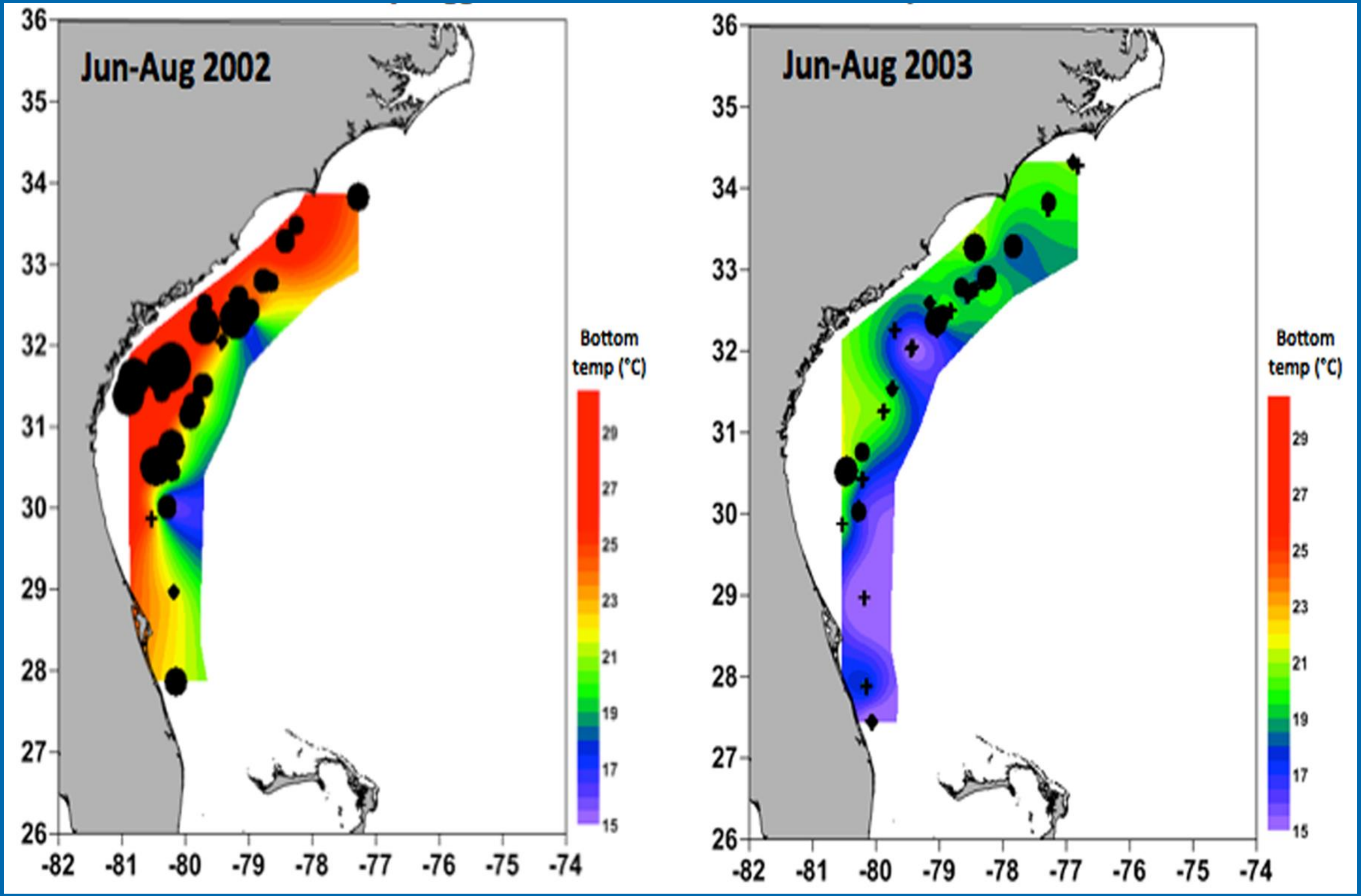
Developing Data Products Derived From Satellite And *In Situ* Observations For Fisheries Stock Assessment

- **PI: Mitchell A. Roffer,** Roffer's Ocean Fishing Forecasting Service, Inc. (ROFFS™) West Melbourne, FL
- **Co-I: Barbara Muhling,** University of Miami Cooperative Institute for Marine and Atmospheric Studies (CIMAS), Miami, FL
- **Co-I: Roger Pugliese,** South Atlantic Fishery Management Council (SAFMC), Charleston, SC
- **Other I: Marcel Reichert, Tracey Smart, Joseph Ballenger,** Marine Resources Monitoring, Assessment and Prediction, South Carolina Department of Natural Resources (SCDNR-MARMAP), Charleston, SC- 1° as Data Providers

Fishery independent Chevron bottom trap survey by SCDNR-MARMAP

Triggerfish and Bottom Temperature



This is important when trying to understand changes in catch rate which are used to derive indices of abundance and <u>illustrated the need to provide quantitative indices of the habitat derived from ocean observations for catch standardization in stock assessment process</u>

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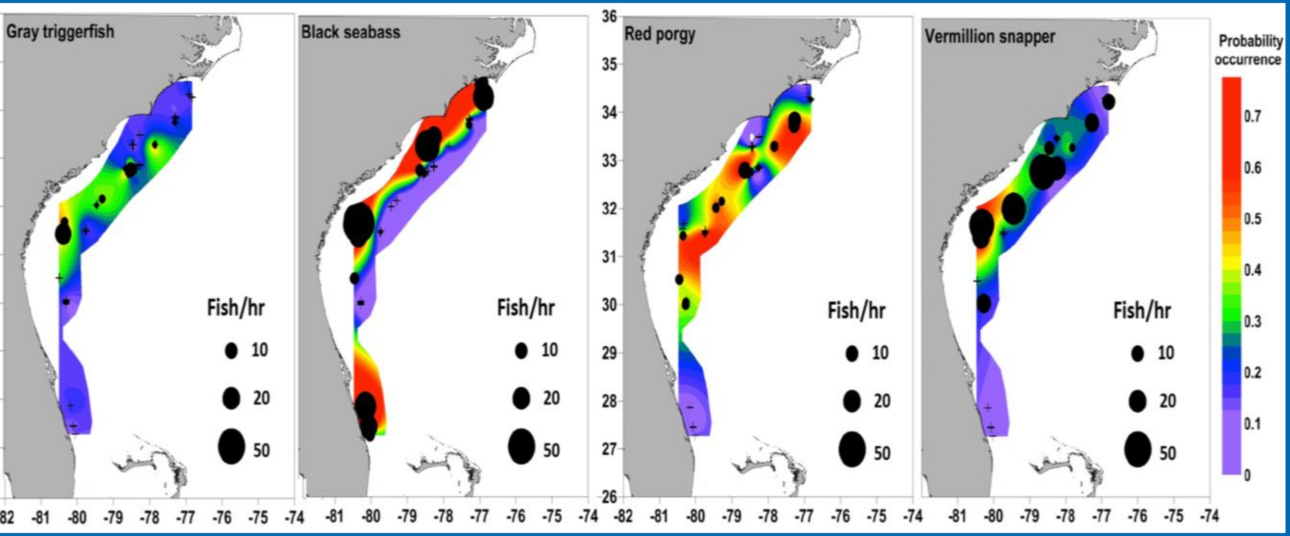
Habitat Model from MARMAP Chevron Fish Trap Data (1990-2008)



Catch June – Aug 2008 Shows good fit

Yields quantitative Index of catchability

Gray Triggerfish		Black Seabass		Red Porgy		Vermillion Snapper	
Variable	*Importance*	*Variable*	*Importance*	*Variable*	*Importance*	*Variable*	*Importance*
Bottom temperature	100	Water depth	100	Water depth	100	Longitude	100
Latitude	76.1	Longitude	16.2	Latitude	50.4	Water depth	97.9
Water depth	56.8	Latitude	9.8	Longitude	42.7	Latitude	85.6
Date	29.0	Date	5.4	Date	10.2	Bottom temperature	82.3
Predator biomass	26.4	Surface temperature	4.4	Time	7.8	Date	39.2
Longitude	23.2	Predator biomass	3.1	Surface temperature	7.5	Wind speed	38.0
Soak duration	16.5	Time	2.3	Moon phase	7.4	Time	31.9

Positional variables Sampling variables Environmental variables Biological variables

Ocean Sciences 2014 Habitat Modeling and Ecosystem Based Resource Management (157)

Breece, M. W.; Oliver, M. J.; Dunton, K. J.; Fox, D. A.. USING SATELLITES AND AUVS IN AN INTEGRATED OCEAN OBSERVATORY TO IDENTIFY ATLANTIC STURGEON HABITAT

Muhling, B.; Walter, J.; Lamkin, J.; Roffer, M.; Li, Y.. HABITAT MODELING FOR HIGHLY MIGRATORY ATLANTIC FISH SPECIES: APPLICATIONS AND CHALLENGES

Danner, E.; Chao, Y.; Chai, F.; Chavez, F.; Nisbet, R.. FROM RIVERS TO THE OCEAN: USING HABITAT MODELS TO UNDERSTAND AND PREDICT VARIATIONS IN CENTRAL CALIFORNIA SALMON

Alabia, I. D.; Saitoh, S.; Igarashi, H.; Ishikawa, Y.; Awaji, T.. EFFECTS OF ENVIRONMENTAL AND CLIMATE VARIABILITY ON SUMMER POTENTIAL HABITAT OF NEON FLYING SQUID IN CENTRAL NORTH PACIFIC

Rincón-Díaz, M. P.; Ortíz-Rosa, S.; Gould, W. A.. IDENTIFYING SUITABLE HABITATS FOR THE RED HIND GROUPER (EPINEPHELUS GUTTATUS) IN THE PUERTO RICAN ARCHIPELAGO BASED ON THE STRUCTURAL COMPLEXITY OF HABITATS

Anderson, M. R.; Gregory, R. S.. STATIC AND DYNAMIC HABITAT FEATURES AS DETERMINANTS OF COD RECRUITMENT OFF NEWFOUNDLAND

Winship, A. J.; Rankin, R. W.; Kinlan, B. P.; Caldow, C.. PREDICTIVE HABITAT MODELING OF MARINE BIRD DISTRIBUTIONS TO INFORM SPATIAL PLANNING AND RISK ASSESSMENT

Georgian, S. E.; Shedd, W.; Cordes, E. E.. RESOLVING BIOGEOGRAPHIC PATTERNS IN THE DEEP SEA: USING REMOTELY SENSED DATA TO PREDICT THE LOCATIONS OF SPATIALLY RARE BUT ECOLOGICALLY VITAL CORALS

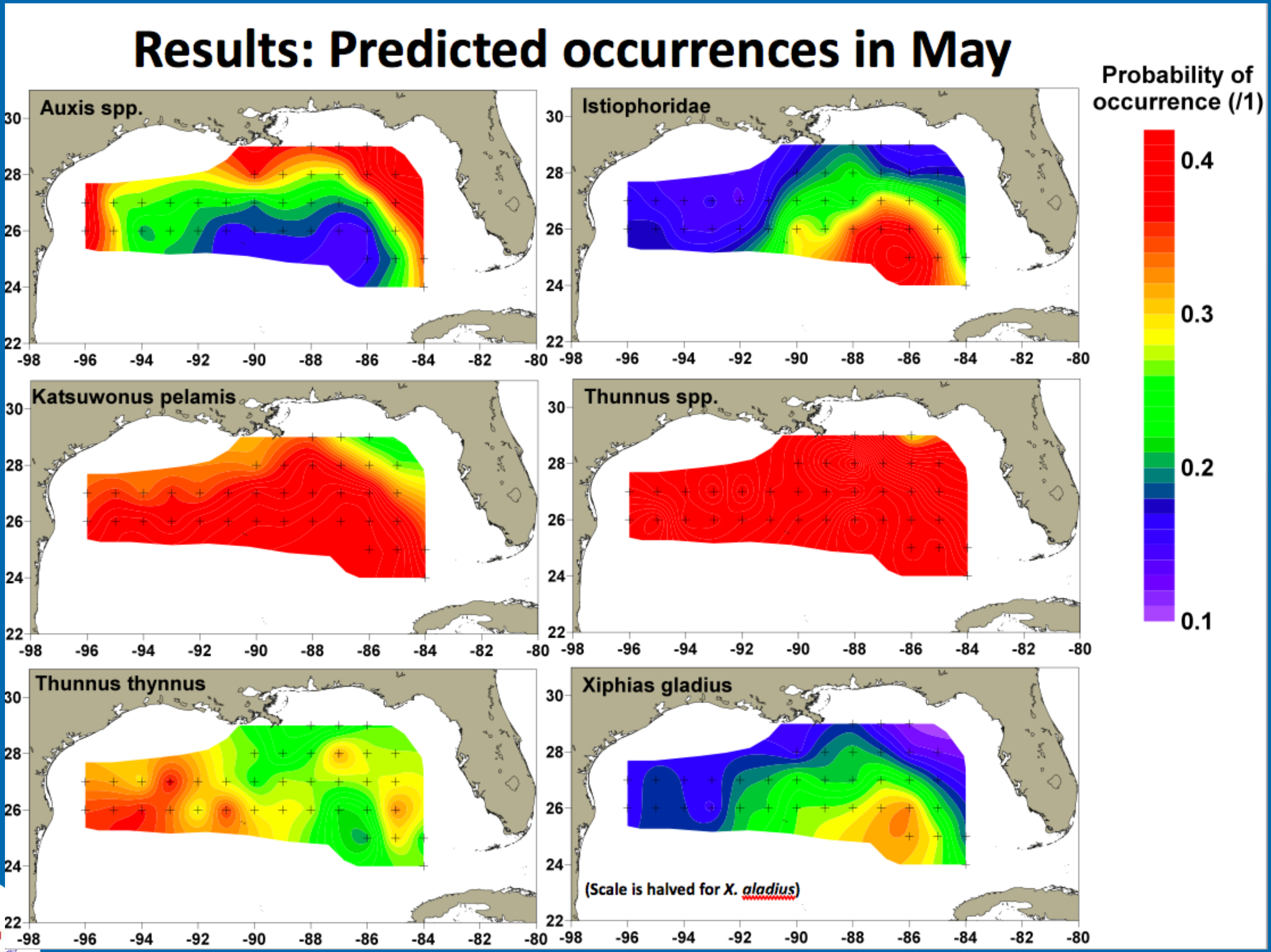
Briscoe, D. K.; Best, B. D.; Peckham, S. H.; Foley, D. G.; Lavaniegos, B.. PREDICTIVE HABITAT USE OF JUVENILE LOGGERHEAD SEA TURTLES (CARETTA CARETTA) OFF BAJA CALIFORNIA, MEXICO

Spillman, C. M.; Hobday, A. J.; Hartog, J. R.; Eveson, P.. DYNAMICAL SEASONAL FORECASTING TO SUPPORT THE MANAGEMENT OF WILD SOUTHERN BLUEFIN TUNA FISHERIES IN AUSTRALIA

Almodovar Acevedo, L.; Hasan, M.; Townsend, H. M.; Stevens, B. G.. DEVELOPING A HABITAT SUITABILITY MODEL FOR BLACK SEA BASS IN THE CHESAPEAKE BAY

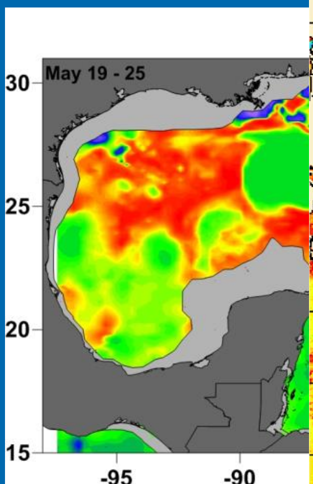
Xu, B.; Zhang, C.; Xue, Y.; Ren, Y.; Chen, Y.. OPTIMIZATION OF SAMPLING EFFORT FOR A FISHERY-INDEPENDENT SURVEY WITH MULTIPLE OBJECTIVES

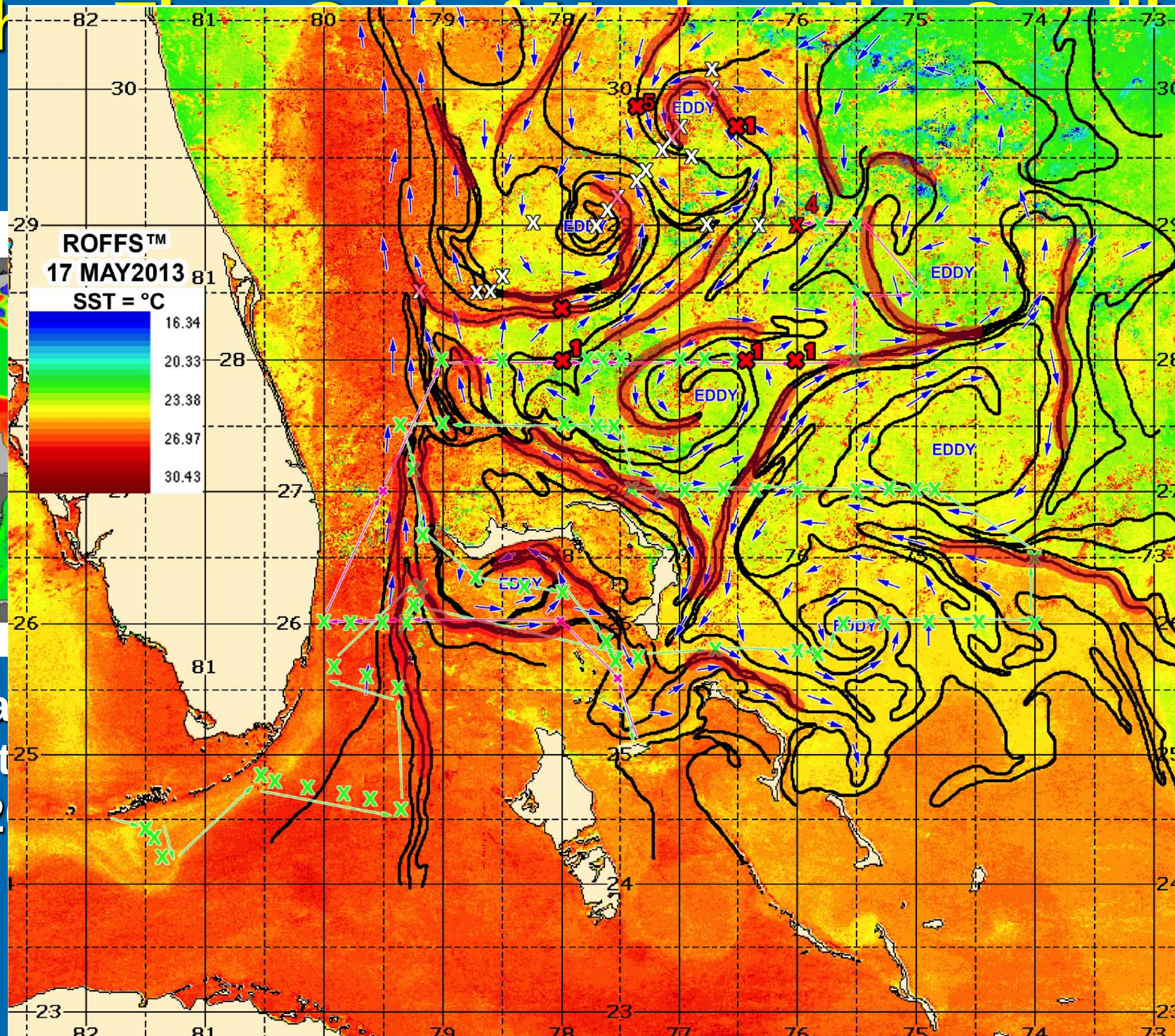
LARVAE HABITAT MODELING

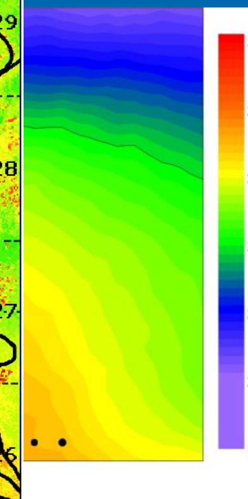


Muhling et. al. from a joint NASA – NOAA project

Use of Habitat Models for Directed Sampling: Finding Alternative Spawning Areas
Oth e







ABT larvae ha
(satellites + ot
May 19-25, 2

7-2012

Lamkin et. al., 2014

Possible SECOORA Subjects

- **Stock assessments**
  - Varying catchability
    - Impact of environmental change on species distributions and sp.-sp. Relationships.
- **Recruitment studies**
  - Spawning area and timing
  - Larval drift
  - Forecasting new year class strength

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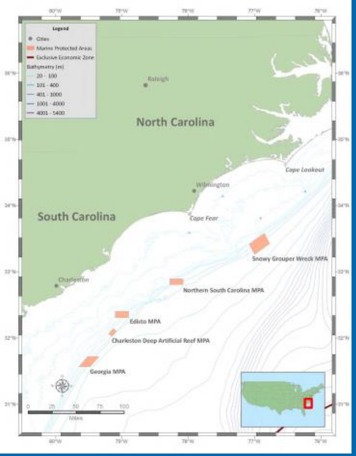
Other Important Needs



- **Marine Protected Areas**
- **Essential Fish Habitat**
- **Habitats of Particular Concern**
- **Special Management Zones**

Physio-biogeochemical Characterization needed for
Selecting areas
Monitoring areas
Evaluating Effectiveness

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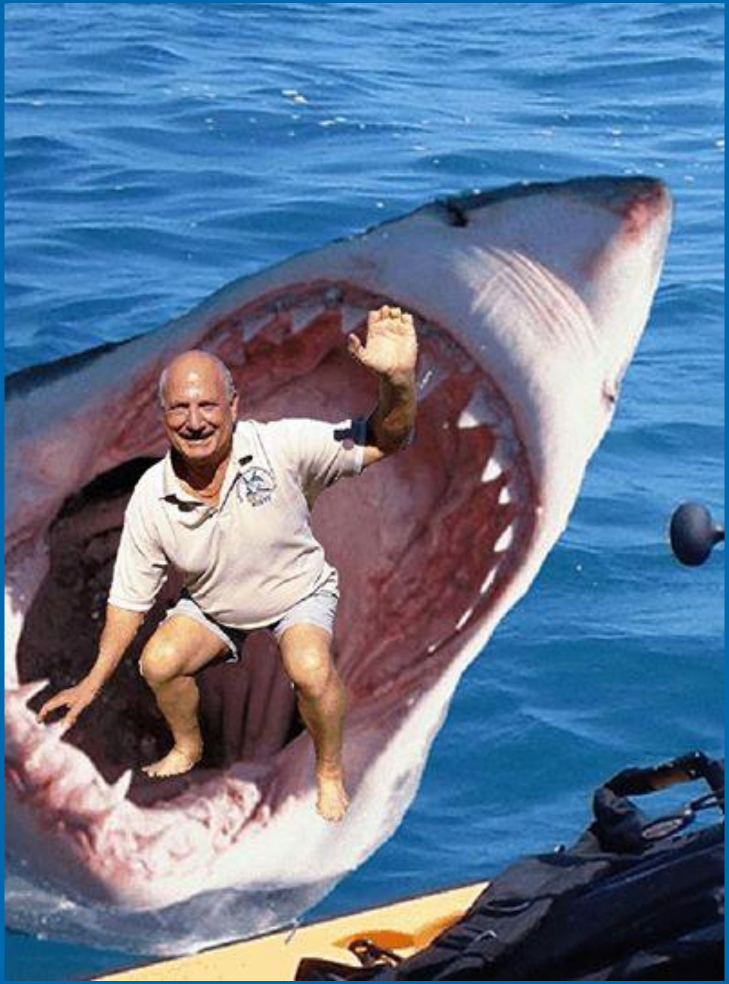
Marine Organisms Can Help Us Collect Data
Just Use Imagination



Godzilla

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Using Marine Organisms

- Use of animals to provide obs. - data.
  - Heat capacity using whale sharks or turtles to carry CTDs to provide obs.
    - <u>Animals that surface with GPS</u>
  - Marine birds have been used.



SECOORA - Partner with Fishermen

- Have Knowledge: Source of Information
- Catch Data at Usable Resolutions
- Fisherman as Observers of Conditions/events
- Observations -> Data
- Fisherman's Network of Obs. & Information
- Deployment, work, recovery of equipment

There are grants for this!

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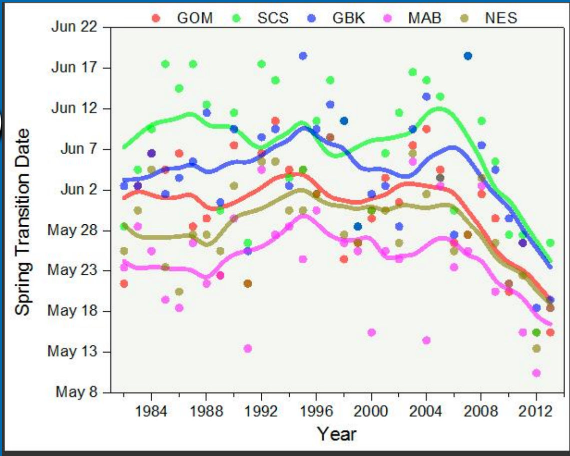
Other Interesting Projects: SECOORA Can Fill Need Statistics Over Time

- Spring & Winter Transition Dates
- Start-End-Duration of Fishing Seasons
  - User Defined
- Number & Frequency of "Extreme Events"
  - Tropical Storms are Obvious
  - Weather - Wind Events
    - Strength, DeltaT°, Duratio
    - Upwelling, cold outbreaks



Spring thermal transition date.

http://nefsc.noaa.gov/ecosys/advisory/current/thermal_trans.htm

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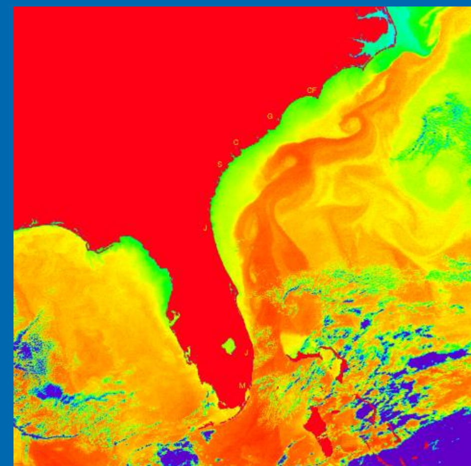
Effects number of trips

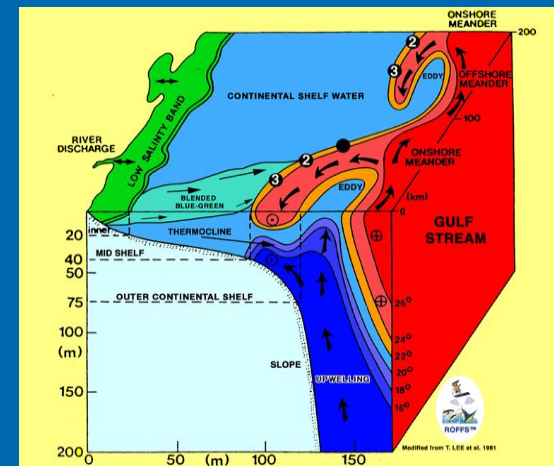
All Affect Catch

Surface and Subsurface Considerations

Importance of Gulf Stream & Eddies

- **Need statistics**
  - **Mean**
  - **Anomalies**





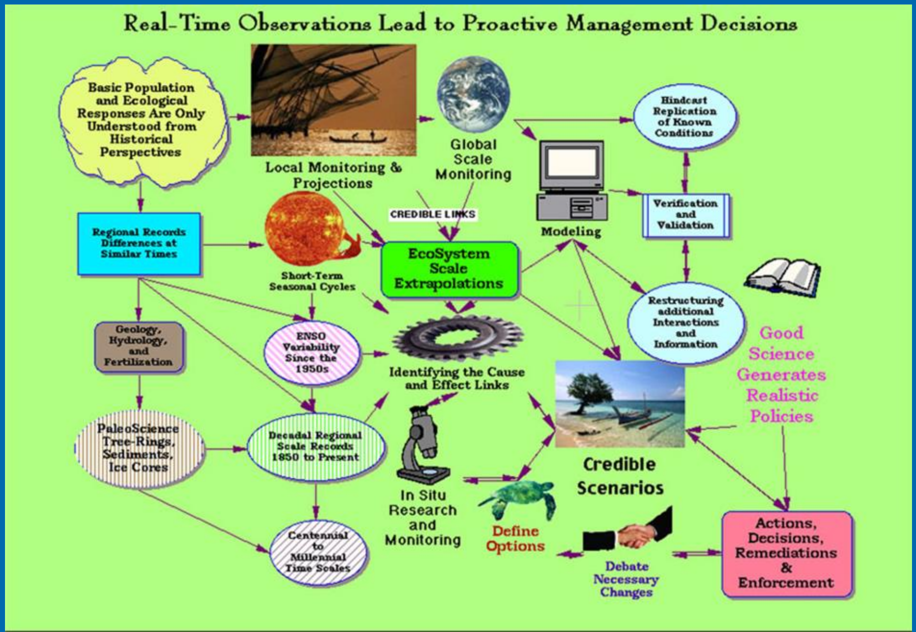
Need a reliable, accurate, ensemble of physical models to be linked biogeochemical models.

NCSU SABGOM is a great start

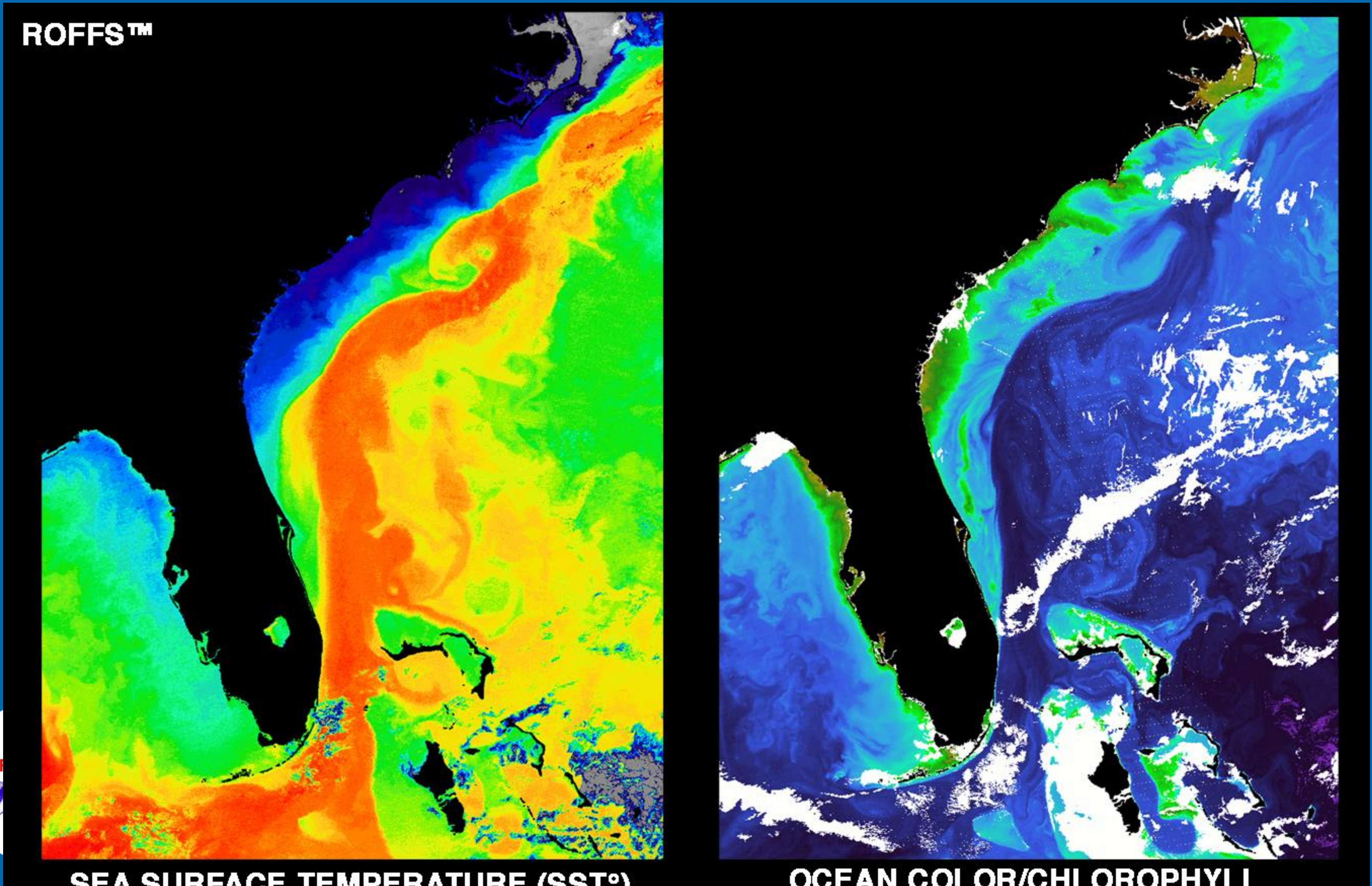
PI Ruoying He

Ecosystem Based Resource Management
Fishery Ecosystem Plan II

- **Navigating Management and Governance Complexity in a Changing Environment**
  - http://www.mafmc.org/council-events/2014/east-coast-climate-change-and-fisheries-governance-workshop
  - Managing fish that move from one management region to the next
- **Modeling Marine Resource Ecosystems**



Thank You & Questions



Appendix

- **See following pages**

Key South Atlantic Region Commercial Species

- Blue crab
- Clams
- Flounders
- Groupers
- King mackerels
- Oysters
- Shrimp
- Snappers
- Swordfish
- Tunas

Commercial Fisheries Facts

Landings revenue

- On average, between 2003 and 2012, the key species or species groups accounted for 78% of total revenue, generating $122 million in the South Atlantic Region.
- Shrimp had higher landings revenues than any other species or species group, averaging $44 million in landings revenue from 2003 to 2012.
- Swordfish had the largest one-year increase in landings revenue over the 10 year time period, increasing 56% from $2.8 million in 2006 to $4.3 million in 2007.
- Shrimp had the largest one-year decrease in landings revenue over the 10 year time period, decreasing 35% from $51 million in 2008 to $33 million in 2009.

Landings

- Key species or species groups contributed an average of 60% annually to total landings between 2003 and 2012.
- Blue crab contributed the most to landings in the region, averaging 41 million pounds from 2003 to 2012.
- Oysters had the largest one-year increase in landings over the 10 year time period, increasing 53% from 938,000 in 2009 pounds to 1.4 million pounds in 2010.
- Shrimp had the largest one-year decrease in landings over the 10 year time period, decreasing 39% from 26 million pounds in 2004 to 16 million pounds in 2005.

Recreational Fisheries

In 2012, there were approximately 11 million recreational saltwater anglers across the U.S. who took 72 million saltwater fishing trips around the country. These anglers spent $4.6 billion on fishing trips and $20 billion on durable fishing-related equipment. These expenditures contributed $58 billion in sales impacts to the U.S. economy, generated $30 billion in value added impacts, and supported over 381,000 job impacts.

Of the U.S. key recreational species or species groups, seatrout (52 million fish), and Atlantic croaker and spot (31 million fish) were the most often caught by recreational saltwater anglers in 2012.

U.S. Summary

Jobs supported by the U.S. Recreational Fishing Industry (2012)

State	Jobs	State	Jobs
West Florida	75,268	South Carolina	4,095
East Florida	34,073	Washington	3,794
North Carolina	18,202	New York	2,959
Louisiana	16,972	Oregon	2,958
Texas	13,944	Georgia	2,787
New Jersey	13,131	Rhode Island	1,794
California	12,134	Maine	1,664
Virginia	8,143	Mississippi	1,649
Alabama	7,501	Delaware	1,242
Massachusetts	6,942	Hawai'i	1,171
Maryland	5,683	Connecticut	1,137
Alaska	4,824	New Hampshire	442

The greatest employment impacts from expenditures on recreational angling were generated in West Florida with 75,000 jobs, followed by East Florida (34,000 jobs), North Carolina (18,000 jobs), and Louisiana (17,000 jobs). The lowest number of jobs were supported in New Hampshire (442 jobs). The highest sales impacts from expenditures on recreational angling were also generated in West Florida with $9.1 billion in sales, followed by East Florida ($4 billion), Louisiana ($2 billion), and New Jersey ($2 billion). The lowest sales were generated in New Hampshire ($48 million).

Total Sales generated by the U.S. Recreational Fishing Industry (2012)

(thousands of dollars)

State	Sales	State	Sales
West Florida	9,142,920	Washington	494,583
East Florida	4,007,766	South Carolina	383,622
Louisiana	1,964,494	New York	381,299
New Jersey	1,888,249	Oregon	325,880
North Carolina	1,867,621	Georgia	298,791
Texas	1,719,709	Rhode Island	192,367
California	1,701,218	Maine	163,679
Massachusetts	848,039	Connecticut	148,140
Virginia	834,499	Mississippi	143,890
Alabama	691,547	Hawai'i	139,142
Maryland	637,237	Delaware	117,752
Alaska	558,078	New Hampshire	47,926

Participation[1]

Nationwide, there were 11 million recreational saltwater anglers who fished in their home states in 2012. Approximately 9.4 million of these anglers were residents of a U.S. coastal county and 1.6 million anglers were residents of a non-coastal county.

Economic Impacts[1]

In this report, the U.S. seafood industry includes the commercial harvest sector, seafood processors and dealers, seafood wholesalers and distributors, importers, and seafood retailers. In 2012, this industry supported approximately 1.3 million full- and part-time jobs and generated $141 billion in sales impacts, $39 billion in income impacts, and $59 billion in value added impacts.

Commercial Economic Impacts Trends for the United States
(thousands of dollars)

	2009	2010	2011	2012
Jobs	1,029,542	1,196,683	1,233,204	1,270,141
Income	31,556,643	36,269,724	36,568,695	38,721,983
Sales	116,224,548	133,135,986	129,386,335	140,660,993
Value Added	48,282,319	55,434,189	55,321,482	59,017,417
Total Revenue	3,926,583	4,528,964	5,335,522	5,099,456

Seafood retailers, which generated the largest job and value added impacts, contributed 610,000 jobs, $32 billion in sales impacts, $12.9 billion in income, and $17.6 billion in value added impacts to the national economy in 2012. The seafood import sector, which generated the largest sales impacts, contributed 207,000 jobs, $57 billion in sales impacts, over $9 billion in income, and $17.3 billion in value added impacts. Wholesalers and distributors constituted the smallest of the seafood industry sectors and contributed 57,000 jobs, almost $8 billion in sales, $2.6 billion in income, and $3.5 billion in value added impacts to the national economy.

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South Atlantic Region FMPs

1. Coastal migratory pelagic resources (with GMFMC)
2. Coral, coral reef and live/hardbottom habitat
3. Dolphin/wahoo (with MAFMC and NEFMC)
4. Golden crab
5. Pelagic Sargassum habitat
6. Shrimp
7. Snapper grouper
8. Spiny lobster (with GMFMC)

Of the stocks or stock complexes covered in these fishery management plans, four are currently listed as overfished: red grouper, red porgy, red snapper, and snowy grouper. Seven stocks or stock complexes are currently subject to overfishing: black sea bass, gag, red grouper, red snapper, snowy grouper, speckled hind, and warsaw grouper.

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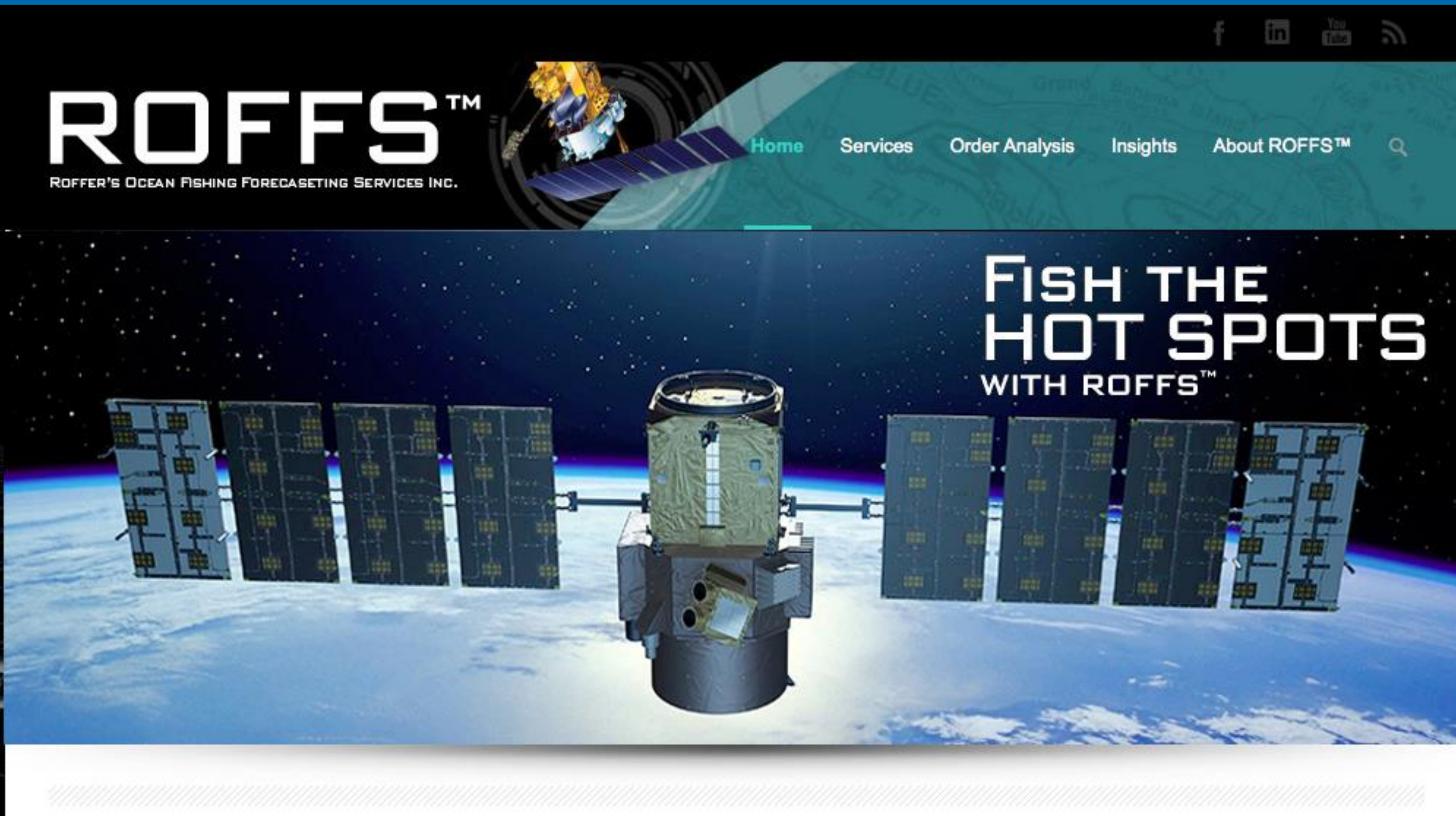
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