

Community wide
consequences of
declines in large
predatory fishes

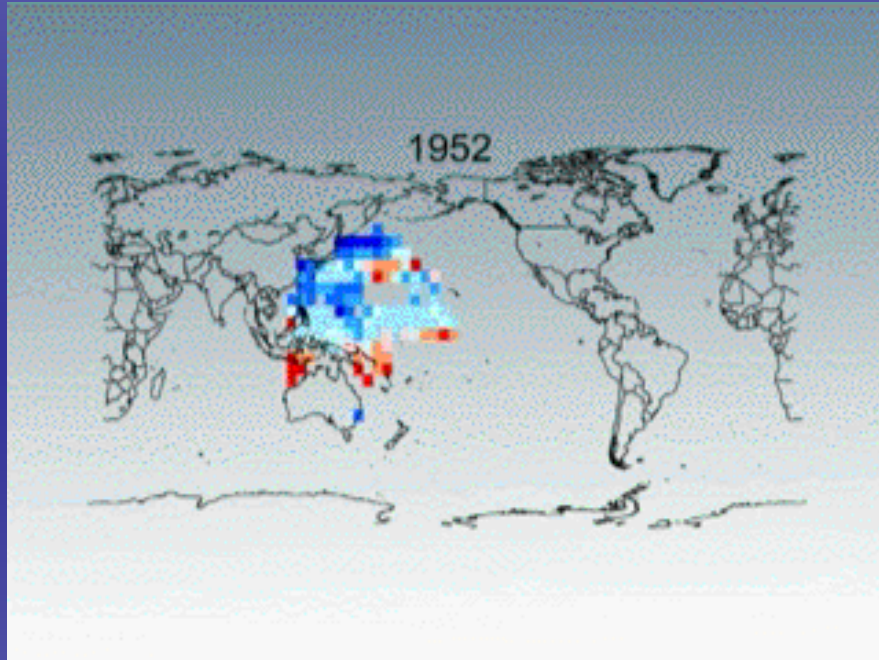
Travis Shepherd
Post-doctoral fellow
Dalhousie University



What to expect

- Changes in elasmobranch populations in the Gulf of Mexico and eastern US
- How has removal of top predatory fish affected associated marine communities?

Global decline of large predators



Myers and Worm, 2003 Nature

- 90% decline in large predatory fishes since 1950
- Tuna, blue marlins, swordfish, sharks
- Erosion of diversity
- Ecosystem stability
- Trophic cascades

Gulf of Mexico

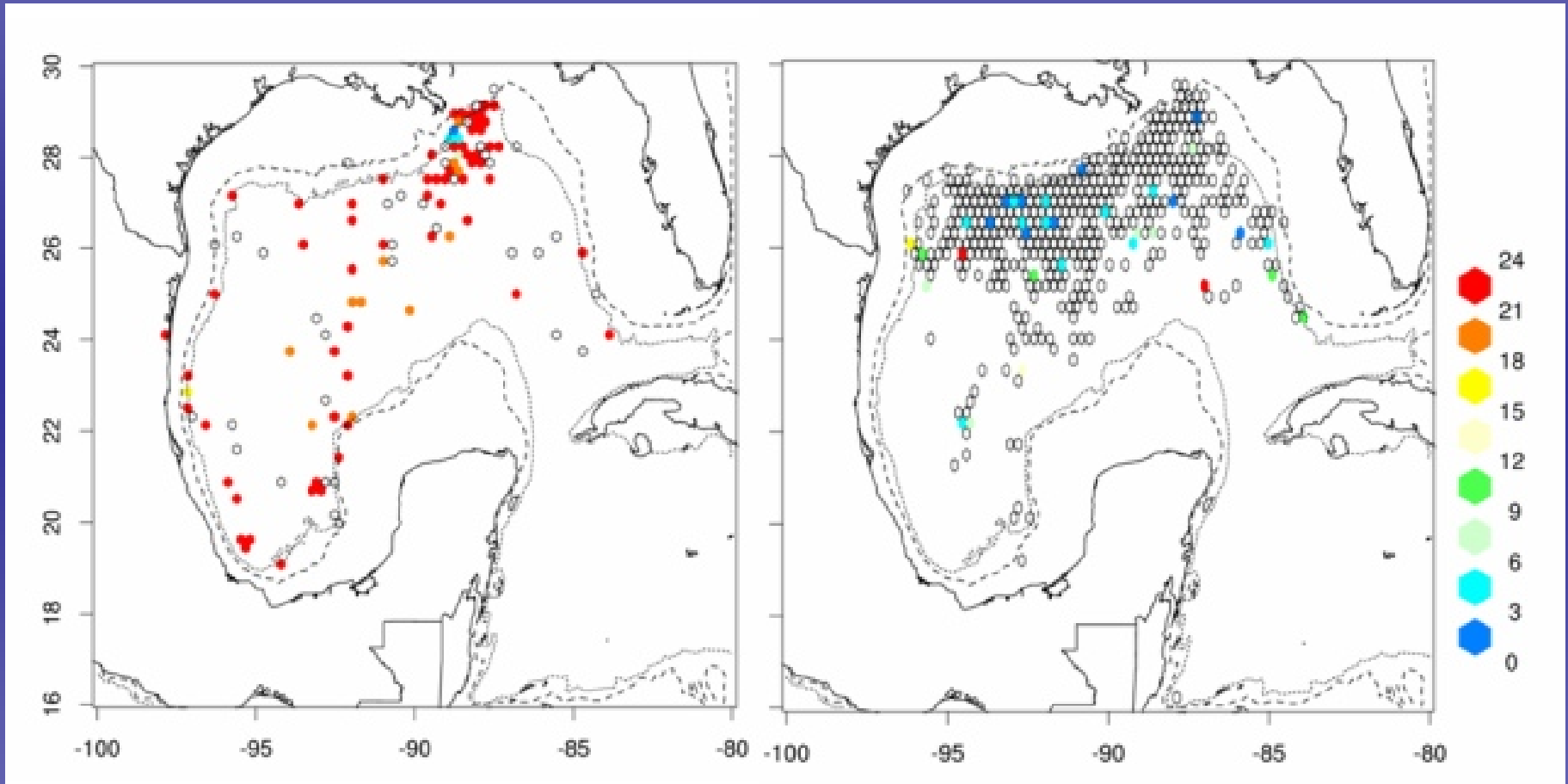
- Historically, location of intensive longline fisheries
- Very intensive nearshore shrimp trawl fishery
- Area of a number of conservation concerns
 - Declines in commercially important fishes
 - High by-catch rates in shrimp fishery
 - Virtual loss of Oceanic whitetip sharks

- Circumstantial evidence of oceanic whitetip sharks being common in the Gulf of Mexico
- Catch records show 300-fold decline since 1950s



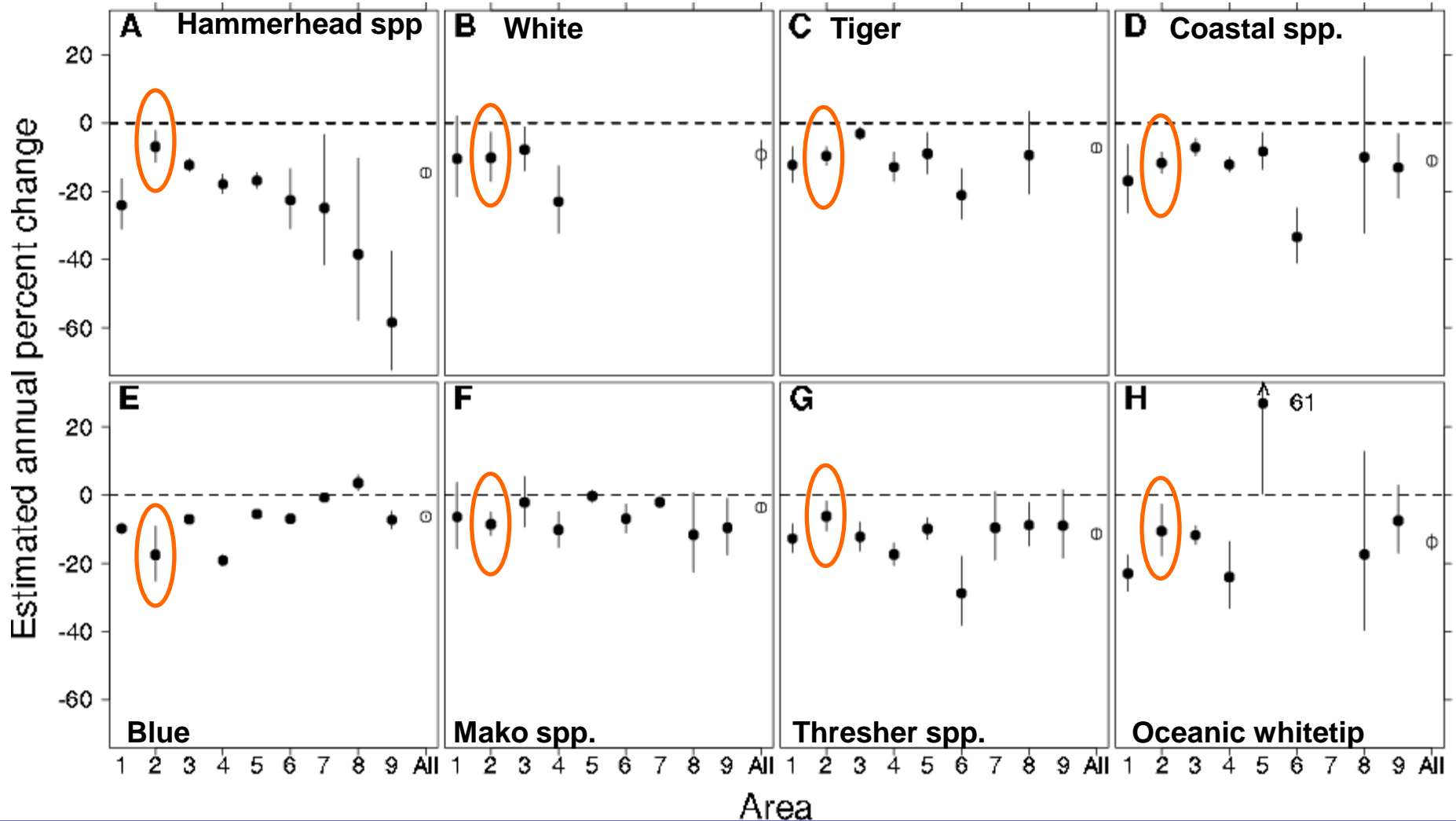


Loss of sharks from Gulf of Mexico



Oceanic whitetip catches per 10,000 hooks

- 1 Caribbean
- 2 **Gulf of Mexico**
- 3 Florida
- 4 S Atlantic Bight
- 5 Mid Atlantic Bight
- 6 NE Coastal
- 7 NE Distant
- 8 Sargasso
- 9 S America



IUCN listed large sharks occurring in the Gulf of Mexico



Oceanic whitetip



Sandtiger



Blacktip



Great white



Dusky



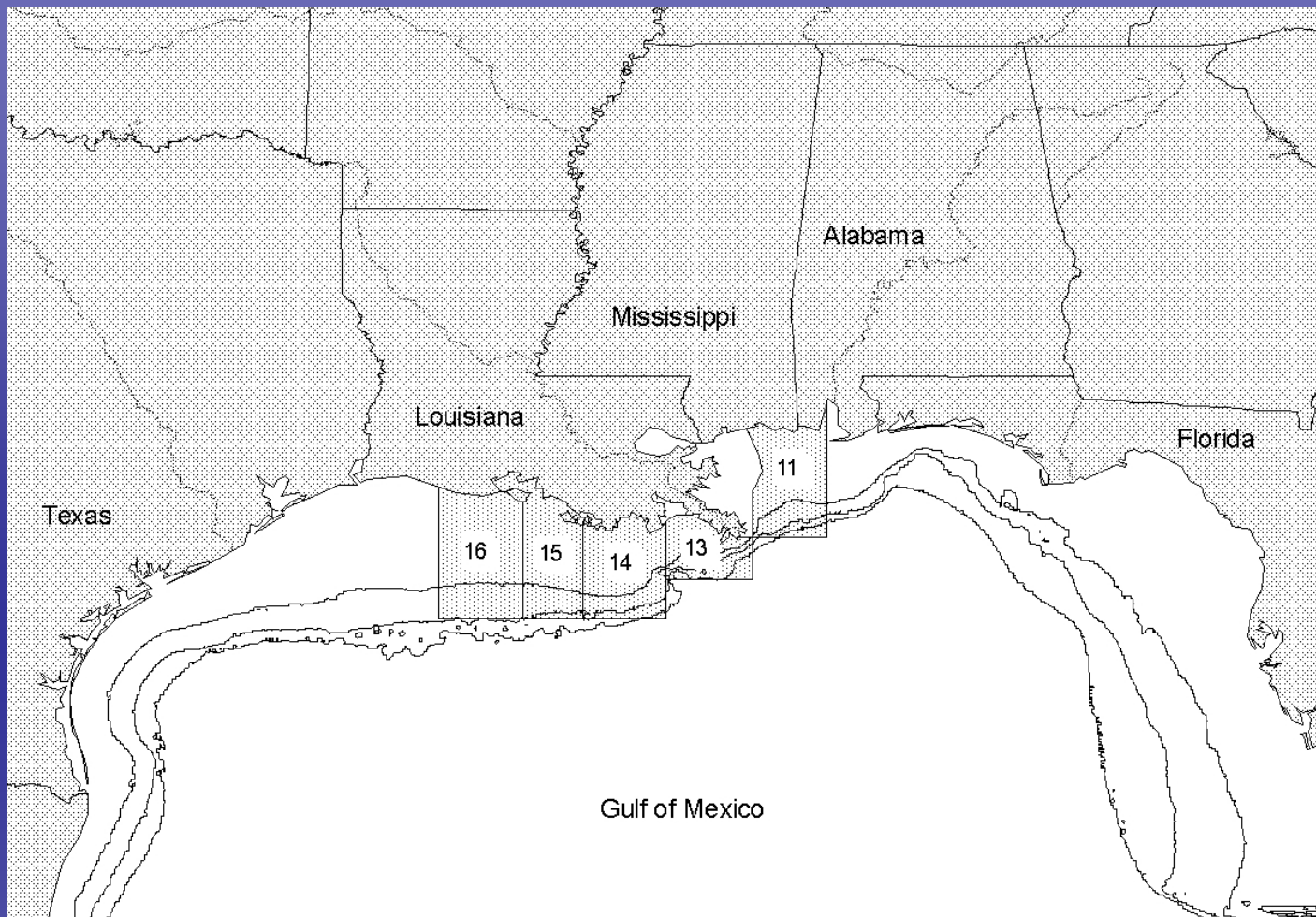
Bull shark



Scalloped
hammerhead

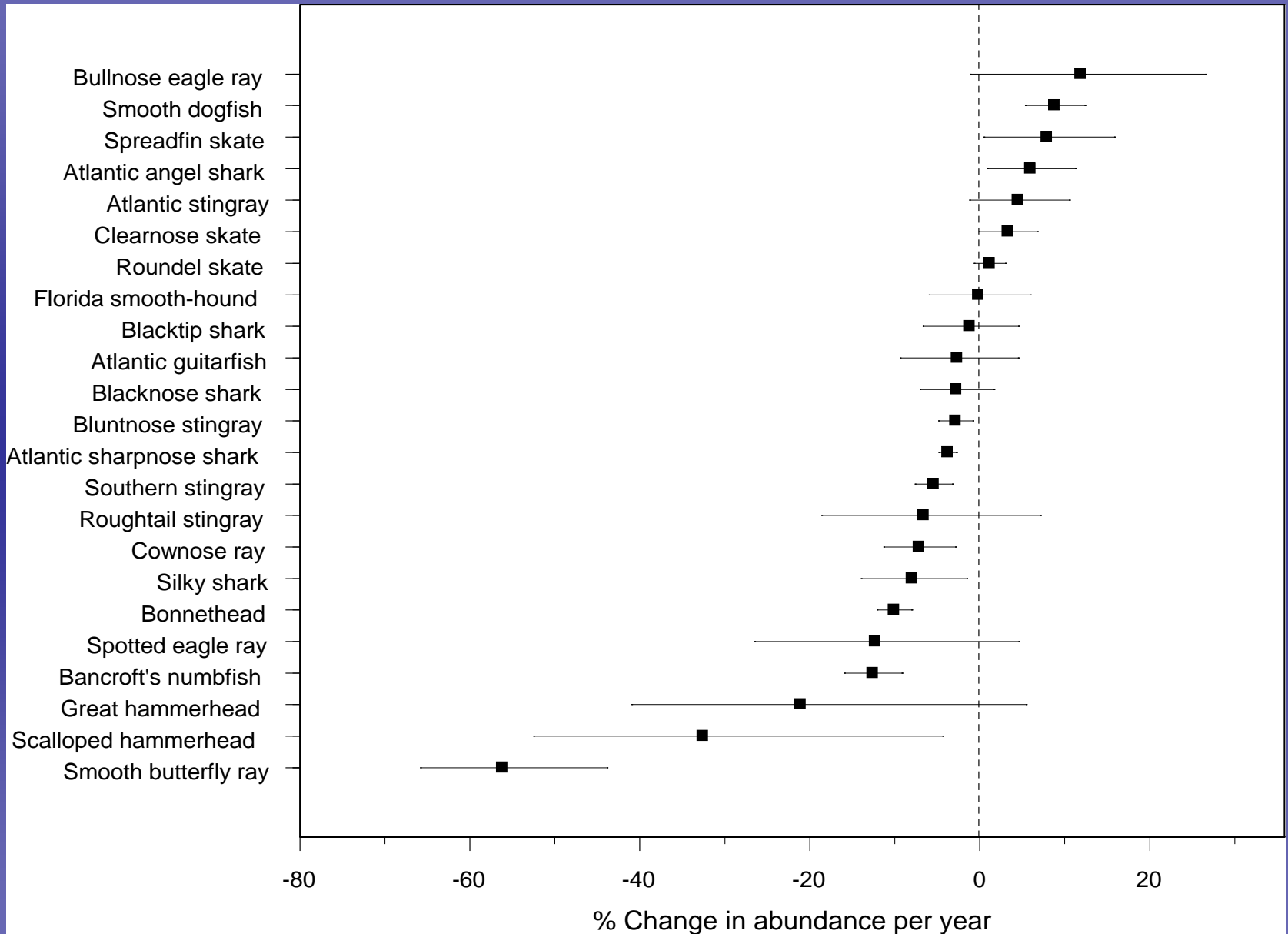


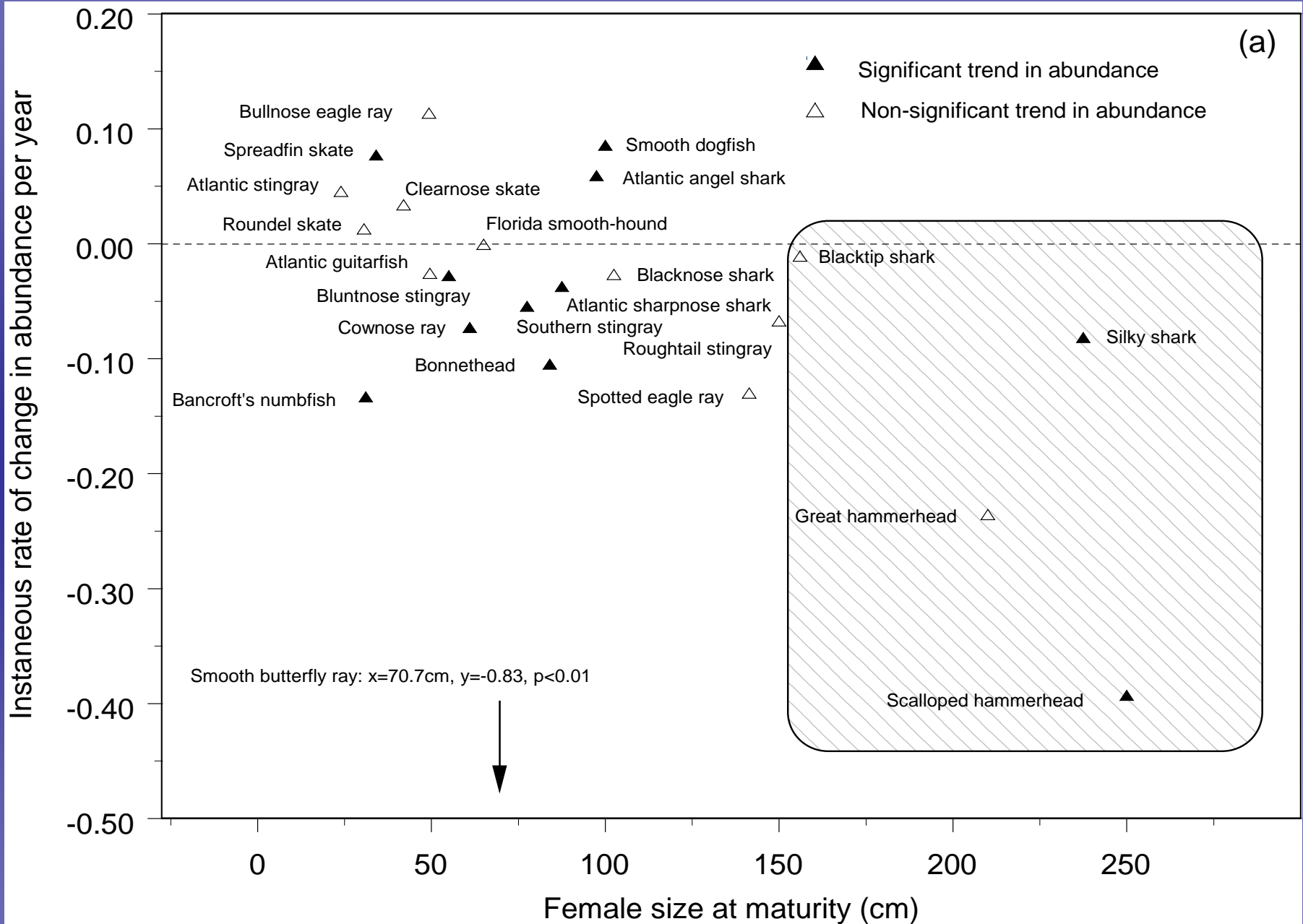
Tiger shark



- Shrimp trawl survey data examined (1972-2004)
- Generalized linear models

Gulf of Mexico SEAMAP survey





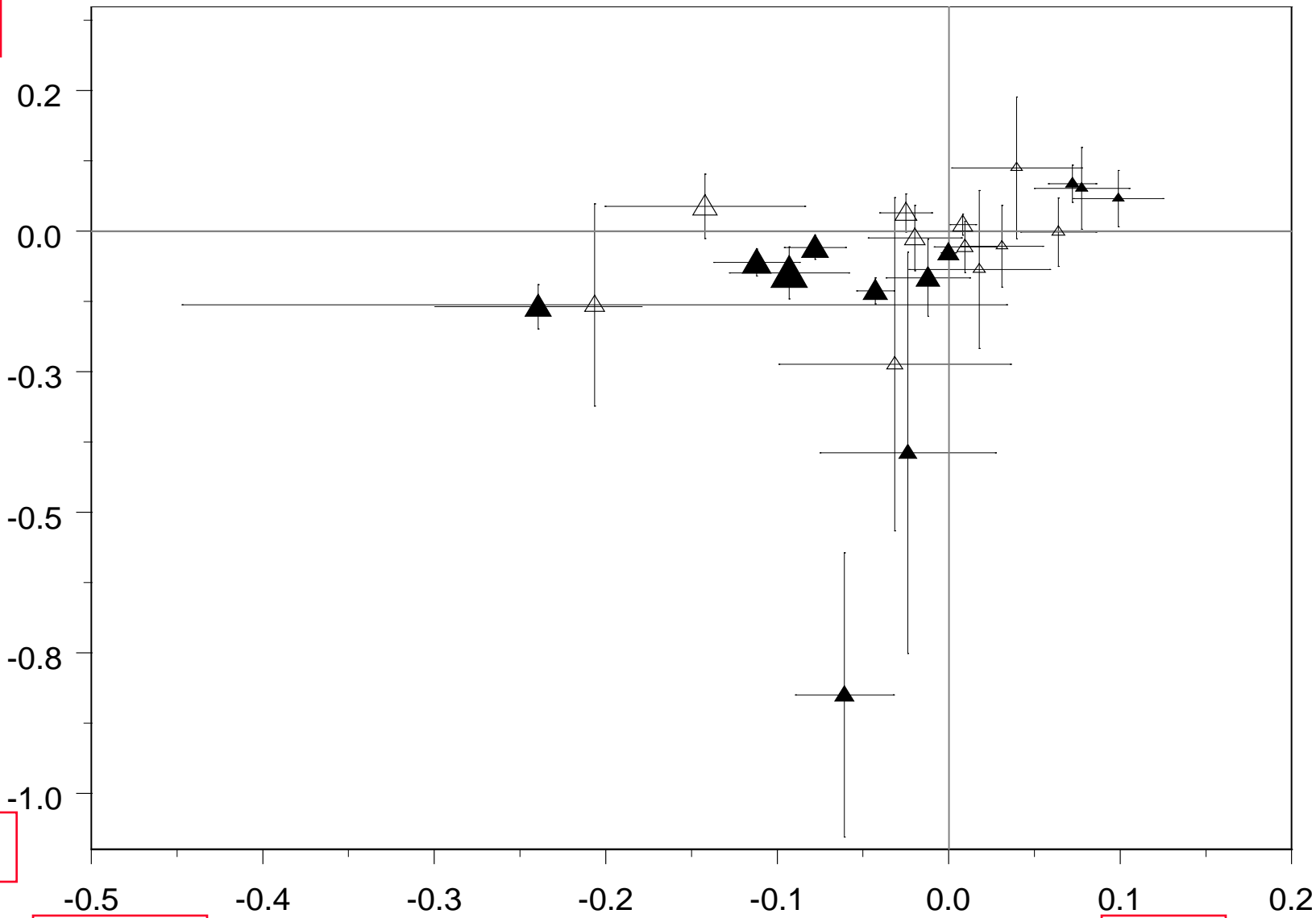
Shallow species are declining

Deep species are increasing

Increase

Instantaneous rate of change in abundance per year

Decrease



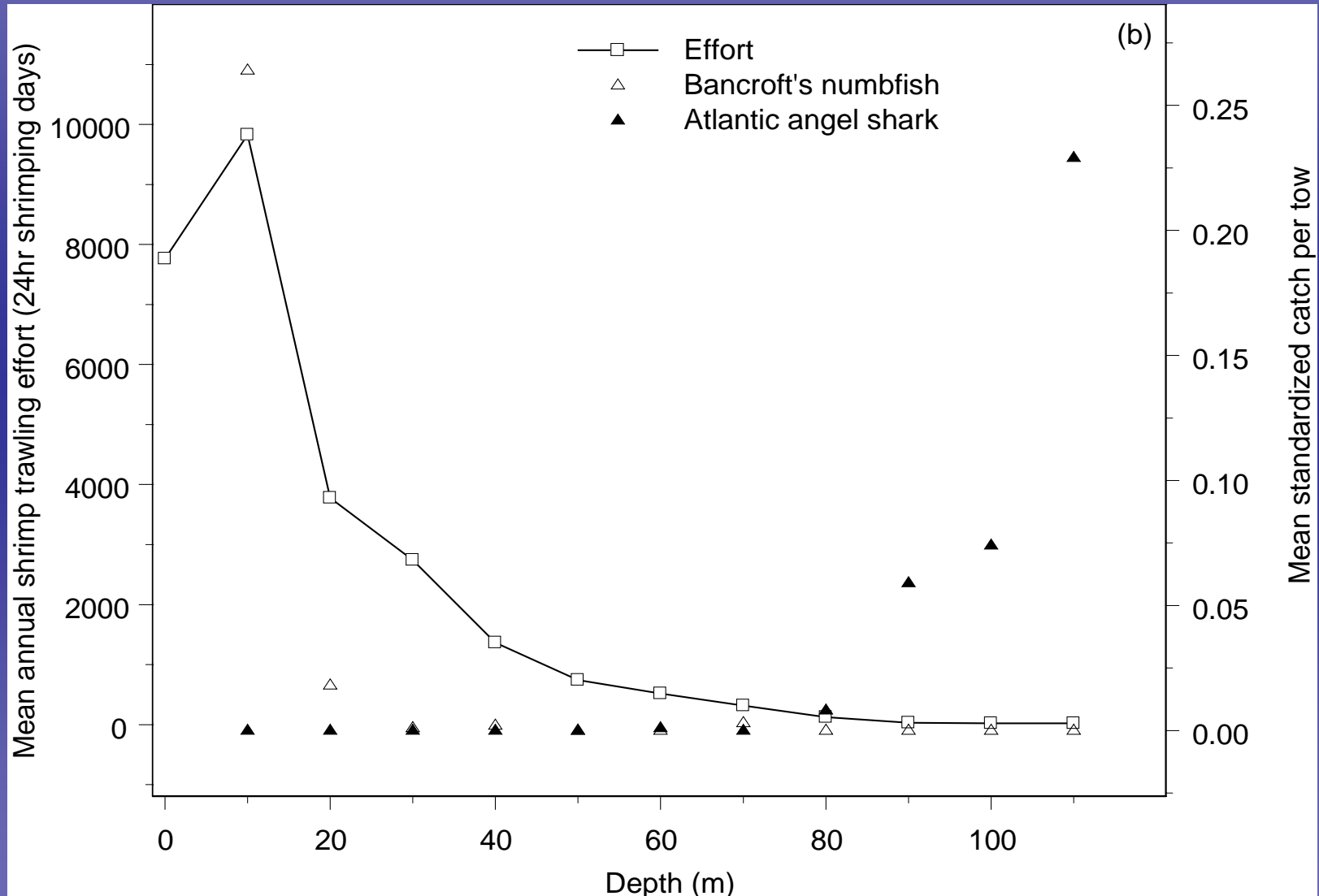
Shallow

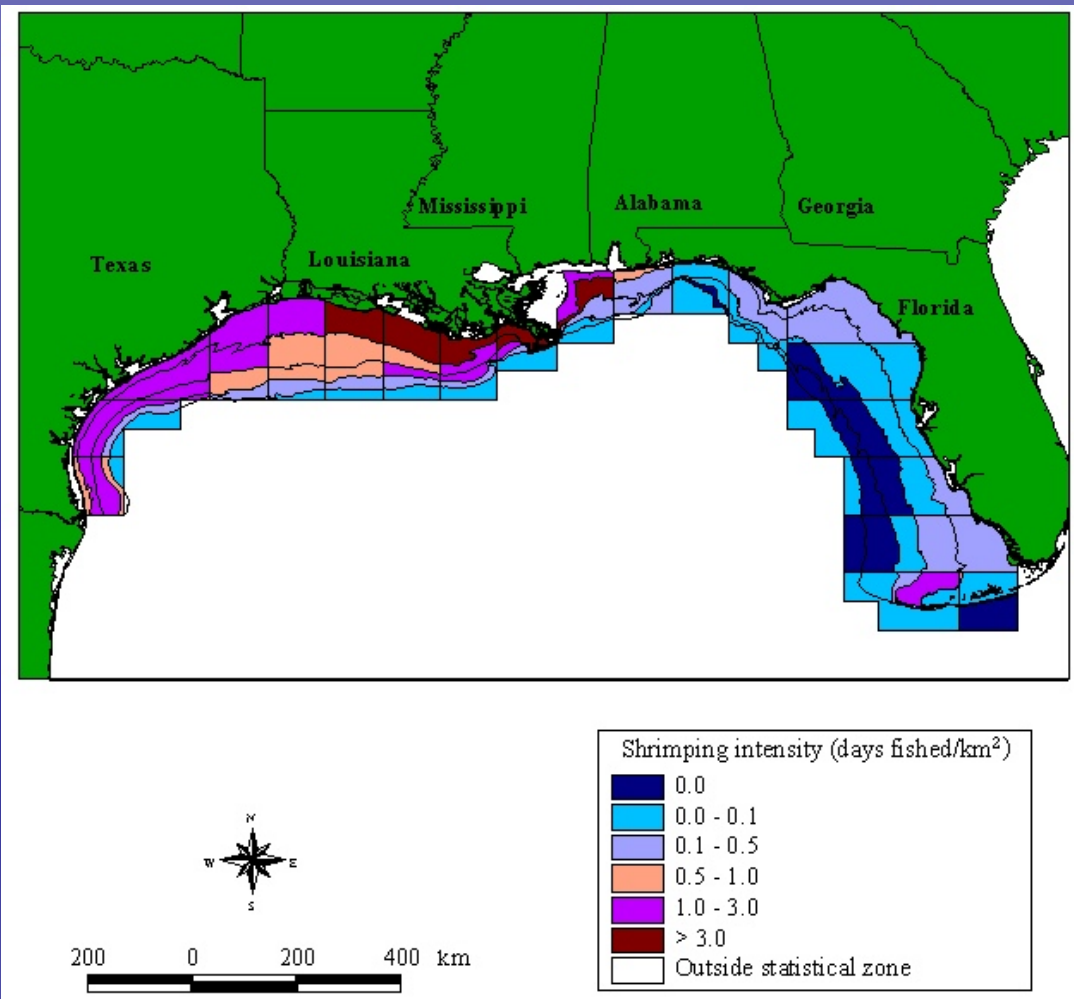
Deep

Instantaneous rate of change in abundance per meter

General patterns in Gulf of Mexico

- Some small elasmobranchs increased, some decreased
- No pattern with body size or age at maturity
- Deep water species tended to increase, shallow water species tended to decrease
- Shallow water species exposed to more commercial shrimp trawl effort





- Very intensive effort near shore
- High by-catch rates
- Some areas swept 37–75 times per year
- Entire fishable area is swept 2.55 times per year."

Gulf of Mexico

- Interacting effects on small elasmobranch community
- Deep water species increased
 - Predation release
- Shallow water species decreased
 - Shrimp trawl bycatch
 - Conservation priority?
- Conservation of large sharks in the area important to maintain biodiversity *and* community structure

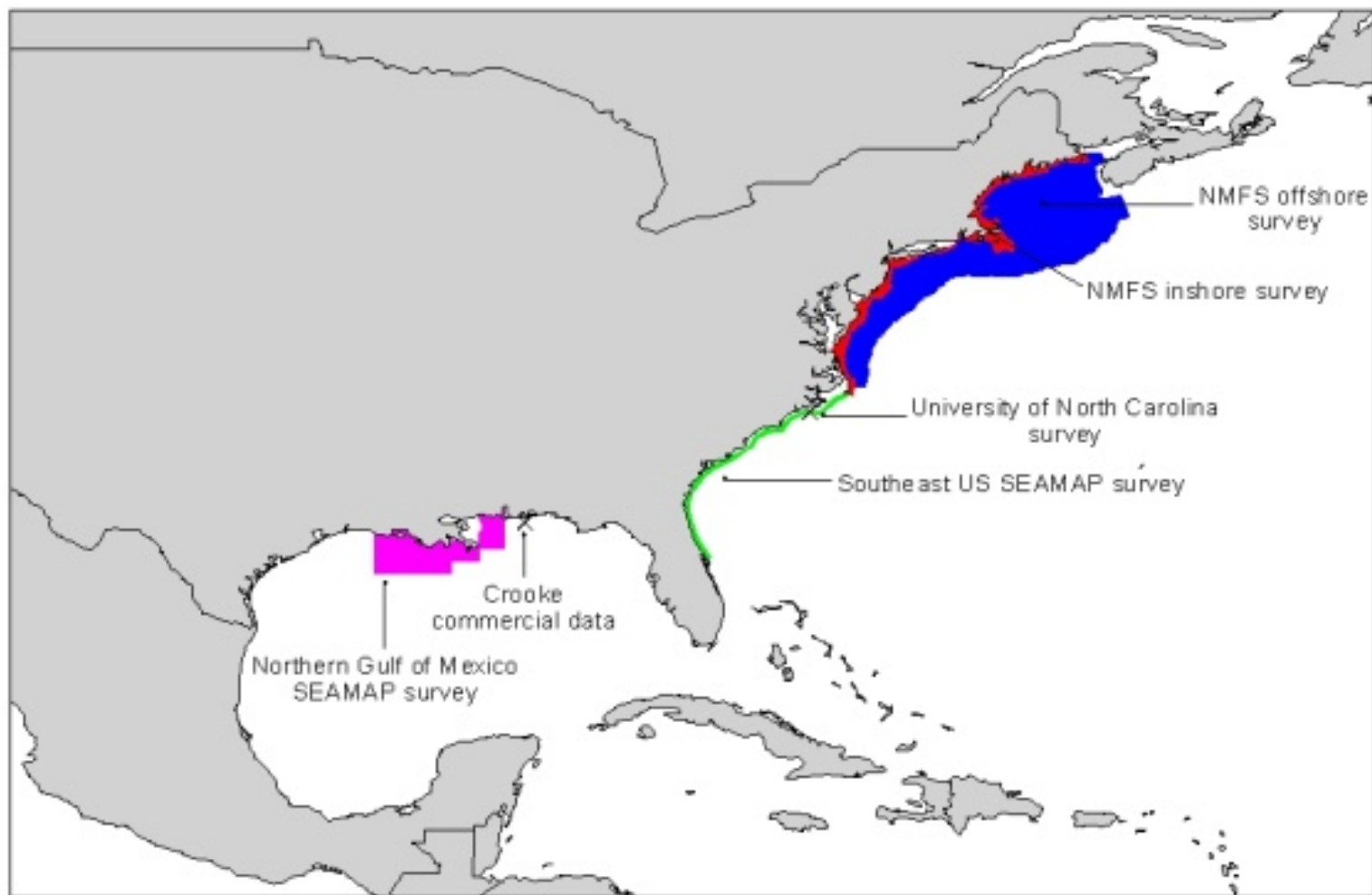
Mid-Atlantic dusky sharks

- Access to longest known longline survey targeting sharks arose
- Continuous bi-monthly samples at two fixed sites since 1972
- Coastal North Carolina
- Used, along with trawl survey data, to assess changes in abundance of dusky sharks

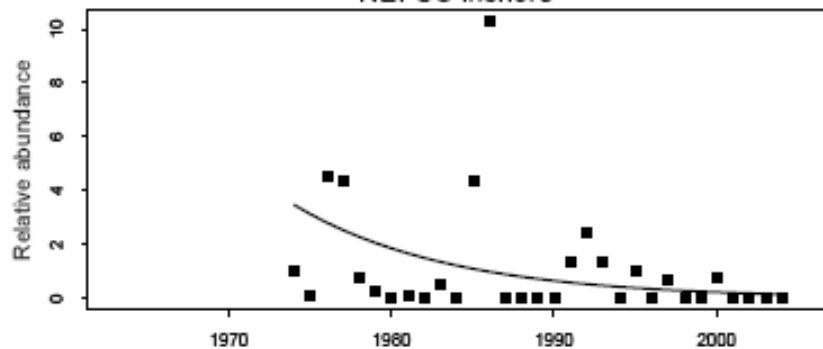
Dusky shark

- Very slow to mature
 - 19-21 years
- Low reproductive output
 - 8-10 pups every 2-3 years
- “Species of Special Concern” - NMFS
- Highly vulnerable to overfishing

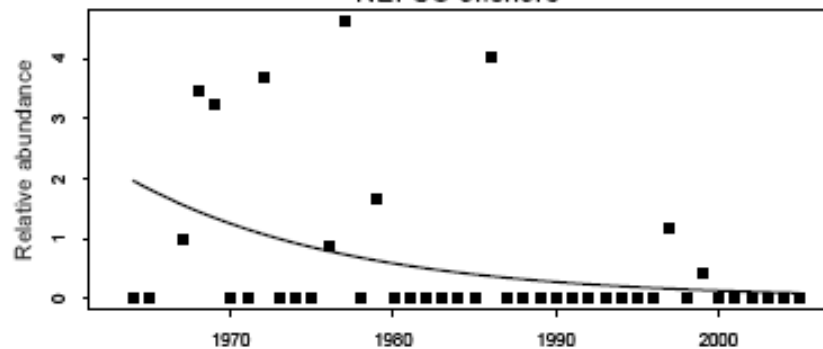




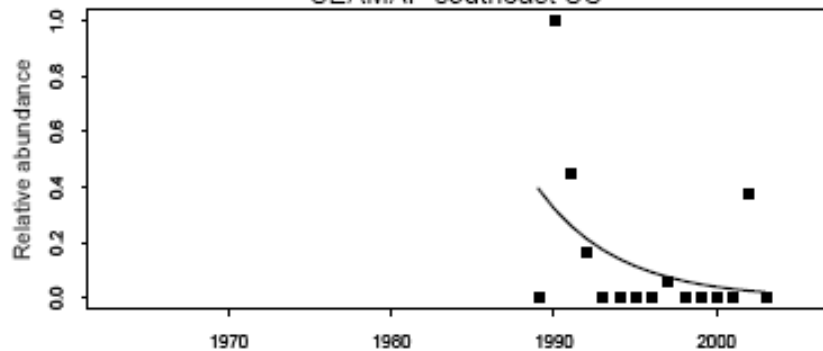
NEFSC inshore



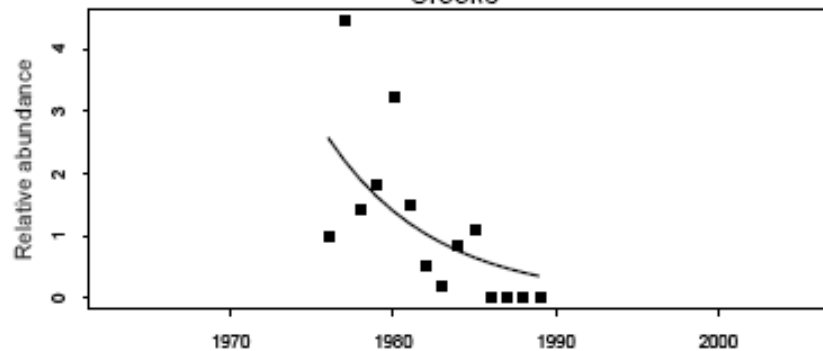
NEFSC offshore



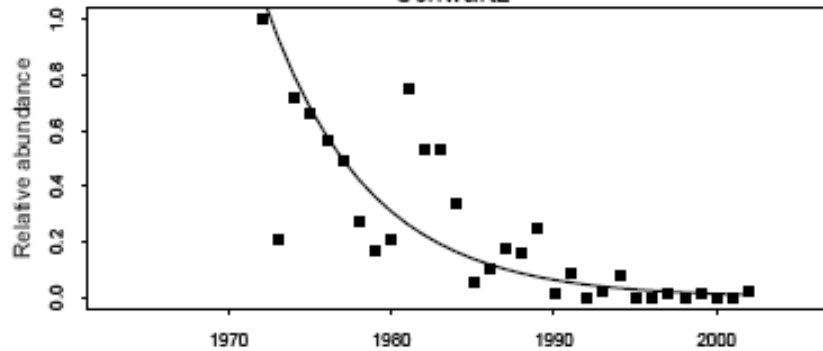
SEAMAP southeast US



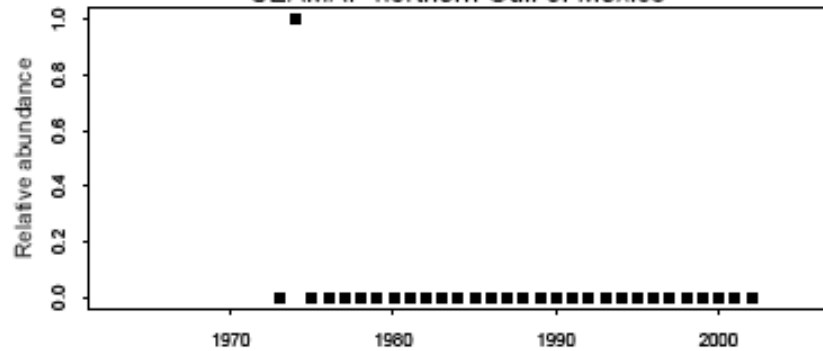
Crooke

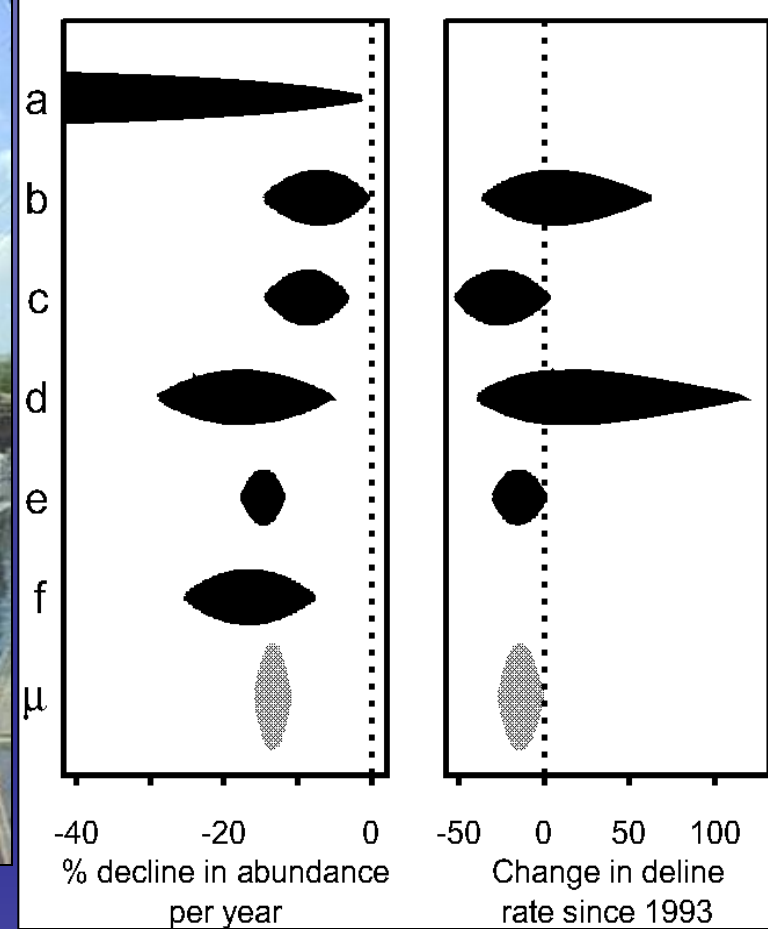
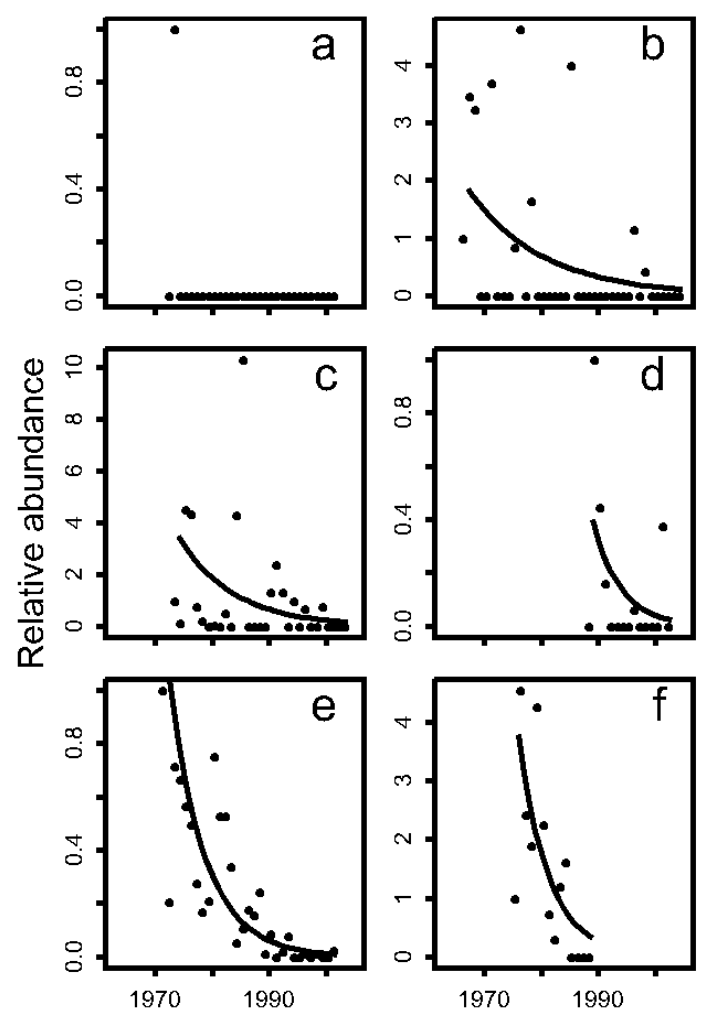


Schwartz



SEAMAP northern Gulf of Mexico





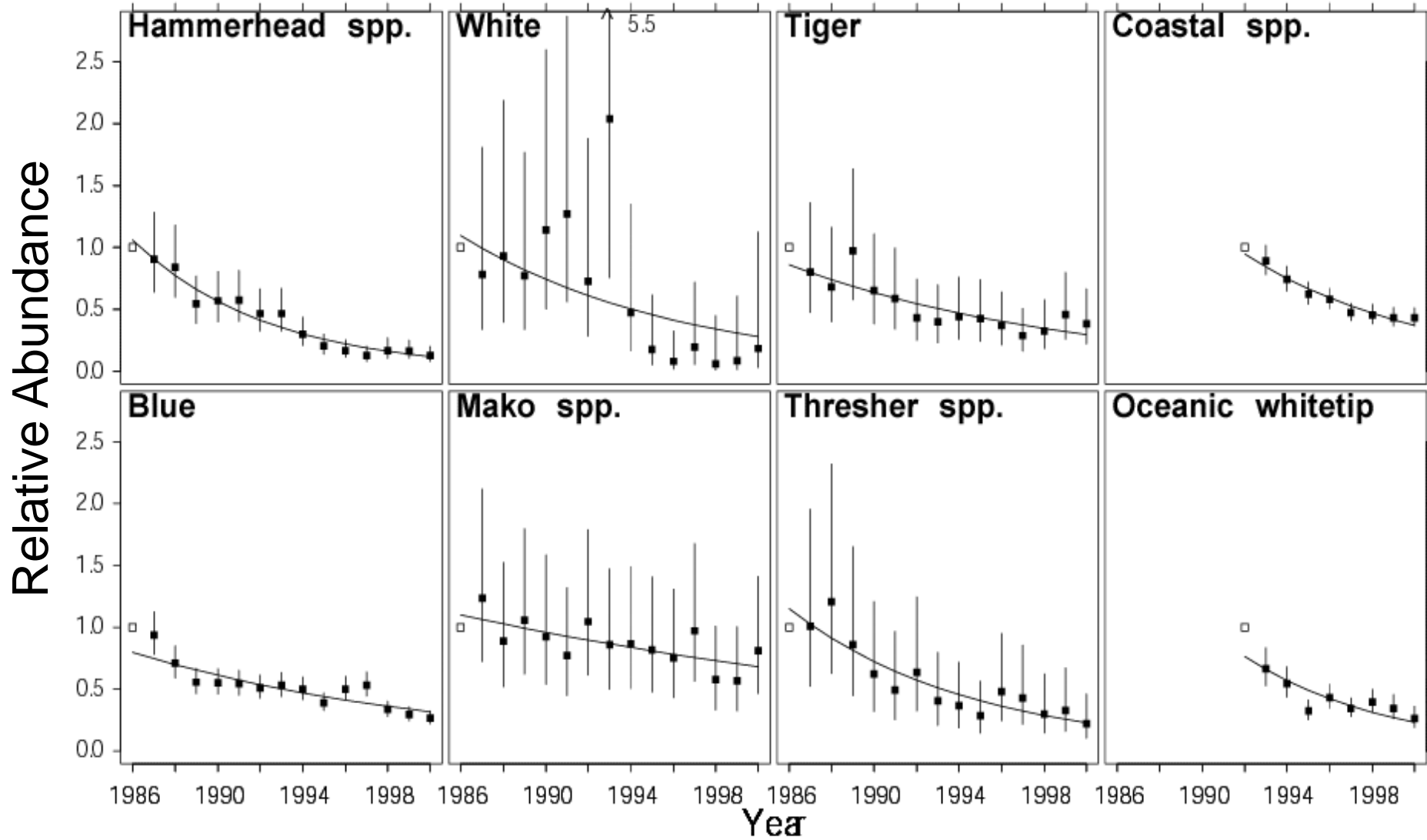
- a.** Northern Gulf of Mexico bottom shrimp trawl survey
- b.** NMFS offshore bottom trawl survey
- c.** NMFS inshore bottom trawl survey
- d.** Southeast U.S. SEAMAP bottom shrimp trawl survey
- e.** North Carolina Institute of Marine Sciences longline survey
- f.** Crooke commercial longline data
- μ .** Meta-analytic mean

Dusky shark summary

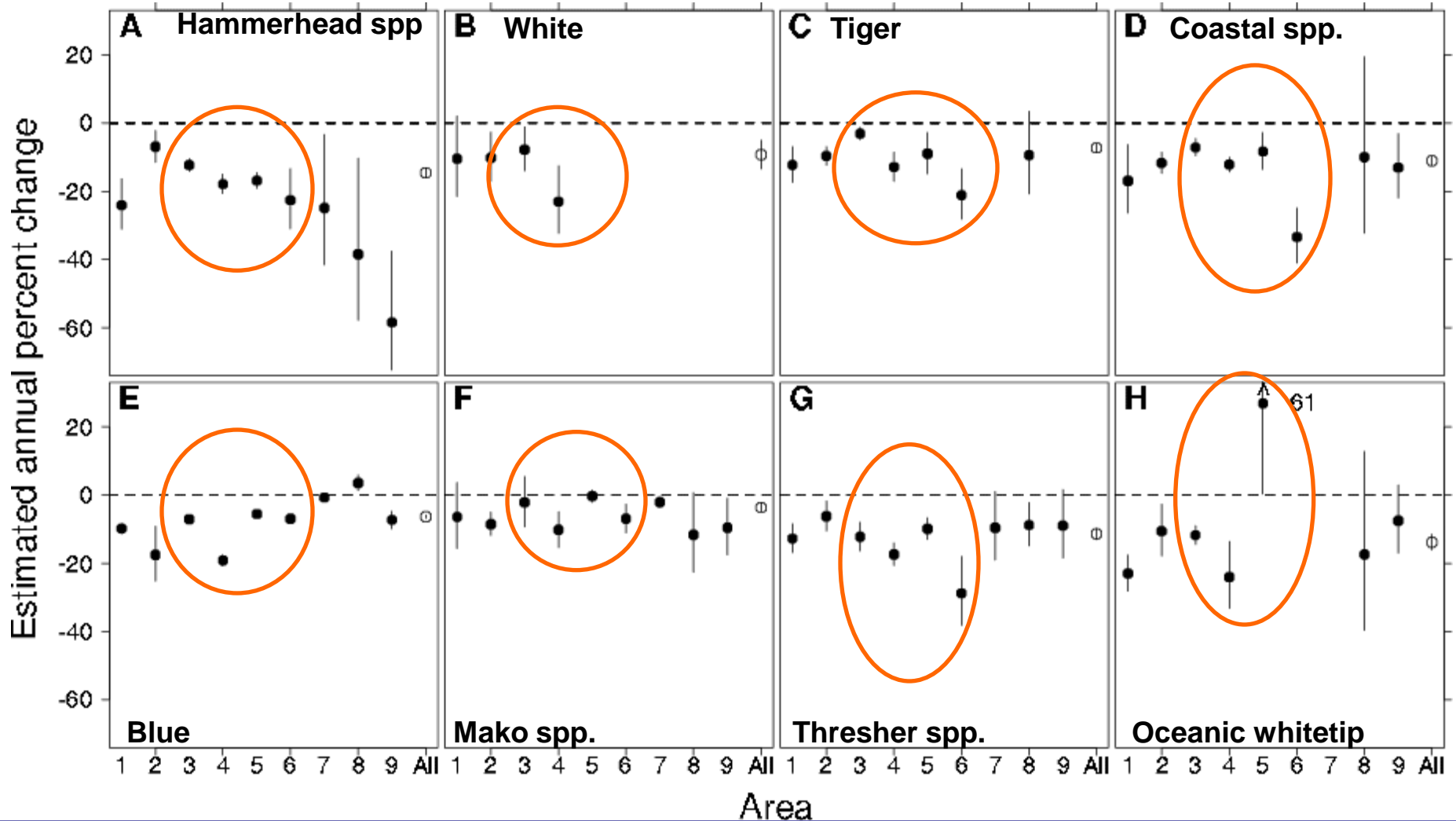
- Declined over 99% since 1970
- Average weight declined by 40% since 1972
- Management measures do not appear effective
 - Pre-1993: decline of 13.3% per year
 - Post-1993: decline of 13.9% per year
- Immediate action is needed throughout the population's range

Northwest Atlantic

- Dusky sharks have undergone great declines
- Other large sharks known to have declined since the 1980s
- Likely longer term declines and possible community wide effects

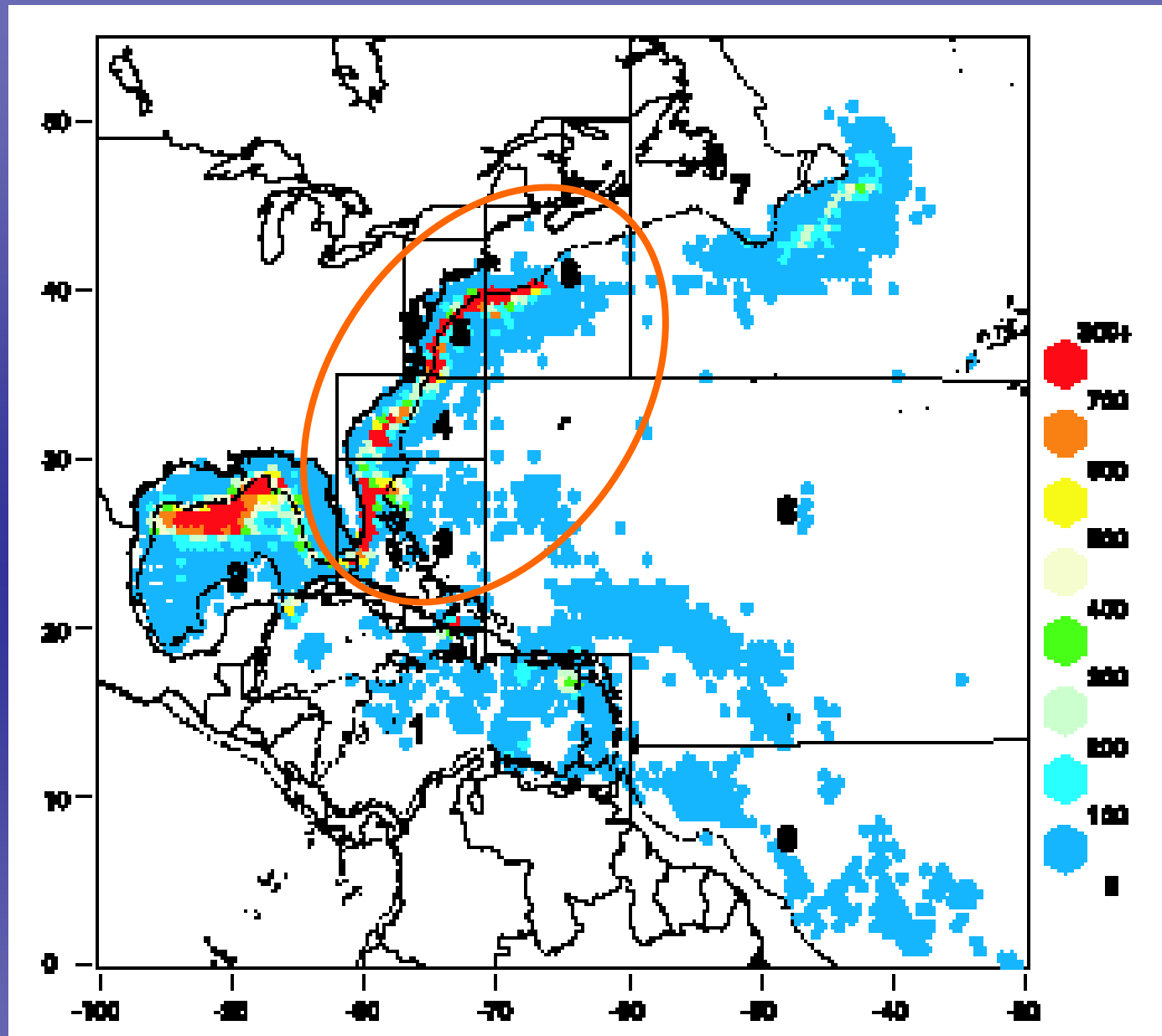


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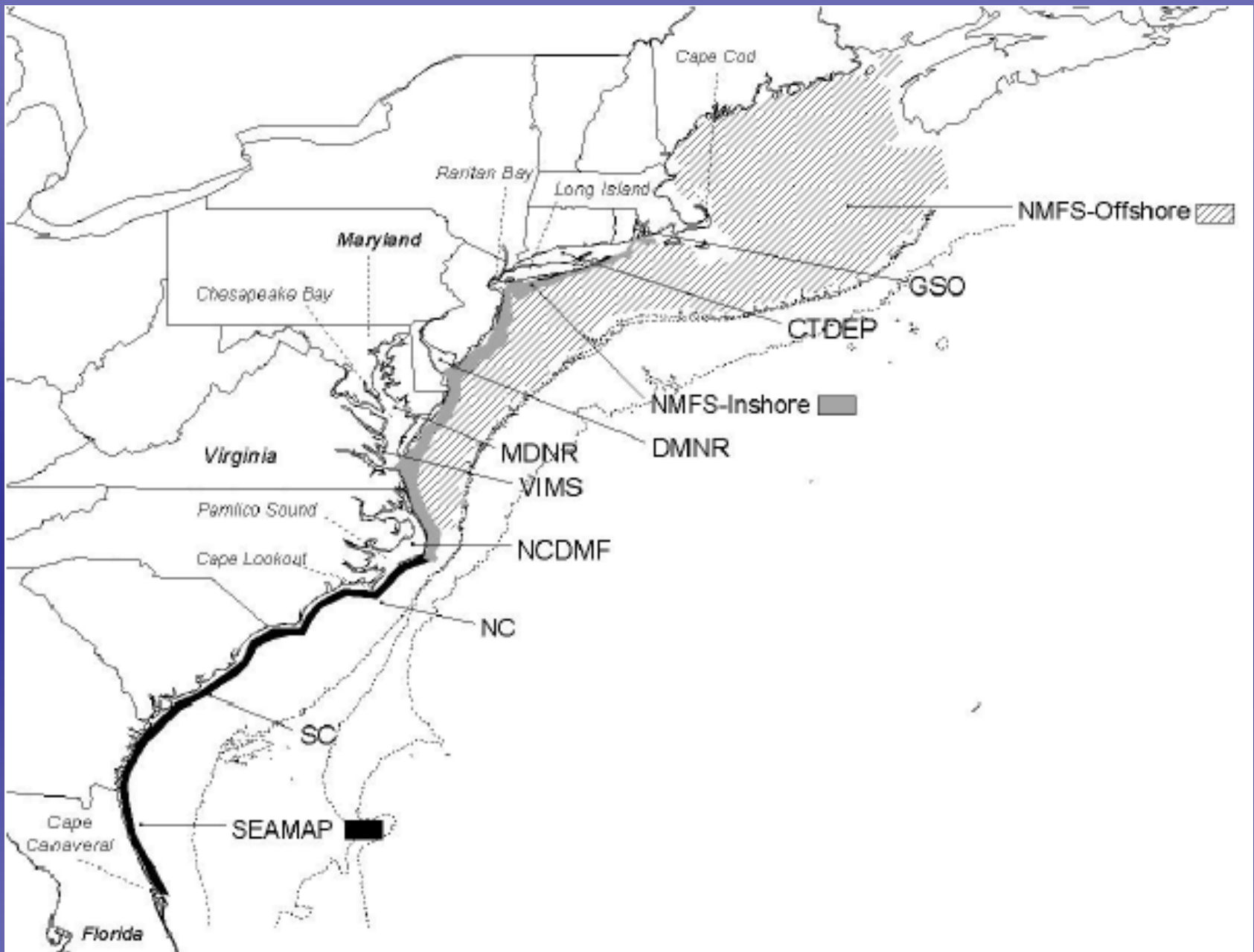


Data sources

- Logbook and observer reports
- 13 bottom-trawl surveys
- 2 seine surveys
- 1 longline survey
- 1 scallop survey
- NMFS and FAO shellfish landings data
- Generalized linear models for trends
- Random-effect meta-analysis within species

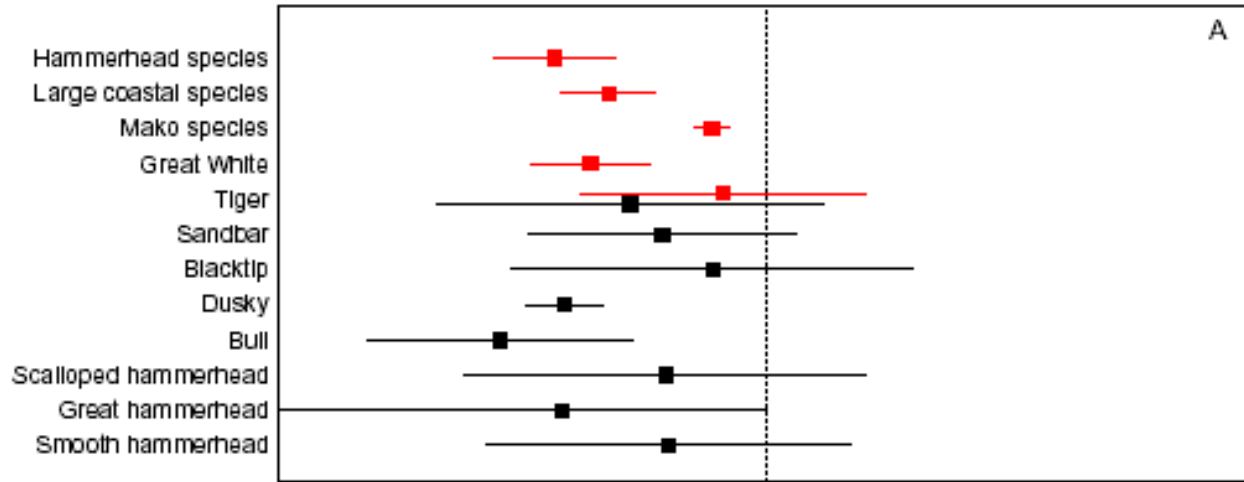


Baum et al, 2003 Science

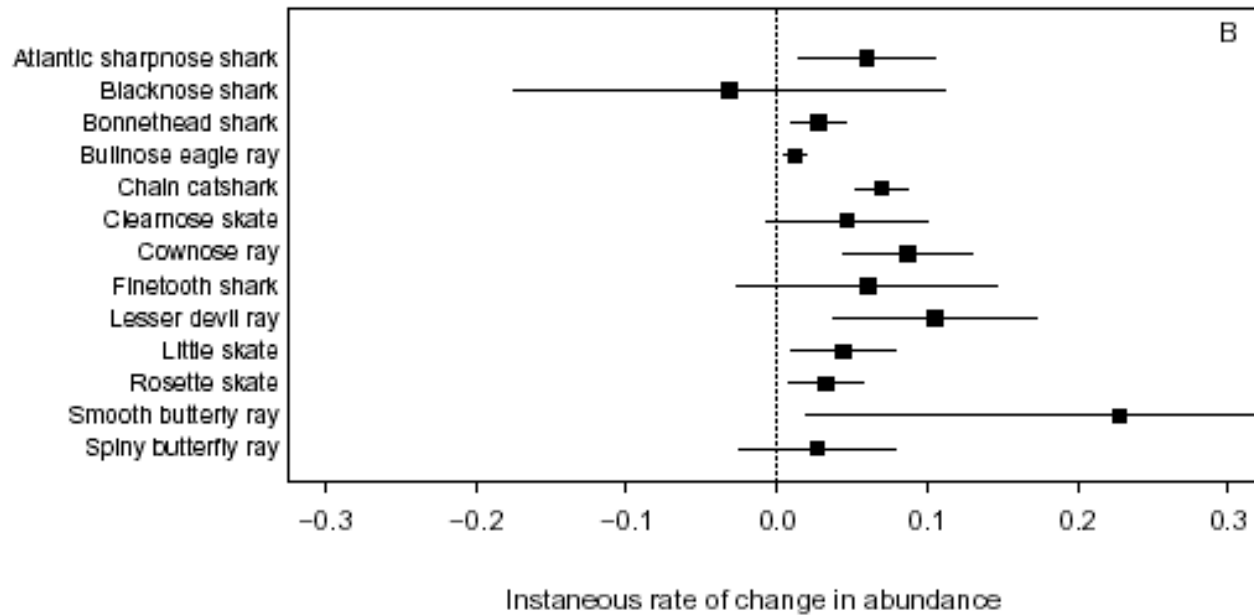


Myers, Baum, Shepherd, Peterson and Powers, in press, Science

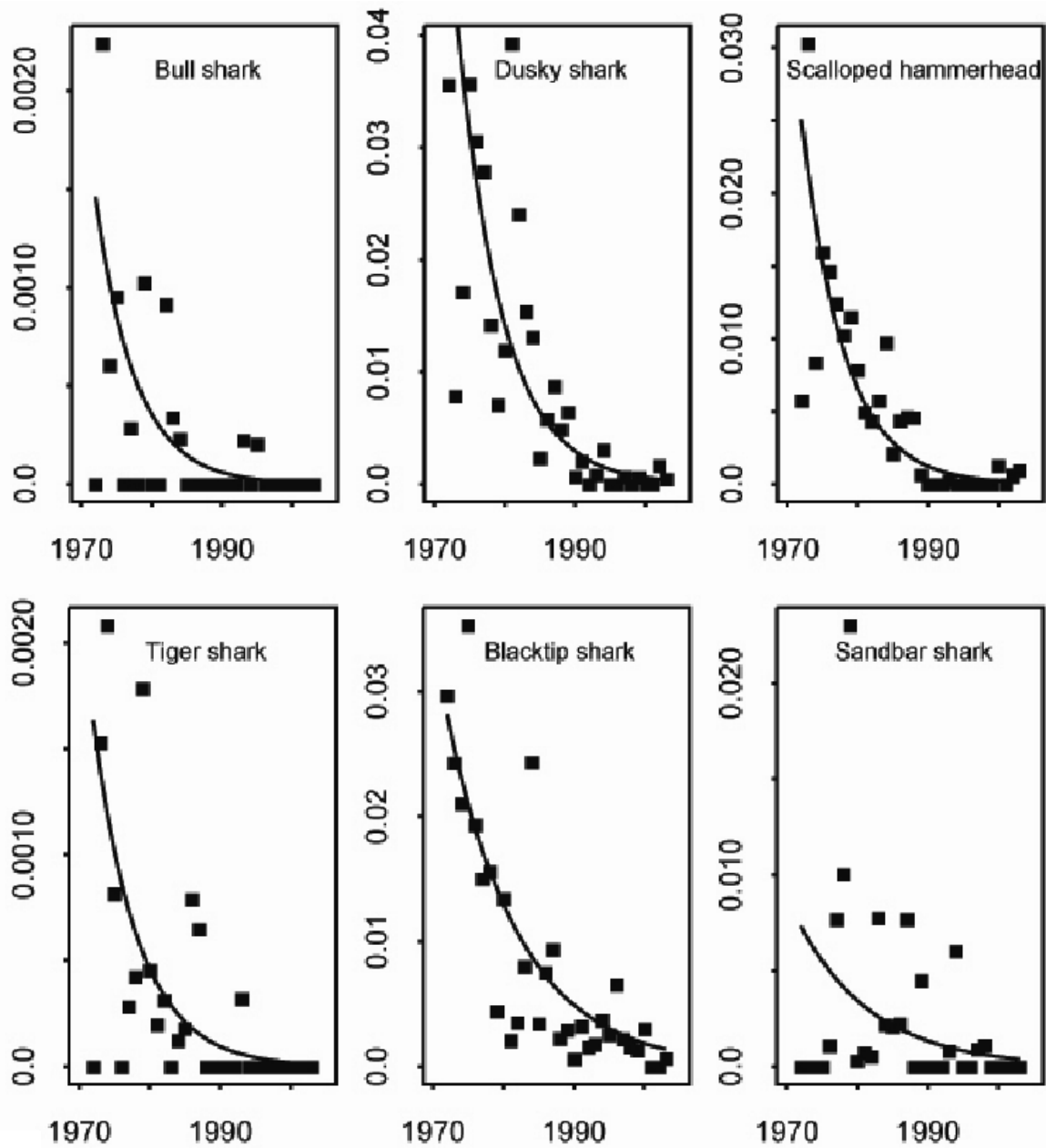
Large sharks



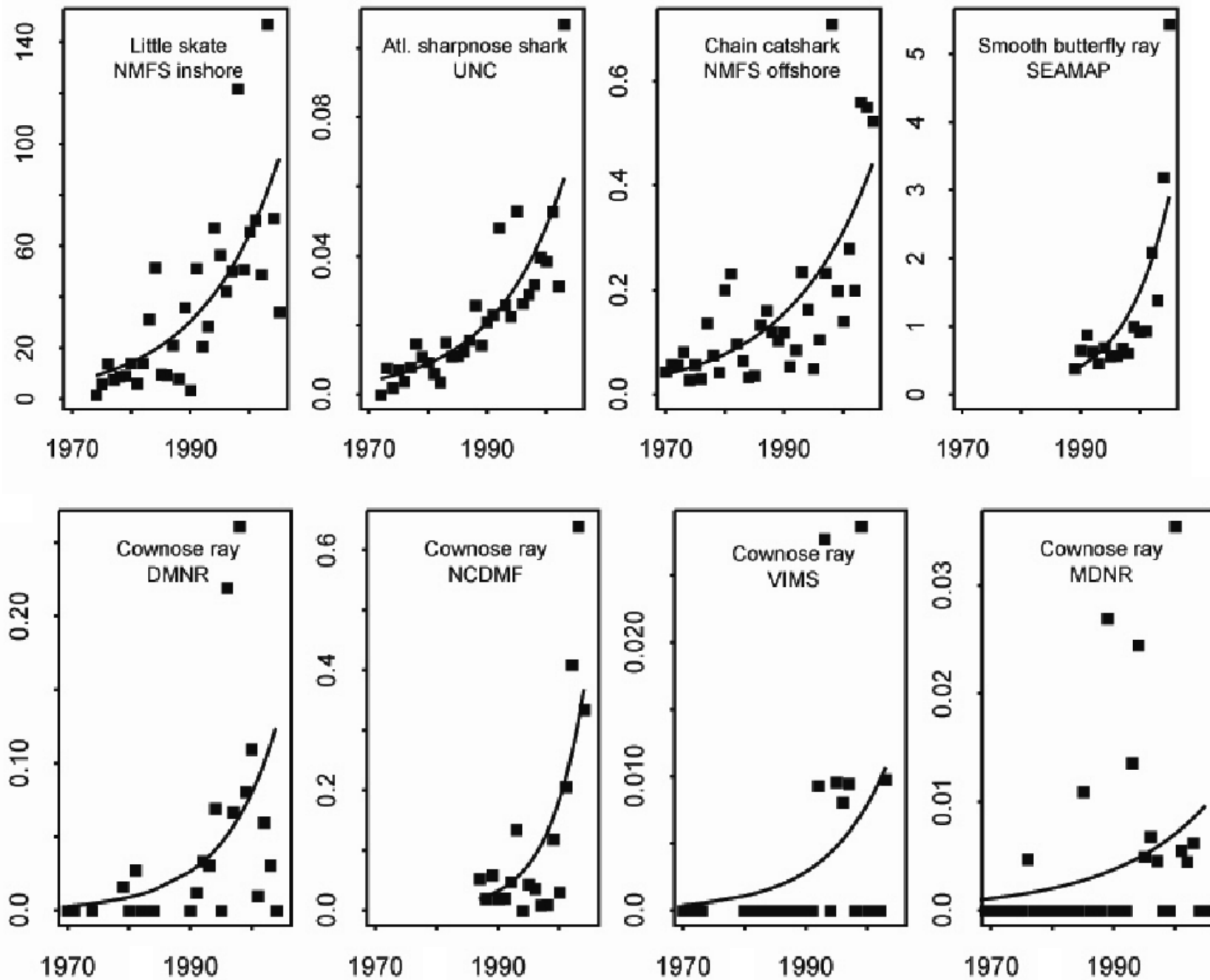
Meso-predators

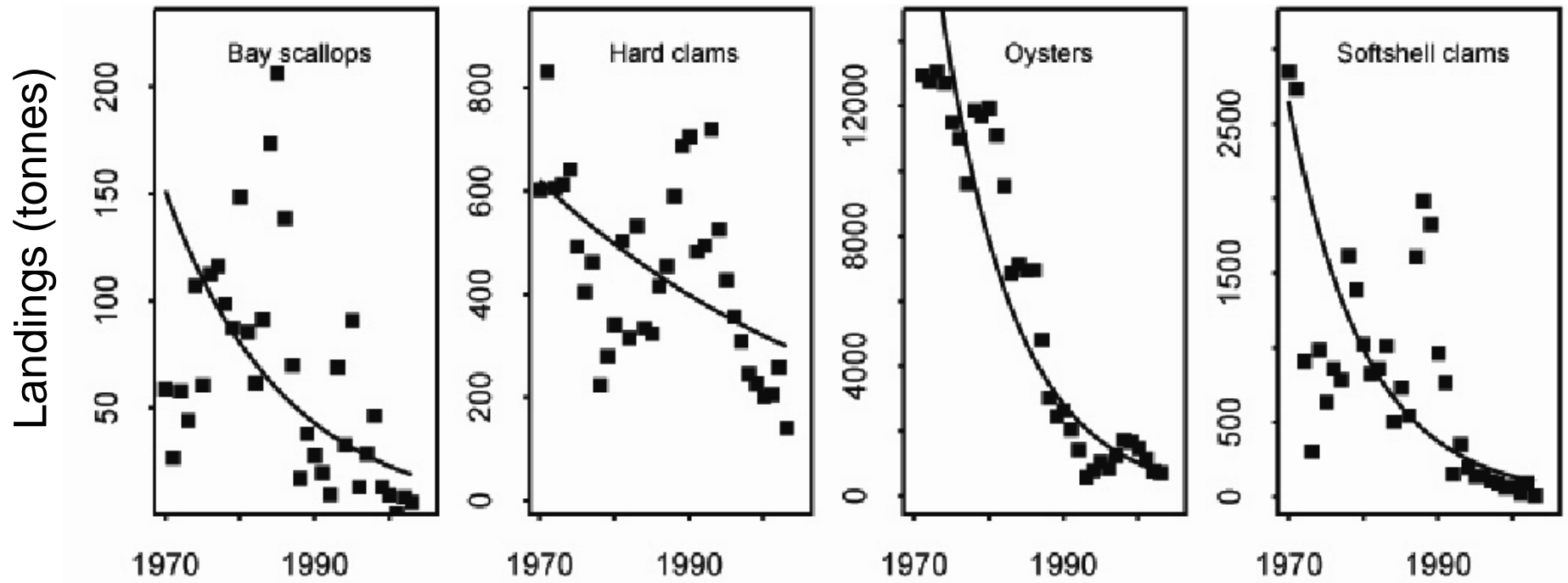


Relative abundance

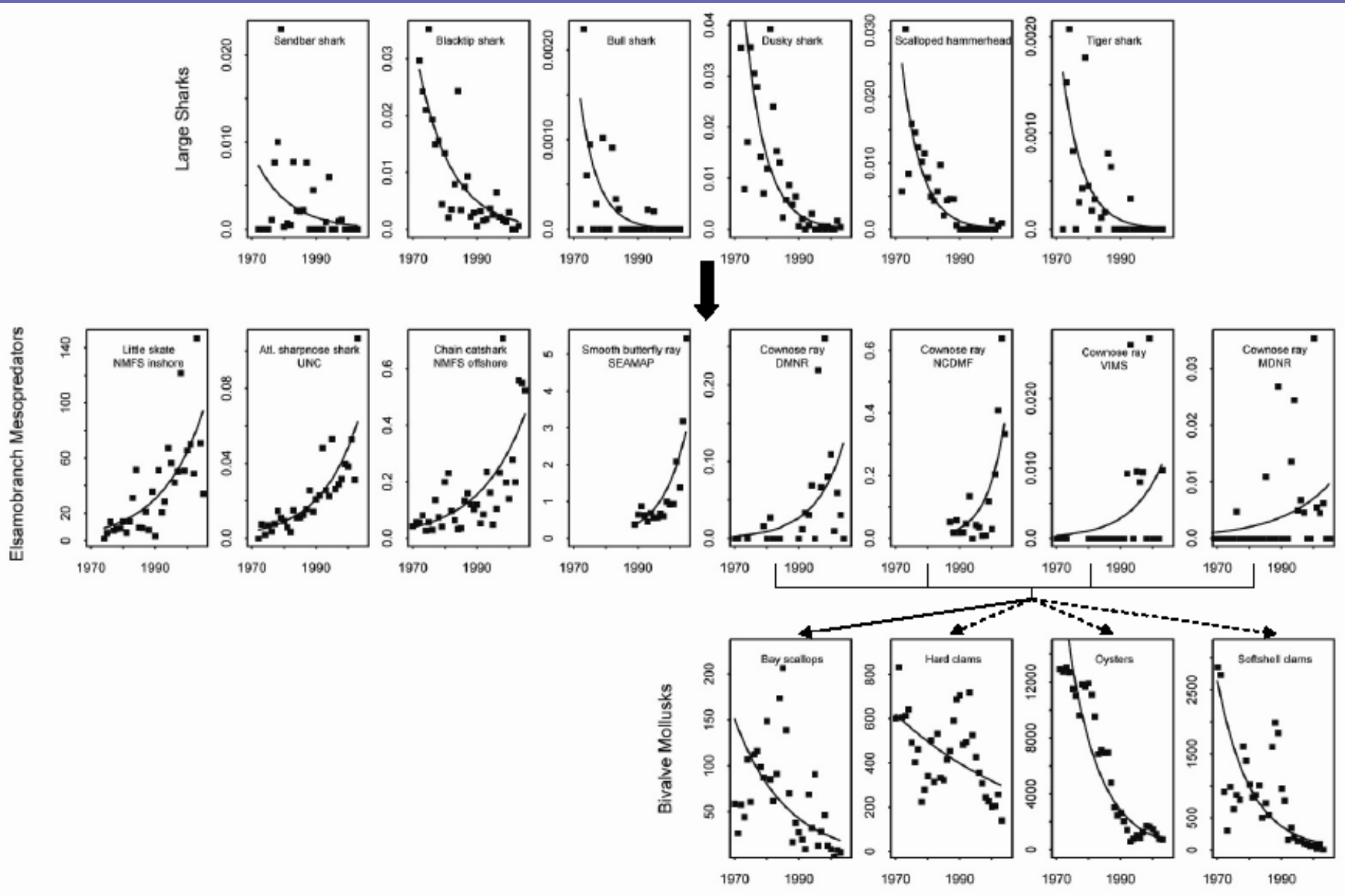


Relative abundance



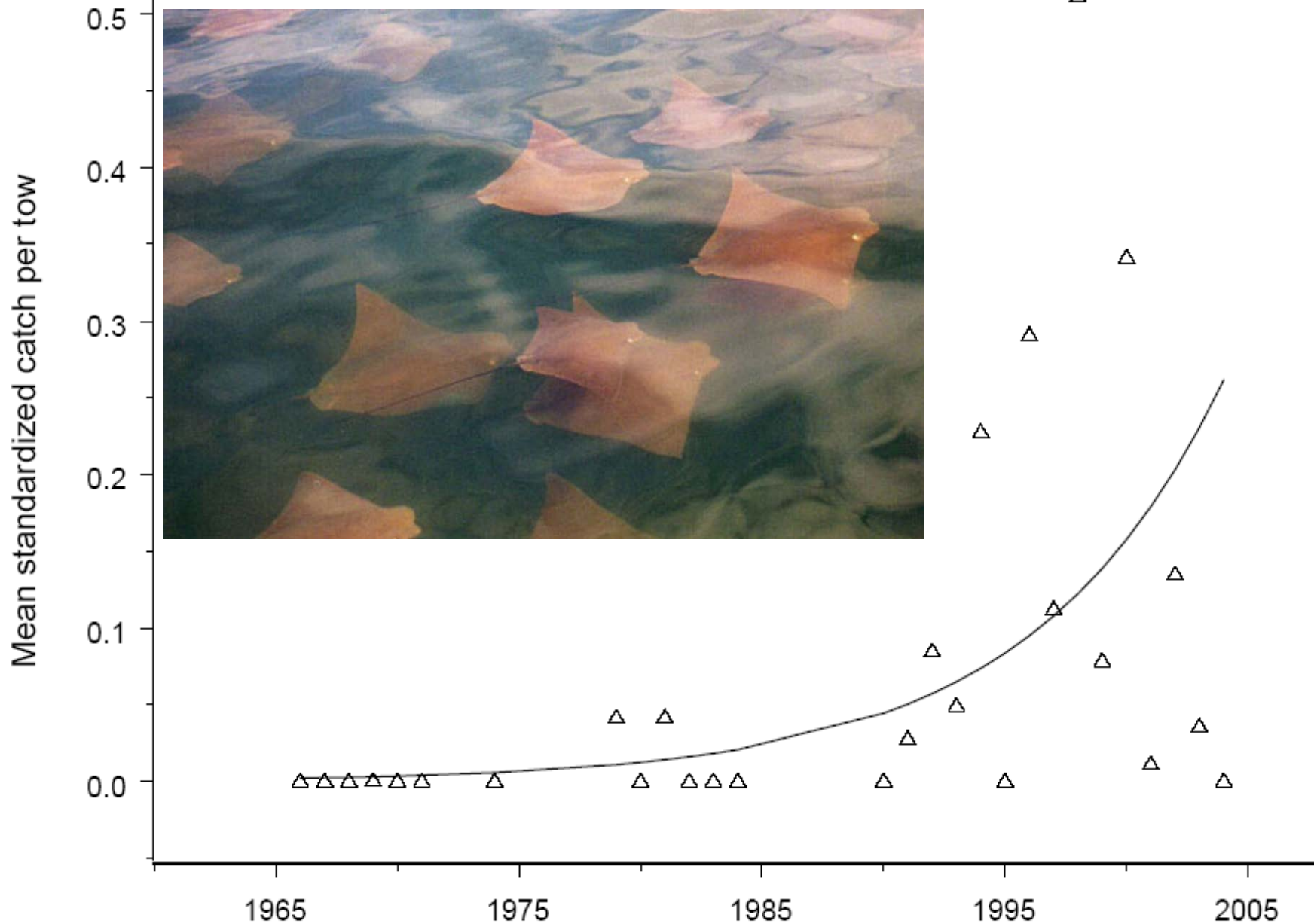


Myers, Baum, Shepherd, Peterson and Powers, in press, Science



Myers, Baum, Shepherd, Peterson and Powers, in press, Science

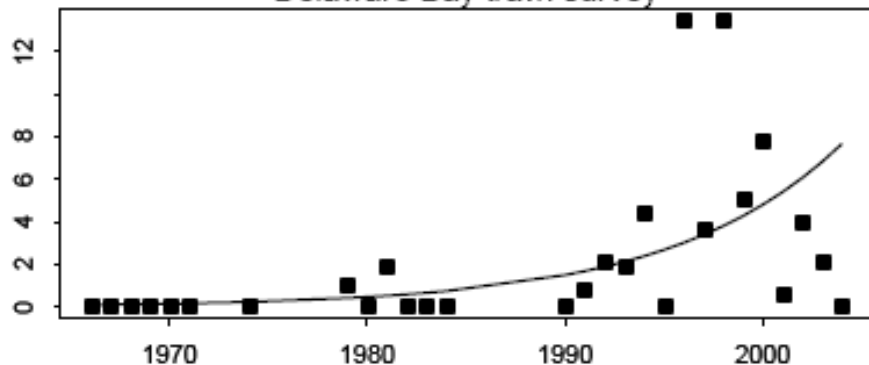
Cownose Ray - Delaware Bay



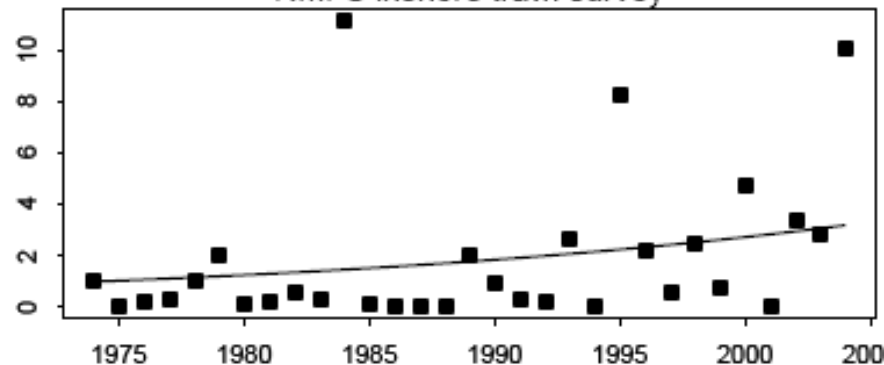
Cownose ray trends

Relative abundance

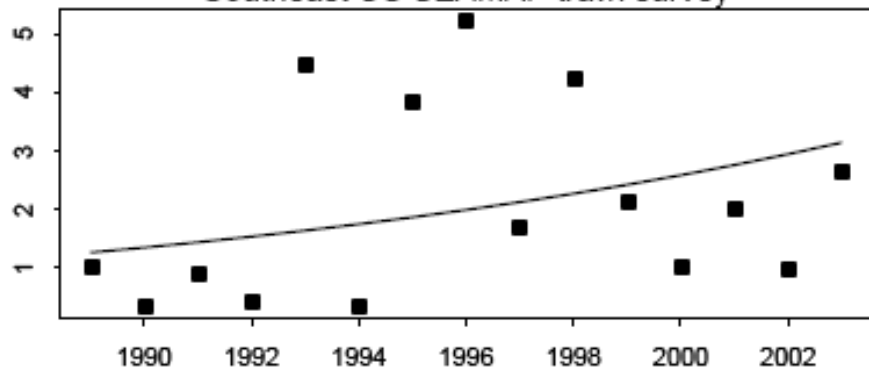
Delaware Bay trawl survey



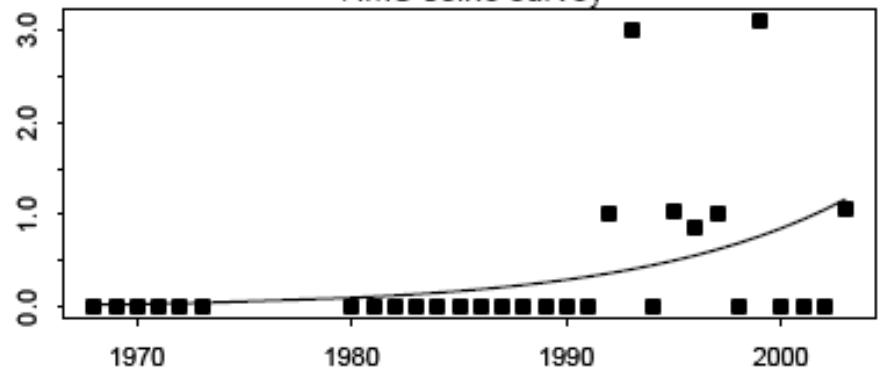
NMFS inshore trawl survey



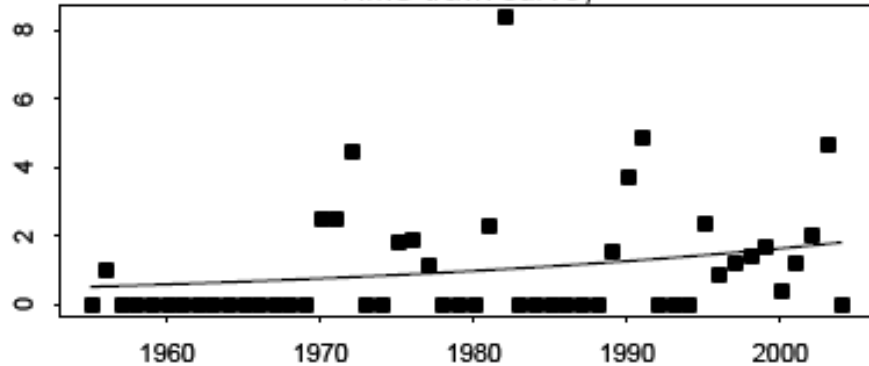
Southeast US SEAMAP trawl survey



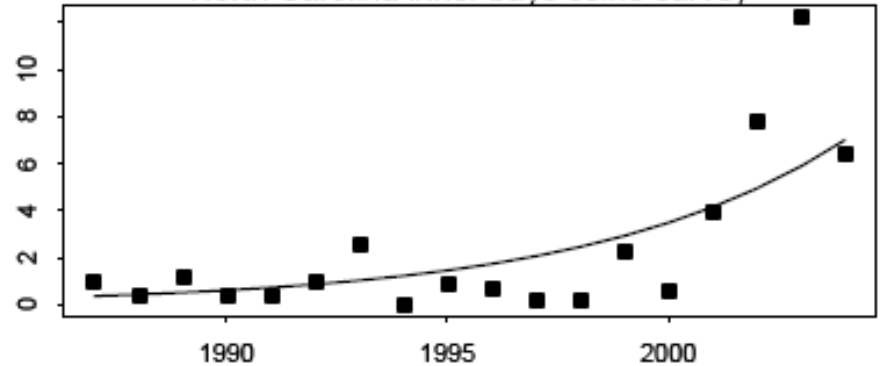
VIMS seine survey



VIMS trawl survey



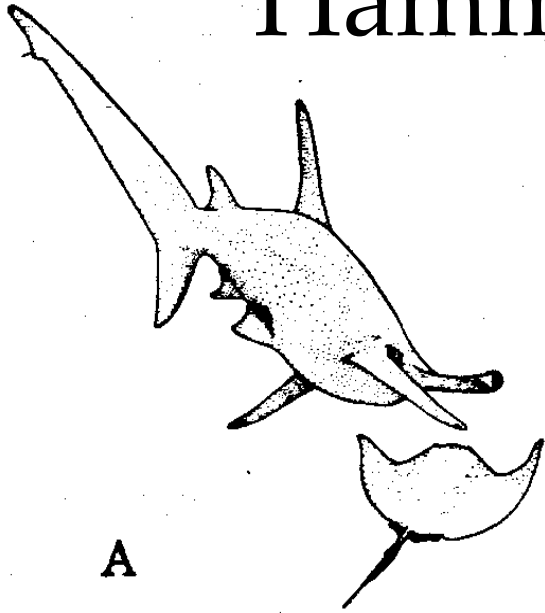
North Carolina inner bays seine survey



Cownose rays have a large impact on the ecosystem

- Over 40 million cownose rays now inhabit Chesapeake Bay
- Each ray eats around ~210g shell-free wet weight a day
- They are in the Bay around 100 days
- This is around 840,000 metric tons (wet flesh).
- The 2003 commercial harvest of these mollusks in Chesapeake Bay totaled only 300 metric tons
- Cownose rays eat over 2,500 times greater than the commercial harvests.

Hammerhead eating stingray



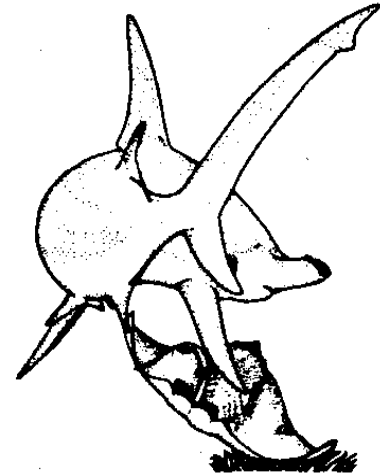
A



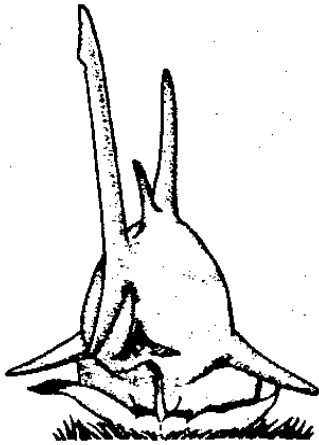
B



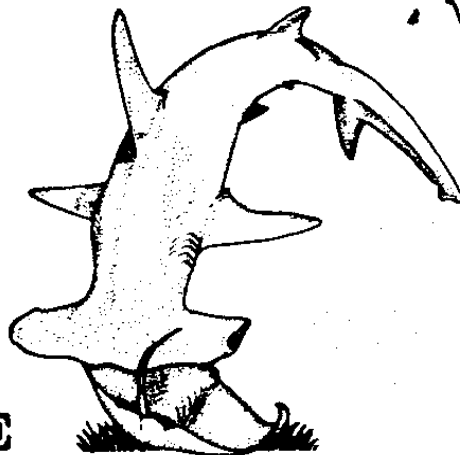
C



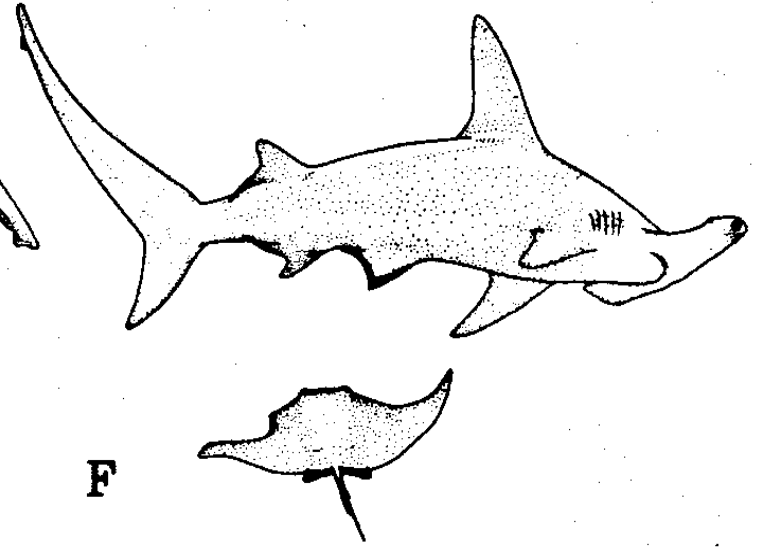
D



E



F



GREAT HAMMERHEAD SHARK PREDATION UPON SPOTTED EAGLE RAY

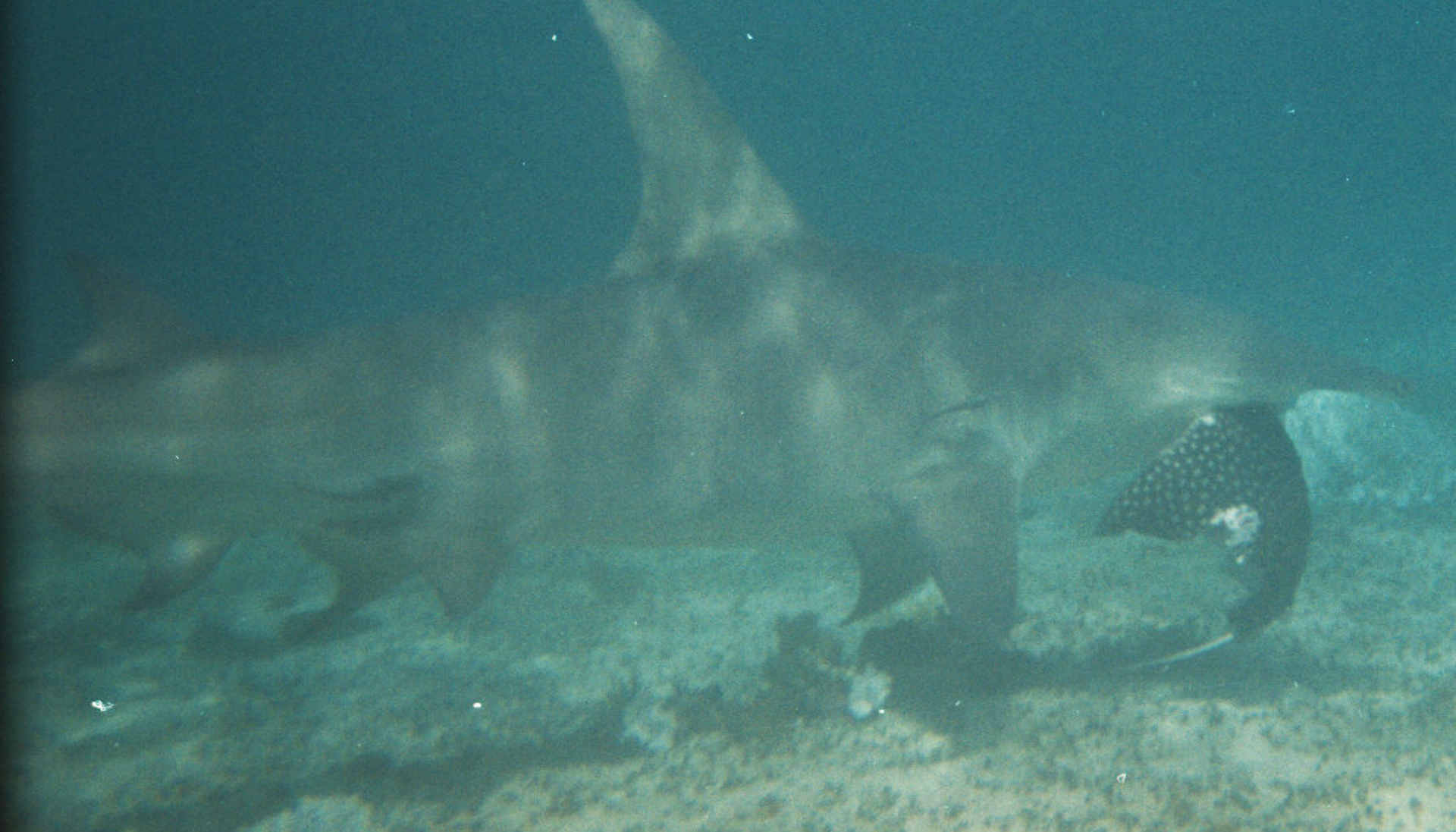


Photo by Demian Chapman

D. D. Chapman and S. H. Gruber, 2002 Bull. of Mar. Sci. 70: 947–952

Declines in Cownose Ray Predators

Shortfin mako 54% (since 1986)



Blacktip 72%



Sandbar 91%



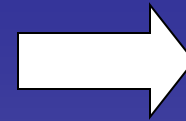
Great hammerhead > 99%



Bull > 99%

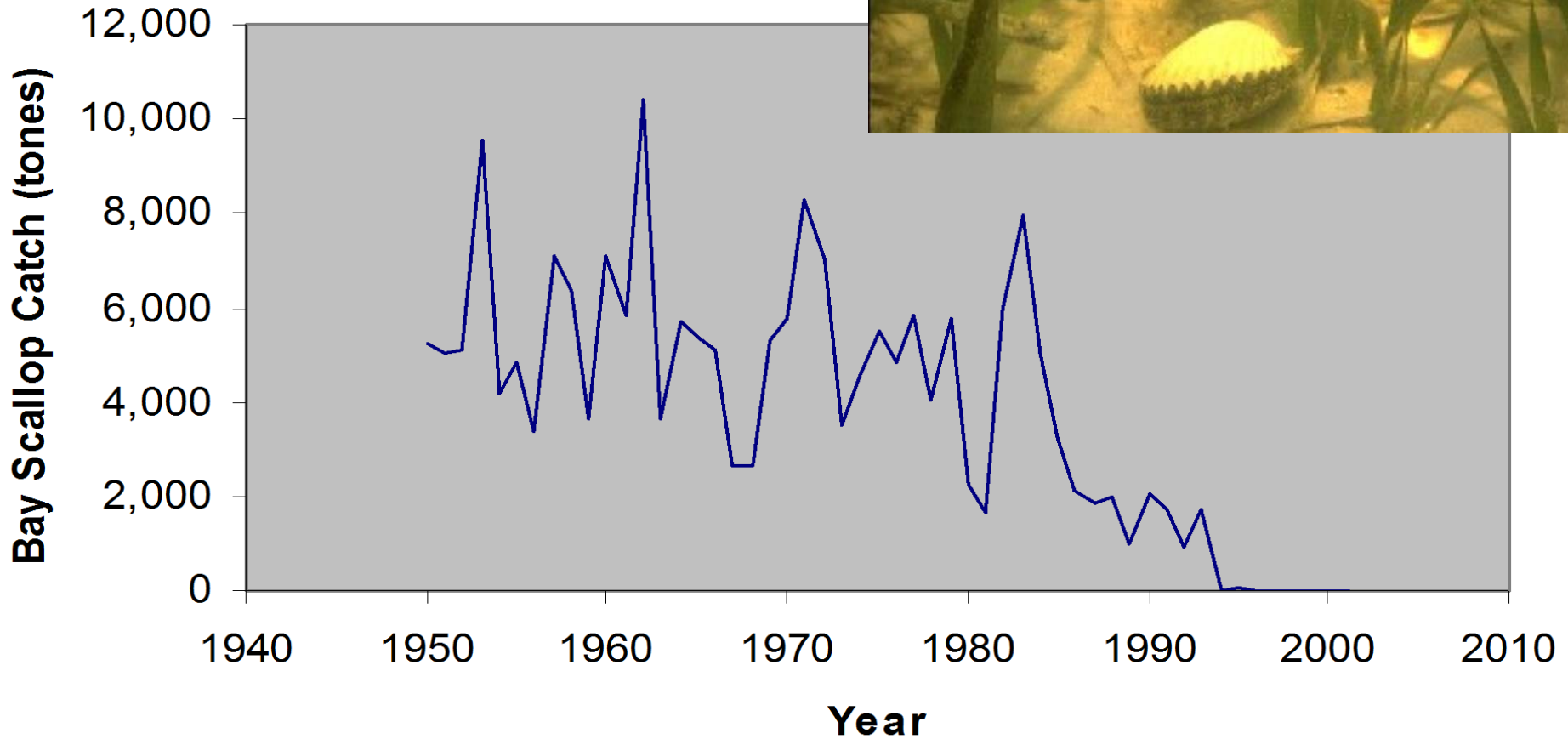


Dusky > 99%

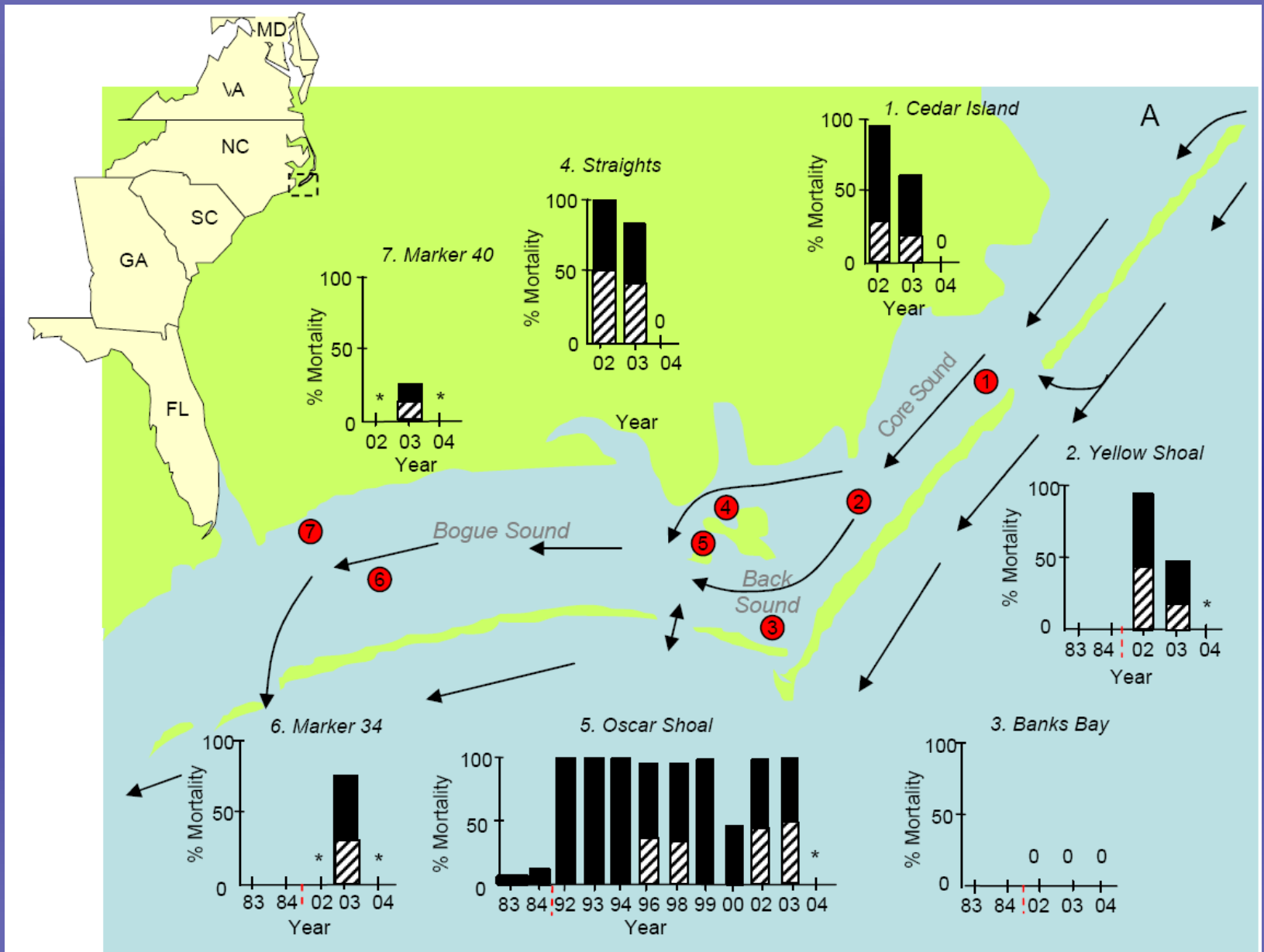


Increased by 20x

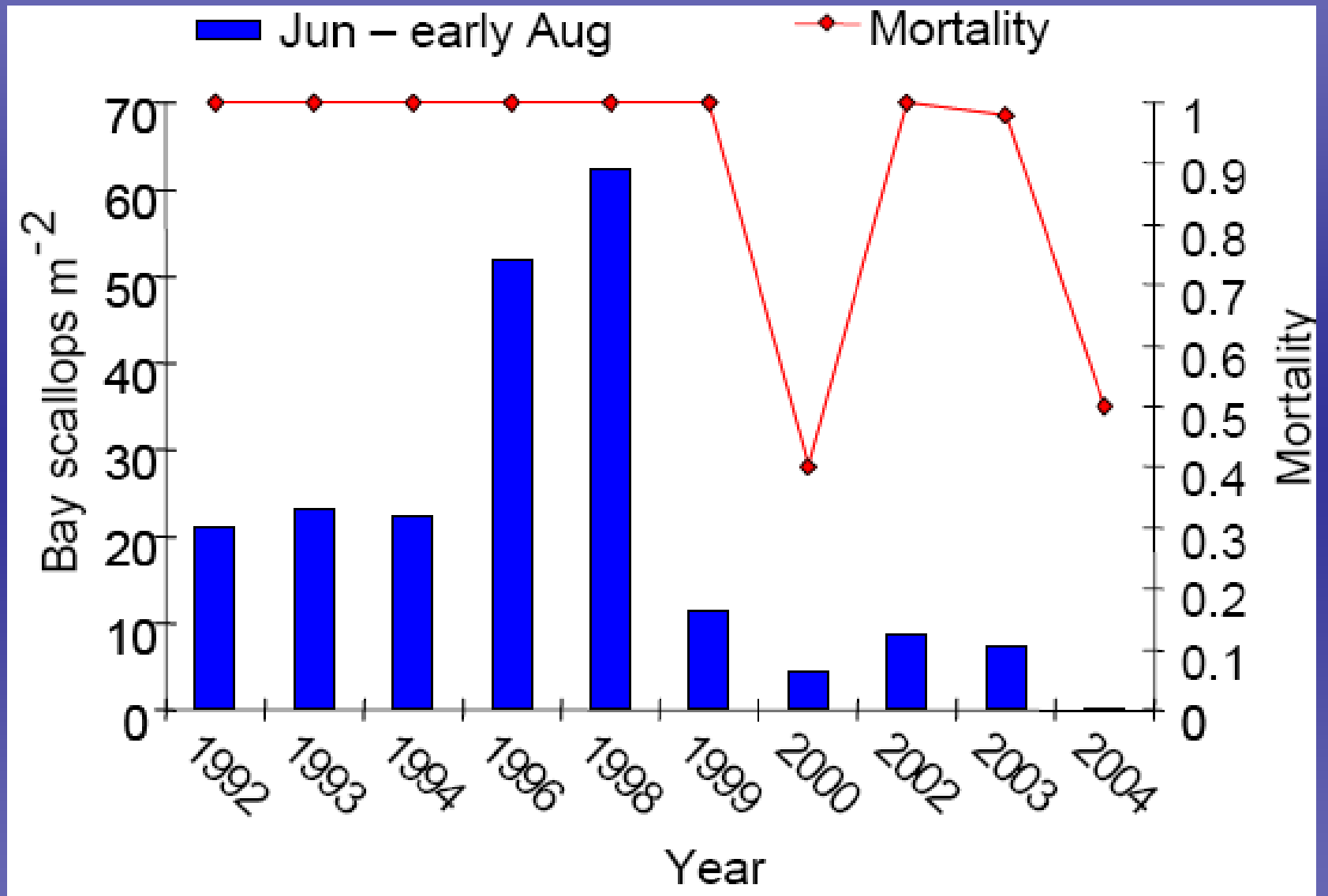
USA Bay Scallops Landings



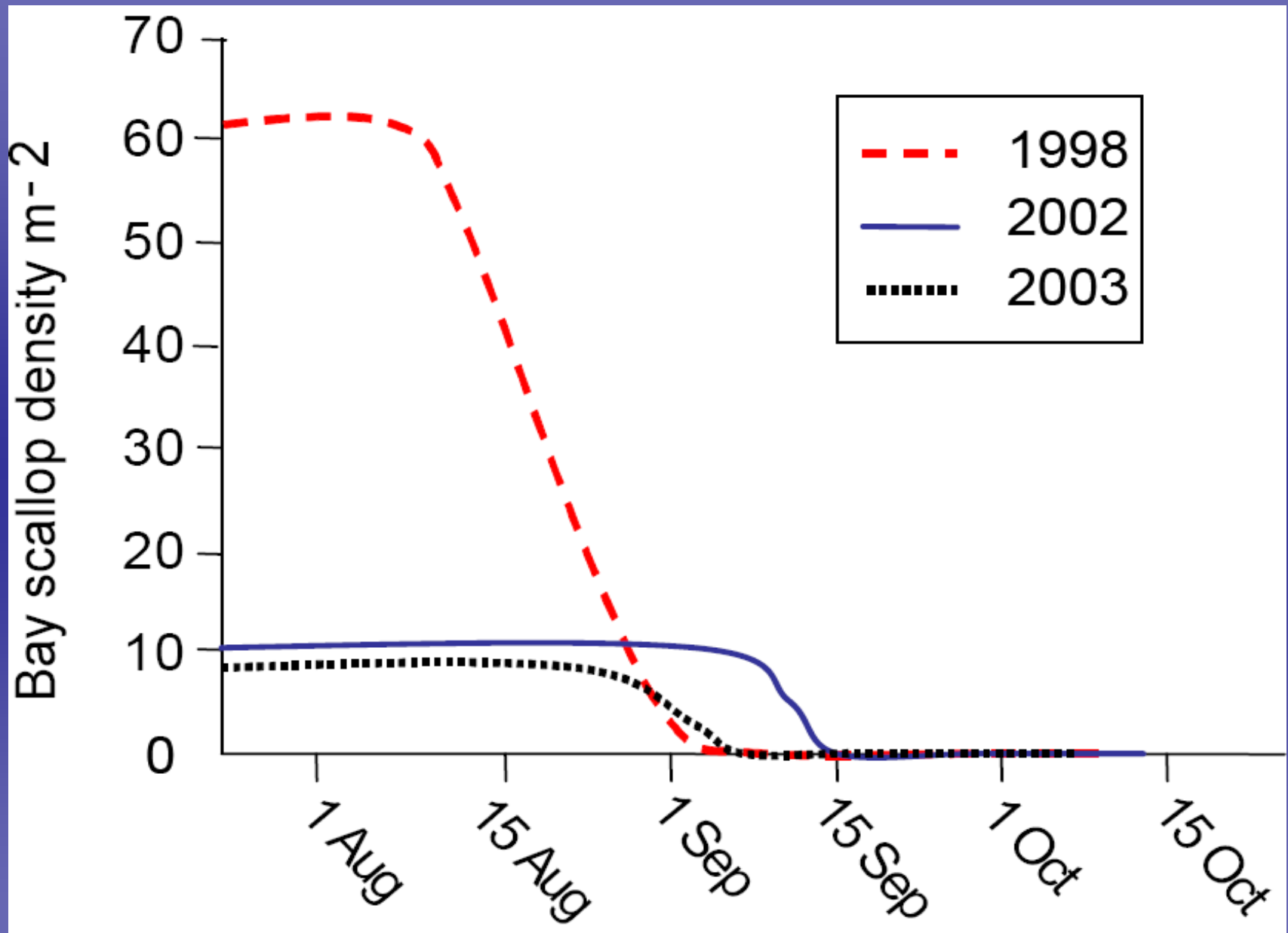
North Carolina experimental field work

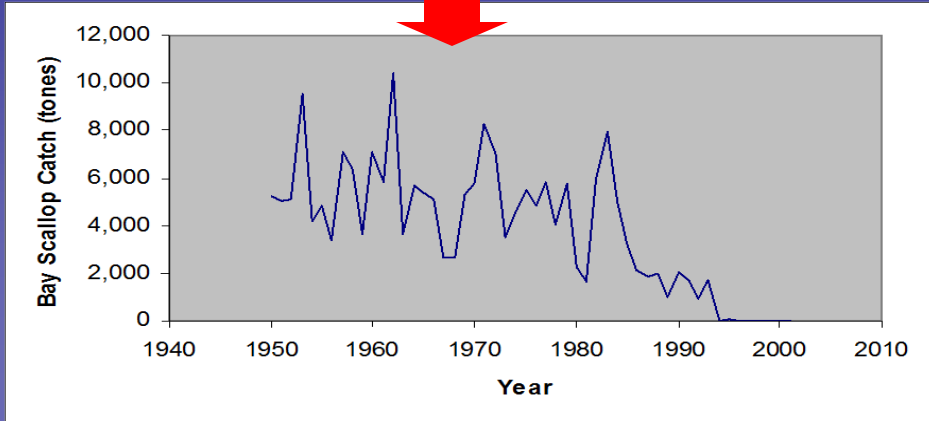
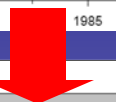
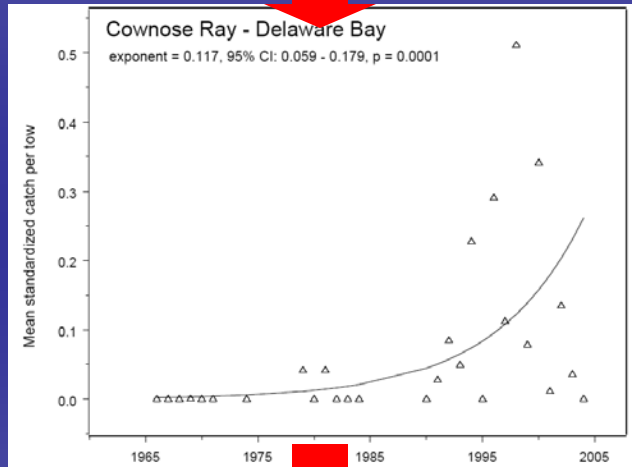
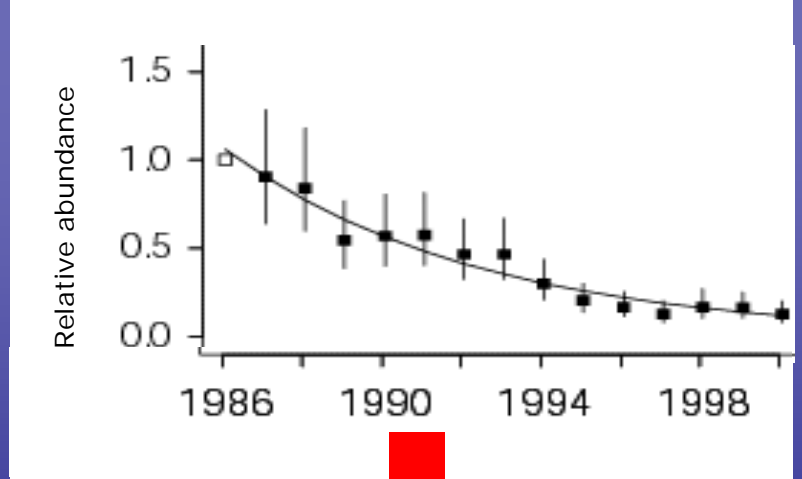
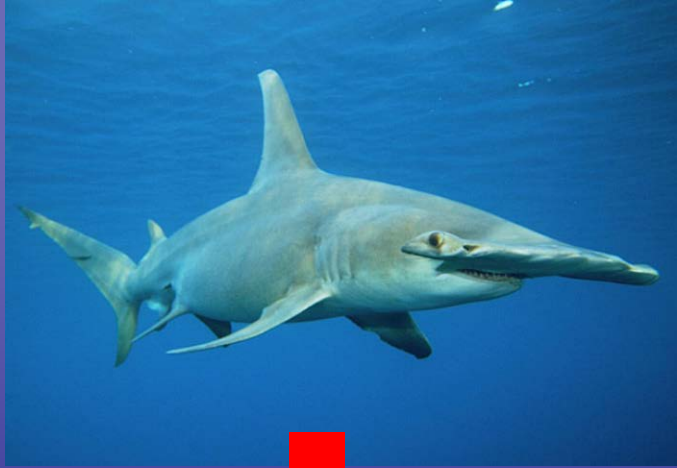


Loss of Bay Scallops



When the cownose rays come by, the bay scallops die



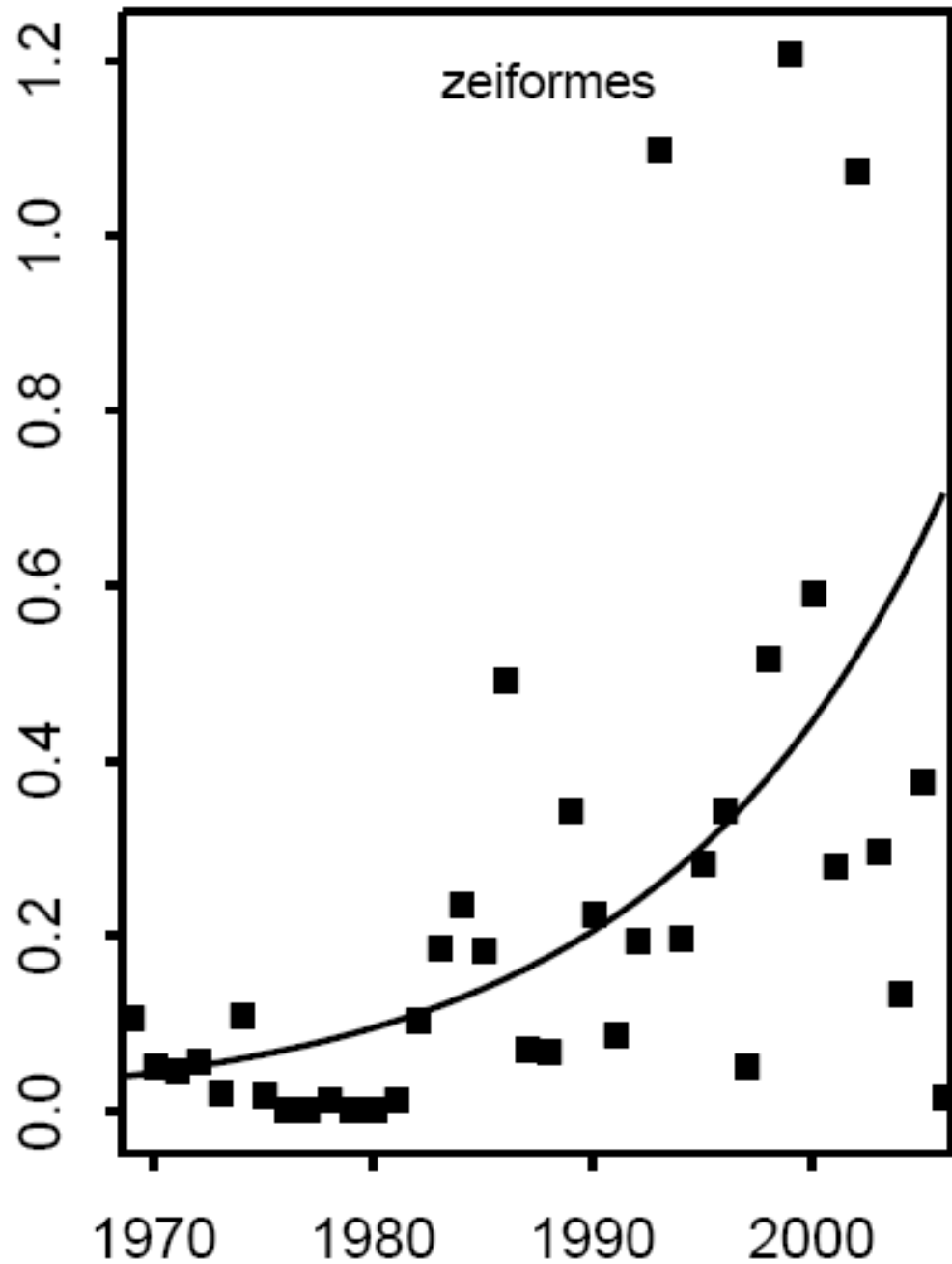


Shark – Ray – Scallop trophic cascade

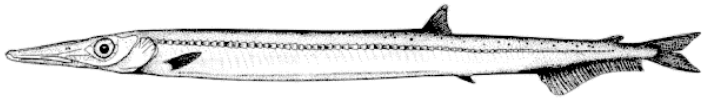
- Previously undocumented ecosystem transformation
- Loss of great sharks has changed community structure
- Indirect consequences of eliminating large predators carry risk of broader marine ecosystem degradation
- Recognition is a big step towards more effective ecosystem-based management and sustainable exploitation

Current work

- Declines in pelagic predatory fishes
- What effect is this having on their prey?
- Meso-pelagic fishes
 - NMFS, DFO, CALCOFI, SEAMAP



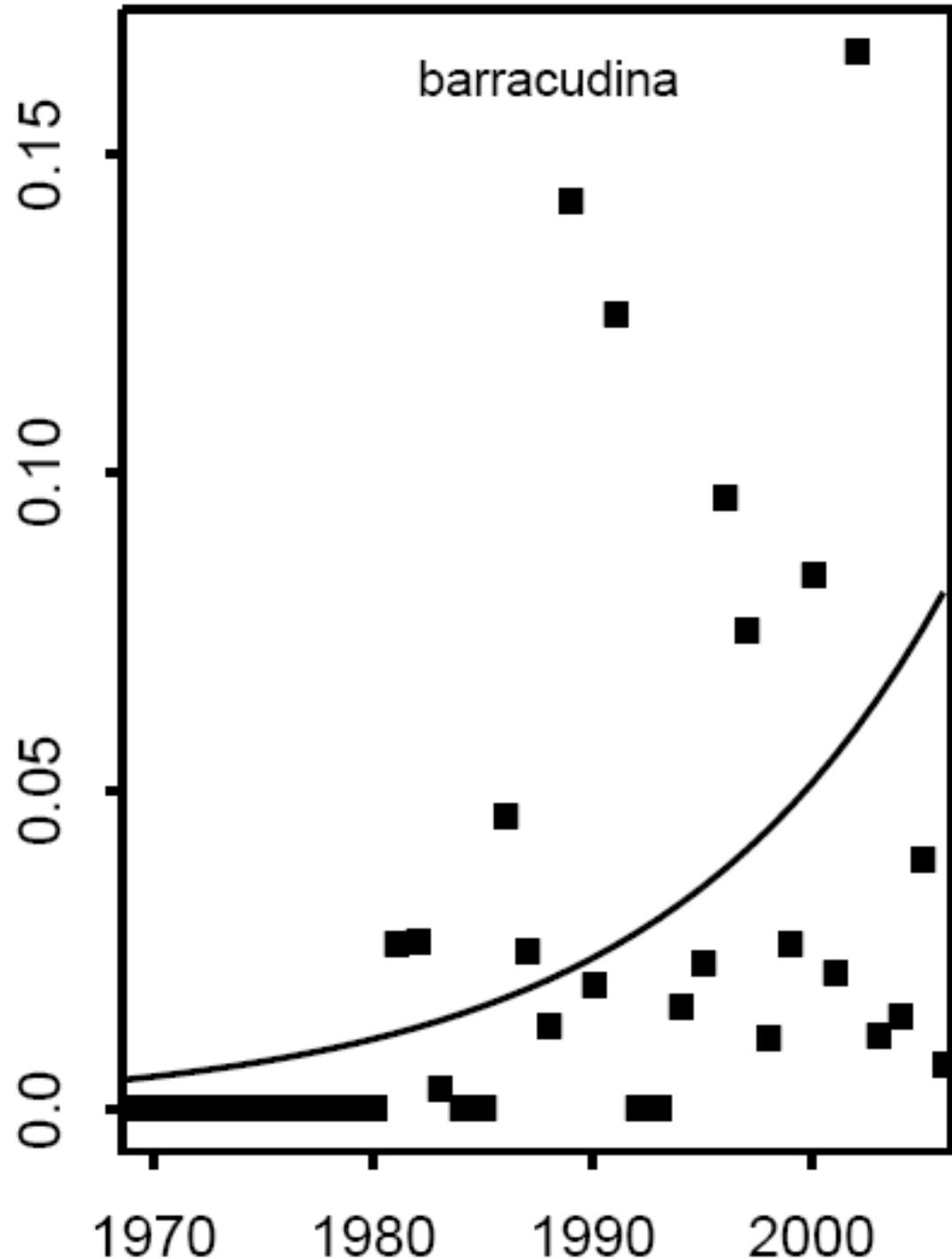
ZENOPSIS CONCHIFERA
BUCKLER DORY



0 5 cm

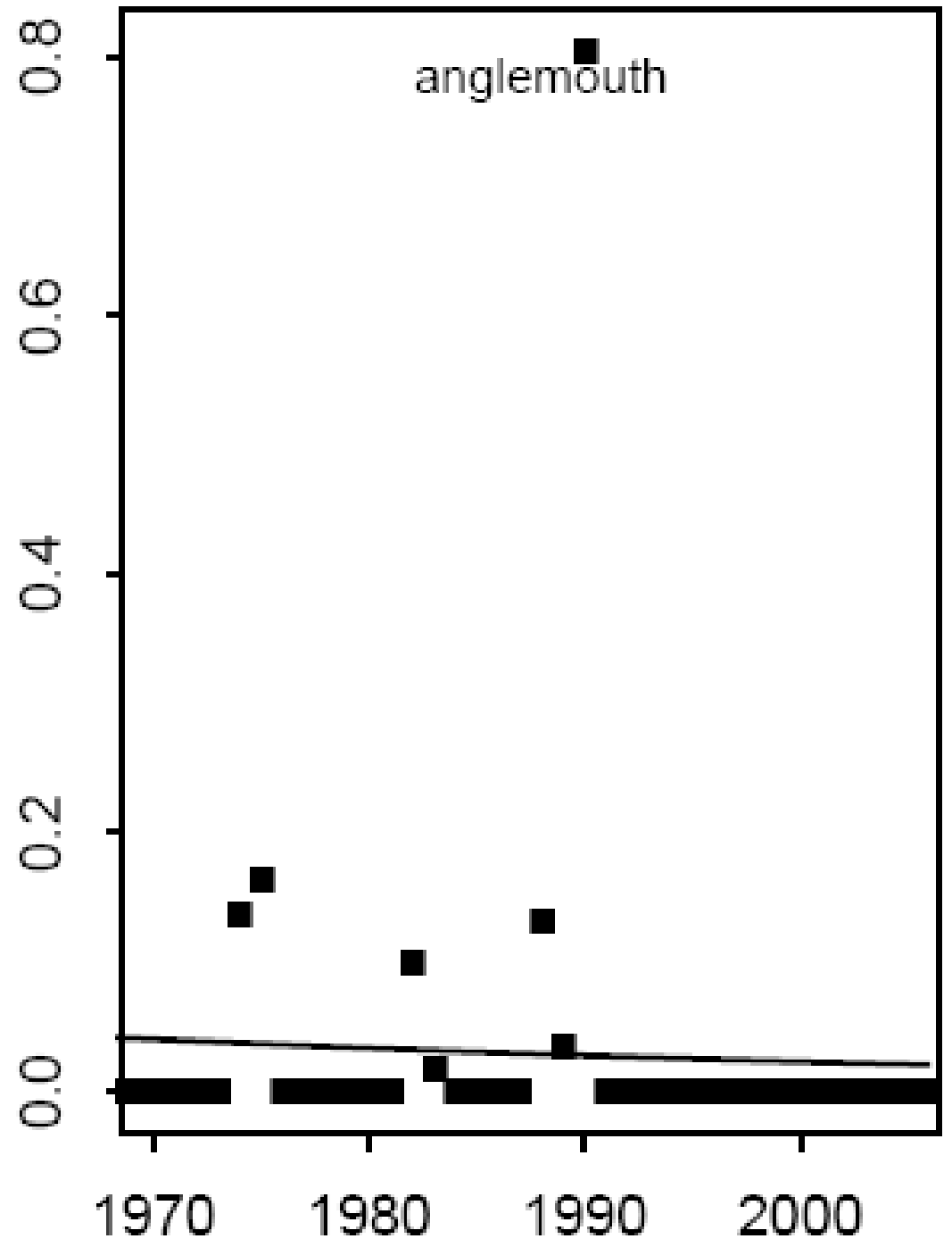
FAO

ARCTOZENUS RISSOI
WHITE BARRACUDINA



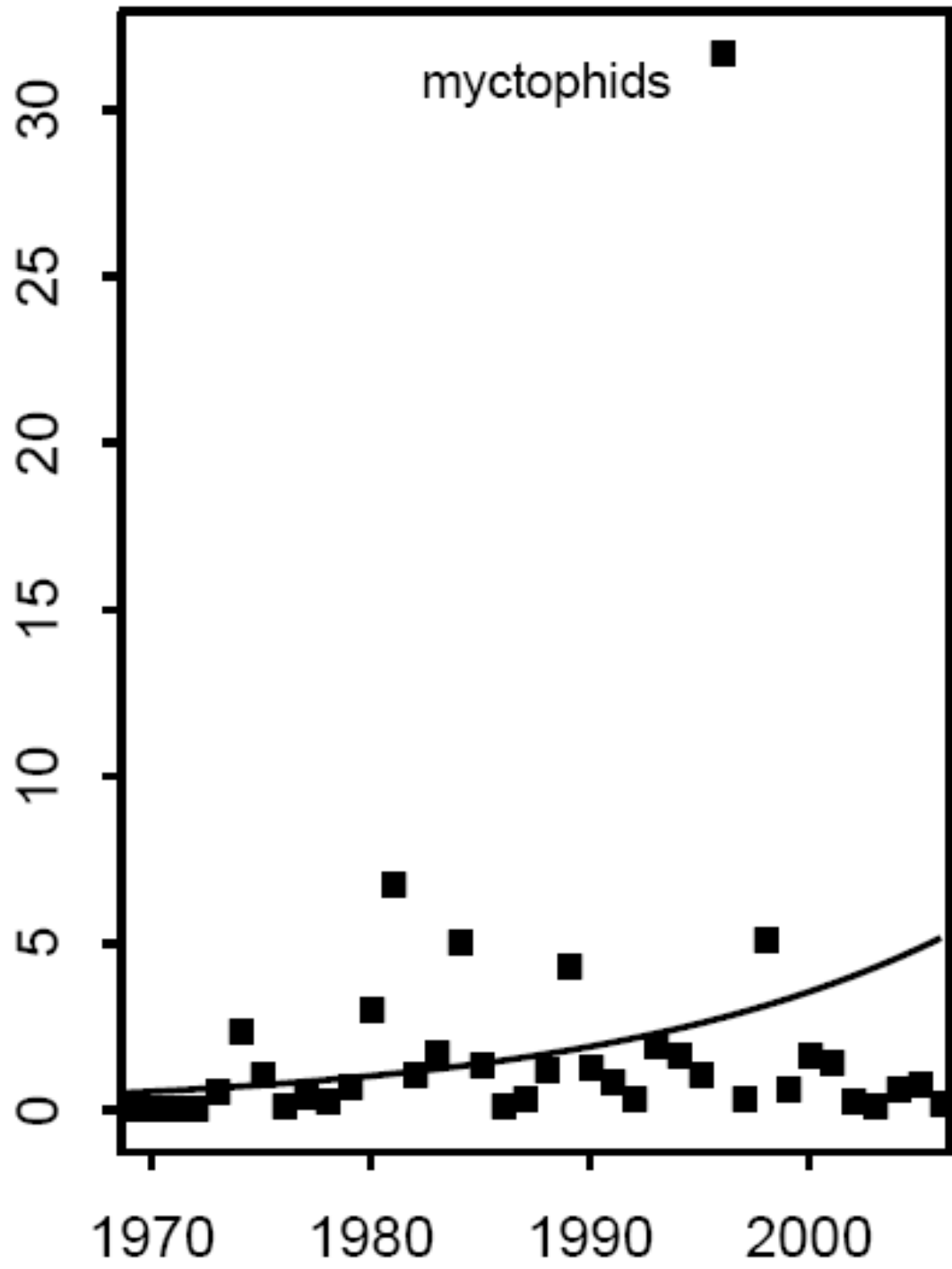


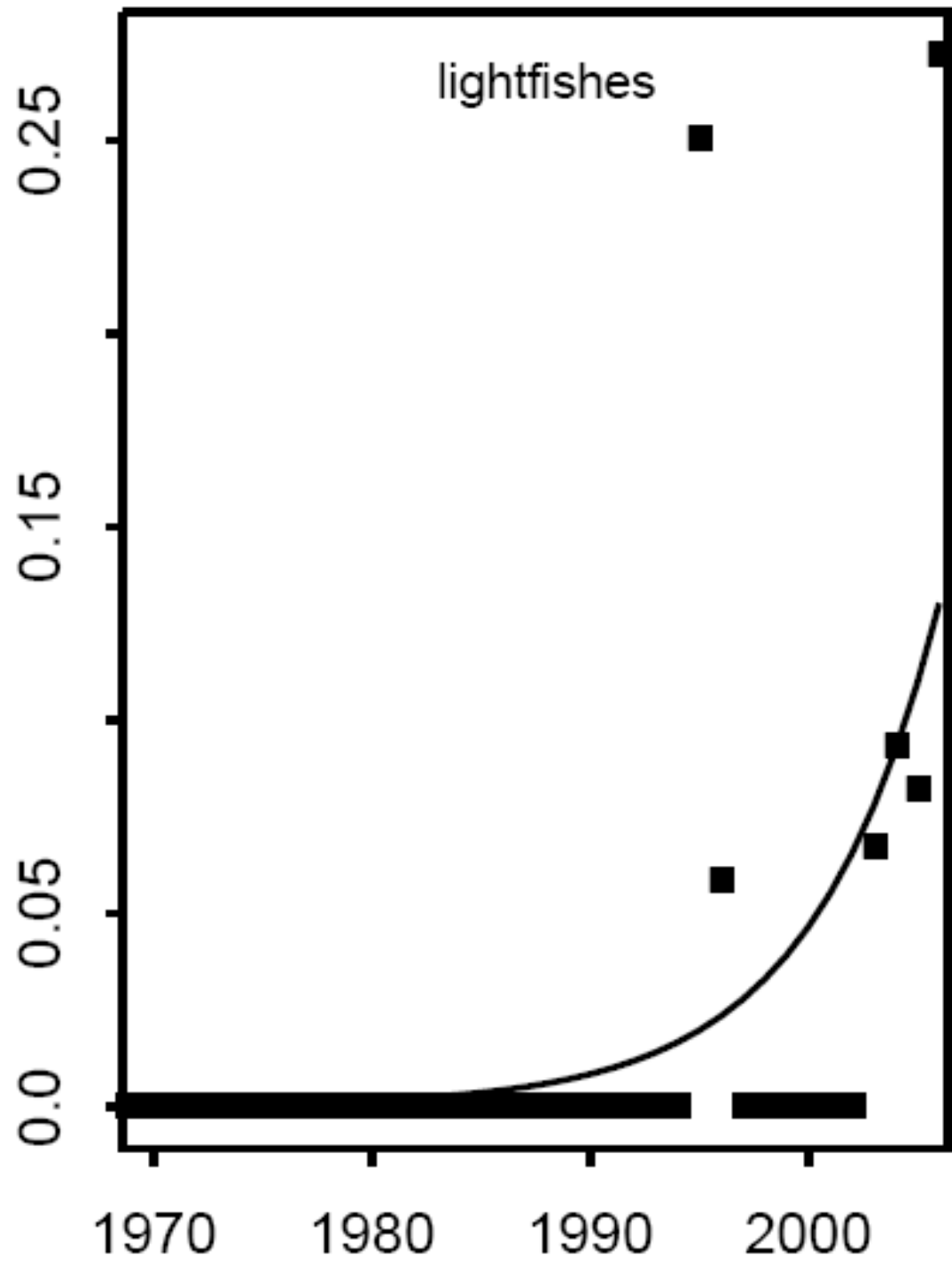
LONGTOOTH ANGLEMOUTH





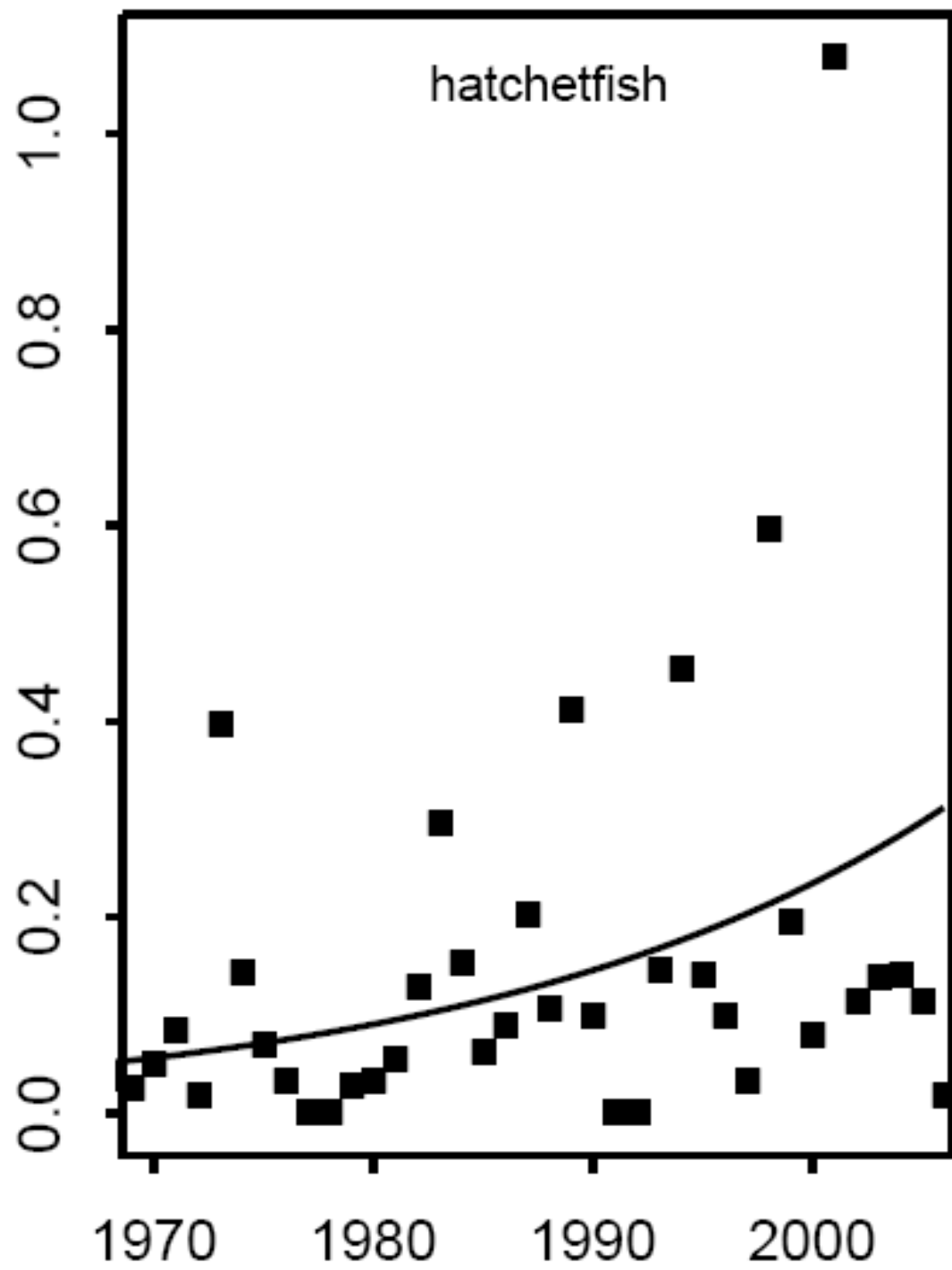
CERATOSCOPELUS MADERENSIS
HORNED LANTERNFISH

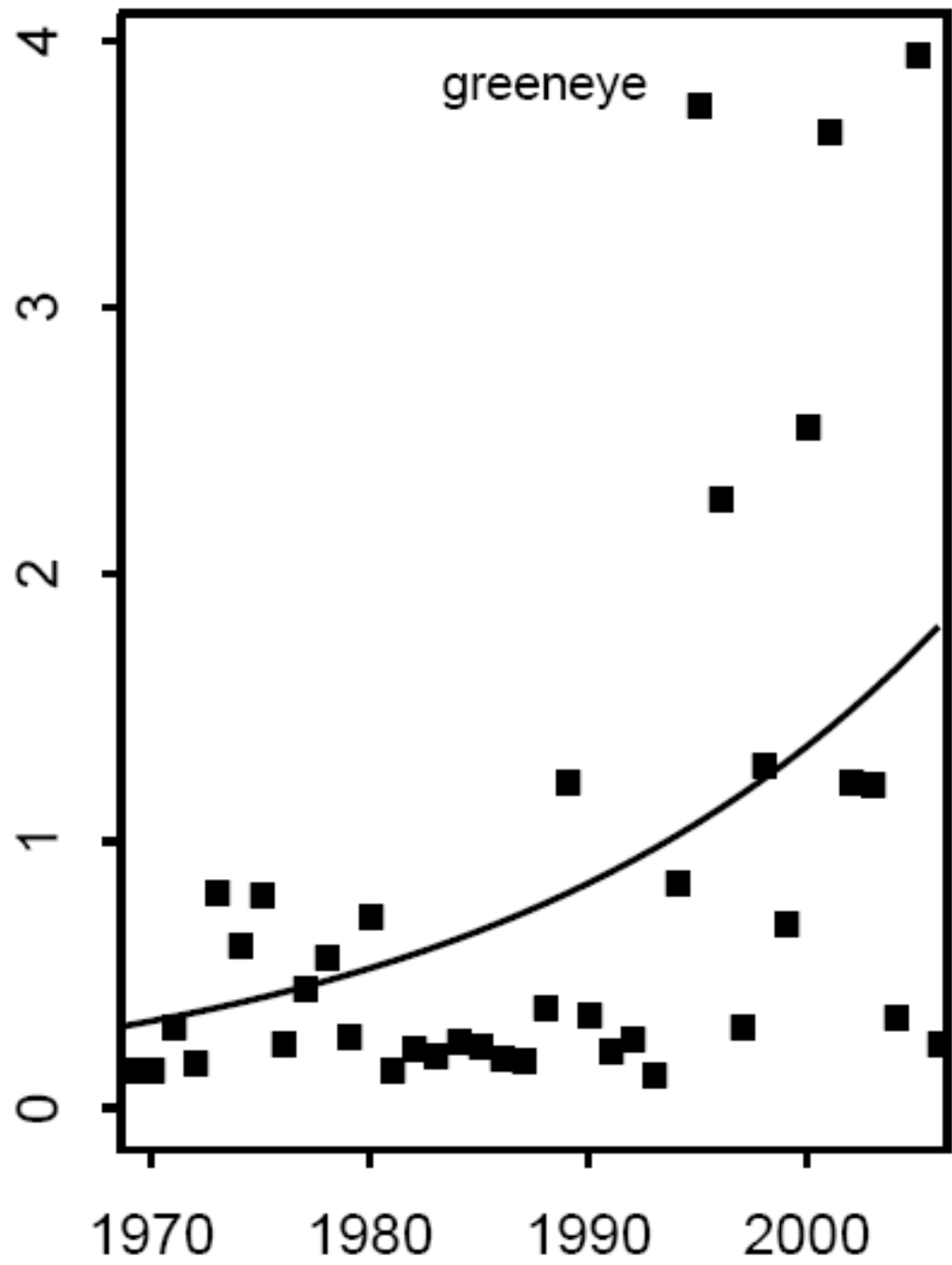


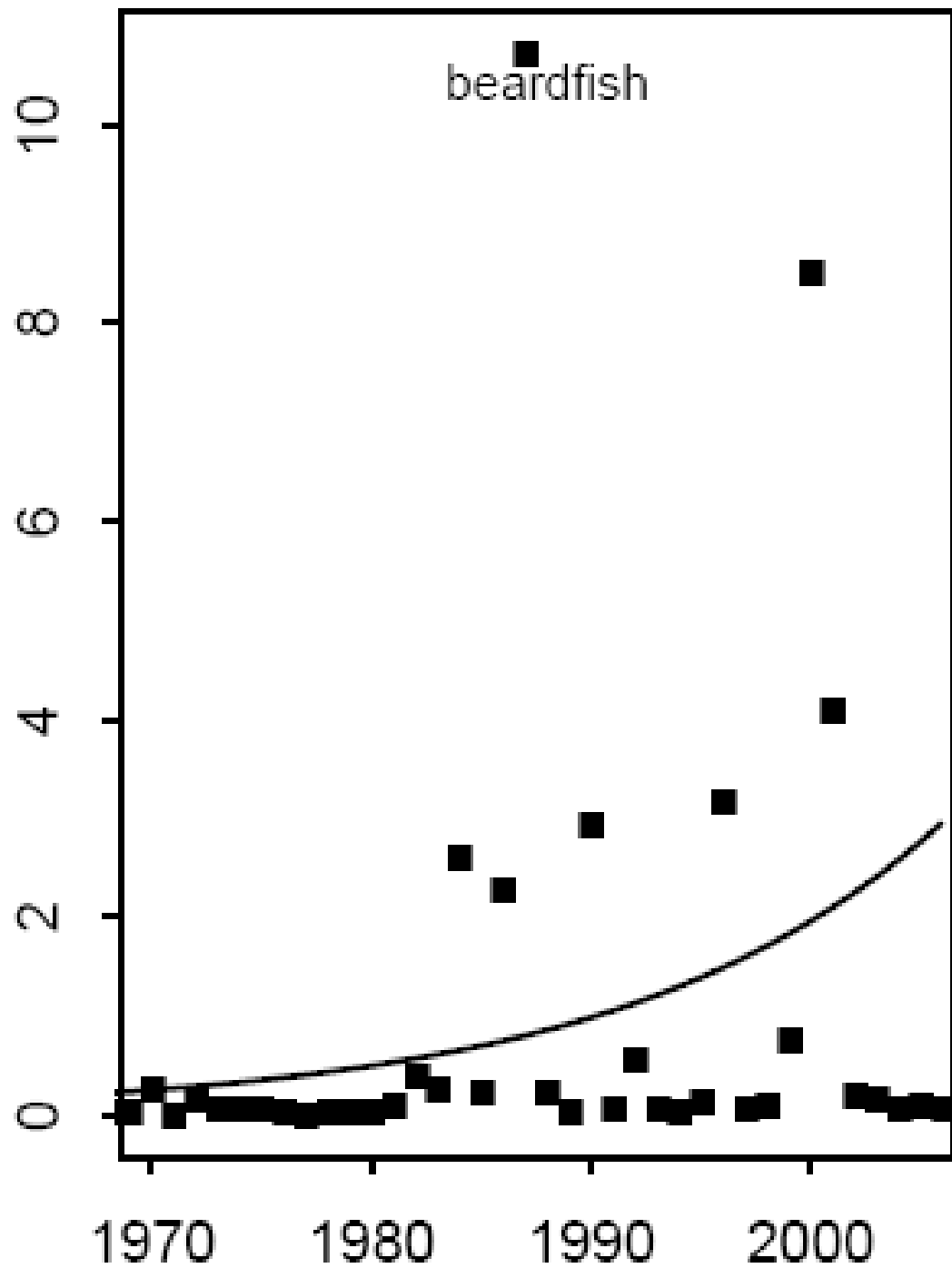
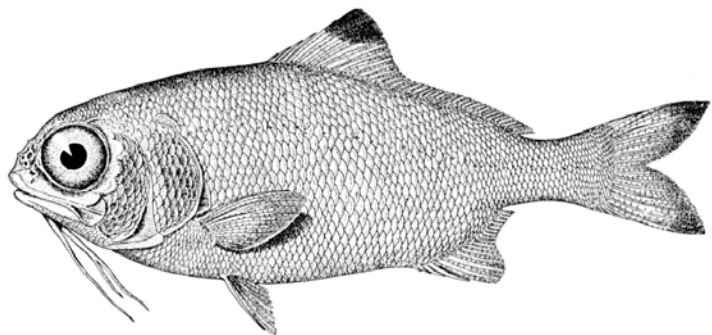




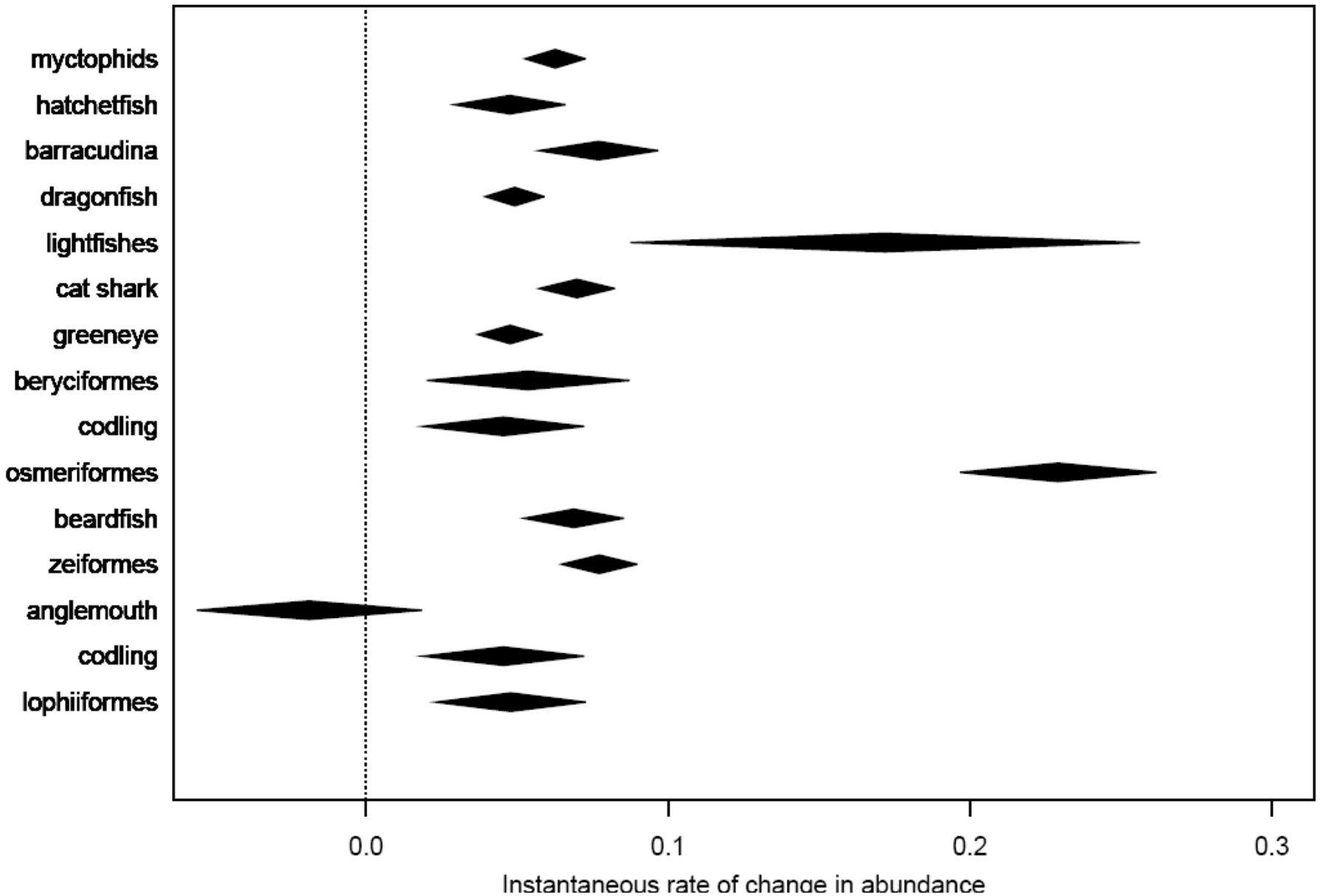
Argyropelecus affinis







Changes since 1963 in meso-pelagic fishes (Eastern US – NEFSC data)



Summary

- Exploitation on any one species or group of common species will have community-wide effects
- Indirect effects between trophic levels appear to be strong
- Reference points for large predatory fishes may need to be conservative
- More assessment effort for rare, commercially unimportant species

Acknowledgments

- Supervisor: Ransom Myers
- Co-Authors: Julia Baum (DAL), Pete Peterson (Univ. of North Carolina), Sean Powers (Dauphin Island Sea Lab)
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- Universities: Univ. of Rhode Island, Univ. of New Orleans, Virginia Institute of Marine Science

