Gray's Reef National Marine Sanctuary

Research or Control Area Concept

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Problems with Reef Fisheries off the Southeastern U.S.

Populations are in decline

Many species overfished (biomass is too low) or undergoing overfishing (fishing mortality is too high)

Severe restrictions have not improved the status of stocks

Reef Fisheries: Complexity

Diverse community

Many interspecific biological interactions

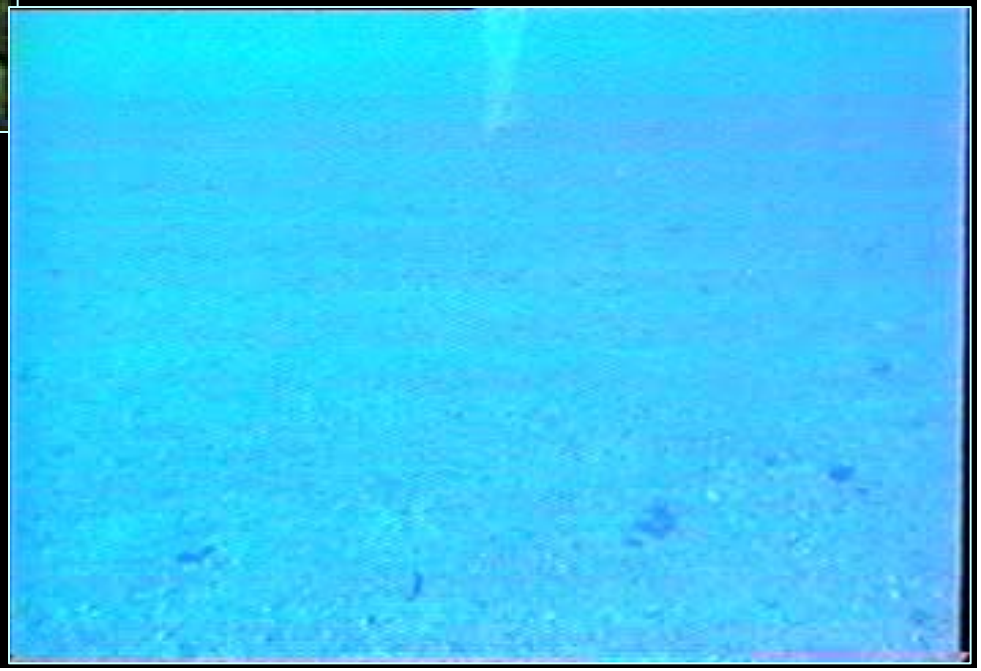
Different fishery objectives

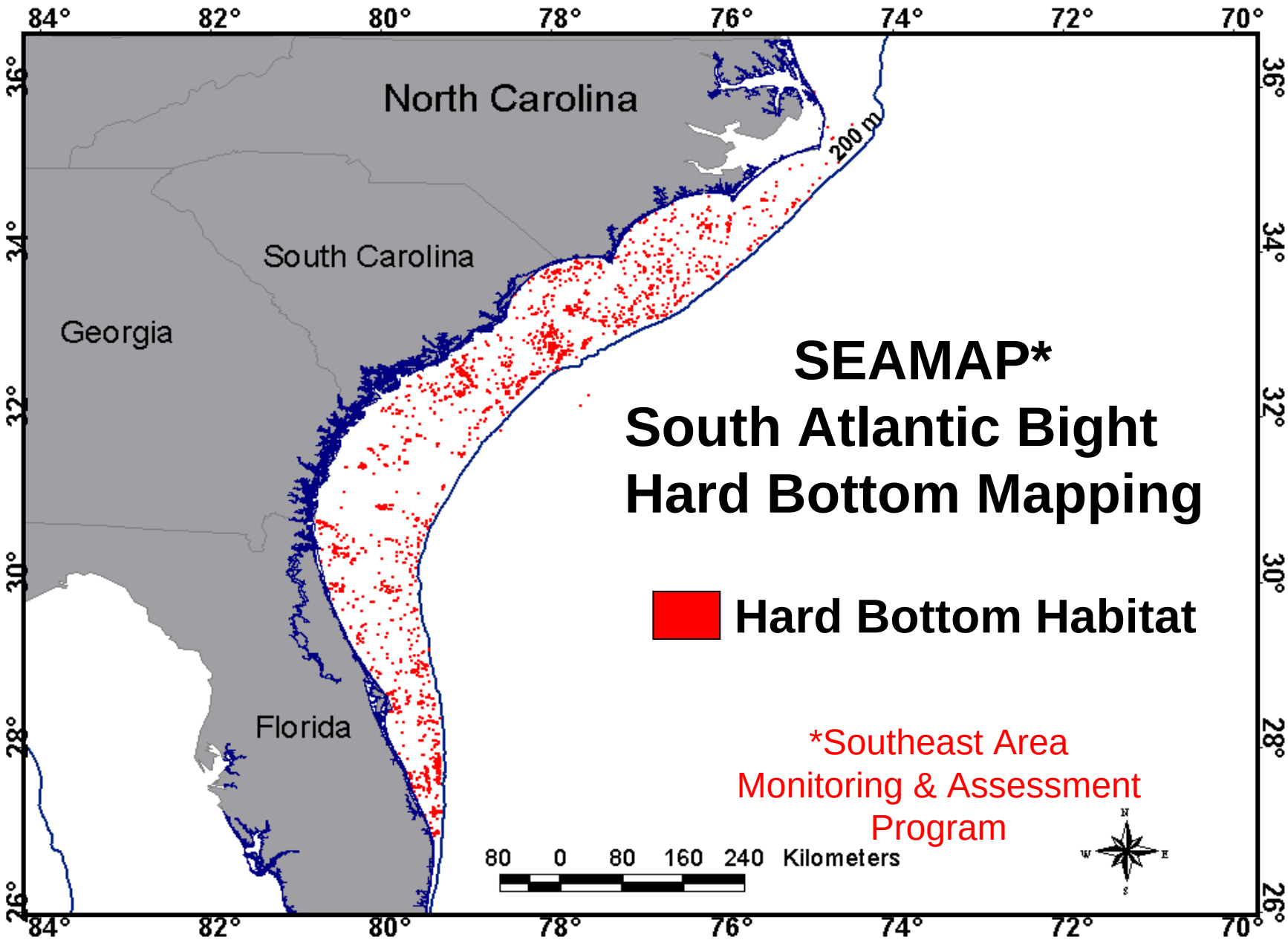
Many gear types

Large number of access points

Dynamic and opportunistic

Reef habitat and “Live Bottom” is patchy




84°
82°
80°
78°
76°
74°
72°
70°
36°
34°
32°
30°
28°
26°
North Carolina
South Carolina
Georgia
Florida
200 m
SEAMAP*
South Atlantic Bight
Hard Bottom Mapping
Hard Bottom Habitat
*Southeast Area
Monitoring & Assessment
Program
80 0 80 160 240 Kilometers

SouthEAst GEOgraphic Fishery-Independent Survey and Historical (SEAGEOFISH) Database - Windows Internet Explorer

http://ekman.csc.noaa.gov/seageofish/viewer.html

Black Sea Bass Catch Locations, 1973-2006

Swap Maps

LAYERS

- All Layers
  - Important Species
    - Bank Sea Bass
    - Black Sea Bass
    - Butterfish
    - Carolina Hake
    - Conger Eel
    - Cuban Anchovy
    - Dusky Anchovy
    - Gray Triggerfish
    - Greater Amberjack
    - Honeycomb Moray
    - Knobbed Porgy
    - Lesser Amberjack
    - Night Shark
    - Palespotted Eel
    - Pinfish
    - Planehead Filefish
    - Red Grouper
    - Red Porgy
    - Roughskin Dogfish
    - Round Herring
    - Round Scad
    - Sand Perch
    - Scamp
    - Scup
    - Snowy Grouper
    - Spanish Sardine
    - Southern Hake

35N

85W

80W

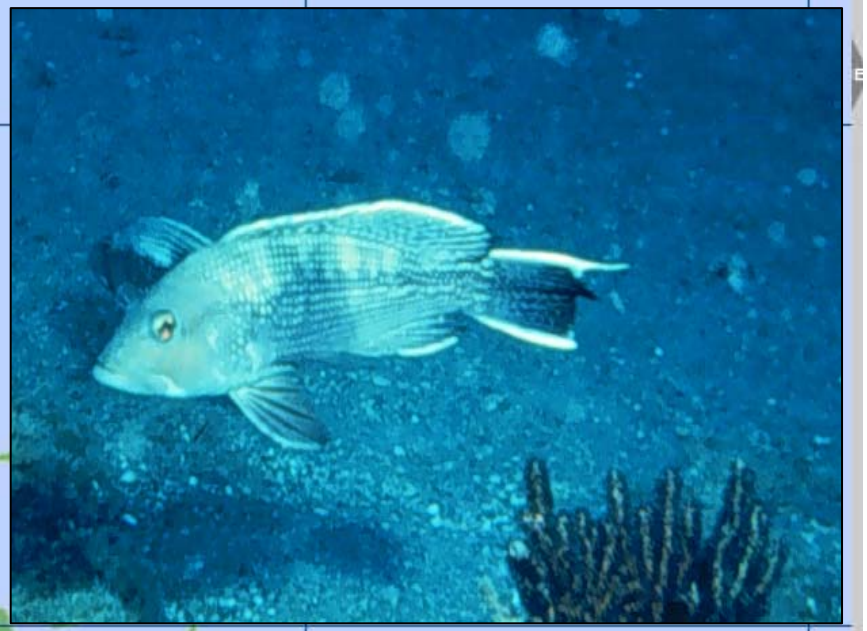
30N

25N

0 260 Miles

NOAA Coastal Services Center

"SEAGEOFISH"



Black Sea Bass Catch Locations, 1973-2006

Gray's Reef

NOAA Coastal Services Center

0 33 Miles

NOAA Fisheries-MARMAP annual fish-trap survey

Pagrus pagrus
Red Porgy

CPUE (Fish per Trap-Hour)

0 1 2 3 4 5 6 7 8

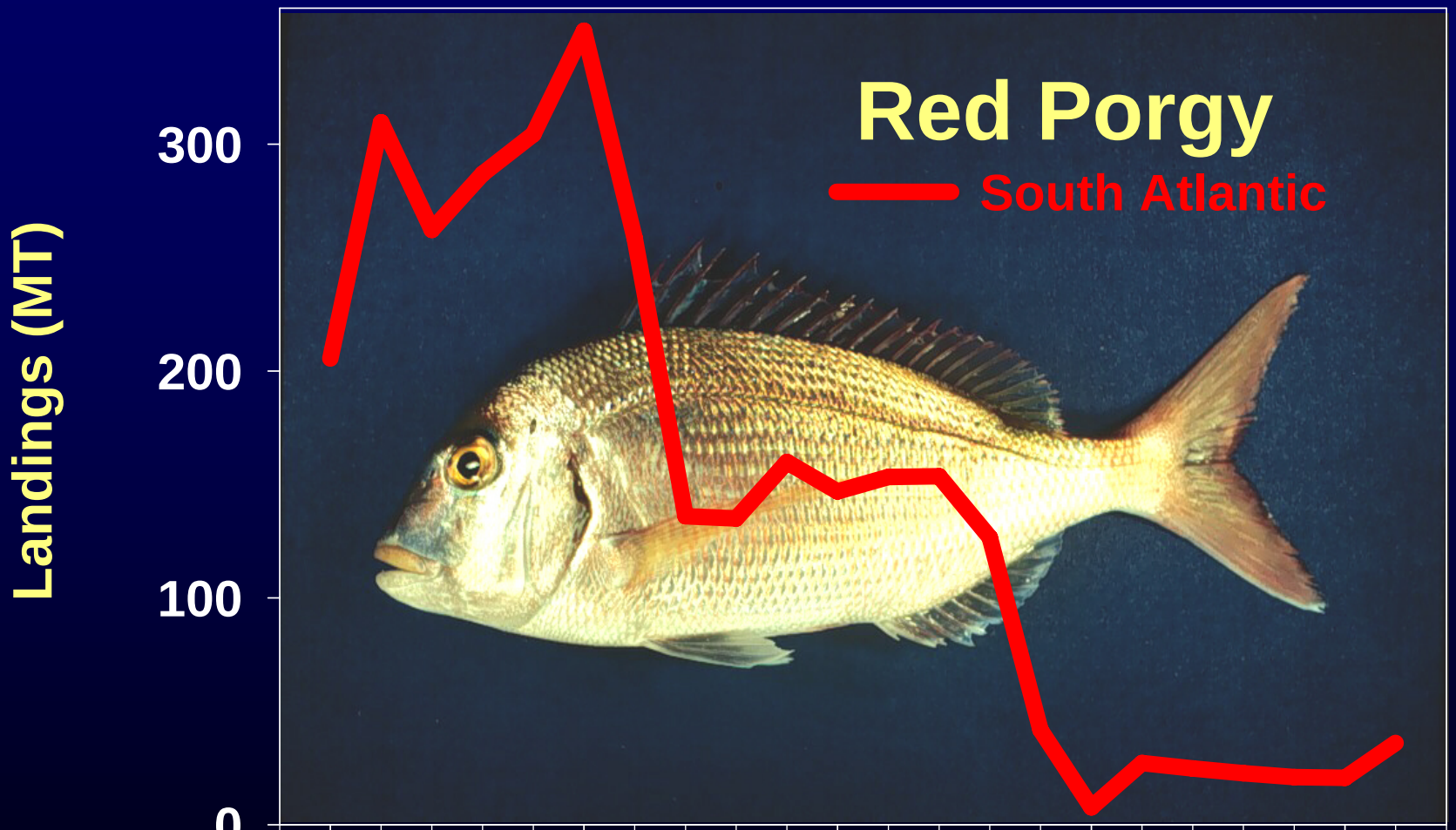
A B C C CD E D

82-84 85-87 88-90 91-93 94-96 97-99 00-02

Year

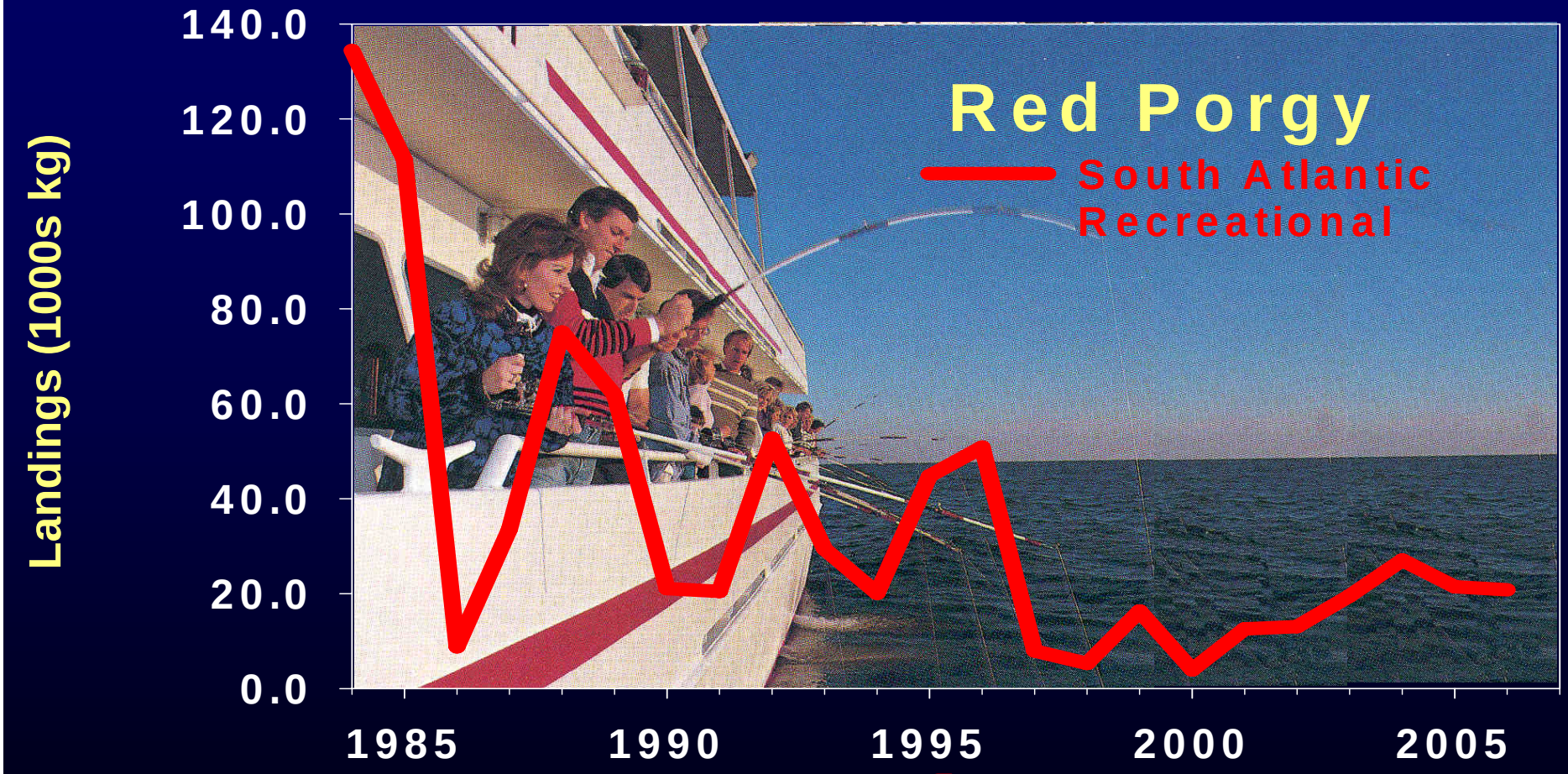
Overfished

Commercial Landings (Southeast U.S. Atlantic)



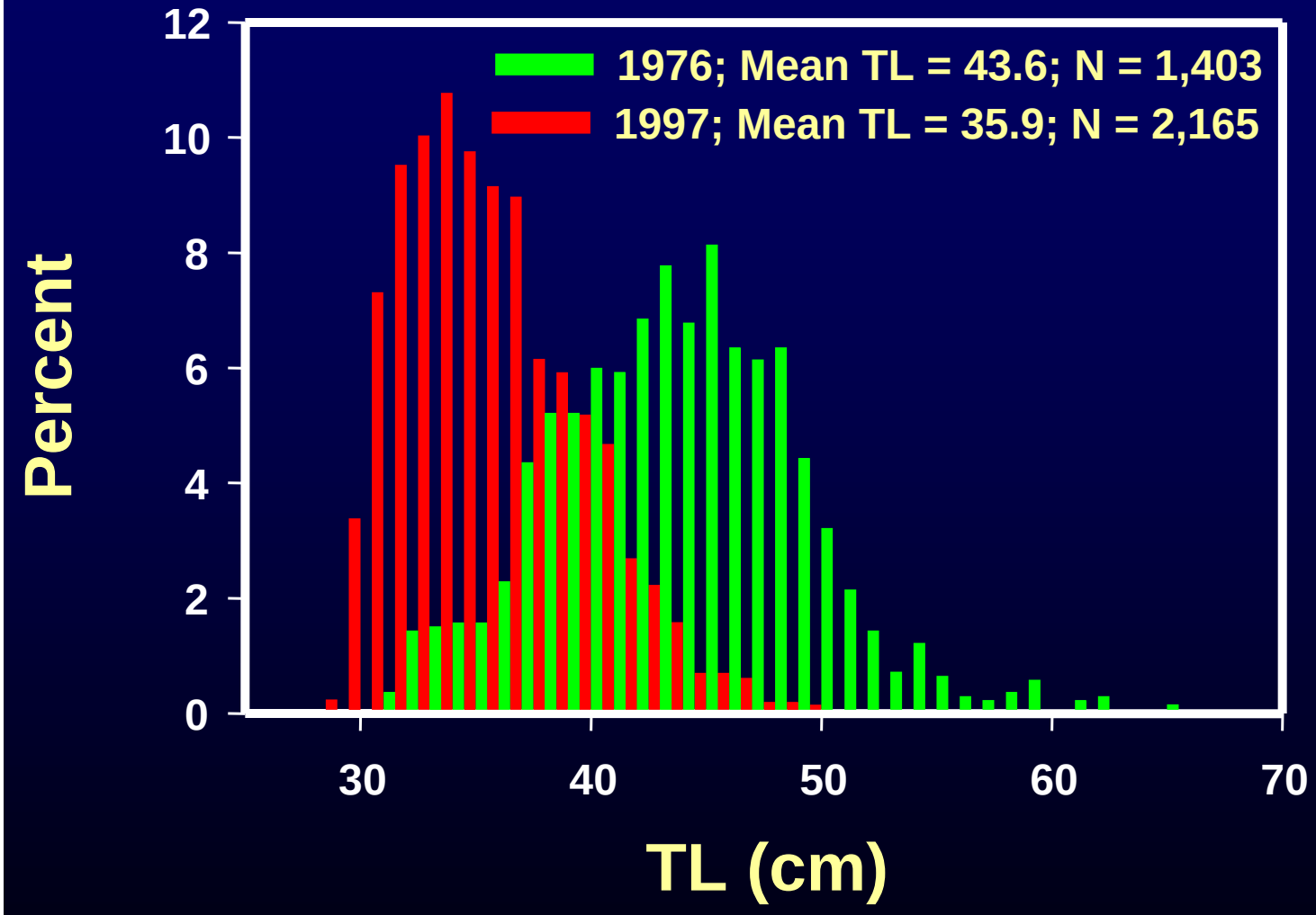
Overfished

South Atlantic Bight Recreational Catches



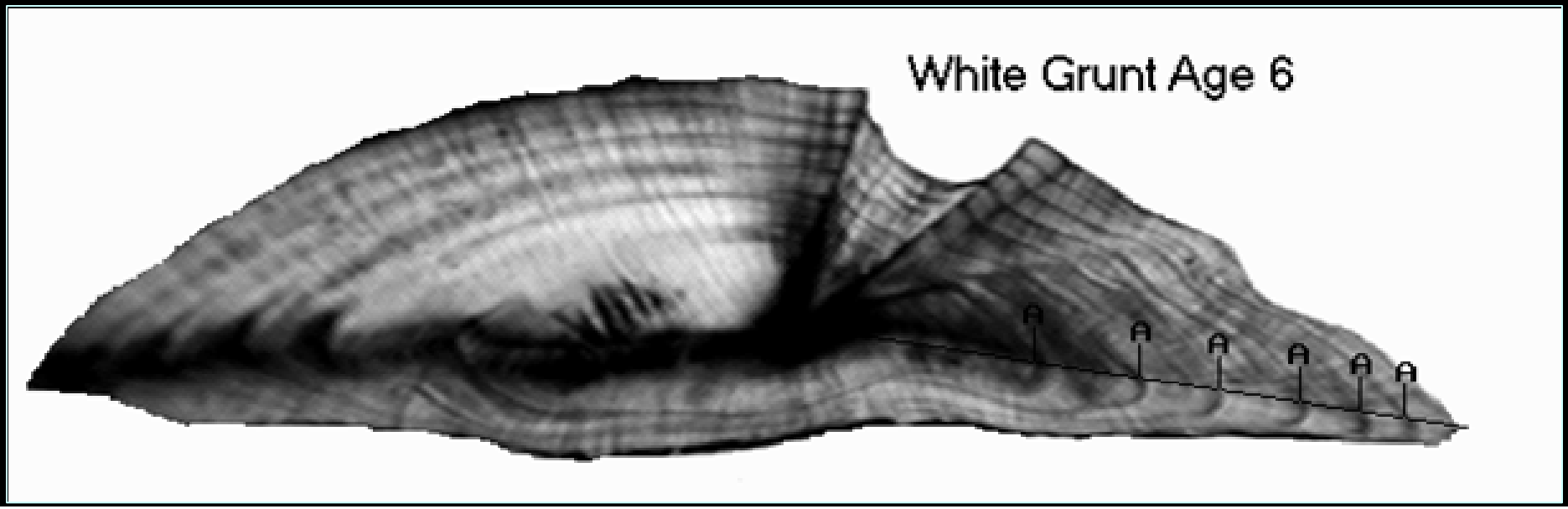
Overfished

Red Porgy

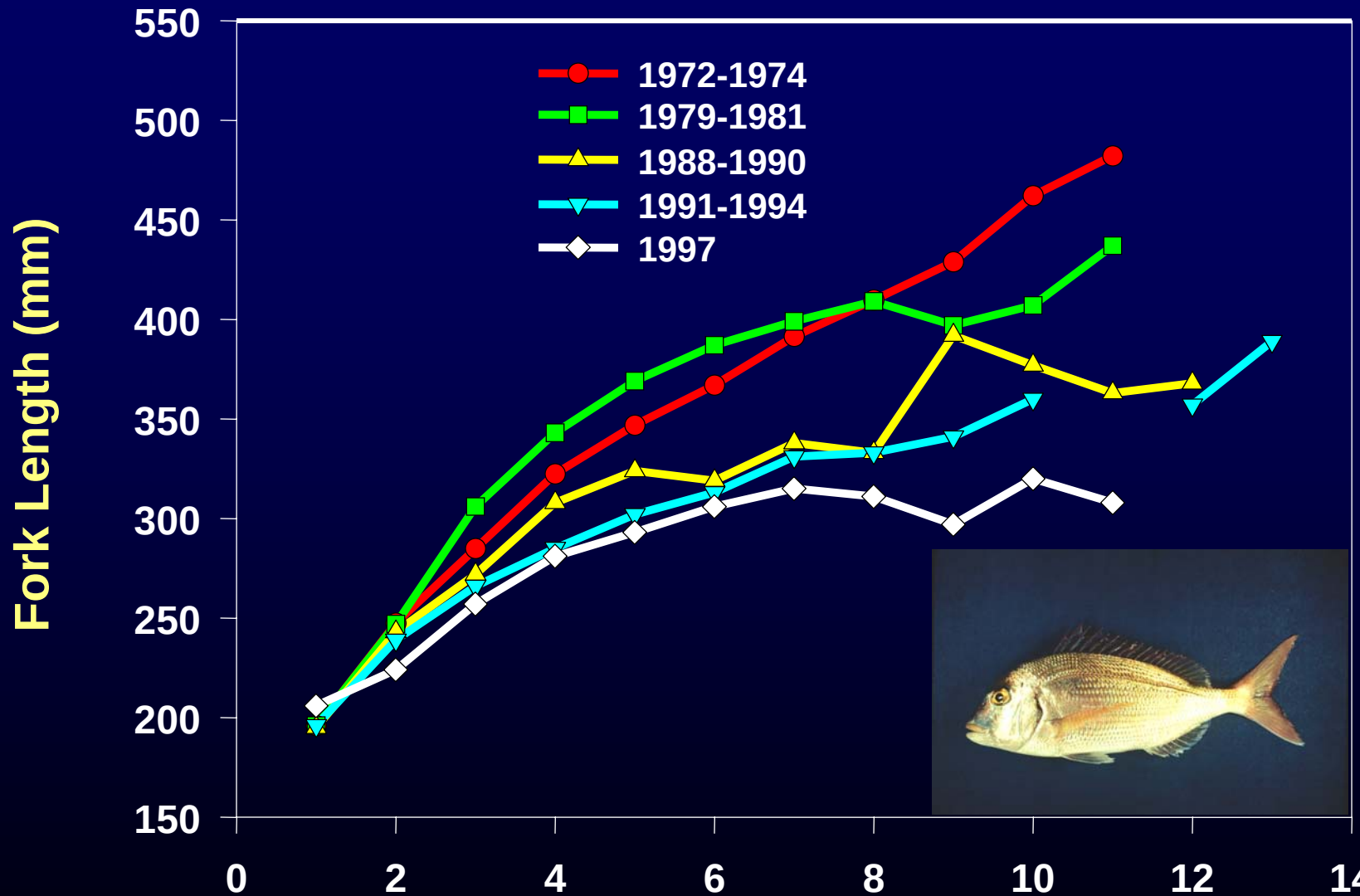


Overfished


Tilefish
Otolith


White Grunt Age 6
A
A
A
A
A
A

Red Porgy Size at Age



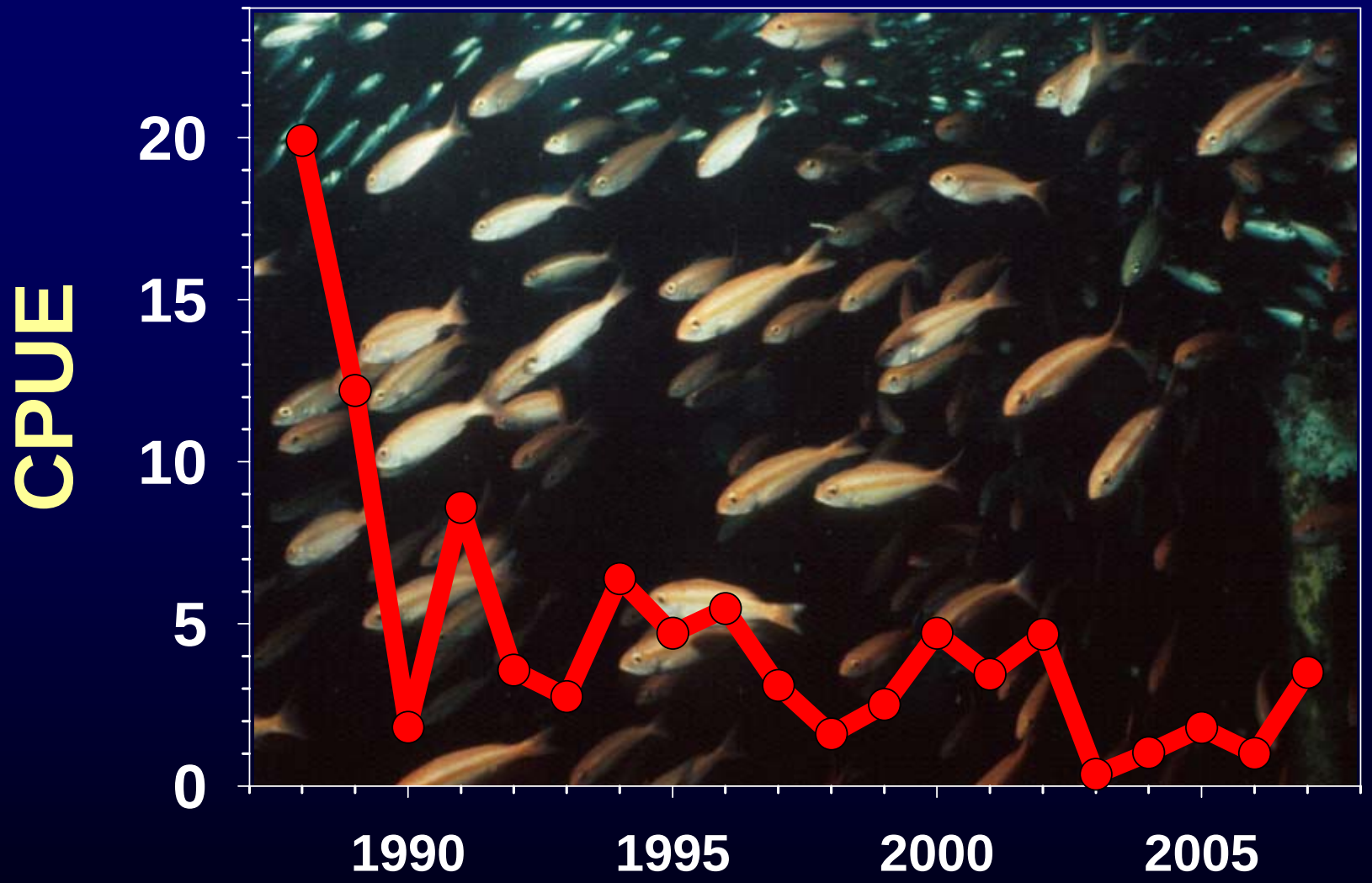
Overfished

Red Porgy Females

mm TL	1979-1981 Total	1979-1981 % Mature	1991-1994 Total	1991-1994 % Mature
<200	16	0	55	3.6
200-225	91	1.1	182	2.2
226-250	85	12.9	156	16.7
251-275	103	27.2	157	54.1*
276-300	78	98.7	211	89.5
>300	512	100.0	615	99.0
Total	885		1376	

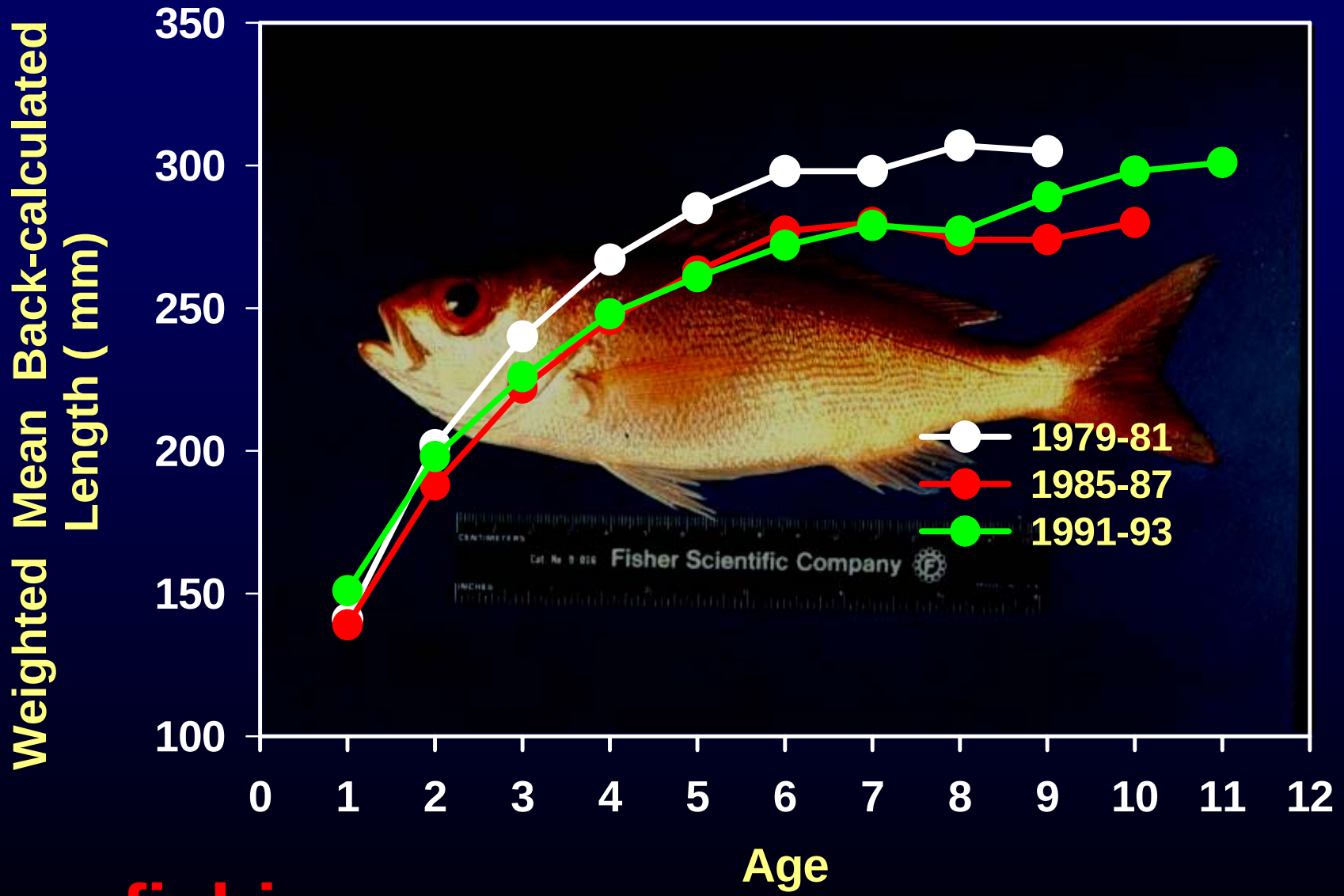
Overfished

Vermilion Snapper (26-55 m)



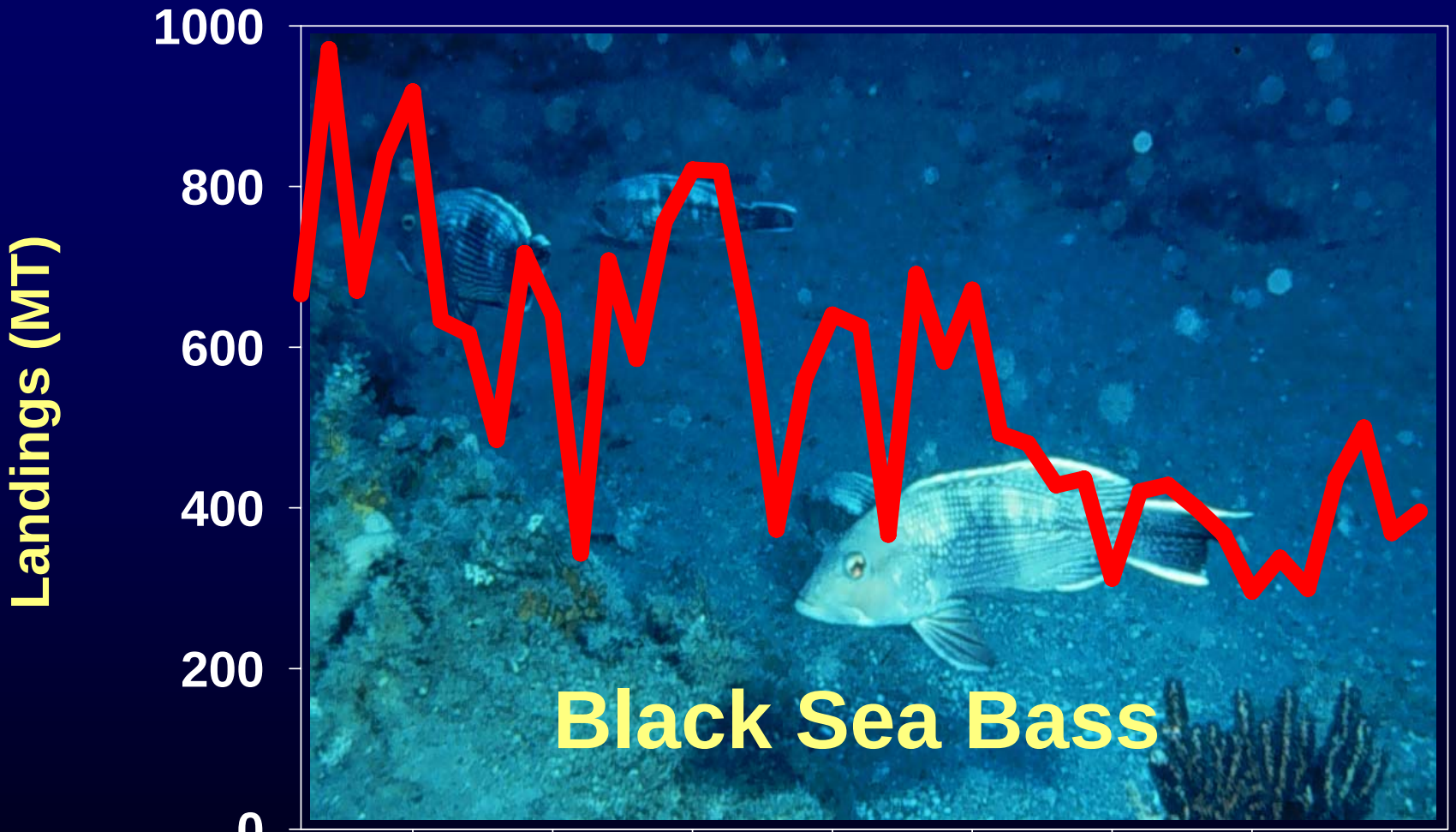
Overfishing

Vermilion Snapper Size at Age



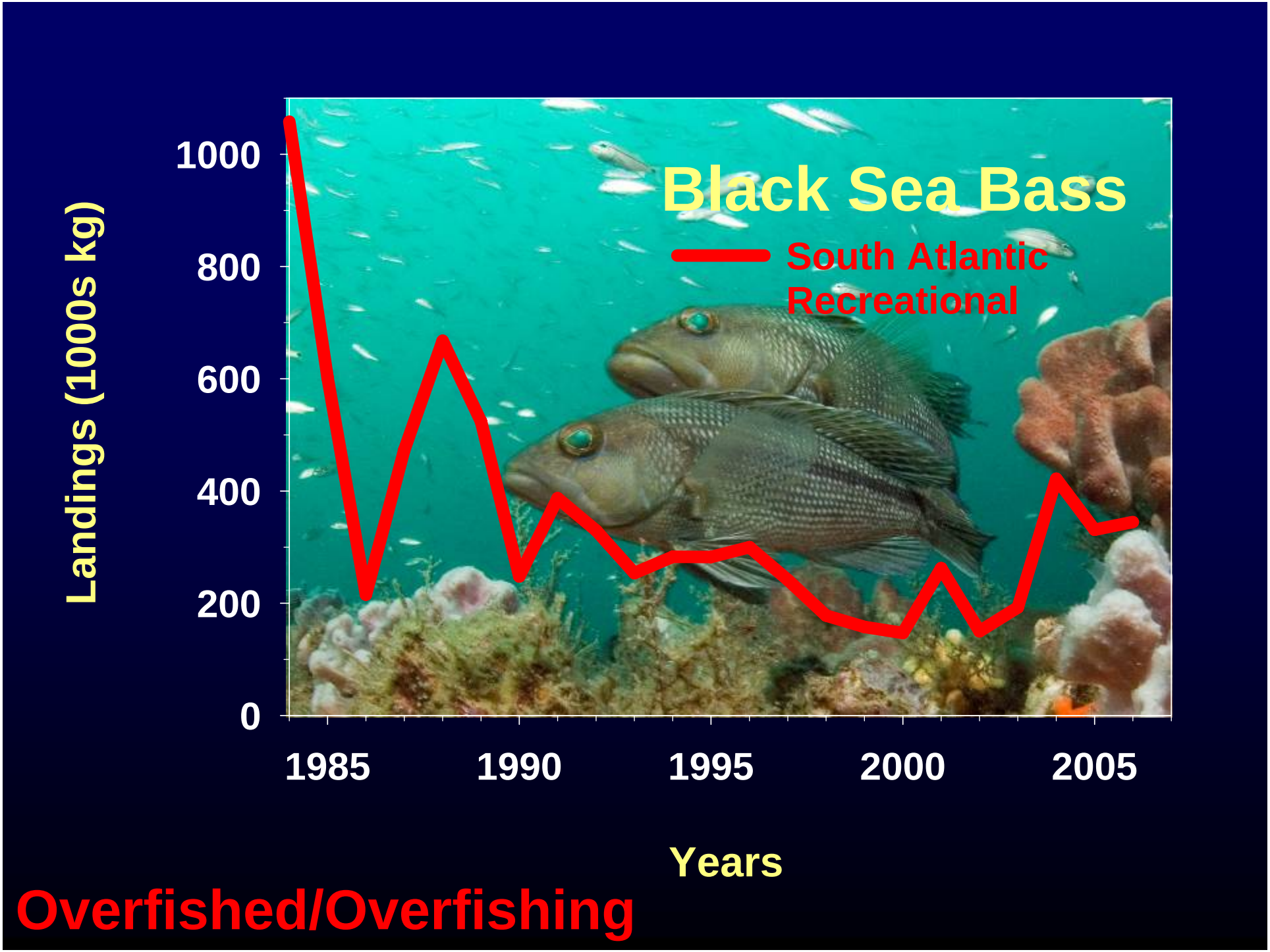
Overfishing

South Atlantic Bight Commercial Landings



Overfished/Overfishing

Years



Overfished/Overfishing

Black Sea Bass

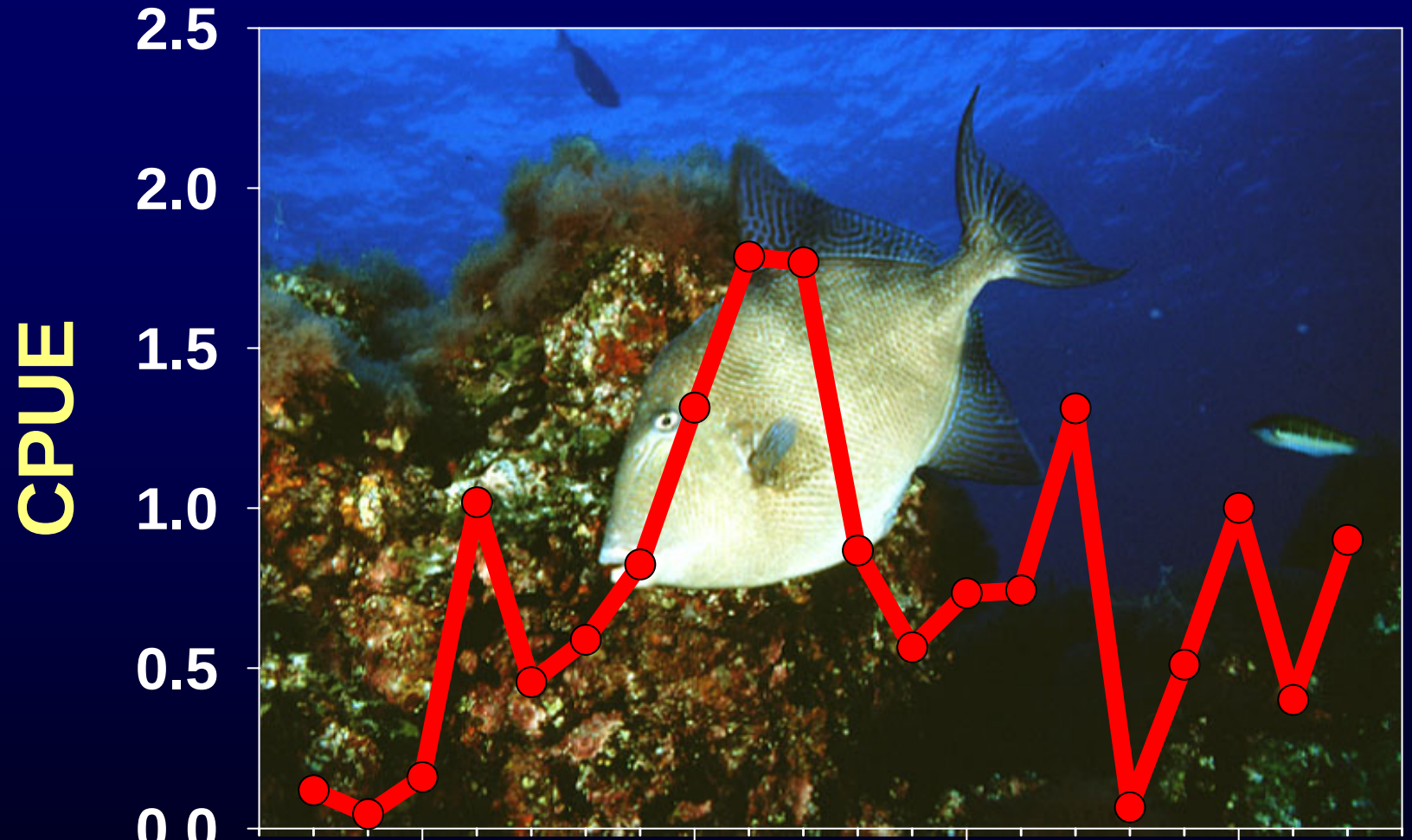
% Mature Female, 31-34ºN

SL (mm)	1978-84	1985-91	1992-97
120-139	63	97	91
140-159	90	99	99
160-179	99	99	100
180-199	100	100	100

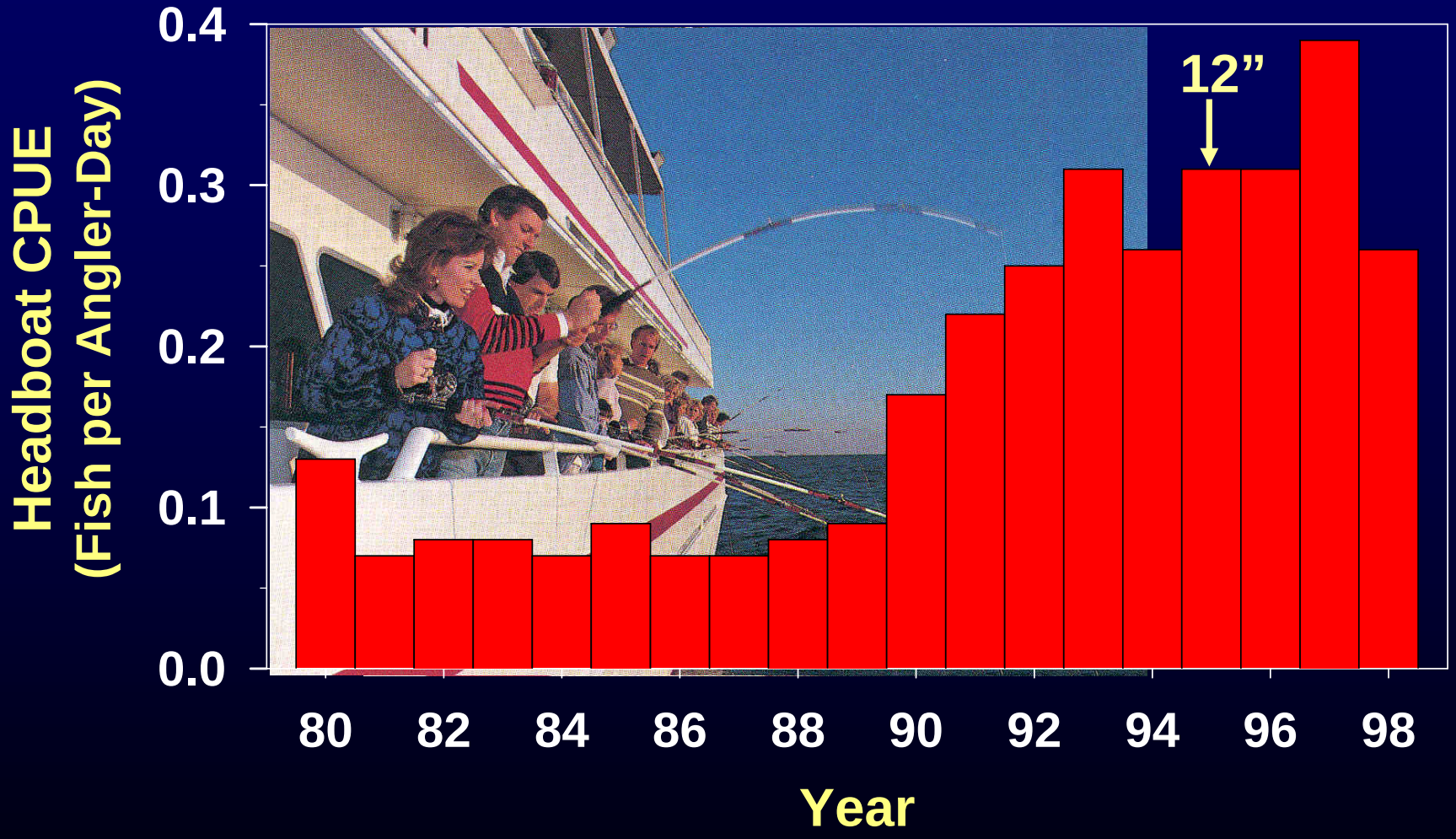
Age	1978-84	1985-91	1992-97
1	58	97	82
2	89	98	99
3	99	100	100
>3	100	100	100

Overfished/Overfishing

Gray Triggerfish (26-55 m)

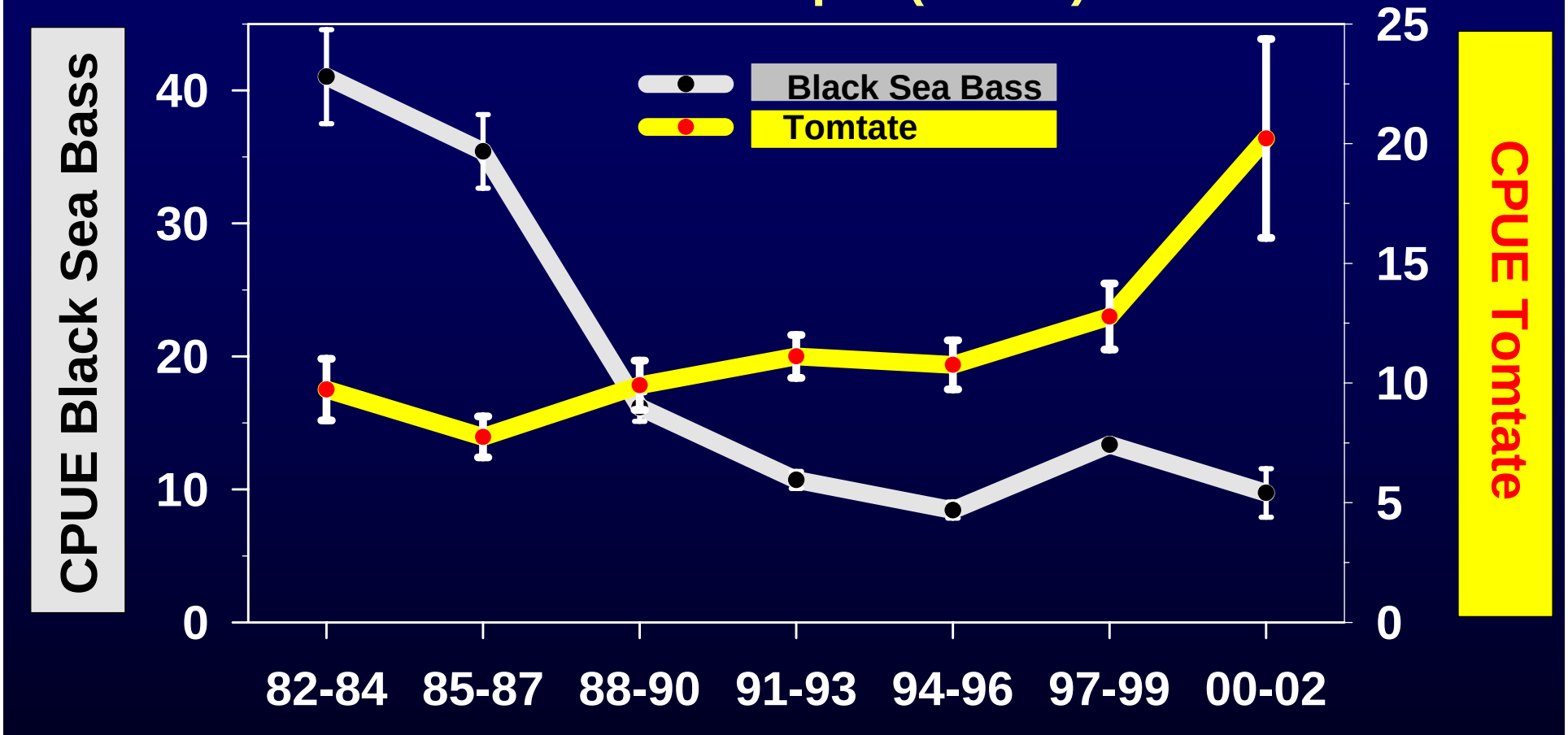


Gray Triggerfish



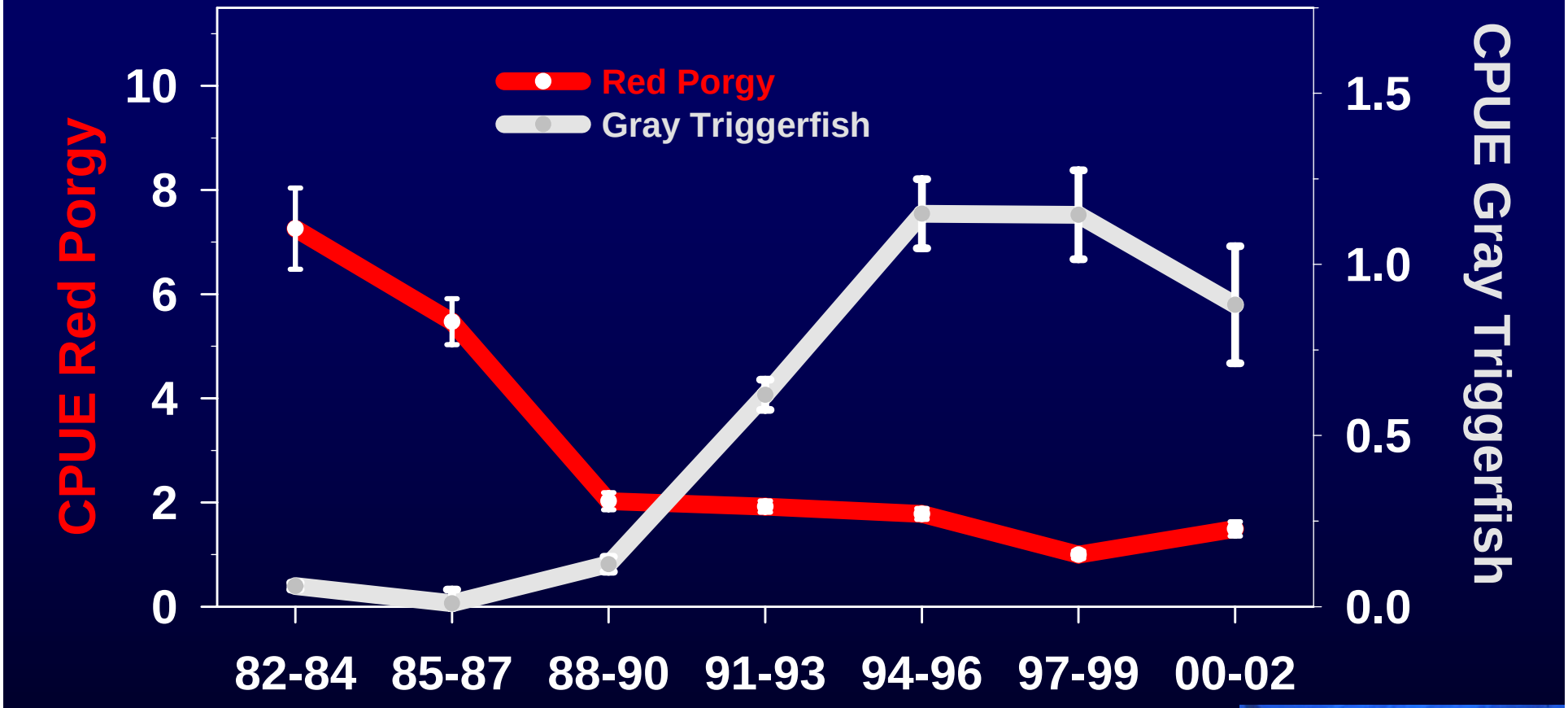
Annual Catch per Unit of Effort

26-35 m Depth (>31°N)



Annual Catch per Unit of Effort

46-55 m Depth



Management of Black Sea Bass and Red Porgy

Date	Black Sea Bass	Red Porgy	Other/Both
08/31/83	8” limit		limited trawls, poisons, traps, explosives
01/12/89			trawls prohibited in SAB
01/01/92		traps prohibited 12” limit	Required permits no longline <50 fms no nets
07/06/93	pot defined		
2/24/99	10” limit 20 fish bag escape panels	14” limit 5 fish rec. bag limit no harvest or possession > bag limit no purchase or sale Mar-Apr	
09/08/99, expired 08/28/00		No harvest or possession	
12/02/99	overfished	overfished	Both ≤ 10 y rebuild
09/22/00		rebuilding timeframe=18 years no sale Jan-April 1 fish bag limit 50 lb. bycatch	
10/23/06	quota 15 fish rec limit 11-12 min size	120 fish trip 132K lb quota 3-fish bag	
Proposed	TAC	TAC	

Problems in the (Global) Reef Fish Fishery

1. Insufficient spawning stock biomass

2. Increased probability of recruitment failure due to environmental uncertainty and shorter generation times

3. Loss of genetic diversity within species, resulting in undesirable stock characteristics (bottlenecks)

4. Growth overfishing for many species

Problems in the Reef Fish Fishery
Continued

5. Declines in overall abundance and average fish size

6. Loss of biotic (interspecific genetic) diversity

7. Potential disruptive reef fish community instability and permanent alterations

8. Faster selection for undesirable traits due to shorter generation times

Reef Fish Life History Characteristics That Make Them Vulnerable to Overfishing

Generally, reef fishes have:

- Long lives
- Slow growth to a late maturity
- Large adult size, with egg production related to size
- Site fidelity, sometimes with migration
- Complex social structure, including sex reversal
- Spawning aggregations that are predictable
- Many co-occurring species in complex assemblages

Reef Fish Life History Characteristics That Make Them Vulnerable to Overfishing

Long lives
Slow growth

Maximum ages (years) of local reef fishes

• Black Sea Bass	10
• Gray Triggerfish	10
• Vermilion Snapper	13
• Red Porgy	18
• Knobbed Porgy	21
• Gag	22
• Red Grouper	25
• Scamp	26
• White Grunt	27
• Yellowmouth Grouper	28
• Snowy Grouper	29
• Blackbelly Rosefish	30
• Black Grouper	30
• Tilefish	32
• Goliath Grouper	37
• Warsaw Grouper	41
• Blueline Tilefish	43
• Red Snapper	45

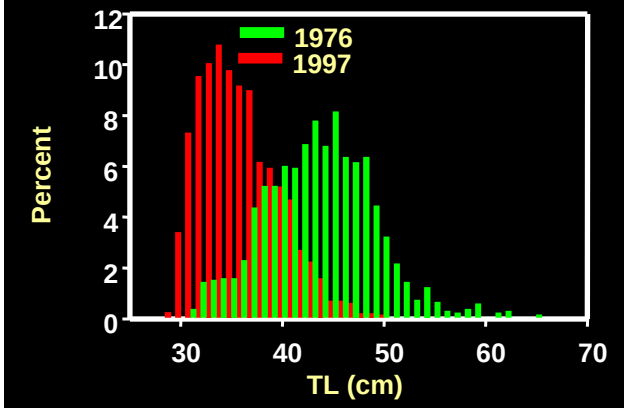
Reef Fish Life History Characteristics That Make Them Vulnerable to Overfishing

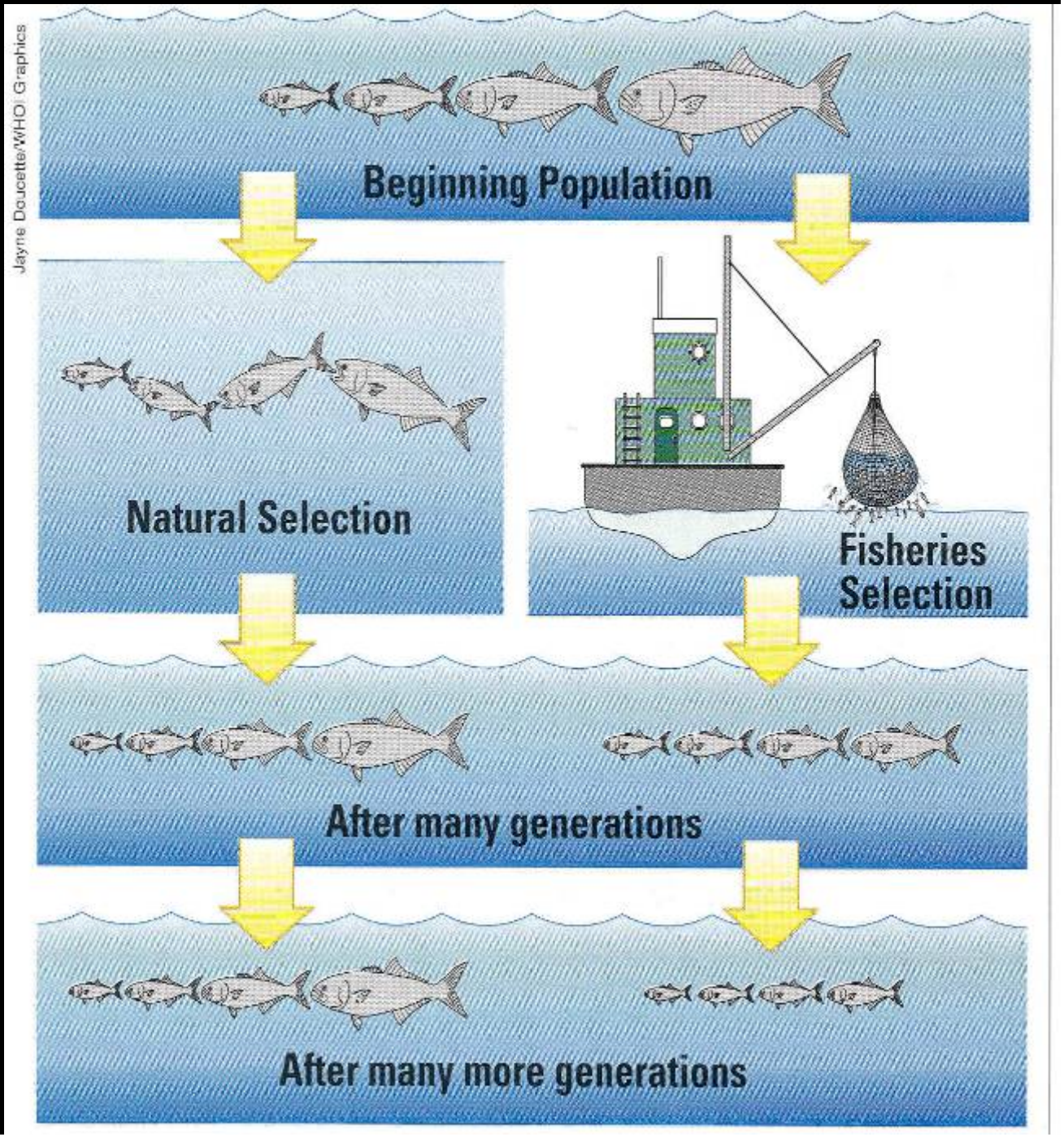
Age (Years) at 100% Maturity (Females)

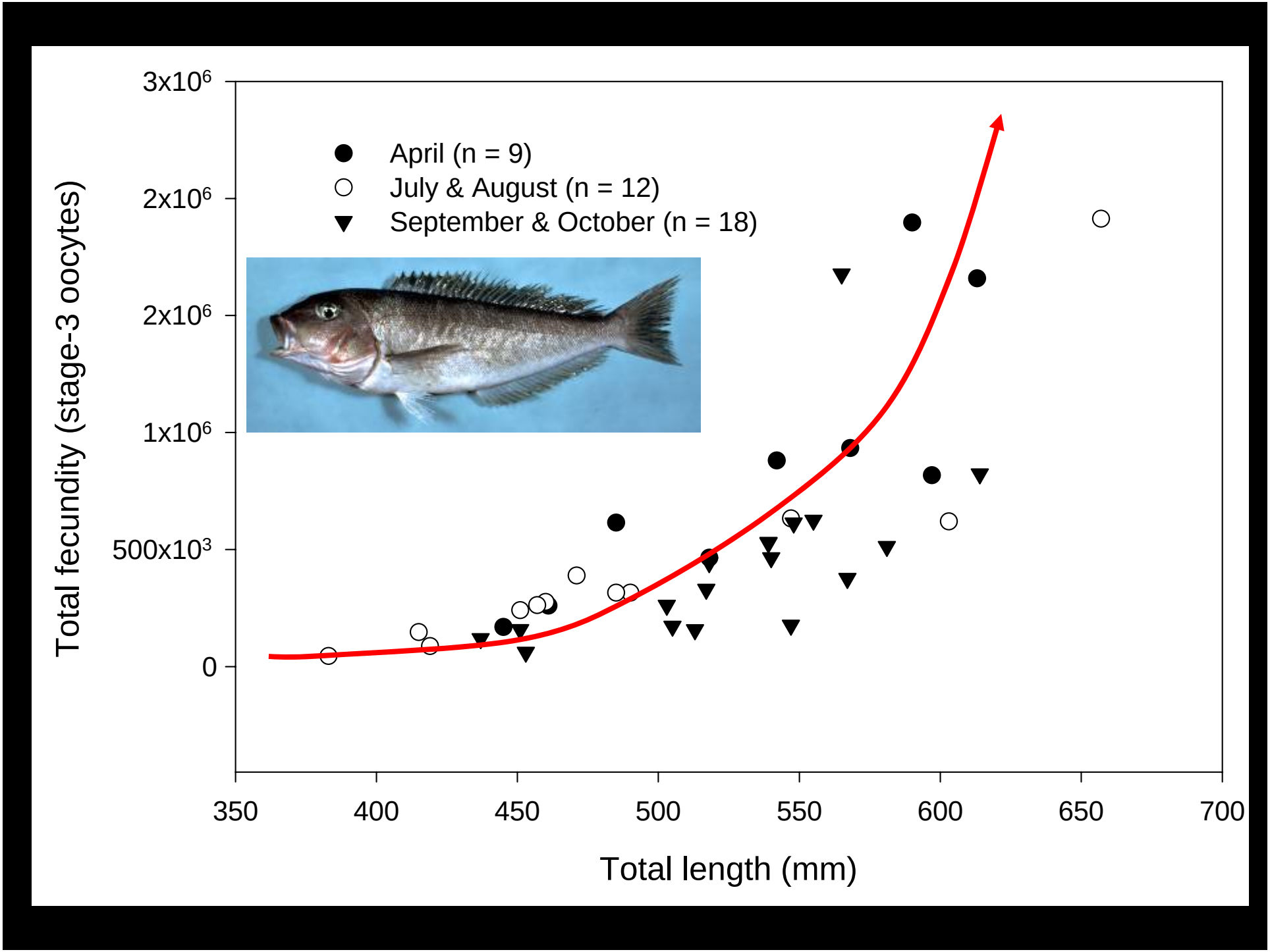
Slow Growth
Late maturity

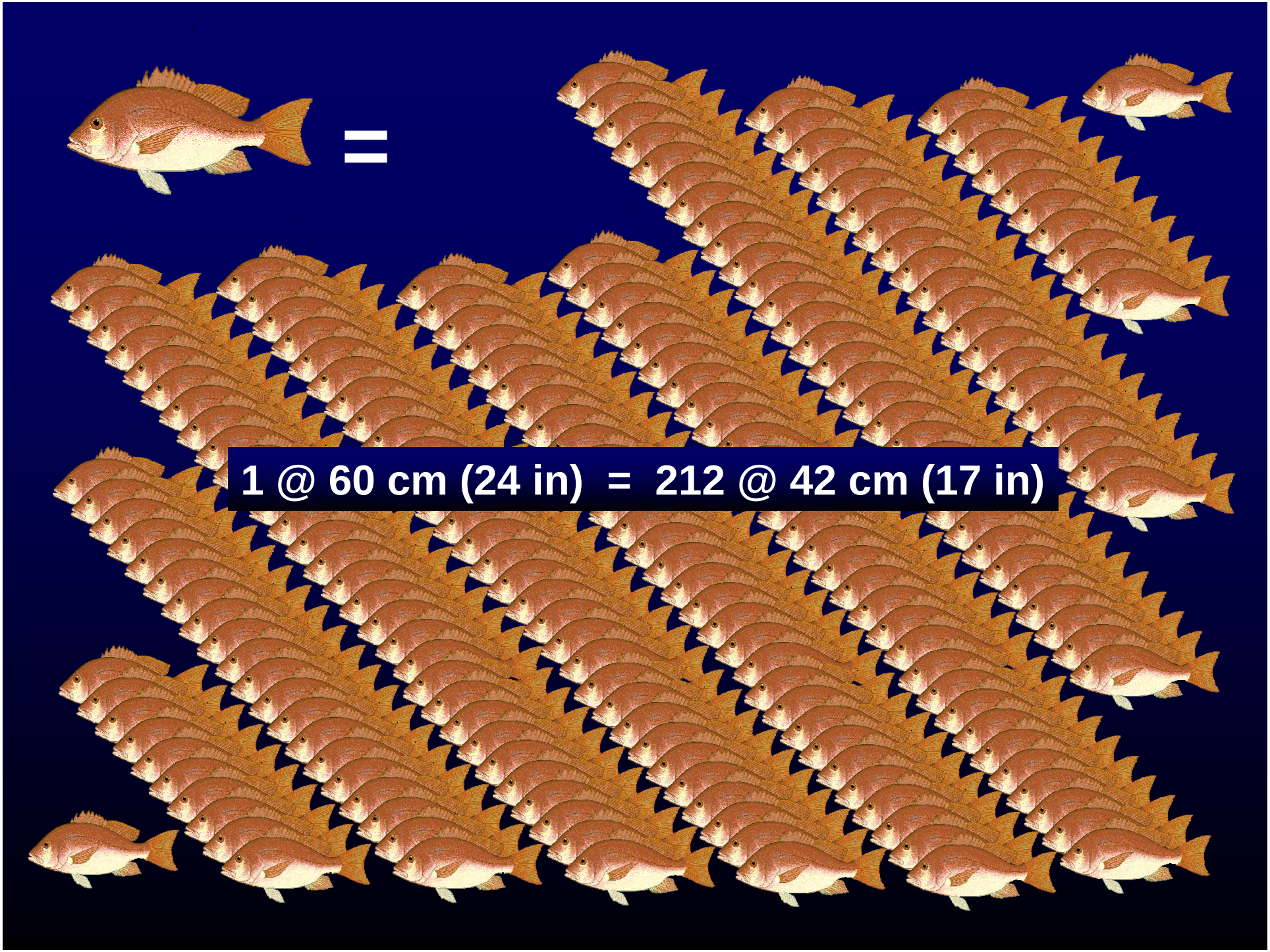
• Gray Triggerfish	2
• Vermilion Snapper	2
• White Grunt	3
• Black Sea Bass	3
• Red Snapper	4
• Scamp	4
• Yellowmouth Grouper	4
• Red Porgy	4
• Red Grouper	6
• Knobbed Porgy	6
• Gag	6
• Snowy Grouper	7
• Blueline Tilefish	7
• Goliath Grouper	8
• Black Grouper	9

Red Porgy


1976
1997
Percent
TL (cm)
0
2
4
6
8
10
12
30
40
50
60
70

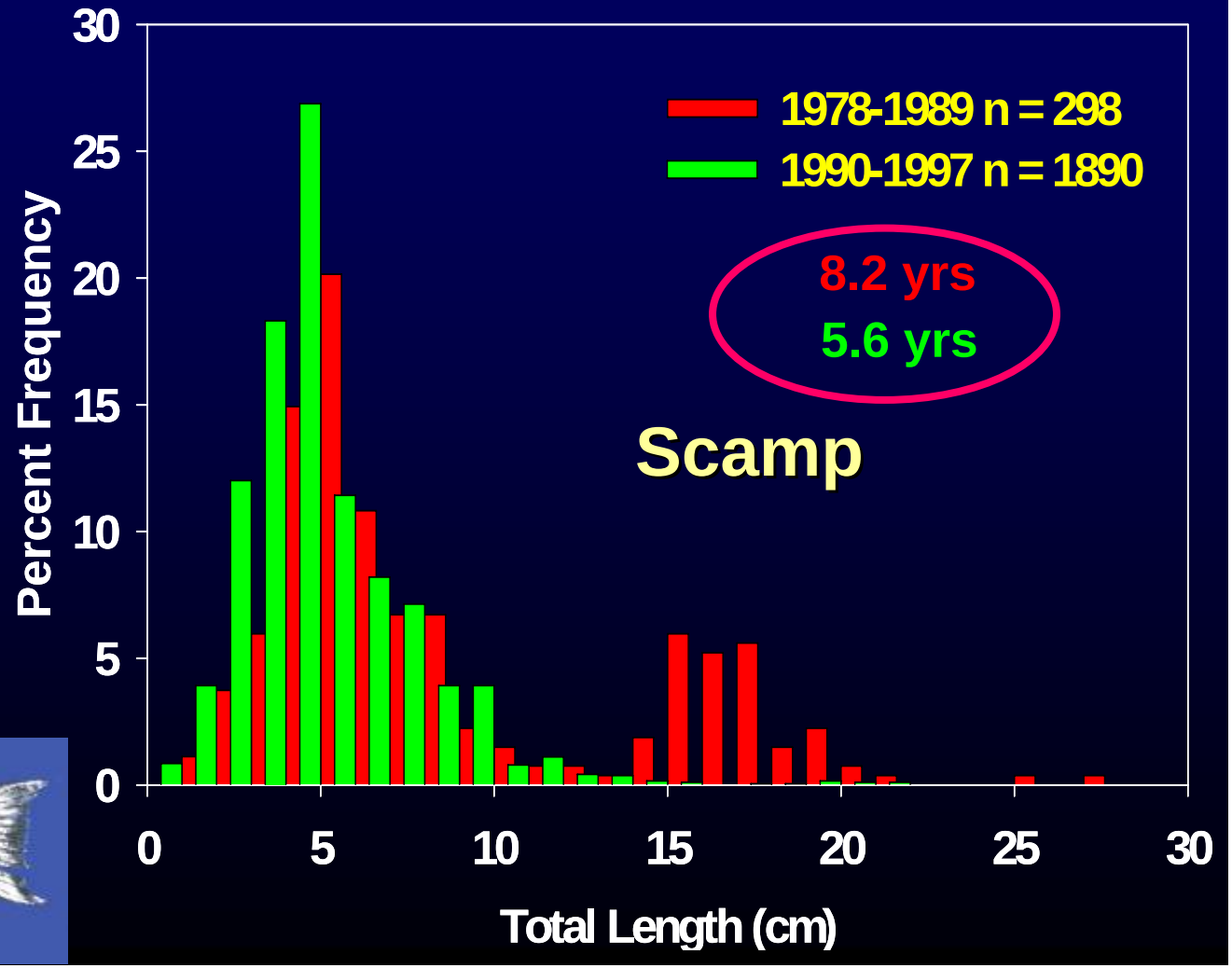

Jayne Doucette/WHOI Graphics
Beginning Population
Natural Selection
Fisheries Selection
After many generations
After many more generations


3x10^6
2x10^6
2x10^6
1x10^6
500x10^3
0
Total fecundity (stage-3 oocytes)
April (n = 9)
July & August (n = 12)
September & October (n = 18)
350
400
450
500
550
600
650
700
Total length (mm)

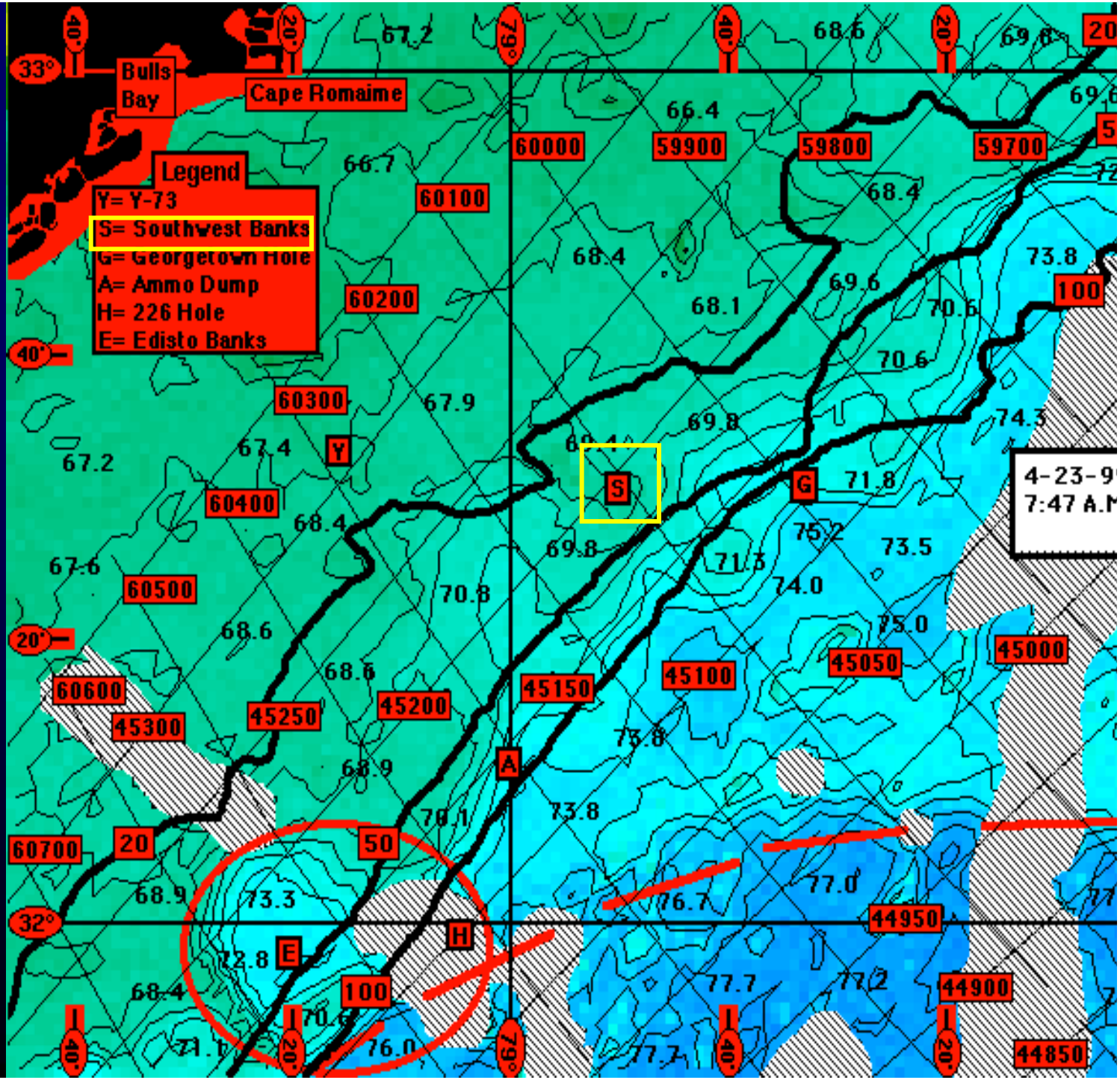

=
1 @ 60 cm (24 in) = 212 @ 42 cm (17 in)

Reef Fish Life History Characteristics That Make Them Vulnerable to Overfishing

Shorter lives; shorter generation time and smaller size



Site fidelity and habitat specificity, sometimes with migration



Goliath Grouper

Red Snapper

Aggregations of groupers, snappers and other species can be predicted because many species aggregate to spawn at the same sites in a predictable manner.

Signs of Overfishing

1. Reduced total landings
2. Declining catch per unit effort (CPUE)
3. Shifts in catch to smaller size fish
4. Shifts in catch to different species
5. Recruitment failure (few or no fish added to exploitable stock)

Signs of Climate Change?

1. Reduced total landings
2. Declining catch per unit effort (CPUE)
3. Shifts in catch to smaller size fish
4. Shifts in catch to different species
5. Recruitment failure (few or no fish added to exploitable stock)

Signs of Lionfish Invasion?

1. Reduced total landings
2. Declining catch per unit effort (CPUE)
3. Shifts in catch to smaller size fish
4. Shifts in catch to different species
5. Recruitment failure (few or no fish added to exploitable stock)

Signs of Overfishing

1. Reduced total landings
2. Declining catch per unit effort (CPUE)
3. Shifts in catch to smaller size fish
4. Shifts in catch to different species
5. Recruitment failure (few or no fish added to exploitable stock)

Management Options for Reef Fishes

1. Size limits (output controls)
2. Catch quotas
3. Seasonal closures
4. Pulse fishing
5. Limited entry (input controls)
6. Habitat alteration/enhancement
7. Supplementary stocking
8. Gear restrictions
9. Permanent no-take MPAs (marine reserves, <1% of world oceans)

Problems With Traditional Management that Might Make Reef Fish More Vulnerable to Overfishing

Releasing prohibited fish (undersized; exceeding bag limit, etc.) does not work because of release mortality

Particularly true on deep reefs

Traditional options promote fishing on the larger, long-lived, most fecund, genetically fit and most valuable individuals.

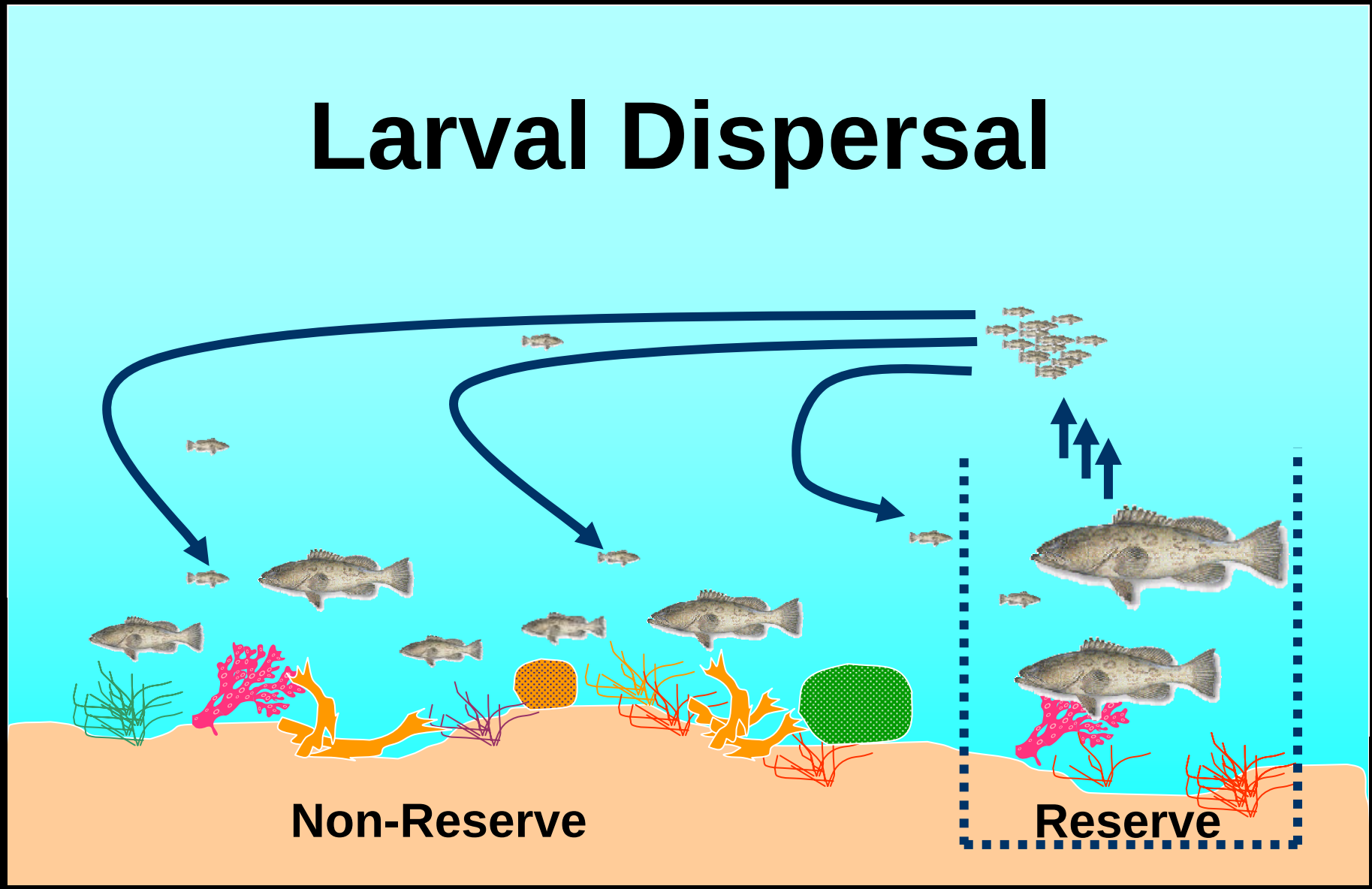
Benefits of No-Take MPAs to Reef Fishes

1. Protection of spawning stock biomass
2. Protection of desirable genetic traits
3. Maintenance of size/age structure and sex ratio
4. Insurance of recruitment under environmental uncertainty because of restoration of age structure
5. Maintenance of natural equilibrium/balance and community
6. Public understanding of “nature reserve”
7. Insurance against failure of traditional management
8. Fairness and equitability
9. Potential for restocking of adjacent areas
10. Provision of research sites
11. Avoidance of bycatch and incidental fishing mortality
12. Simplified enforcement
13. Reduction of incidental poaching
14. Leadership role

Problems with No-Take MPAs

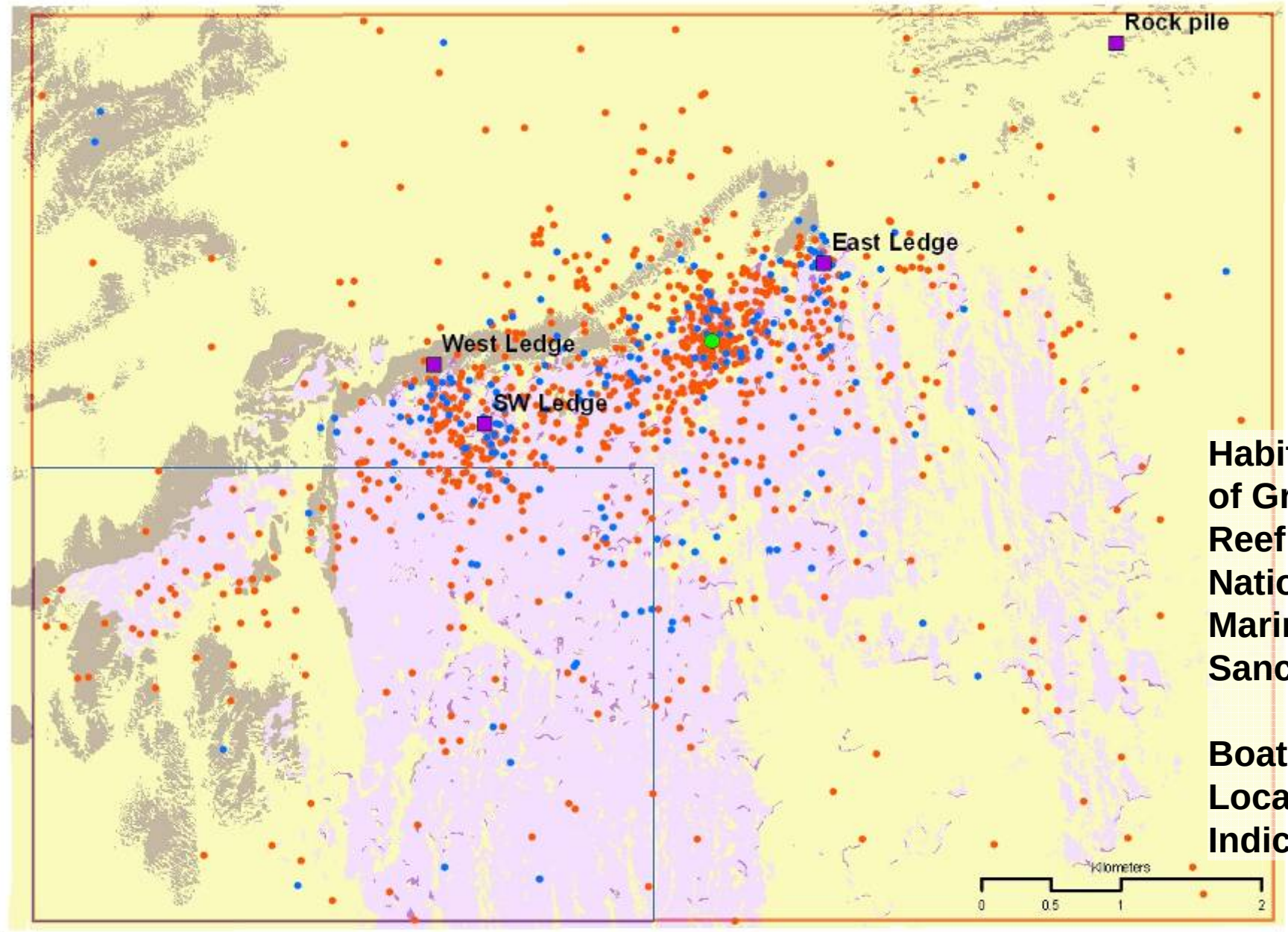
1. Institutional inertia (20 years in SAB)
2. Local and special interest opposition
3. Short-term landings decline
4. Long-term loss of fishing area
5. Conflicts with other fisheries and their management (e.g. sharks)
6. Lack of research on effectiveness, size, habitats, etc.
7. Lack of knowledge on all life history stages of fishes
8. Do they work?

Can No-Fishing Zones Enhance Fishing Opportunities? Yes! (or Maybe!)



81°24'
81°6'
80°48'
31°54'
31°36'
31°18'
Savannah
Atlantic Ocean
Georgia
0 10 Miles

Gray's Reef National Marine Sanctuary



Habitat Map of Gray's Reef National Marine Sanctuary

Boat Use Locations Indicated

Black Sea Bass Fishing Mortality From Catch Curve Analysis

Year	Gray's Reef (summer)	Gray's Reef (fall)	Chas (all sites in summer)	Edisto (all sites in summer)	Murrells (all sites in summer)
1993	1.27	1.85	1.36	1.33	1.10
1994	1.33	1.51	1.10	1.13	1.48
1995	1.74	1.66	1.47	1.13	1.05
1996	-	-	1.55	1.15	1.47
1997	1.64	-	1.34	0.92	1.31
1998	1.23	-	1.15	1.05	1.39
1999	1.16	1.34	1.24	1.05	-
2000	-	1.22	1.19	1.13	1.00
2001	1.46	1.29	1.36	1.21	1.58
2002	1.77	1.43	1.10	1.29	1.32

NOAA National Marine Sanctuary Program

Program Goals:

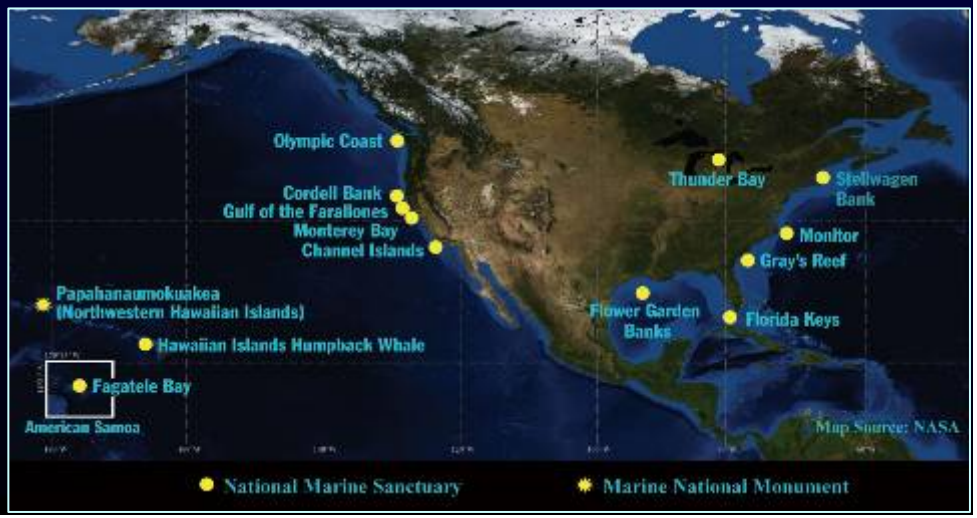
1. Designate and manage areas of the marine environment with special national significance

2. Primary objective to protect marine resources, such as coral reefs, sunken historical vessels or unique habitats

3. Research and monitoring

4. Enhance public knowledge

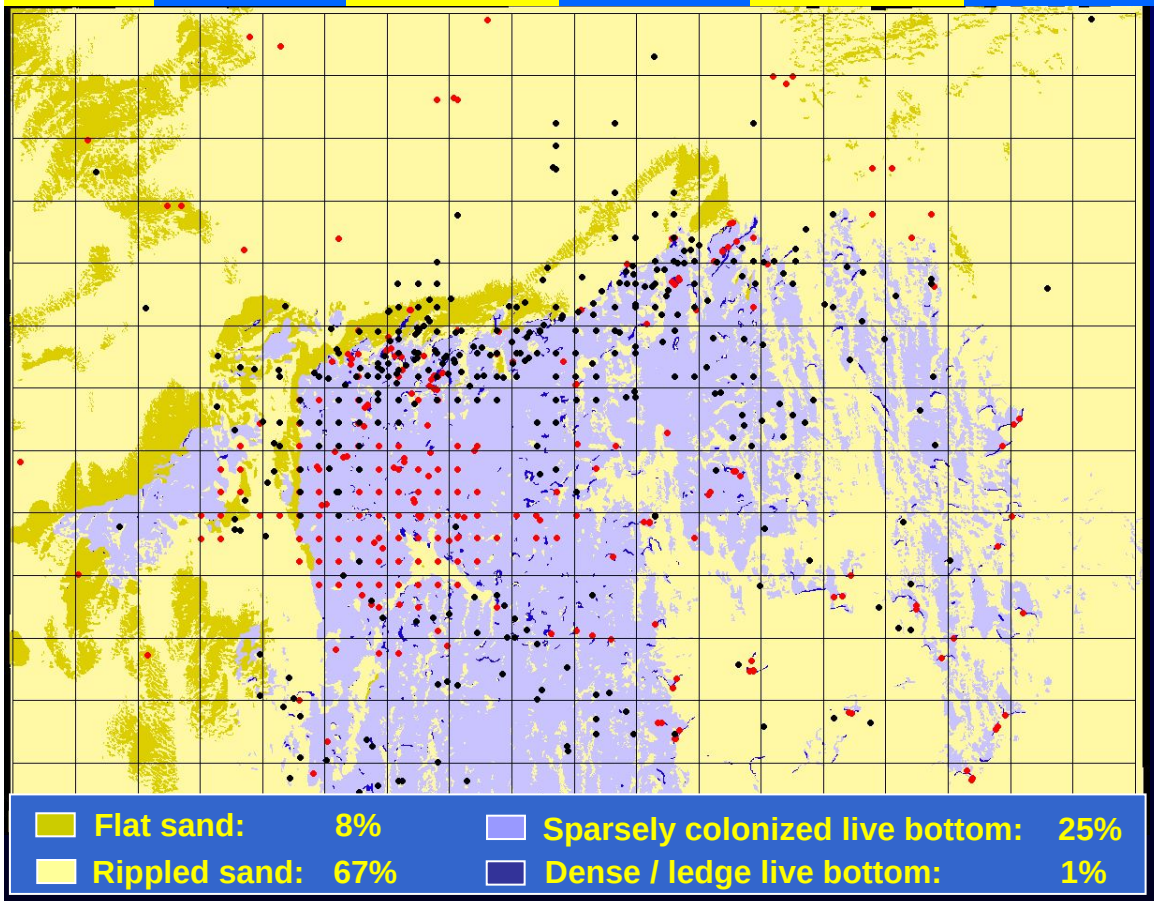
5. Facilitate compatible use



A Research Area for Gray's Reef National Marine Sanctuary

- Mixed temperate and subtropical fauna
- Important habitat for juvenile reef fishes
- A sentinel site for inner shelf live bottom reefs
  - Climate change
  - Fisheries recruitment
  - Contaminants
  - Ecosystem health.....

Gray's Reef National Marine Sanctuary



Habitat Map of Gray's Reef National Marine Sanctuary

- Research sites
- Fishing boats

- Fished (recreational)
- Historical research
  - Bottom invertebrates
  - Fish monitoring
  - Water quality

Research/Control Area Concept Time Line

- **1999: Concept proposed during public scoping for revision of GRNMS management plan**
  - **Problem: There are no naturally occurring, live-bottom sites within the Sanctuary (or the region) established exclusively for research**
  - **Outcome: Increase opportunity to discriminate scientifically between natural and human-induced change to species populations in the Sanctuary**

Research/Control Area Concept Time Line

- **2003 Draft Management Plan:**
  - **Direct a working group established by the Sanctuary Advisory Council to study the marine research area concept**
  - ***Research Area Working Group* – Sport diving, sportfishing, commercial fishing, enforcement, scientists, educators, conservation, state, federal**

Research/Control Area Concept Time Line

May 2004 – December 2005 – Research Area Working Group and Sanctuary Advisory Council made, and GRNMS adopted, four recommendations:

Research questions exist at Gray's Reef that can only be addressed by establishing a control (research) area through a public review process.

Use available data to investigate a research area with proper siting criteria.

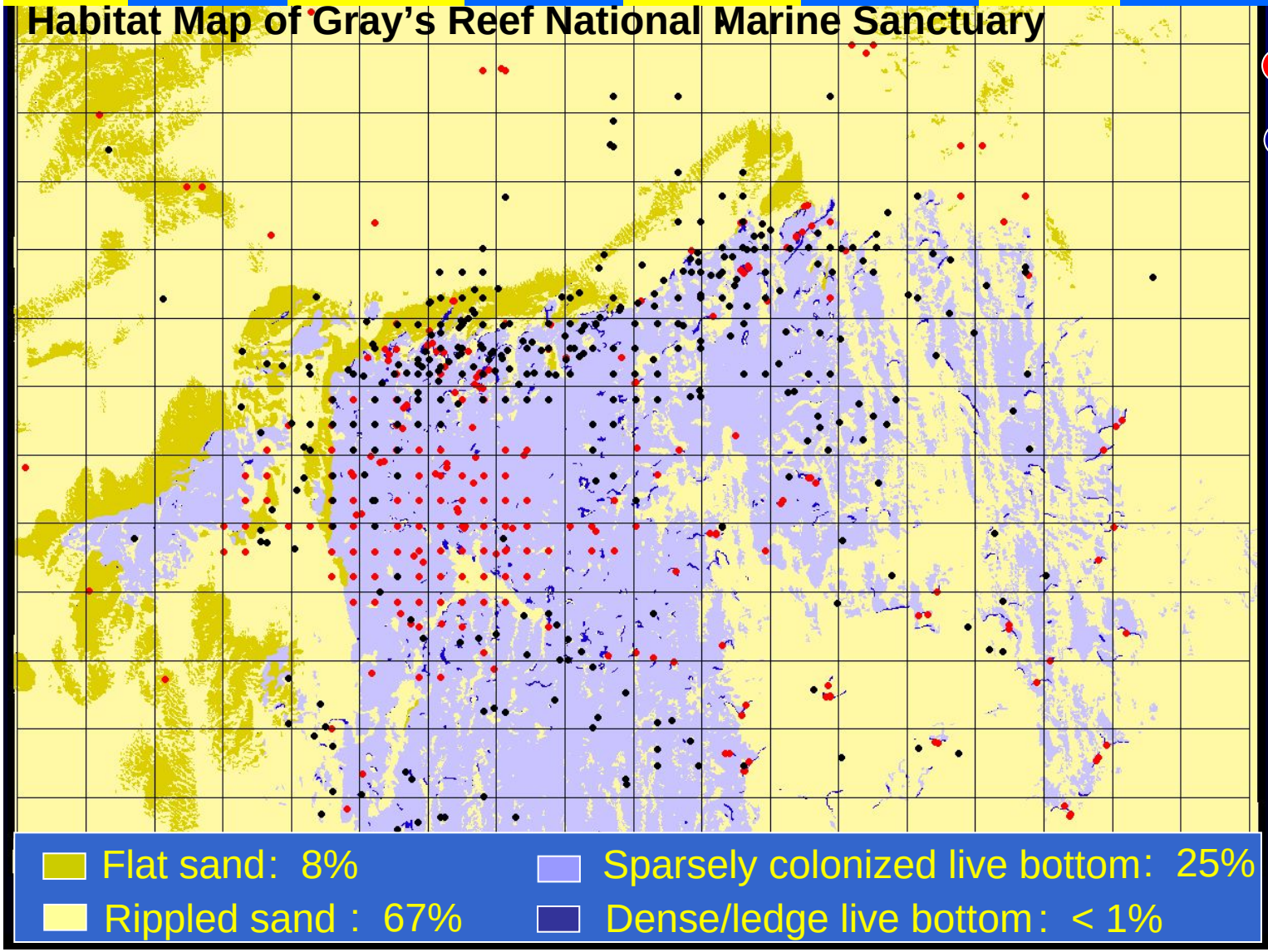
Consider the diversity of habitats, with emphasis on high relief, as the primary siting criterion

Minimize impacts to users

What Are Research Unknowns? (May 2004)

- **Impacts of extractive activities?**
  - **Provide baseline for fishery independent surveys, other ecological studies, comparative regional studies**
- **Differences between "natural" and "impacted" reefs?**
  - **Natural vs. human-influenced variability in physical conditions and marine life**
  - **Abundance and diversity of all marine life in the absence of human activity**
  - **Un-impacted trophic structure: food chain connections between plankton and fish production**
  - **Fish community structure and population dynamics in the absence of fishing (species, size and age structure)**
- **Can Sanctuary help conserve natural resources?**

Research Area Siting Criteria (May – Oct 04)
Example Application



- Research sites
- Fishing boats

Other Activities

Habitat Type (include all)

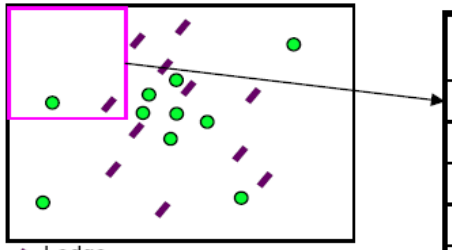
Size/shape of Area

User Interaction
- Acceptance
- Cost
- Enforcement
- Science apps

Using Existing Data to Explore the Research Area Concept

Analysis process

Start the window in northwest corner of the sanctuary, this is option 1.



Option	# Ledges Inside	# Research Sites Inside	# Ledges Outside	# Research Sites Outside
1	1	1	9	9
2				
.				
.				
n				

Sliding window…

1. Tally variables within and outside the window
2. Slide it over 100m
3. Re-tally
4. Comprehensively slide throughout the sanctuary
5. Results in a table 50 columns wide by n rows long

Using GIS and Existing Data to Explore the Research Area Concept

Scoring boundary options

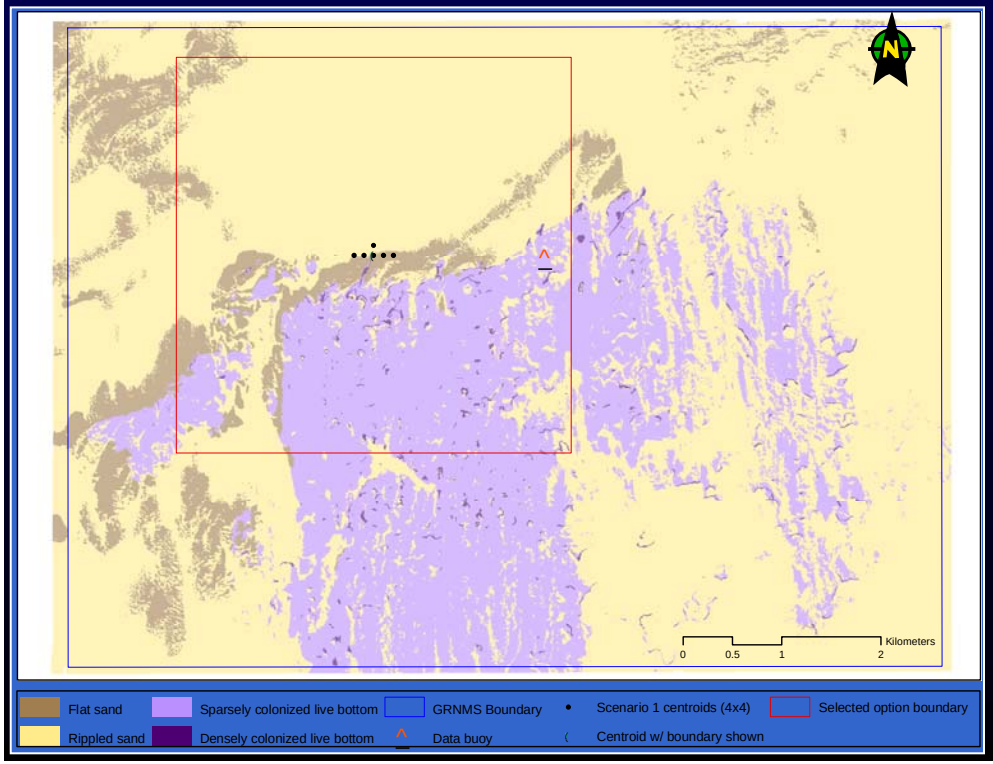
- 30,307 options!
- Step-wise selection of acceptable variable values to reduce to acceptable list of options
- Five scenarios chosen for public comment
  - Optimal scientific option by the RAWG
    - Representative habitat proportions; at least 30 ledges of each height class
  - Minimizing fishing displacement
    - Smaller--At least 30 ledges of each height category but NO proportional habitat representation, minimum inclusion of fishing areas
  - Intermediate option
    - Maximize habitat and ledges, minimize fishing displacement
  - SE or SW quadrants (do not meet habitat criteria)
    - Suggested at prior public meeting or by GRNMS staff

An Optimal Scientific Scenario:

Scenario # 1: Optimal scientific option

(representative habitat proportions and at least 30 ledges of each height category)

Factors
Size - 4x4 km preferred (6 centroids)
Habitat - Minimum # ledges (densely colonized live bottom) – 30 tall, 30 med, 30 short)
Fishing displacement - not considered



Comments:

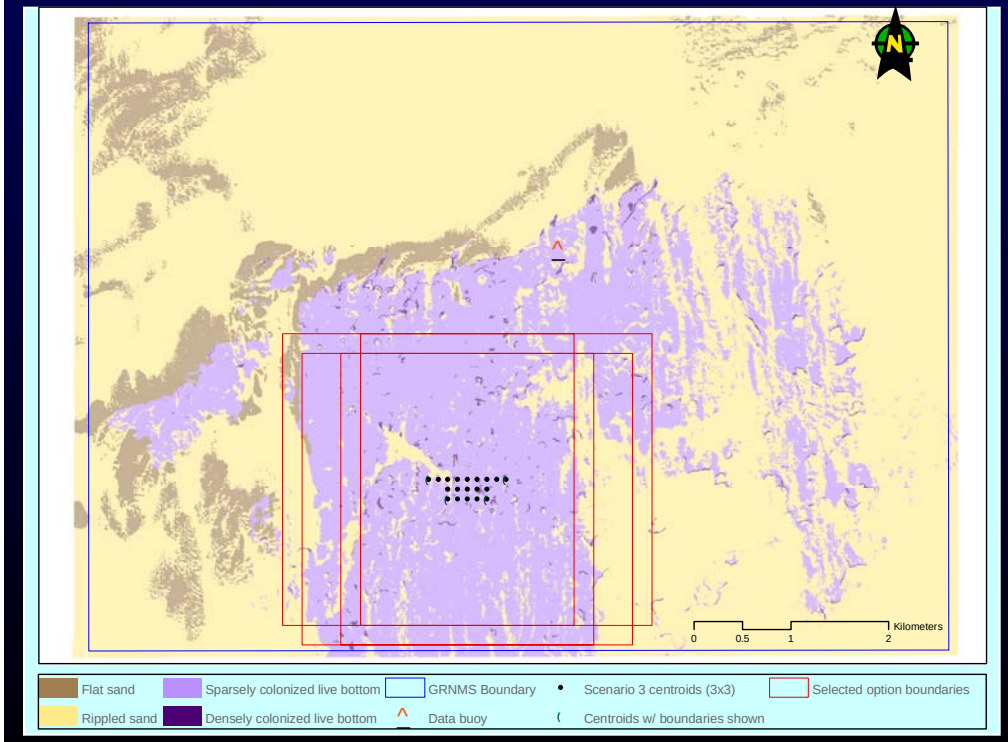
- Most representative of Sanctuary.
- Leaves at least 79 (54%) of all ledge types outside the RA for fishing and comparative research.
- At least 30 of all ledge types (height and area) are inside.
- Some of all bottom types are outside the RA.
- All options encompass ~two-thirds of the primary fishing area (based on boat sightings).
- All options include the Long Term Monitoring Site.
- All options include large amounts of prior research
- All options encompass the data buoy

A Minimal Fishing Displacement Scenario:

Scenario # 2: Minimize fishing displacement

(At least 30 ledges of each height category but NO proportional habitat representation)

Factors:
Size - 3x3 km (19 centroids)
Habitat – relaxed proportional rule, 30 of each ledge type (short, med., tall)
Fishing displacement – minimized



Comments:

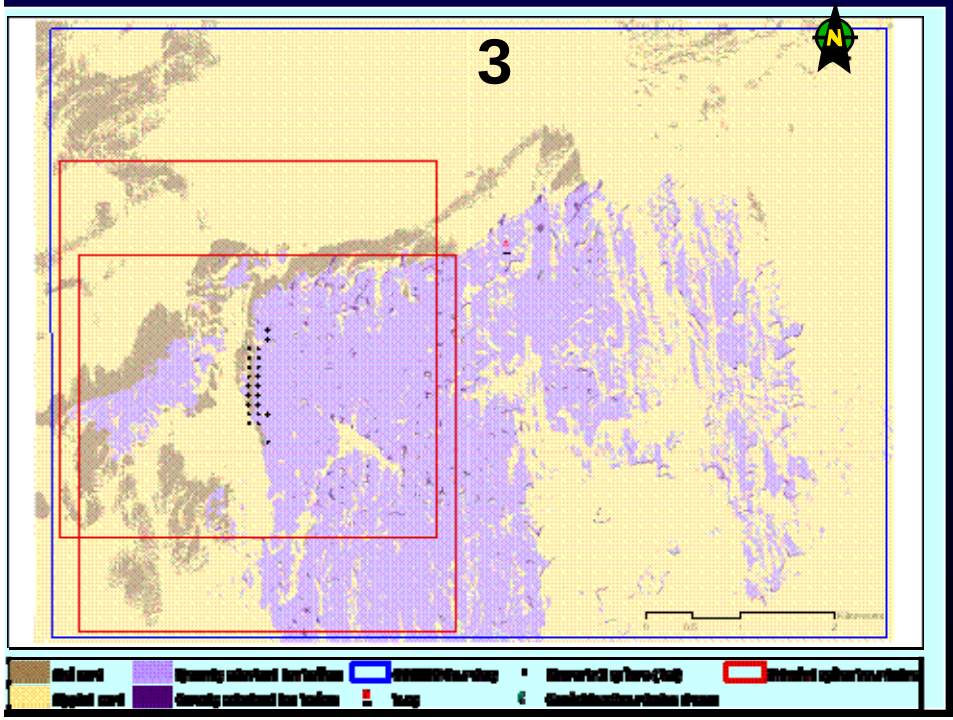
- Options contain no or a very low amount of flat sand; % rippled sand is from 11-20%.
- At least 61 (42%) of all ledge types are outside the RA for fishing and comparative research.
- Some of all bottom types are outside.
- No options contain the Long Term Monitoring Site.
- All options include large amounts of prior research.
- All options avoid prime fishing area and do not encompass the data buoy.

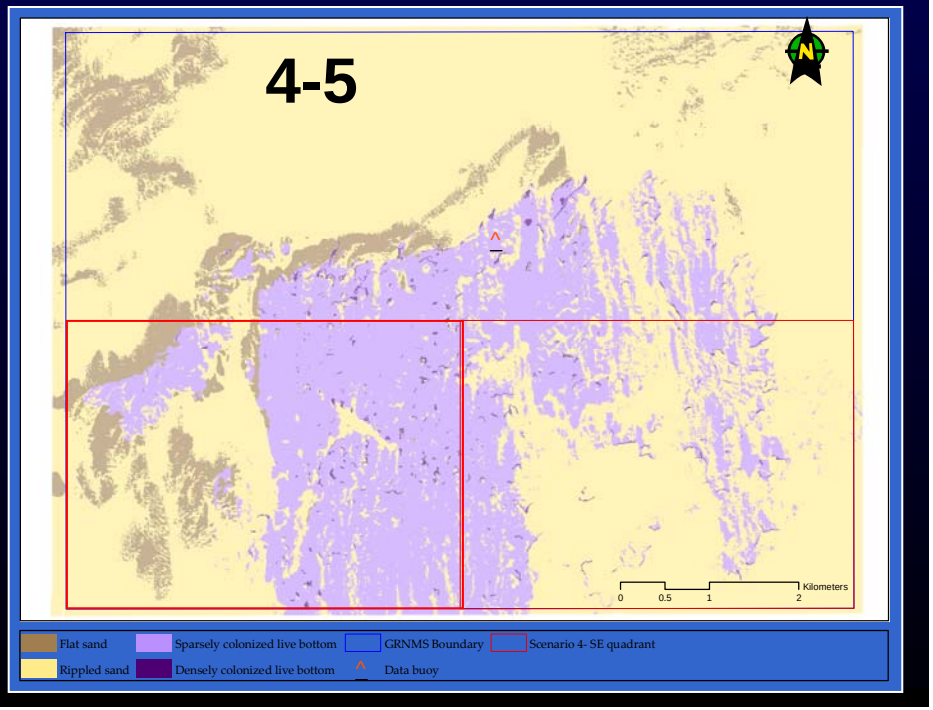
Intermediate or Quadrant Scenarios:

Scenarios 3-5:

3: Intermediate between optimal science and minimum fishing displacement (22 centroids; 4 x 4 km)

4-5: Corner quadrants (suggested by fishermen, GRNMS staff, LE)





Additional Research Area Issues

- Additional information on trolling
- Effects of recreational diving
  - Effects of these activities on habitats, organisms, and a “control area”
- Enforcement
- Limiting entry into research area

Research/Control Area Concept Time Line

- **January 31, 2008 – GRNMS Advisory Council meeting to present RAWG recommendations, boundary options, and socioeconomic analysis**
- **March 2008 – Public scoping**
- **April/May 2008 – Develop Draft EIS, proposed revised designation document (scope of regulations), Draft science and monitoring plan, and IF NEEDED fishing regulations request for SAFMC**

Summary: The Need for a Research/Control Area

- Why a research areas?
  - None exist: no natural inner or mid-shelf live bottom areas in the region set aside for research; we do not fully understand their function
  - Significant research questions exist at GRNMS that can only be answered with a control area
  - Need data on the status and natural variability of fish communities, habitats and ecological systems for informed management
  - To provide these data, a control area is needed within the sanctuary
  - Such a control area will allow us to monitor conditions over time and to tell the difference between some human-induced and natural changes
- This is not a fishery management plan; this is resource protection (through research) and compatible use

Summary: The Research Questions

- What are the research questions?
  - What impacts, if any does fishing have on the reef and living marine resources?
  - What would fishery populations look like in the absence of fishing impacts? Is fishing an impact?
  - What impacts does removal of targeted species have on overall fish community structure and resident fish?
  - What is bottom invertebrate community structure and/or reef food chain structure in the absence of fishing?
  - What are the spatial and temporal dynamics of fish communities in a natural population? Is it different when fished?
  - Does fishing affect size, movements, spawning?
  - What variability in the natural system is independent of human impact?
  - How well is NOAA conserving the resources of Gray's Reef National Marine Sanctuary?

Summary: The Benefits of a Research/Control Area

- **What benefits will accrue to the Sanctuary?**
  - **Better understanding of the role of inner shelf live bottom in the life history of reef fishes of the region**
    - **Nursery area?**
    - **Spawning ground?**
  - **Sentinel sites for climate change and other non-fishing effects**
  - **A Sanctuary from fishing, where species composition, size/age structure, trophic structure, behavior and community structure are natural and fishing effects are minimized**
  - **Increases the value of the Sanctuary for multiple compatible uses, including research**

Monitoring and Research Needed to Evaluate Fishing, Regulations and Natural Variation

1. Dedicated research and monitoring efforts to evaluate impact of RA (inside and outside RA; before and after RA)
2. Monitoring of fish species composition, genetic diversity, abundance and size
3. Documentation of effects of RA on fishing success
4. Economic study of fishing and fishing restrictions
5. Effectiveness of enforcement
6. Effects of pelagic fisheries on bottom fish
7. Determination of most efficient size, placement of a closed area for research and management
8. Determine “edge effects” and effect on catches near and distant from the RA
9. Determination of re-supply to fished areas (locate and map spawning sites, circulation and hydrography)
10. Utilize fishermen in research and monitoring efforts (tagging, creel census---what else?)

Immediate Research Objectives to Be Addressed

1. Water quality monitoring
2. Fish monitoring
3. Daily and seasonal movement of juvenile and adult fish—spillover; with acoustic tagging
4. Socioeconomic impacts
5. Request For Proposals

Satellite-tracked drifter data indicate that eggs and larvae spawned in GR stay near or in GR—what happens to later stages?

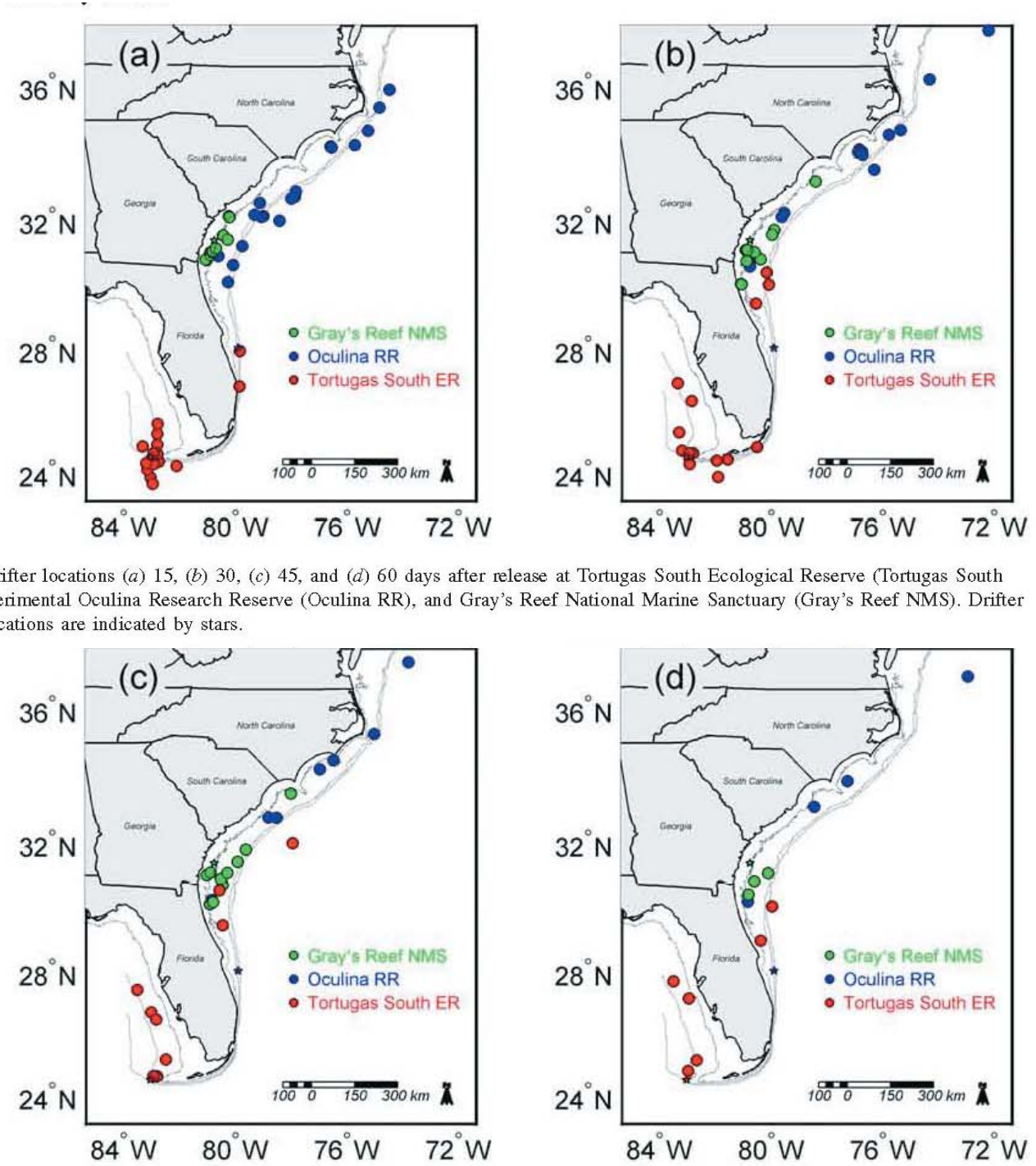


Fig. 5. Drifter locations (*a*) 15, (*b*) 30, (*c*) 45, and (*d*) 60 days after release at Tortugas South Ecological Reserve (Tortugas South ER), Experimental Oculina Research Reserve (Oculina RR), and Gray's Reef National Marine Sanctuary (Gray's Reef NMS). Drifter release locations are indicated by stars.

Ocean Observing Systems "SABSOON"