DEVELOPMENT OF AN OCEAN CLIMATE DECISION SUPPORT SYSTEM FOR PREDICTING CATCH IN PELAGIC FISHERIES

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INTRODUCTION

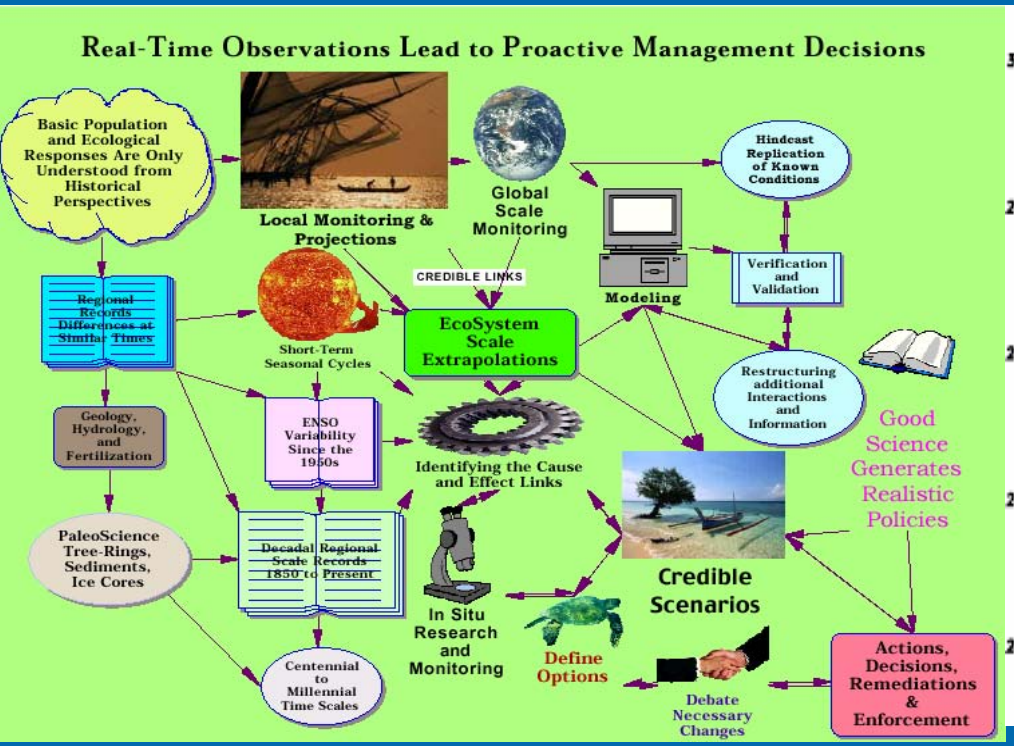
- THE ABILITY TO DIFFERENTIATE BETWEEN APPARENT CHANGES IN STOCK SIZE MEDIATED BY CHANGES IN FISHING MORTALITY AND NATURAL MORTALITY COMPARED WITH CHANGES IN CATCHABILITY (q) MEDIATED BY ENVIRONMENTAL VARIABILITY IS CRITICAL FOR FISHERIES MANAGEMENT.
  - E.G. GOOD CATCH = HIGH ABUNDANCE OR IS IT HABITAT AVAILABLE TO FISH & LOCAL FISHERS ?
  - BAD CATCH: IS IT A DECLINE IN ABUNDANCE OR LACK OF AVAILABILITY OR VULNERABILITY ?

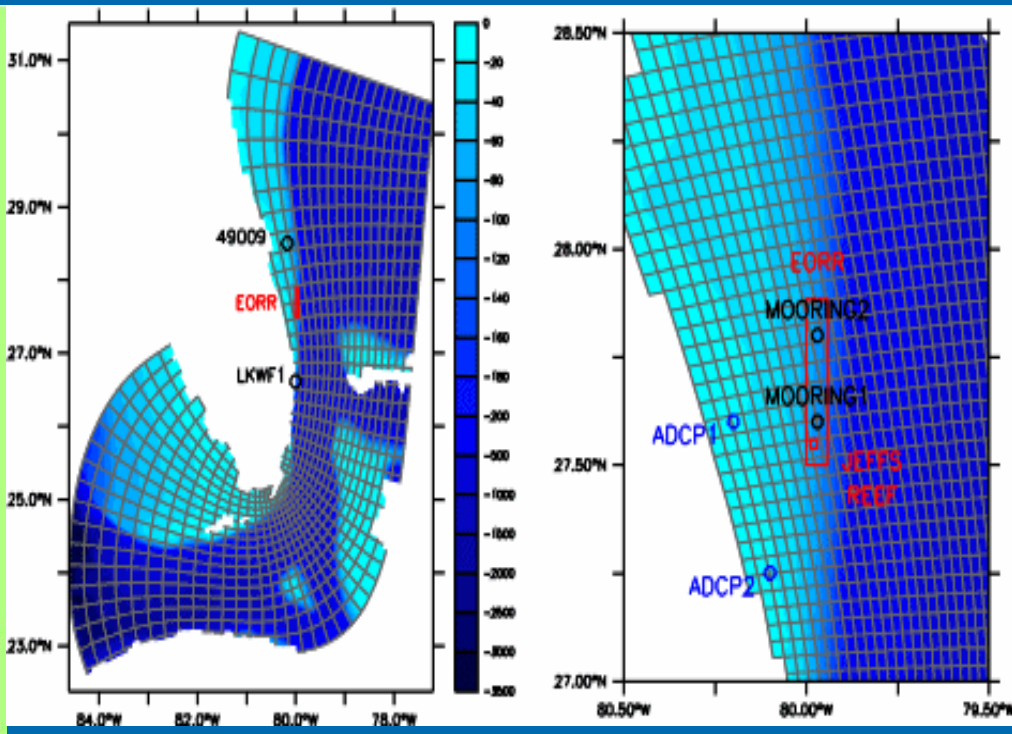
PENULTIMATE GOAL

- DEVELOP BETTER DECISION SUPPORT TOOLS FOR FISHERIES MANAGERS AND POLICY MAKERS THAT INCORPORATE OCEANOGRAPHIC OBSERVATIONS.
  - REAL-TIME, RETROSPECTIVE
- ESTABLISH A PRACTICAL AND OPERATIONAL DEFINITION FOR "ESSENTIAL FISH HABITAT"
  - A DIGITAL, GEO-SPATIAL CHARACTERIZATION OF OCEAN CIRCULATION FEATURES IN 3D.

ULTIMATE GOAL

DEVELOP DECISION SUPPORT SYSTEMS FROM ACCURATE & RELIABLE (OVER TIME) BIO-PHYSICAL PREDICTIVE MODELS

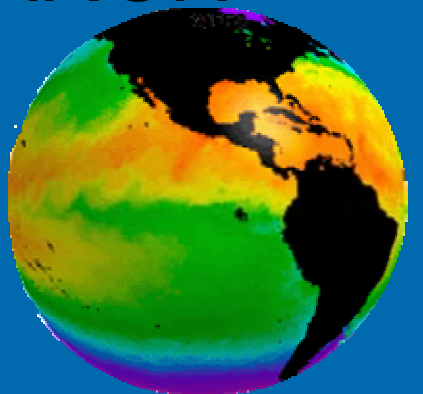




SHORTER-TERM GOALS

PRESSING SCIENCE QUESTIONS

- DEVELOP FUNCTIONAL RELATIONSHIPS BETWEEN THE FISH AND THEIR ENVIRONMENT
  - OBSERVABLE FROM SATELLITES
- DEVELOP AUTOMATED TOOLS THAT ONE CAN USE WITH LARGE DATA BASES FOR CLIMATE RESEARCH

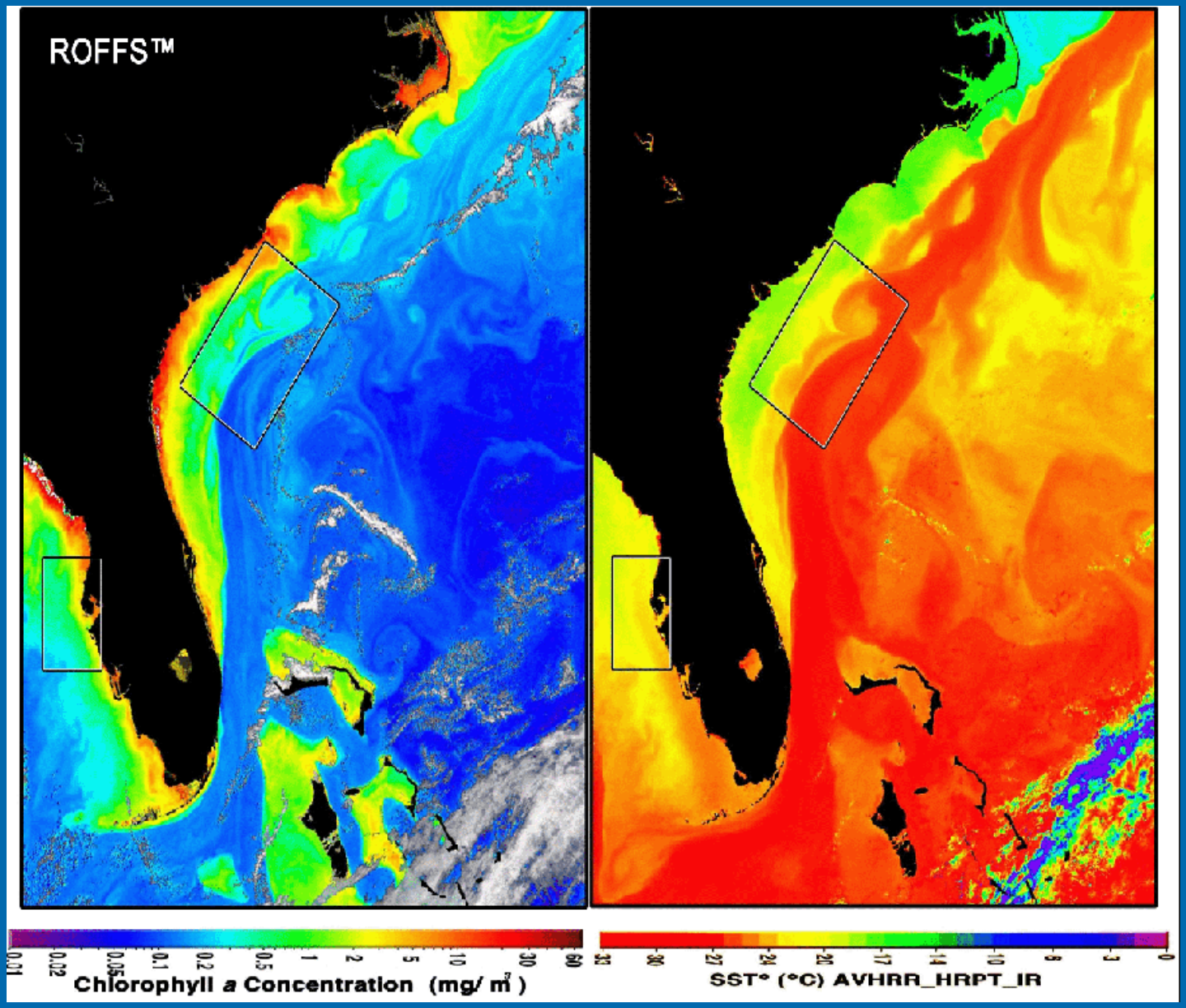


TODAY

- BLUE MARLIN (MAKAIRA NIGRICANS)
  - BAHAMAS
- ☒ DOLPHINFISH (*Coryphaena hippurus*)
  - SOUTH CAROLINA, USA
- ☒ KING MACKEREL (*Scombermorus cavalla)*
  - TAMPA, FLORIDA, USA
- KING MACKEREL, SARDINE (*Sardinella aurita)*, & GAG GROUPER (*Mycteroperca microlepis)*
  - SOUTHWEST FLORIDA COAST

Some results of a three year study to determine which environmental parameters can be used to forecast the effects of climate variability on dolphin fish or mahimahi (Coryphaena hippurus) and king mackerel (scombermorus cavalla) in the oceanic waters off South Carolina and coastal waters off Tampa, Fl, respectively.

STUDY AREAS


ROFFS™
0.01
0.02
0.05
0.1
0.2
0.5
1
2
5
10
30
60
Chlorophyll a Concentration (mg/ m³)
33
30
27
24
20
17
14
10
6
3
0
SST° (°C) AVHRR_HRPT_IR

SPECIES

DOLPHIN FISH
Coryphaena hippurus

KING MACKEREL
Scombermorus cavalla

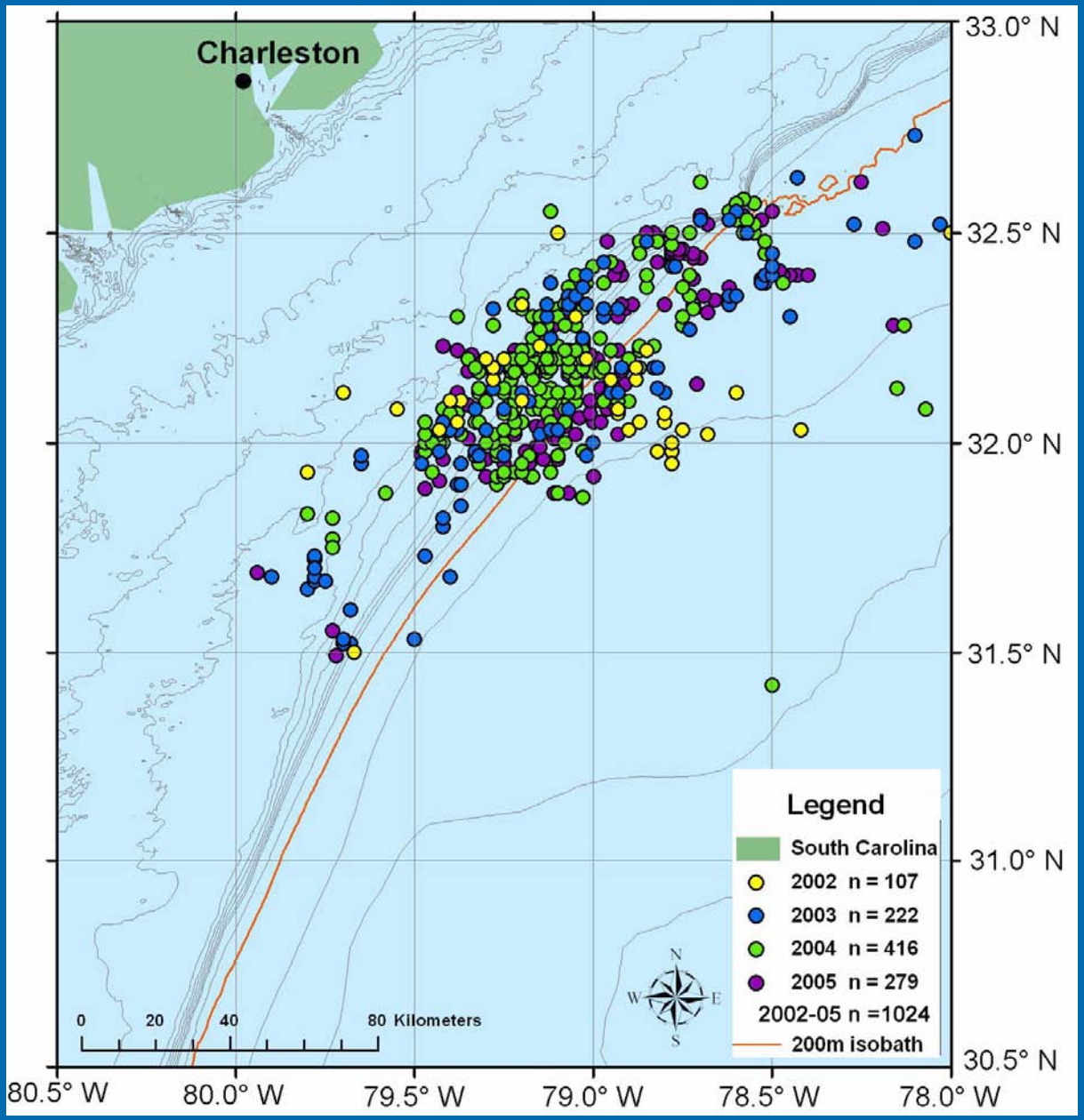
OCEANIC MIGRATORY VS COASTAL MIGRATORY

FISH ART

STEVE GOIONE AND CAREY CHEN

COMMERCIAL AND RECREATIONAL INDUSTRIES

MAHI TAGGING 2002-2005



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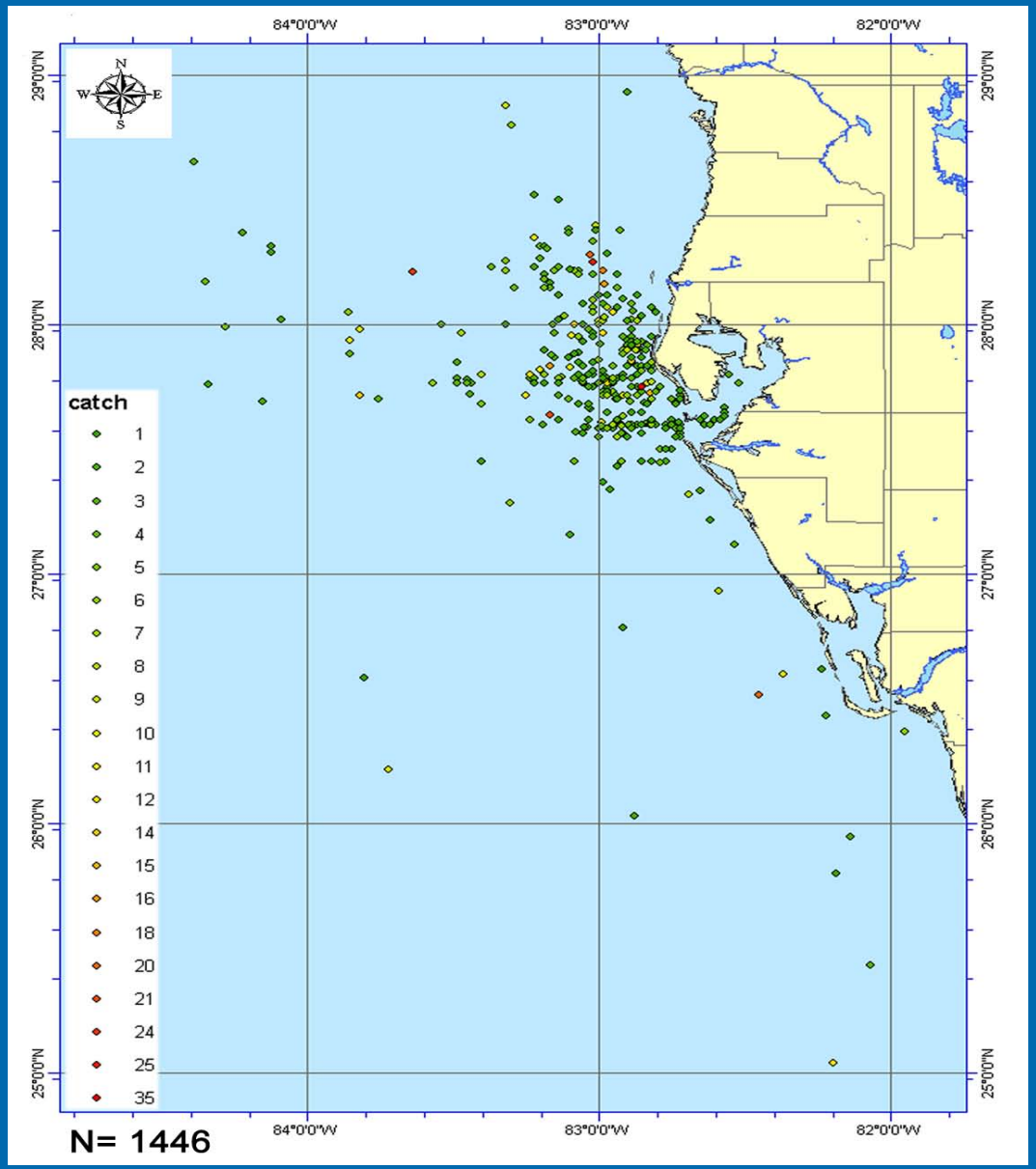
COMBINED 2004 KING MACKEREL CATCH



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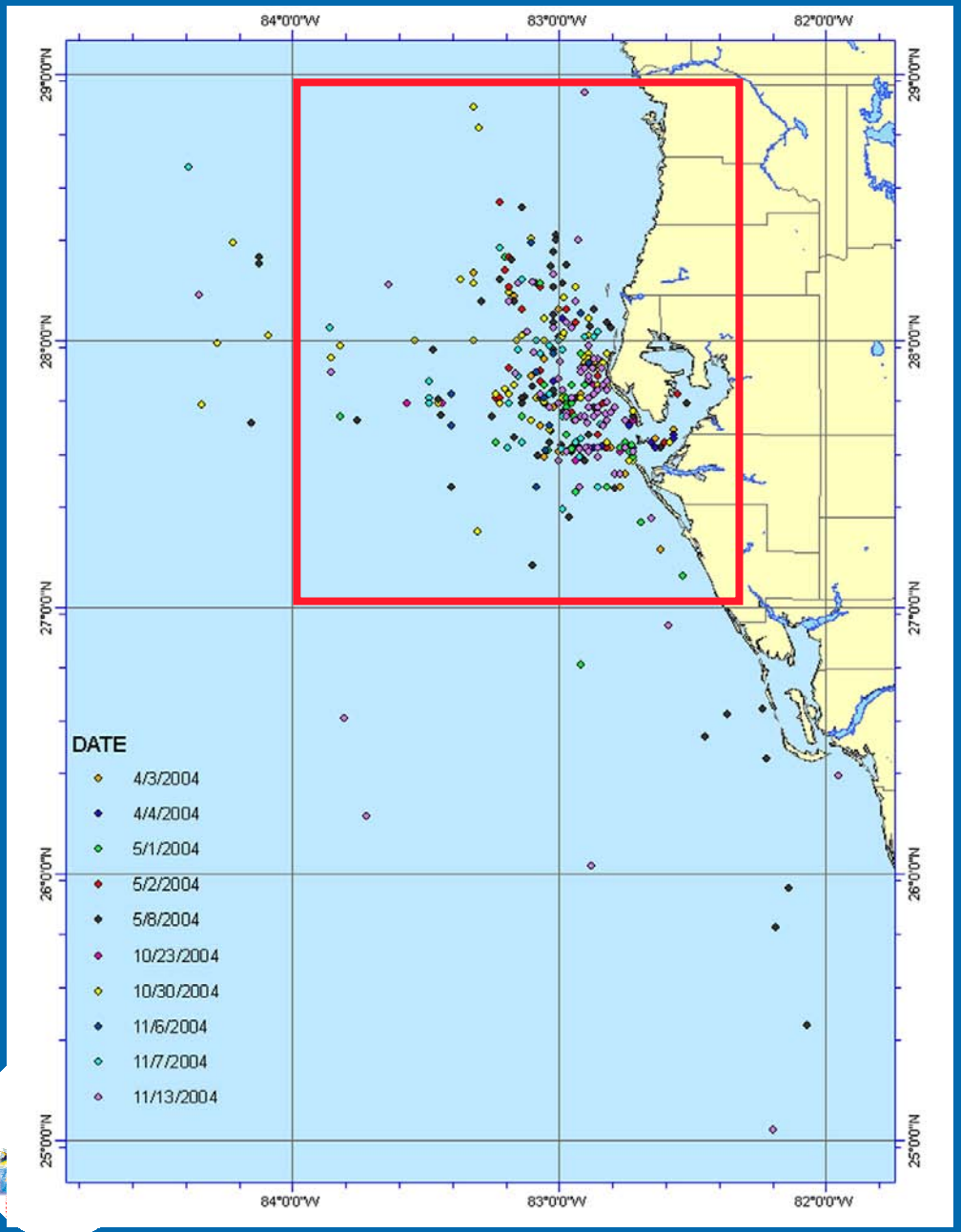
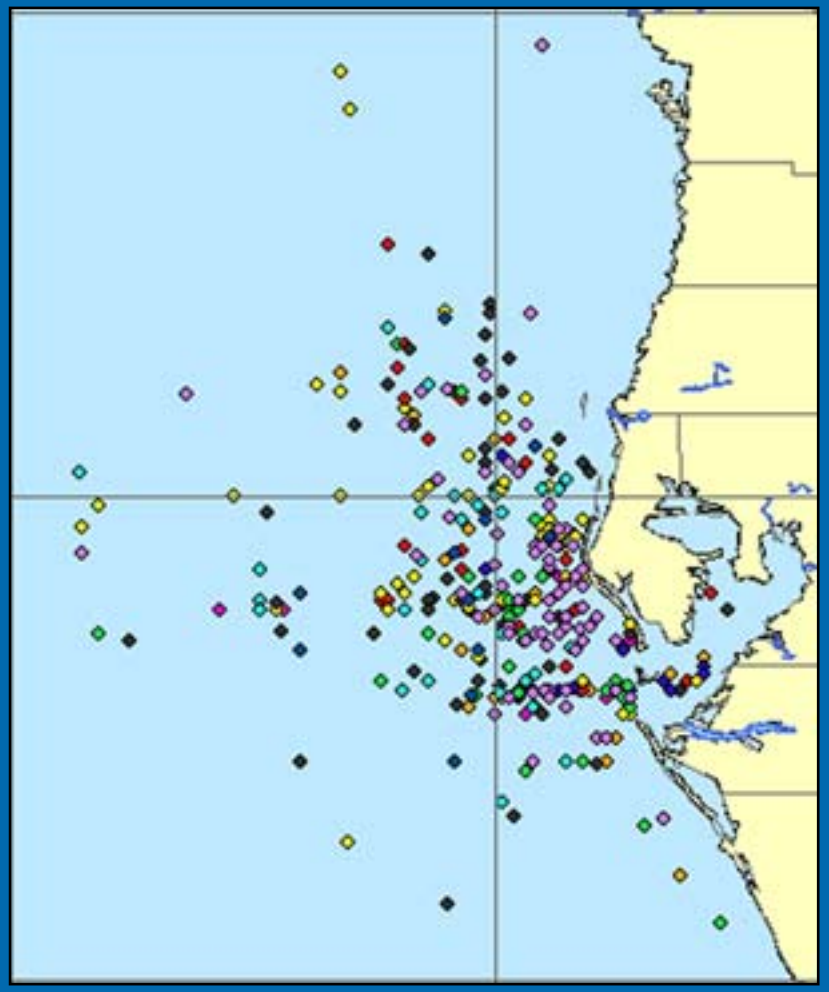
MACKERAL CATCH BY DAY





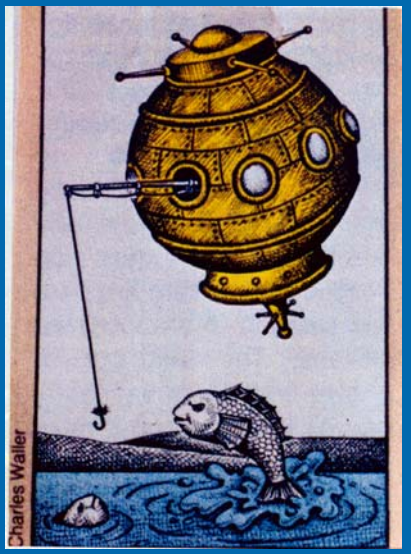
AFFECTED BY
VARIABLE CONDITIONS

WORKING HYPOTHESIS

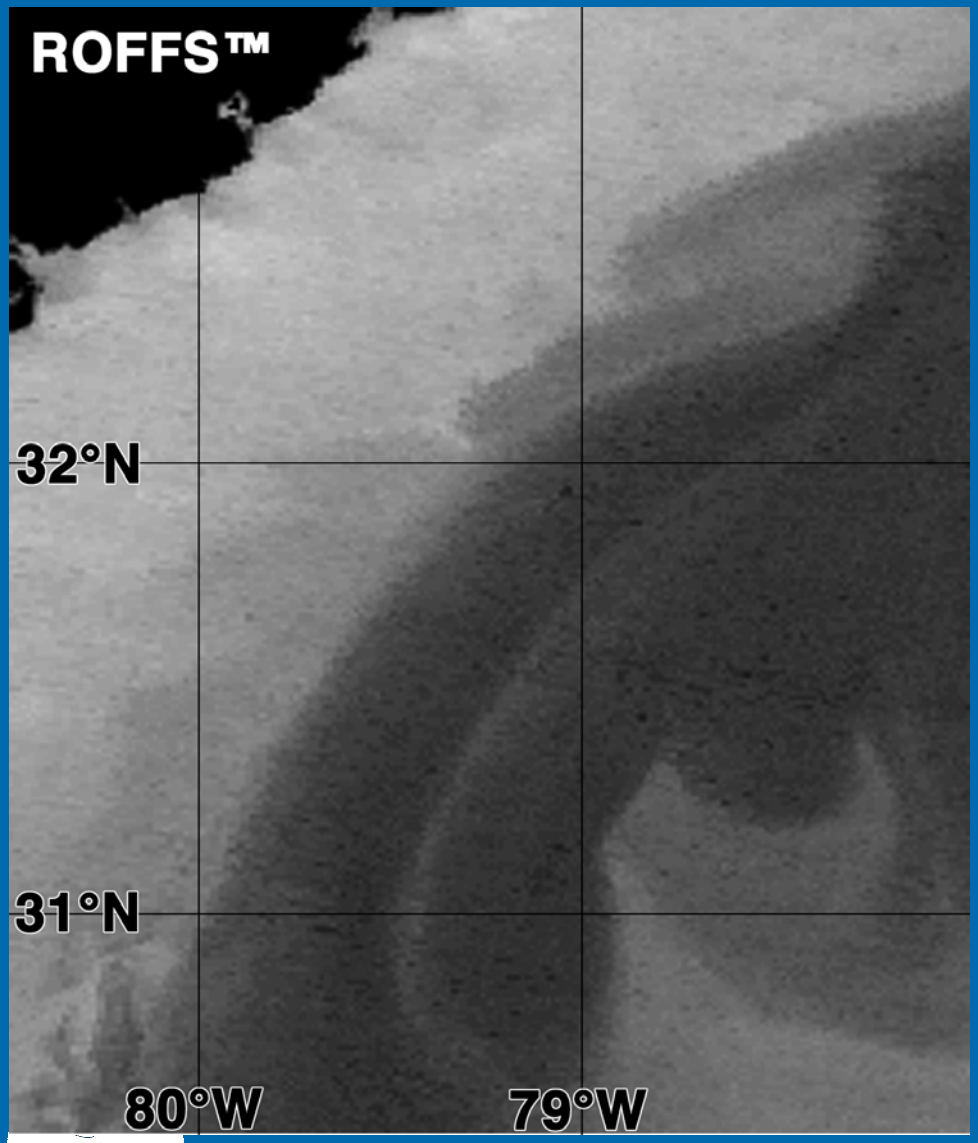
PRESSING SCIENCE QUESTIONS:

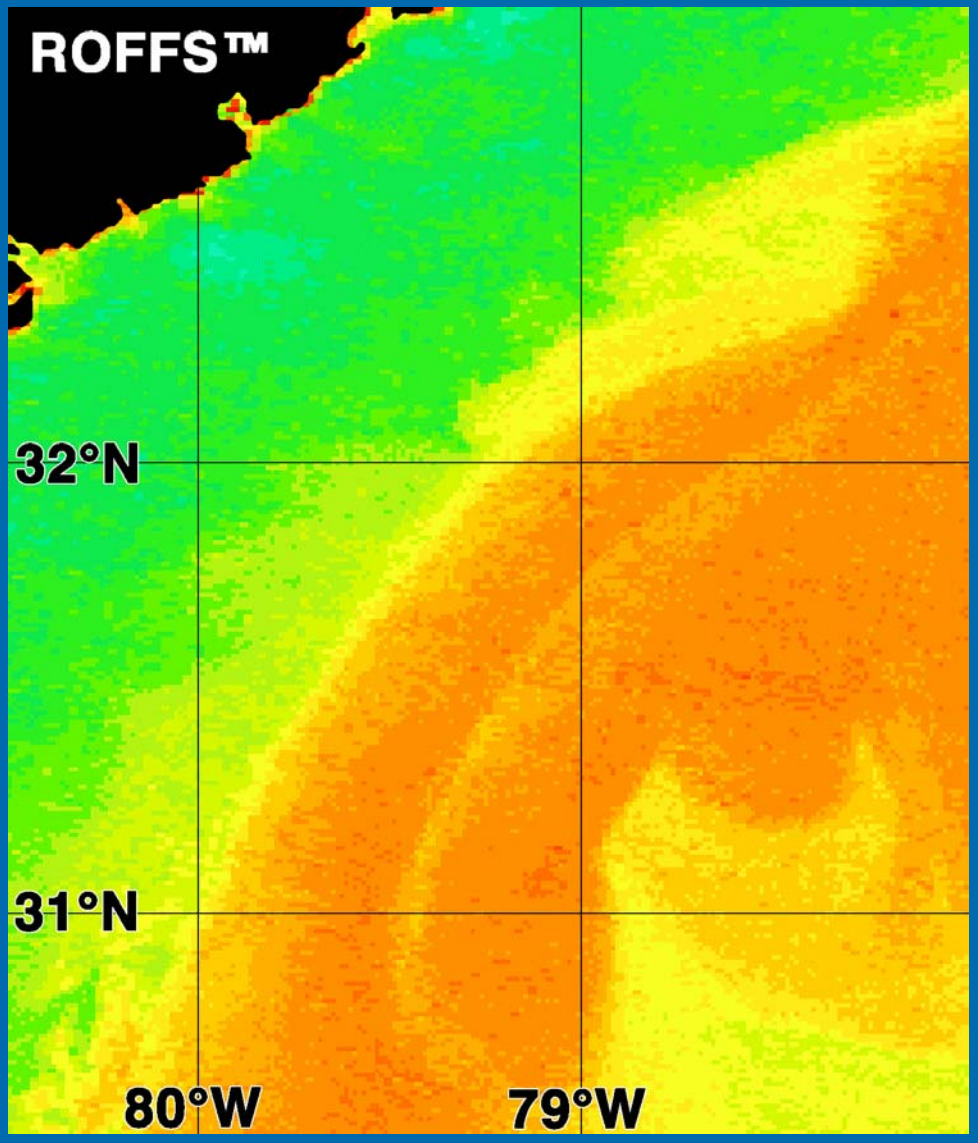
DETECTION OF FRONTS CHALLENGES

- NON-CONTINUOUS WATER MASS BOUNDARIES
- CLOUDS AND OTHER ATMOSPHERIC EFFECTS
- NOISE
- NUMBER OF FRONTS
  - TOO MANY - NOT MEANINGFUL
  - TOO FEW

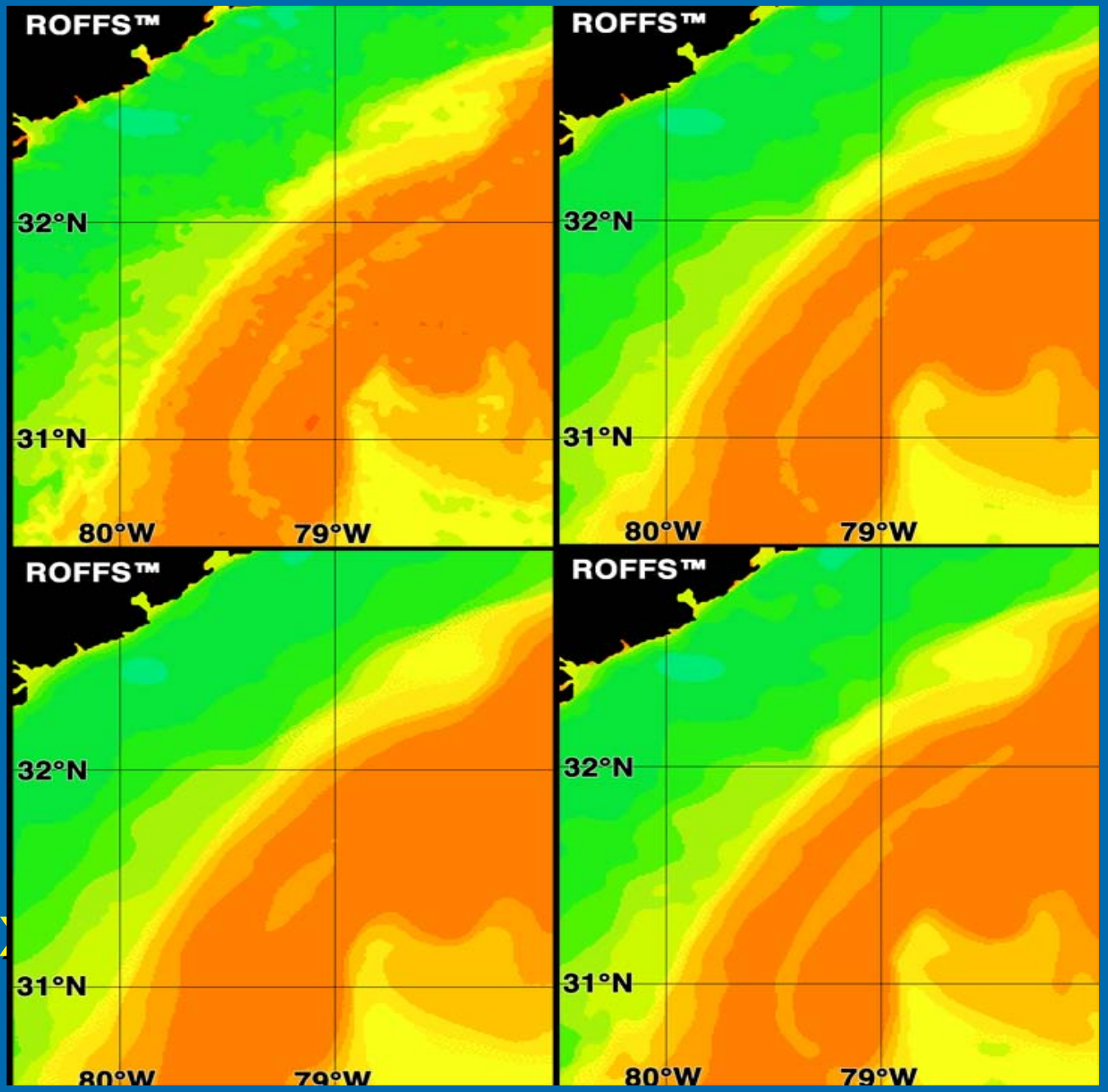


DETECTION OF FRONTS





FILTERING



3x3

6x6

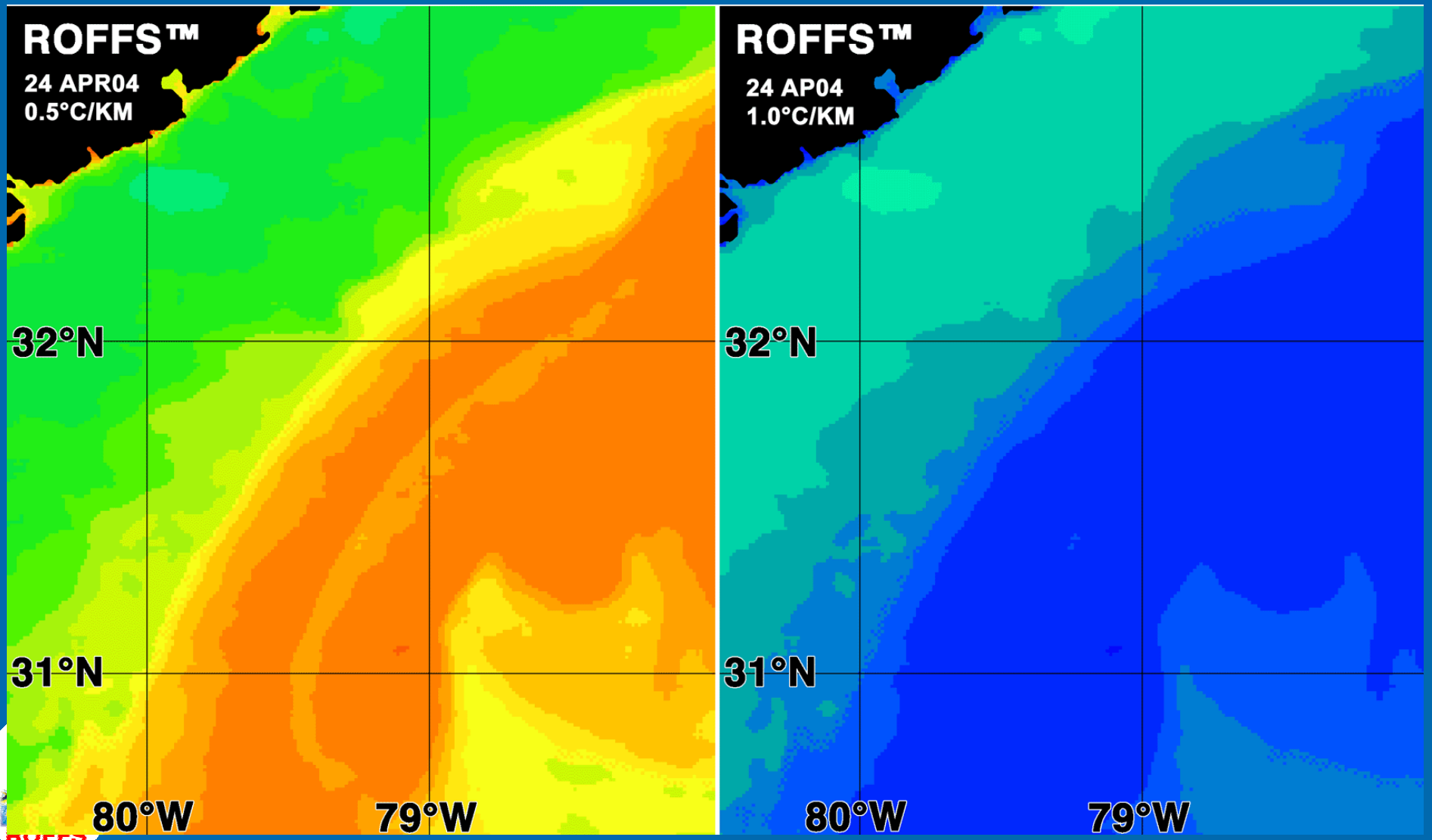
9x9

(3

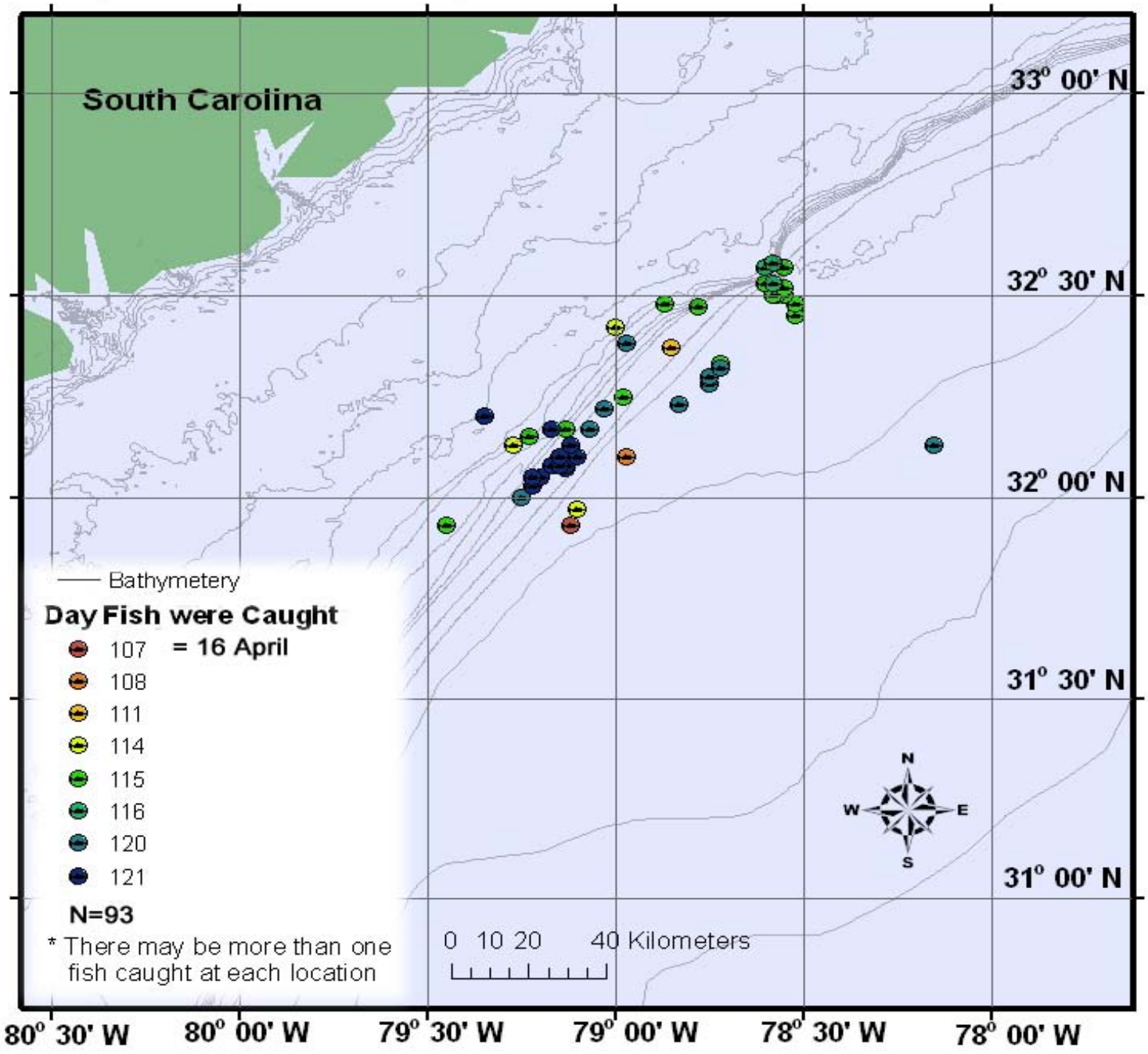
3x3

NUMBERS OF BOUNDARIES

0.5°C/KM VS 1.0°C/KM FILTERED 3X3



April 2004 Dolphin Catch Locations



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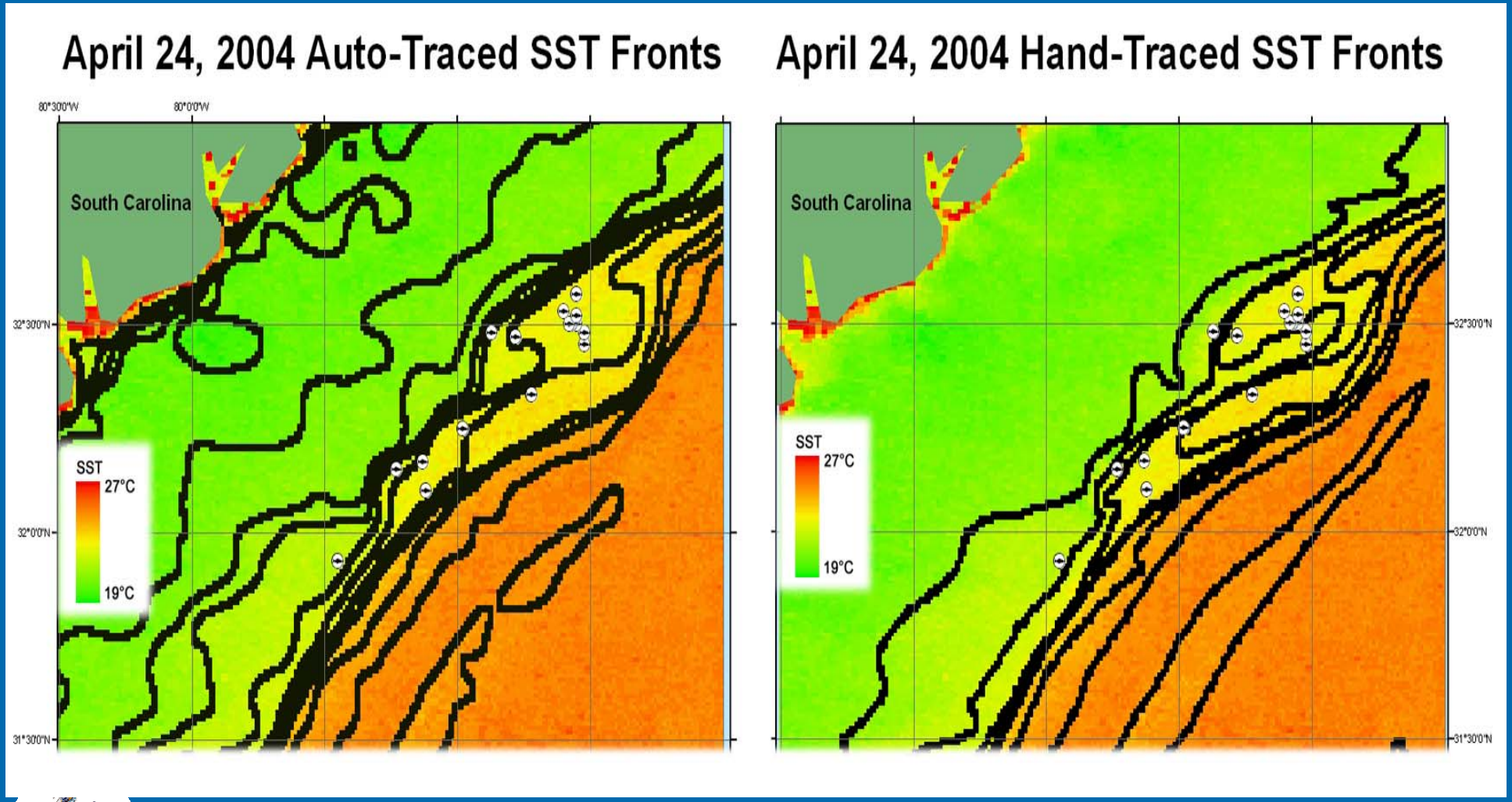
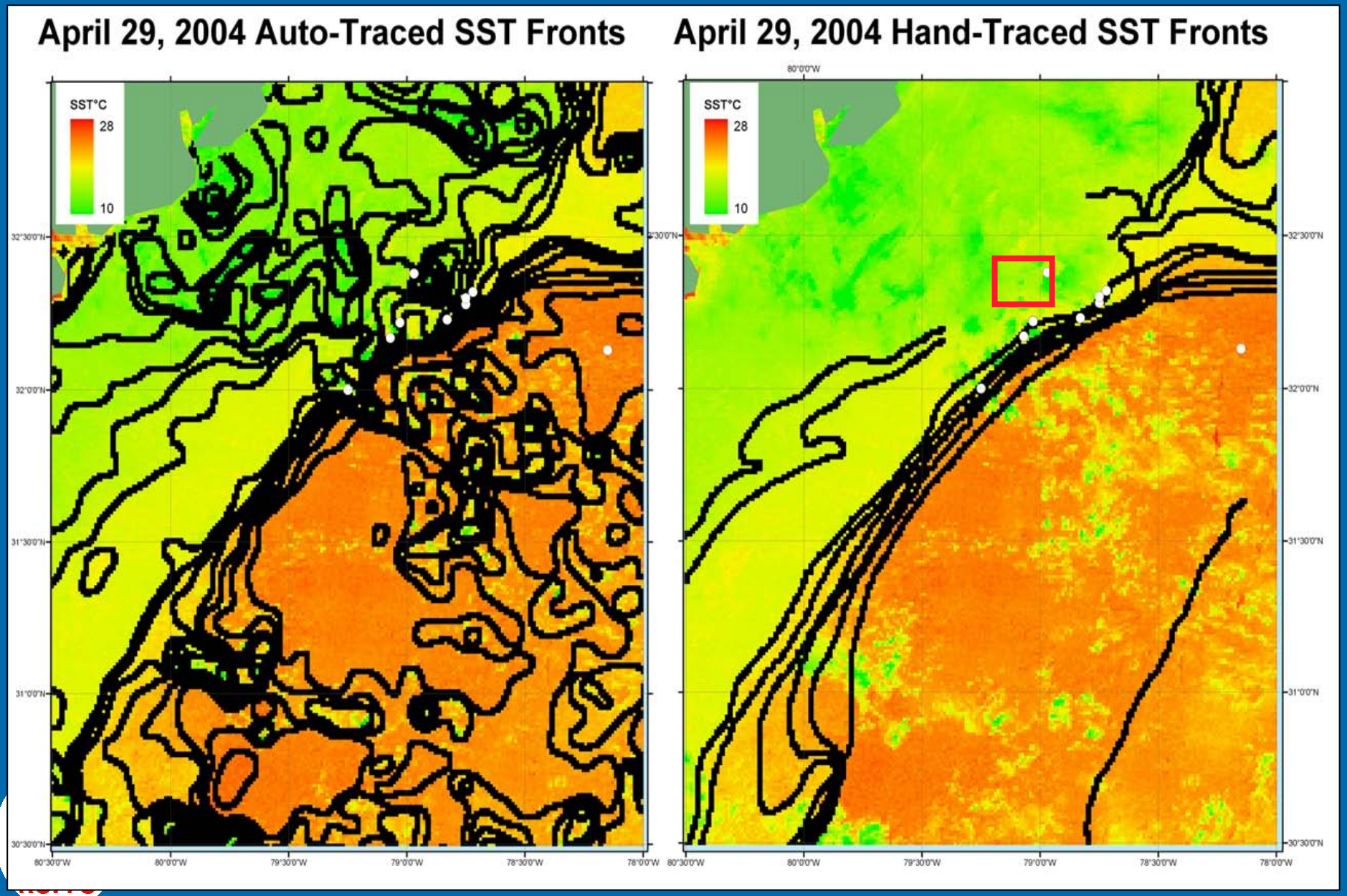
FRONTAL ANALYSES

AUTO-TRACED VS HAND-TRACED

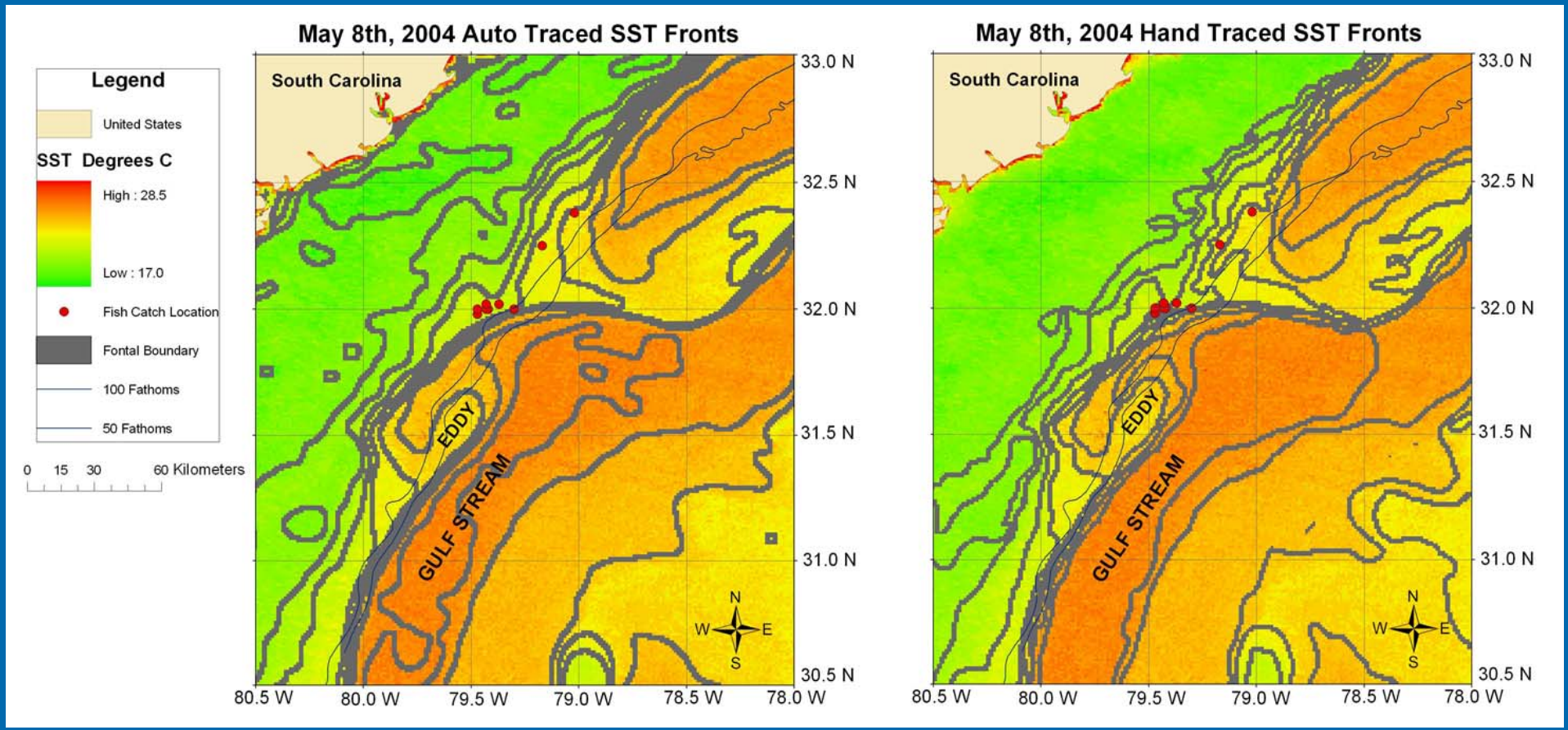


CLEAR DAY, BUT AUTO MISSED EDDY

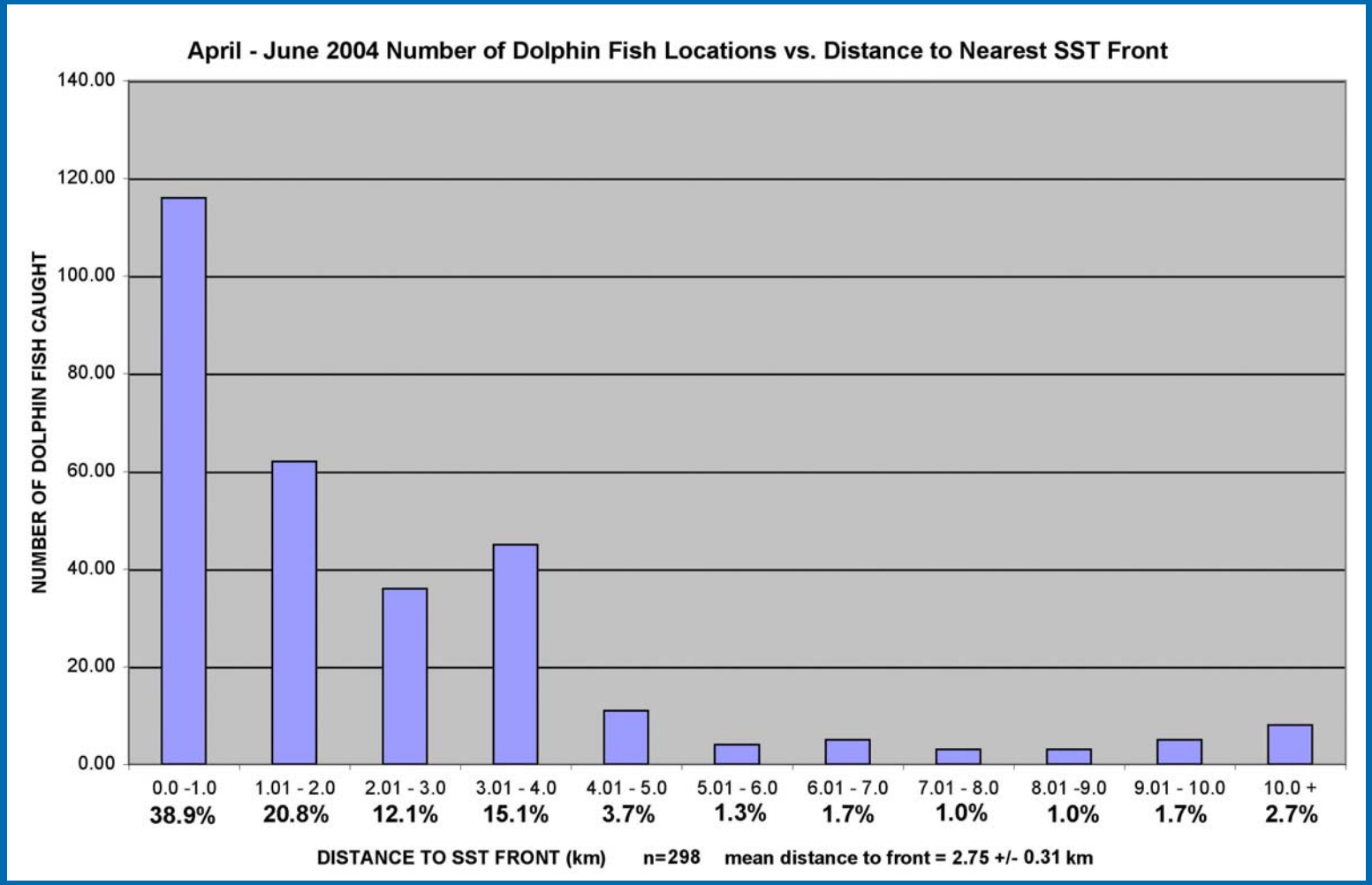
CHALLENGING DAY



MAY 08, 2004


May 8th, 2004 Auto Traced SST Fronts
May 8th, 2004 Hand Traced SST Fronts
Legend
United States
SST Degrees C
High : 28.5
Low : 17.0
Fish Catch Location
Fontal Boundary
100 Fathoms
50 Fathoms
0 15 30 60 Kilometers
South Carolina
EDDY
GULF STREAM
N
W
E
S
33.0 N
32.5 N
32.0 N
31.5 N
31.0 N
30.5 N
80.5 W
80.0 W
79.5 W
79.0 W
78.5 W
78.0 W

APRIL- JUNE, 2004 MANUAL TRACE

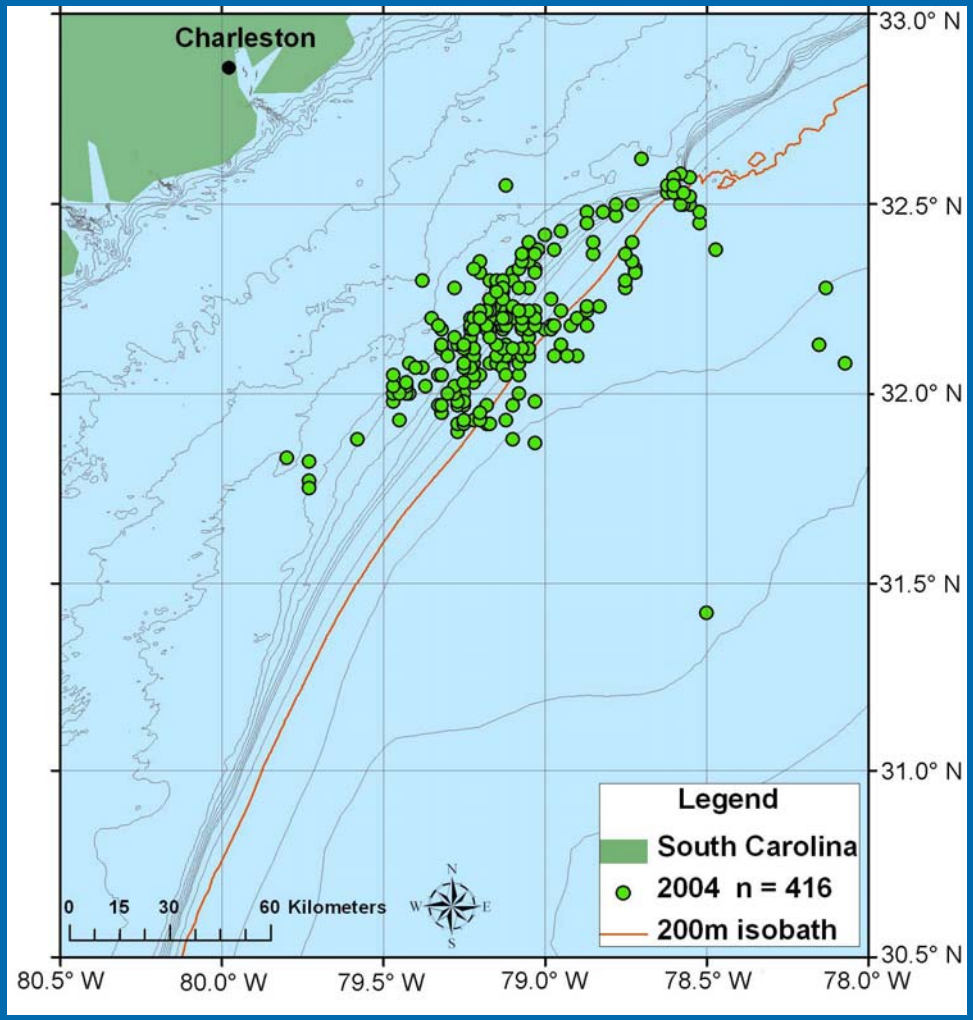


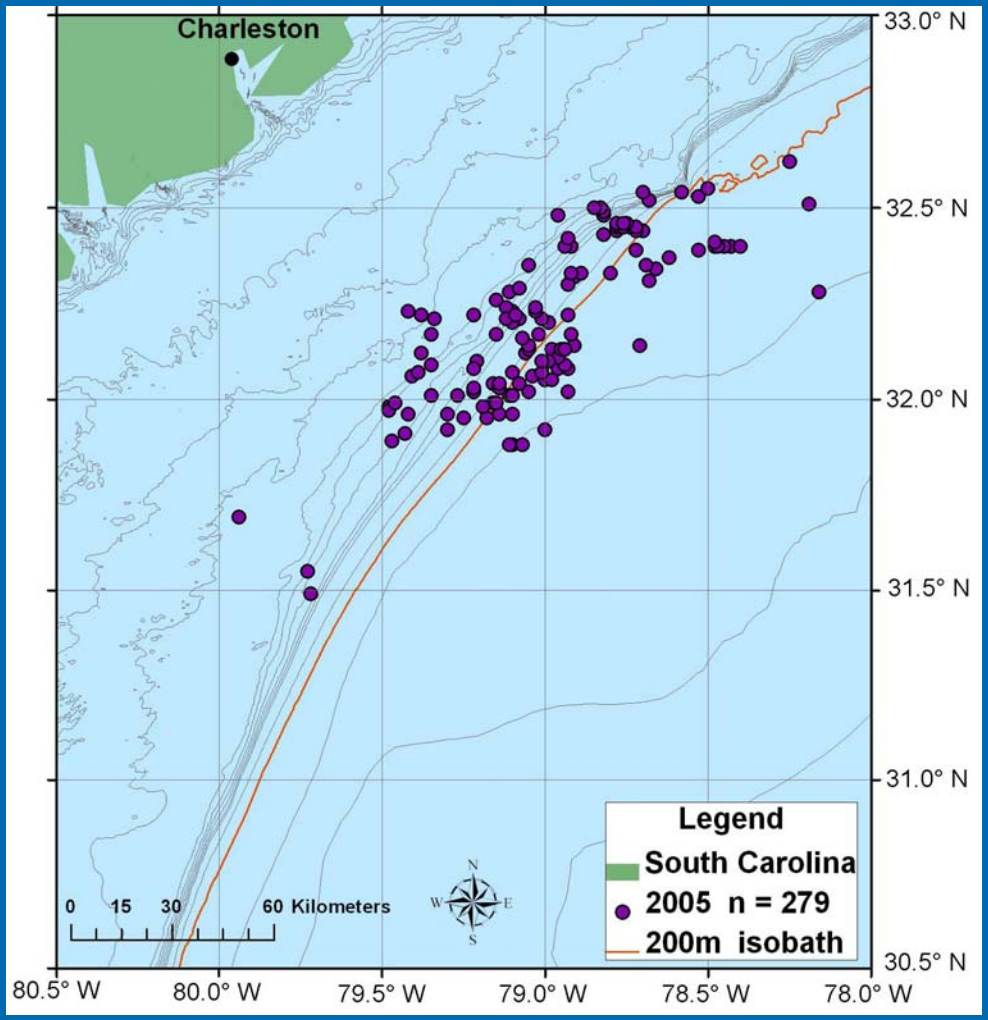
86.9% WITHIN 4 KM

GOOD: 1KM RES. & +/- 1KM NAVIGATION + FISH

COMMUNICATING INFORMATION:

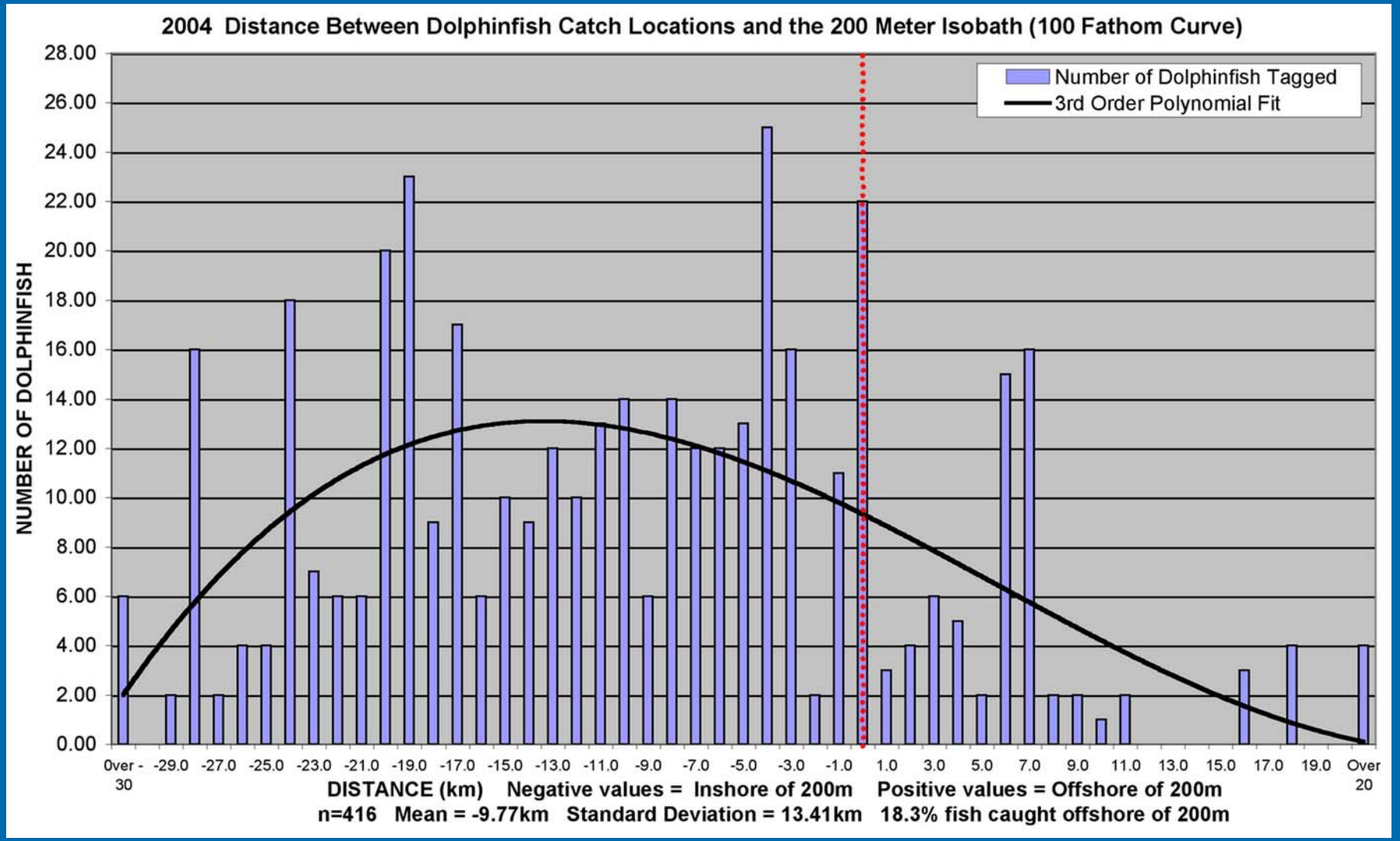
DECISION SUPPORT





CATCH DECLINED, WHY?

ABUNDANCE OR CATCHABILITY ?



COMMON BELIEF THAT THE FISH ARE CAUGHT OVER THE 200 METER ISOBATH

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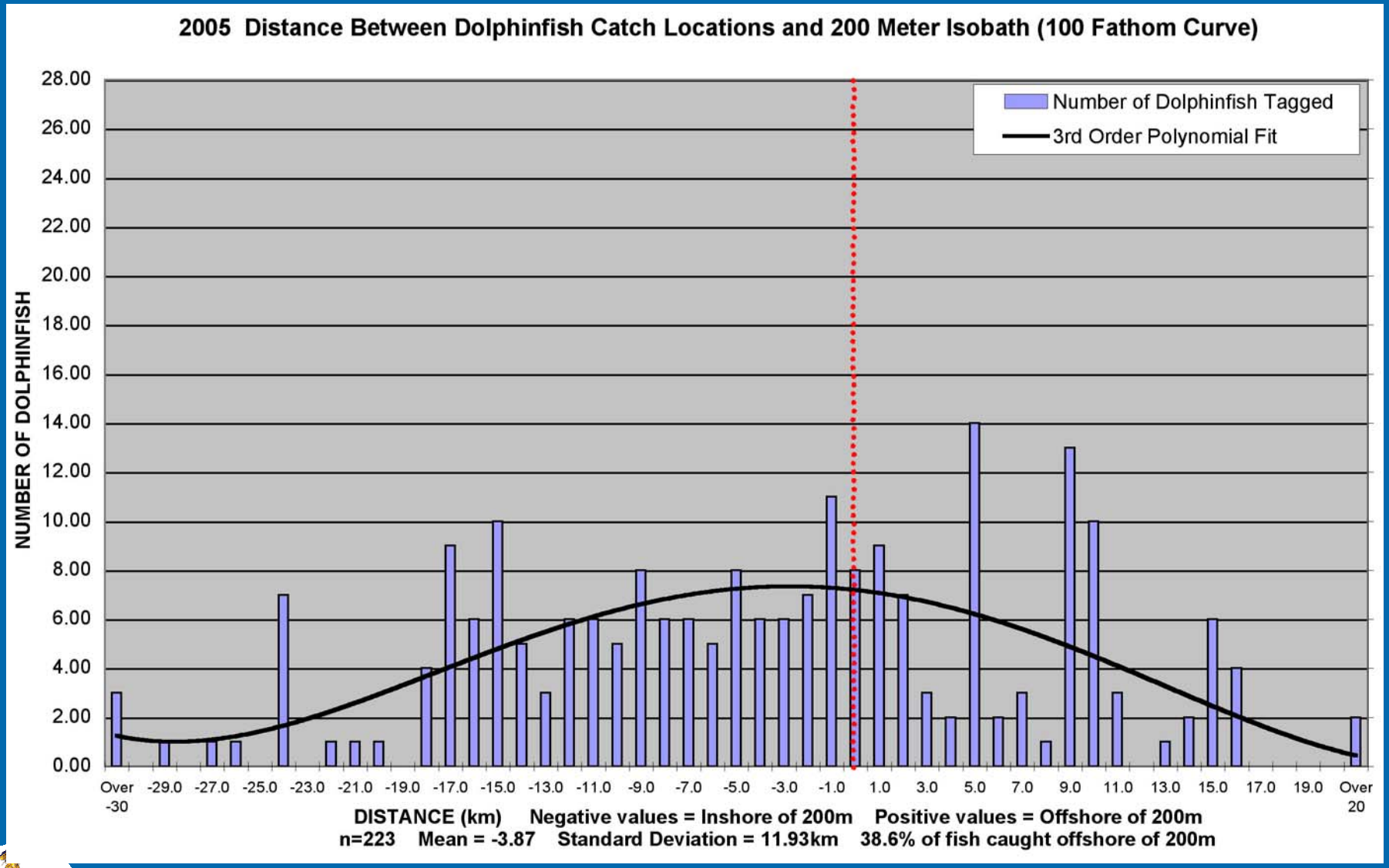
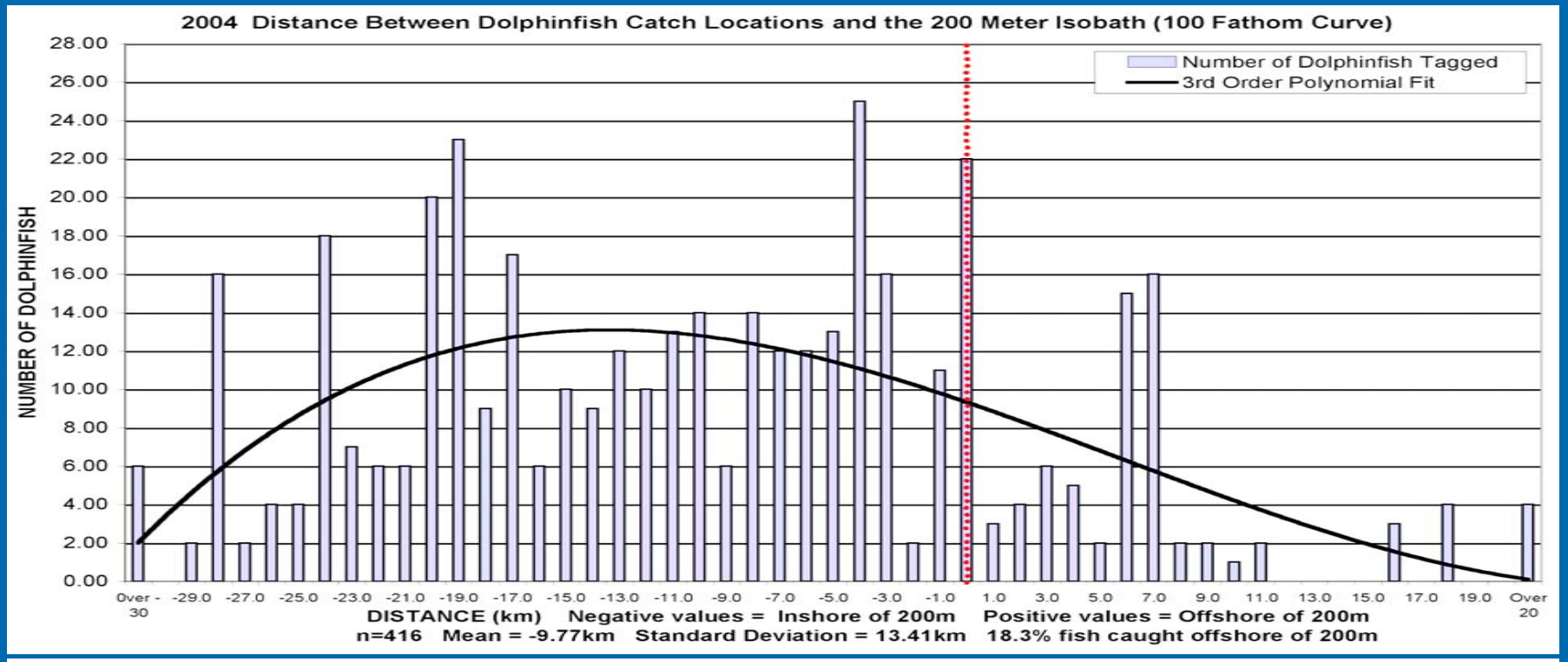
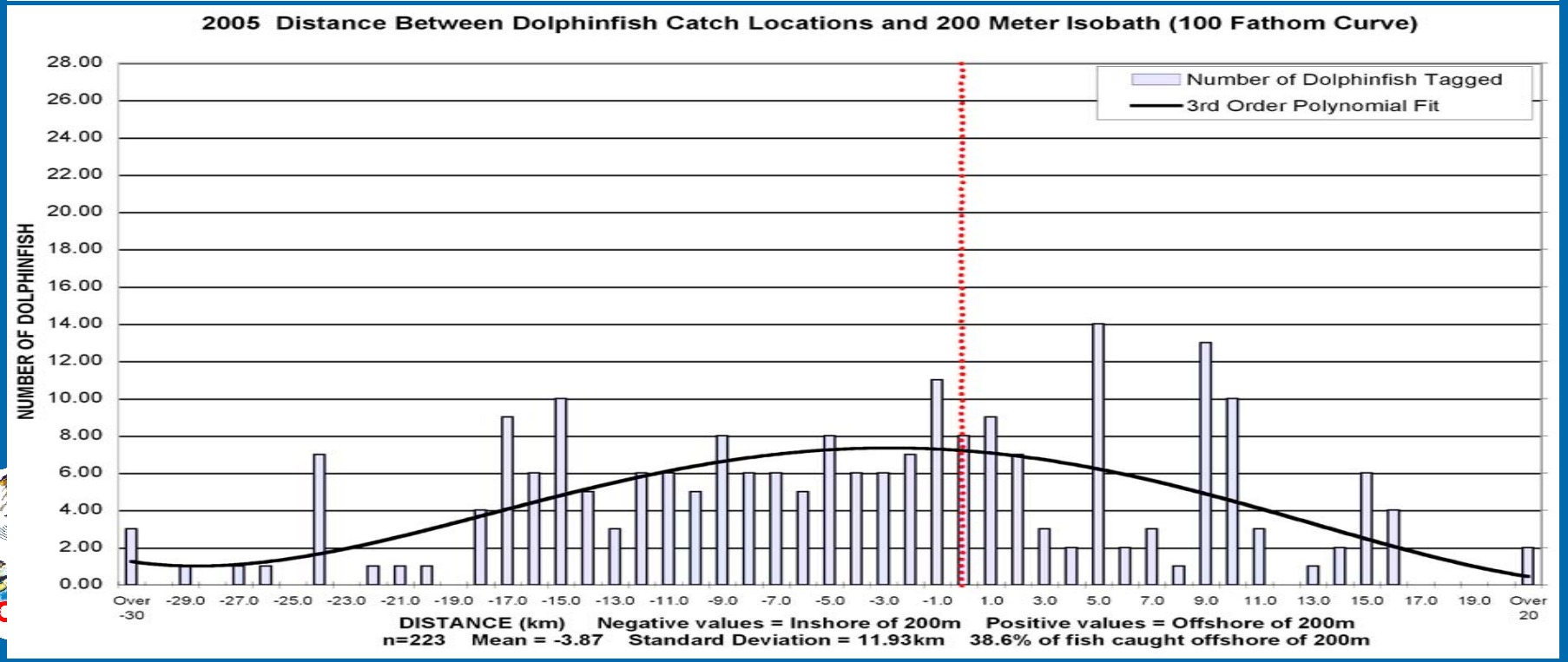

2005 Distance Between Dolphinfish Catch Locations and 200 Meter Isobath (100 Fathom Curve)
NUMBER OF DOLPHINFISH
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Number of Dolphinfish Tagged
3rd Order Polynomial Fit
Over -30
-29.0
-27.0
-25.0
-23.0
-21.0
-19.0
-17.0
-15.0
-13.0
-11.0
-9.0
-7.0
-5.0
-3.0
-1.0
1.0
3.0
5.0
7.0
9.0
11.0
13.0
15.0
17.0
19.0
Over 20
DISTANCE (km) Negative values = Inshore of 200m Positive values = Offshore of 200m
n=223 Mean = -3.87 Standard Deviation = 11.93km 38.6% of fish caught offshore of 200m


2004 Distance Between Dolphinfish Catch Locations and the 200 Meter Isobath (100 Fathom Curve)
NUMBER OF DOLPHINFISH
Number of Dolphinfish Tagged
3rd Order Polynomial Fit
DISTANCE (km) Negative values = Inshore of 200m Positive values = Offshore of 200m
n=416 Mean = -9.77km Standard Deviation = 13.41km 18.3% fish caught offshore of 200m


2005 Distance Between Dolphinfish Catch Locations and 200 Meter Isobath (100 Fathom Curve)
NUMBER OF DOLPHINFISH
Number of Dolphinfish Tagged
3rd Order Polynomial Fit
DISTANCE (km) Negative values = Inshore of 200m Positive values = Offshore of 200m
n=223 Mean = -3.87 Standard Deviation = 11.93km 38.6% of fish caught offshore of 200m

APRIL 18-21, 2004 vs MAY 05-09, 2005

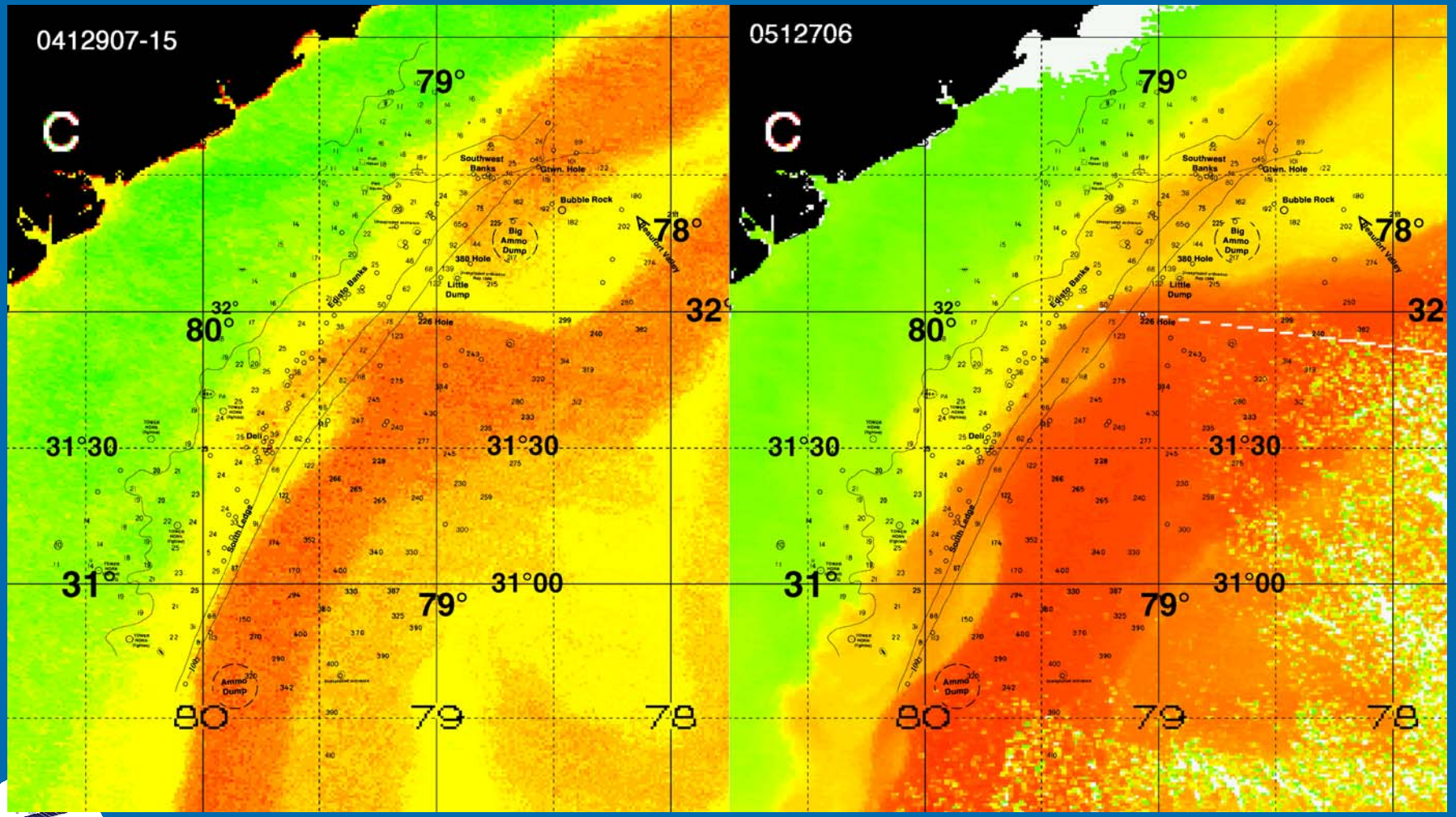
QuickTime™ and a
Video decompressor
are needed to see this picture.

QuickTime™ and a
Video decompressor
are needed to see this picture.

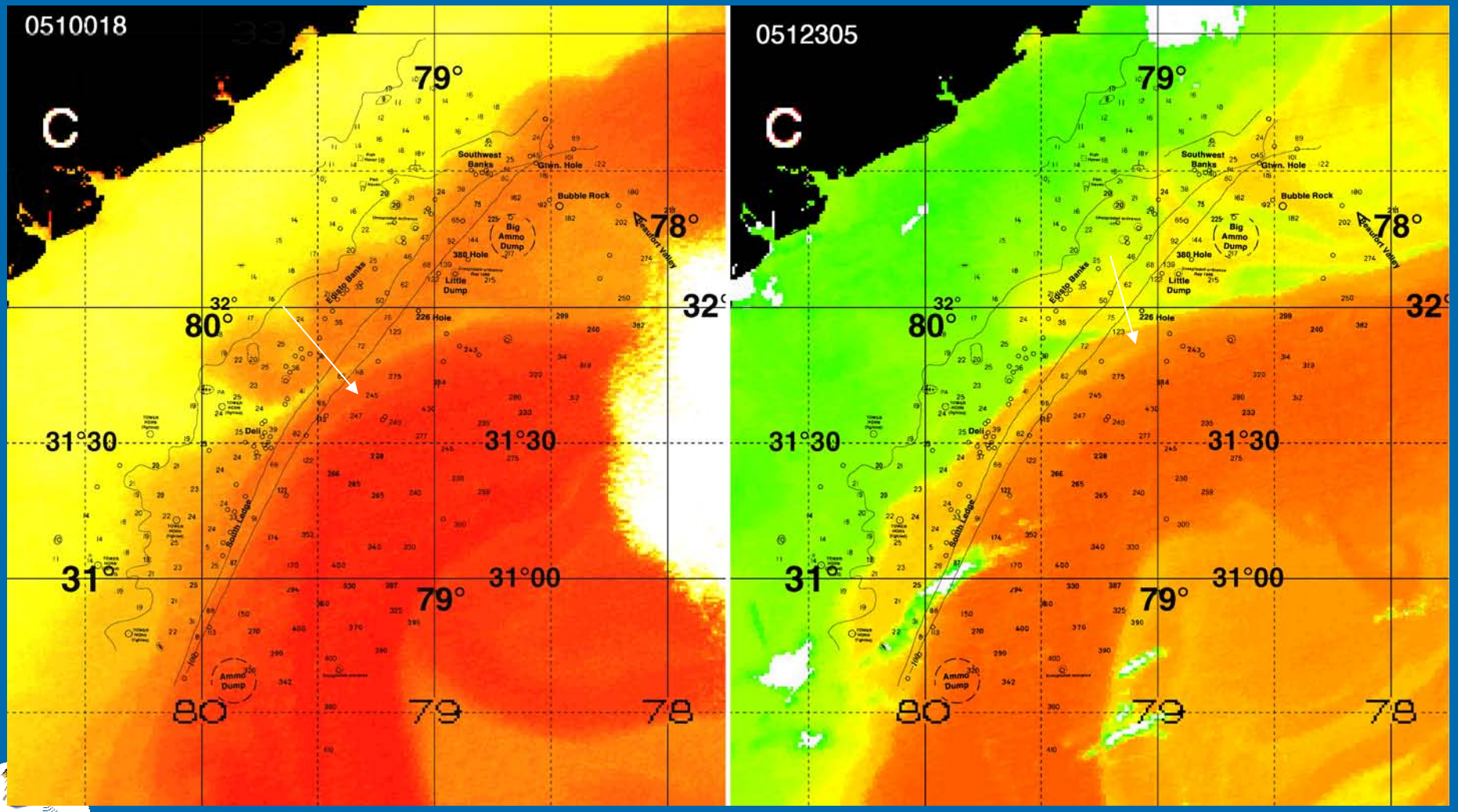
2004 VS 2005

May 09, 2004

May 07, 2005



2005 SMALL FASTER

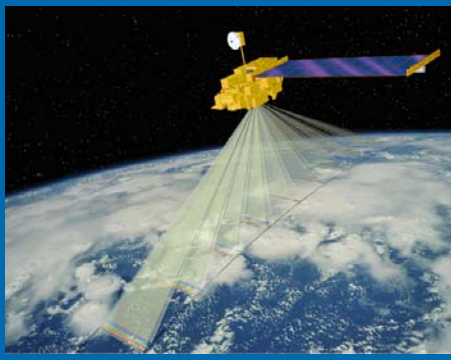


MAINTAINING DIALOGUE/EVOLVING PROGRAM:

DECISION SUPPORT

- SOUTH CAROLINA DEPT. NATURAL RESOURCES. - DOLPHINFISH
  - NC, MS, LA,
  - NOAA/NMFS - COUNCILS INTERESTED
- FLORIDA MARINE RESOURCE INSTITUTE - KINGFISH<->SARDINES<->GAG GROUPER
- MANAGERS
  - NEED FOR DESKTOP VISUALIZATION AND MANIPULATION TOOLS TO FACILITATE ROUTINE USE OF SATELLITE & OTHER ENVIRONMENTAL DATA.
    - EASY TO USE !

WORK CONTINUES



- ✓ GOOD RELATIONSHIP BETWEEN FRONTS AND DOLPHINFISH
- ➢ CONSIDER EFFECTS OF TIME (PERSISTENCE)
- ➢ CONSIDER EFFECTS OF TOPOGRAPHY
- ➢ IMPROVE AUTOMATIC FRONTAL DETECTION - WEAKER GRADIENTS?
- ➢ CONSIDER CHLOROPHYLL FRONTS

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FOUR QUESTIONS

1) What Type of Information Do Decision Makers Need & What Are The Pressing Science Questions?
2) Are We Communicating Information To Decision Makers Effectively Or Are We Falling Short On Delivering The Information Decision Makers Need?
3) What Are The Barriers To Using Climate Information In Decision Making & How Can They Be Overcome?
4) How Can The Climate Change Science Program Best Maintain A Dialogue With Decision Makers To Evolve The Program?

1: What Kind Of Info?

Need Climate (Historical Time Series) And Real-time Oceanographic Indices That Provide Quantitative Information To Show The Presence Of A Trend Or State Of A Condition, Temporally And Spatially In 3d.

Volume Based (Isotherm Depths) In Many Cases Is More Relevant Than Planar Observation Such As SST OR SSS).

- ✓ PRESSING ISSUES: These Indices Should Have A Functional Relationship With The Ecosystem Response Making Them Useful Indices, Not Spurious.

Annual "mean" anything is ecological nonsense. The annual mean is the arithmetic average of all the variations of the year. Organisms respond daily and sub-daily. Not annual scale.

2: COMMUNICATING & DELIVERING ?

- Generally Not Communicating & Not Delivering or Not Sharing the Most Useful Information.
- Fisheries Oceanography In The USA
  - Has Not Been a Priority
  - Lack of Interest = Lack of Funding
- “Ecosystem Based Fish Management”
  - Will There Be Support For 25-50 Years?
    - Human Resources, Monitoring Equipment, Program $$$$
- Ecosystem Orientated Resource Managers Are Needed: Dynamic Environments - Not Linear
  - Seasonal/Climate Scale Changes, Urbanization, Pollution, Coastal Development, Other Stressors

3: OVERCOMING BARRIERS

- $$$$
- Ability to Obtain and Manipulate Data
  - Few Easy to Use Desktop Image Analysis Tools For Satellite & Other In-Situ Data.
  - Easy To Access & Use Data Bases
- Fisheries Needs Close Partnerships Between Physical Oceanographers & Biologists.
- Higher Spatial & Temporal Data
  - Physical & Resource Data Collection In 3D
  - 1 Km & 1 Hour Resolution Improvement
    - Higher In Coastal Areas
  - Data Useful To Calibrate Remotely Sensed Data

4: DIALOGUE & PROGRAM EVOLUTION

- Teach Decision Makers The Benefits Of Incorporating Climate (Environmental - Ecological) Based Data.
- Find Funding For Teaching/Using Climate Based Data.
- Find Funding To Do the Required Sampling of Both Environmental & Resource Data.
  - Critical Decline Of In-Situ Data Records & Calibrated Ocean Observations.

THANK YOU & QUESTIONS

USF UNIVERSITY OF SOUTH FLORIDA
COLLEGE OF MARINE SCIENCE

Institute for Marine Remote Sensing

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