

Macroecological changes in exploited marine systems

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Derck Tittensor
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FMAP (Future of Marine Animal Populations)

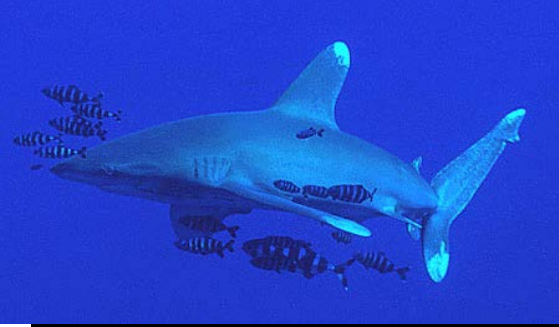
part of the Sloan Census of Life <http://www.fmap.ca>

Pew Global Sharks Assessment

<http://www.globalsharks.ca>

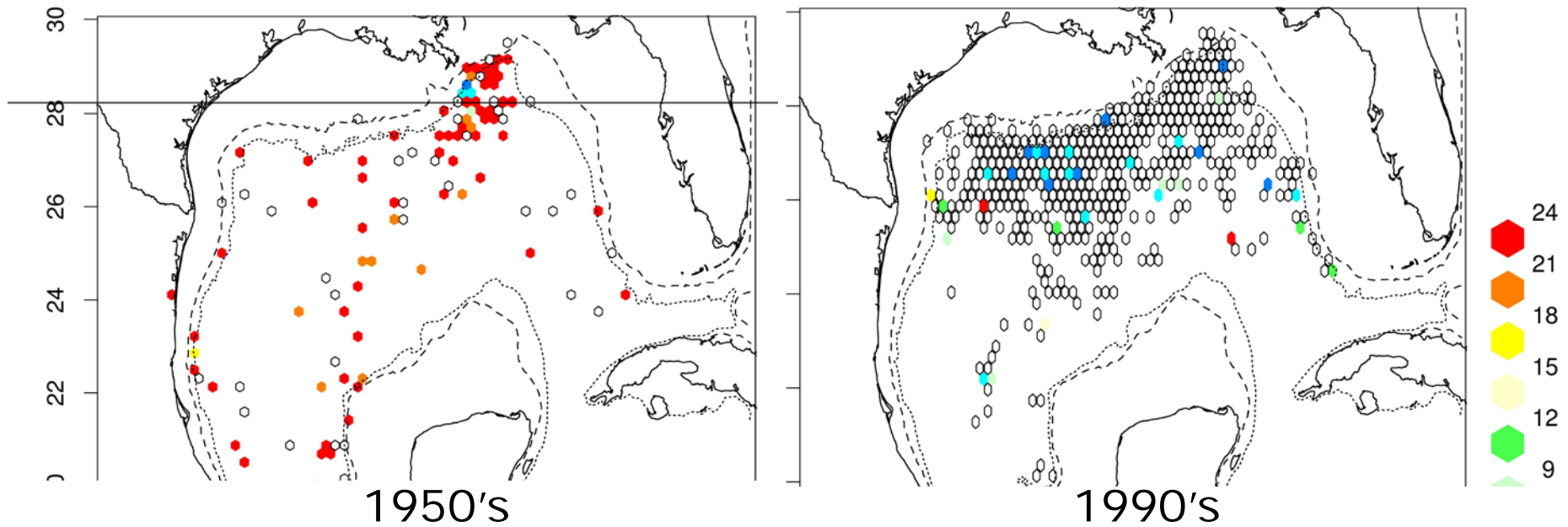
What was the most common large animal (>40 Kg) in the world? (perhaps this one was)





Loss of sharks in the Gulf of Mexico

300 fold decline – no one noticed



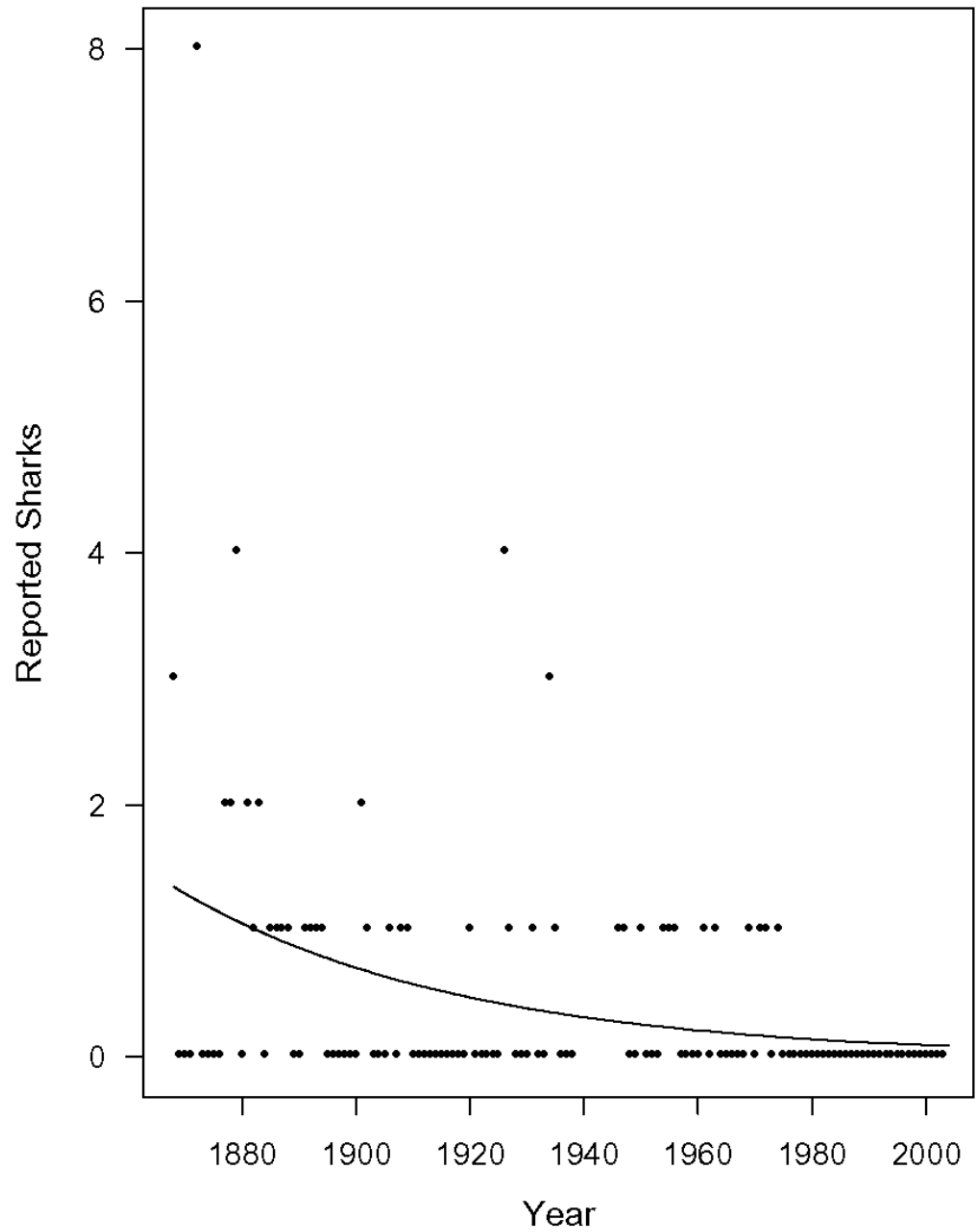
Oceanic Whitetip captures per 10,000 hooks

Circumstantial
evidence of oceanic
whitetip sharks being
common in the Gulf
of Mexico



Fitting a simple model to crazy data can yield reliable, and very powerful conclusions

Newspaper reports of sharks in Croatia



With training, “experts” can ignore the most obvious of data:

1872 - Man's head and leg and dolphin in stomach

1872 – 8 Great White Sharks reported caught

1888 - Woman's body and lamb in stomach

1894 - Preserved at Zagreb Nat. Hist. Mus.

1926 - Woman's shoes, laundry in stomach

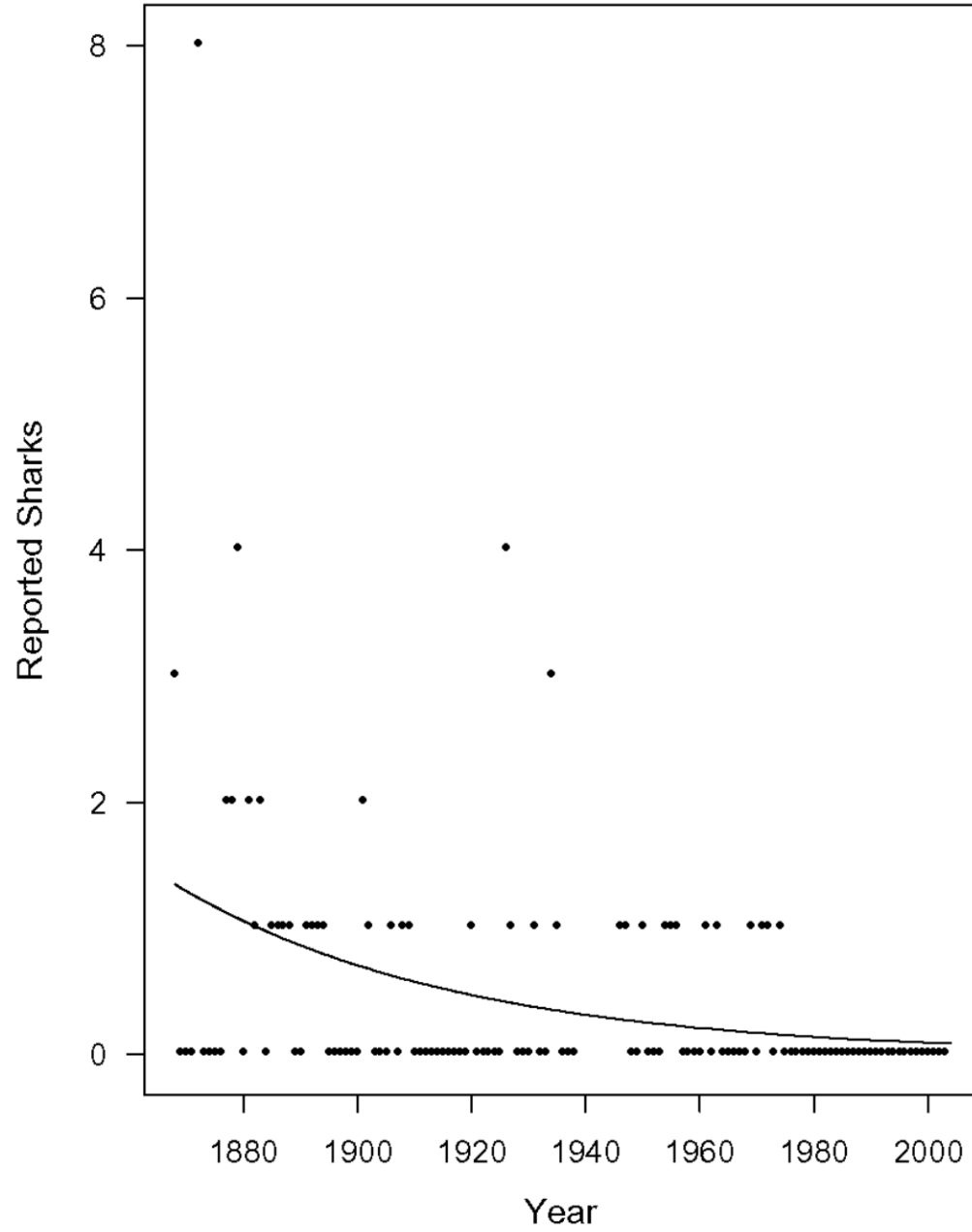
1946 - Pig of 10 kg in stomach

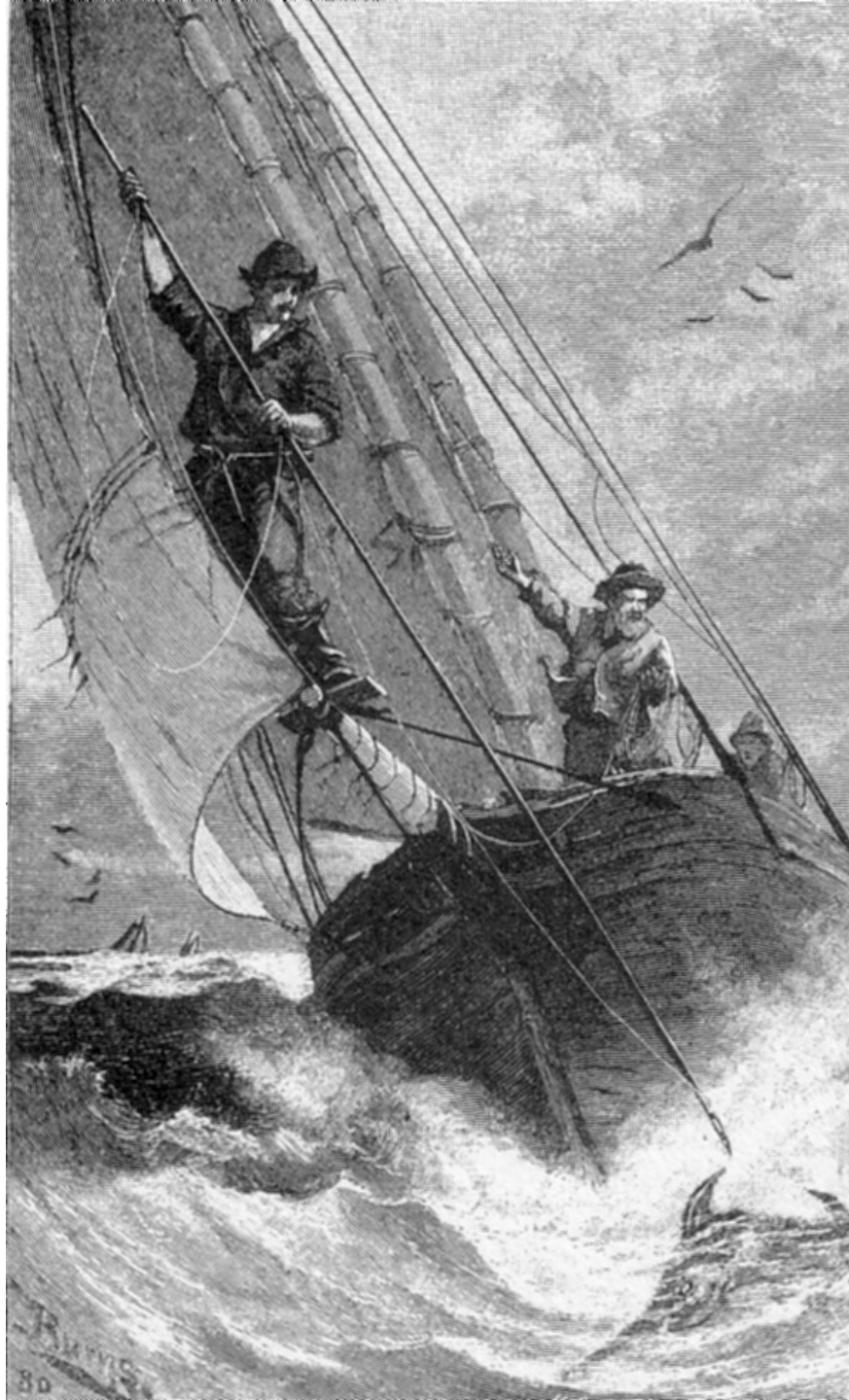
1950 - Encounter during eating a dead calf

1954 - Attack on boat

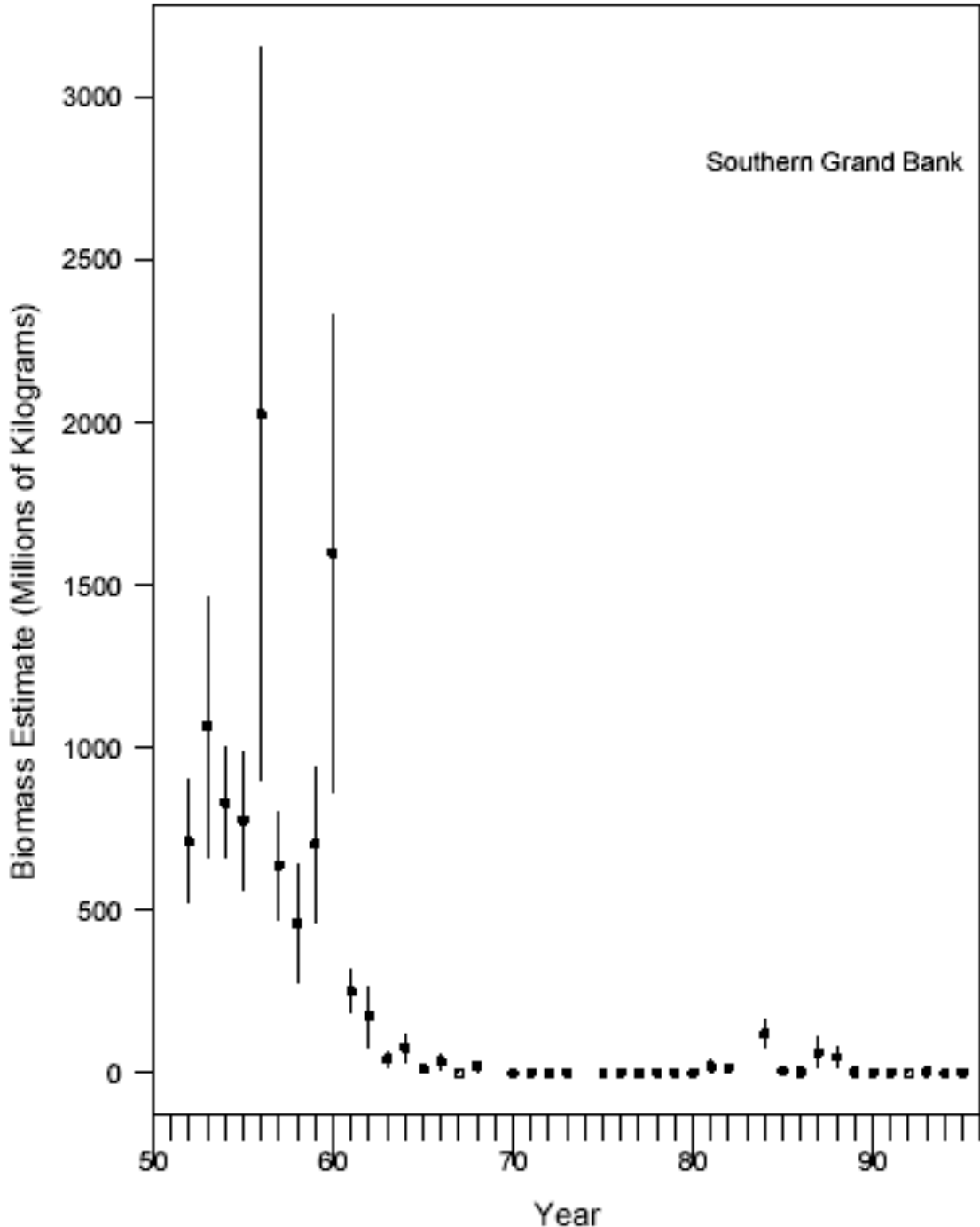
1975+ -**No sightings.**

Newspaper reports of sharks in Croatia





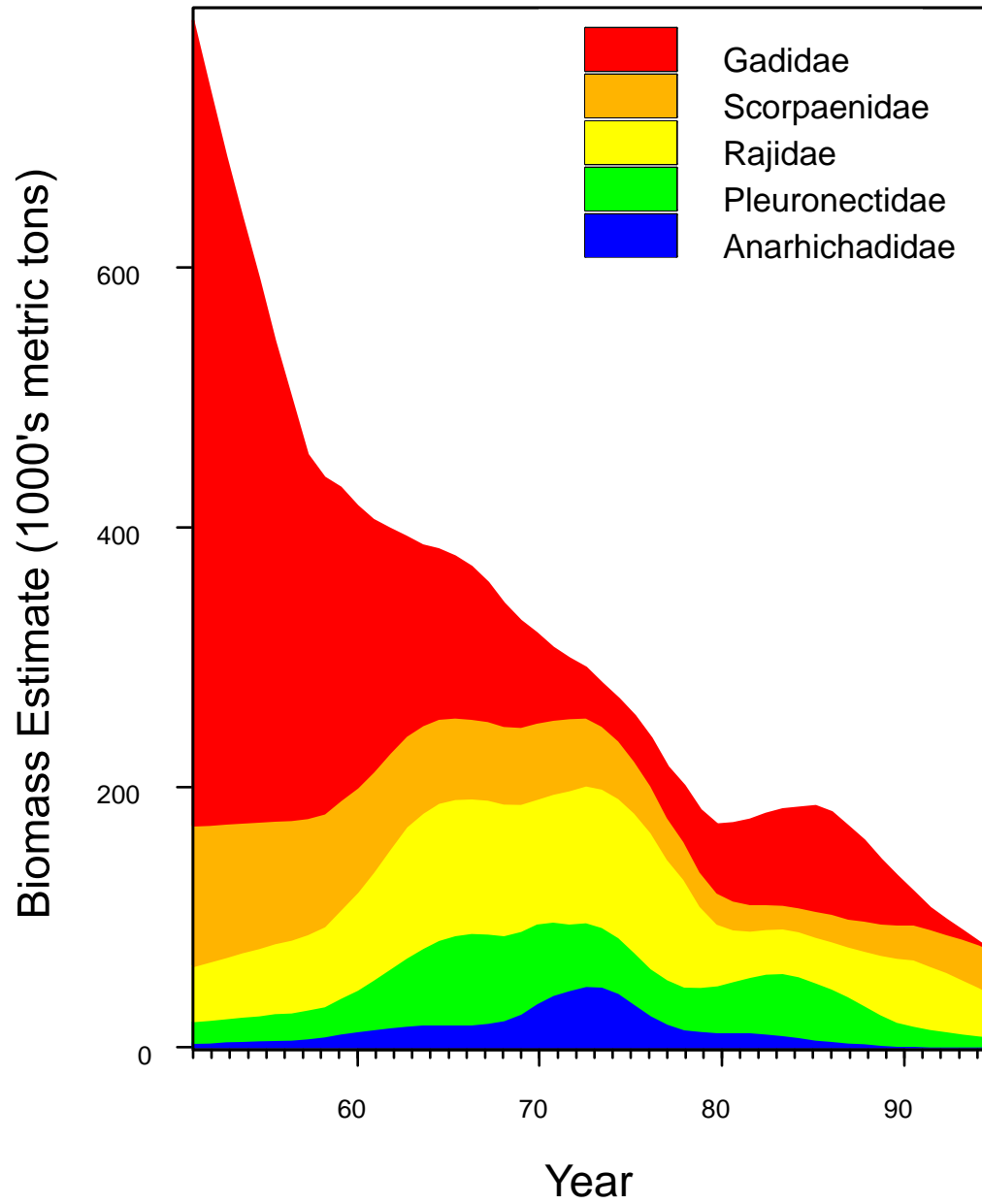




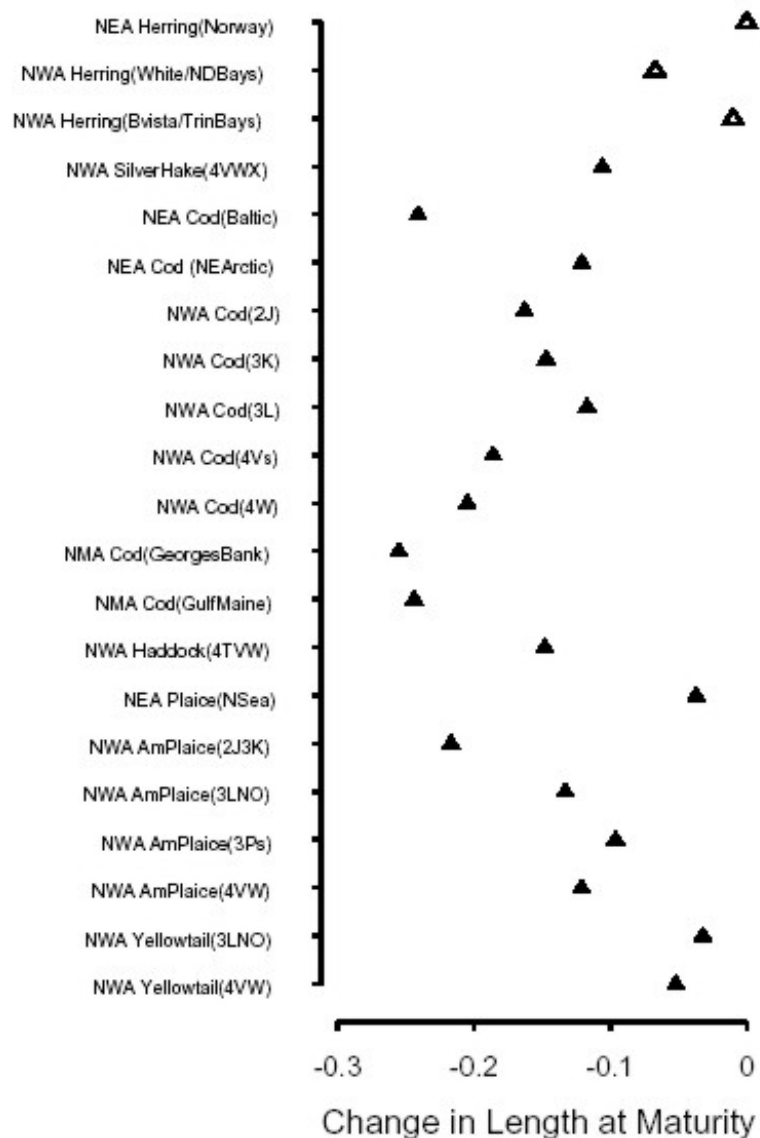
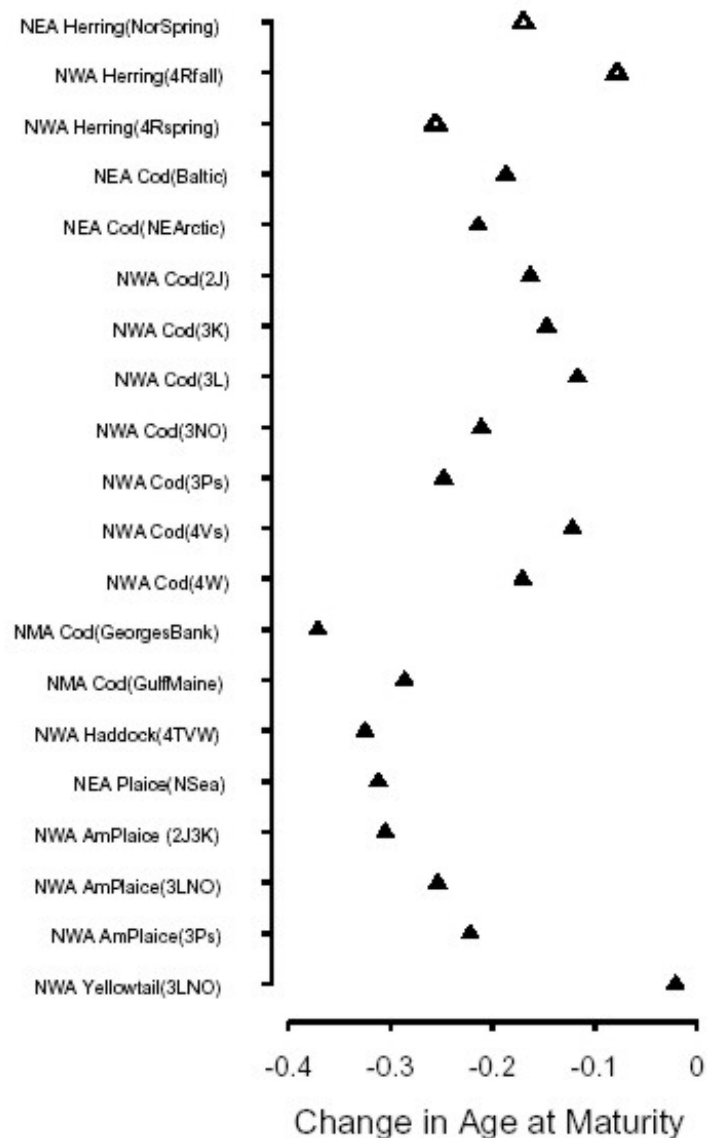
Southern Grand Bank

Loss of haddock on the Grand Banks – data from research surveys

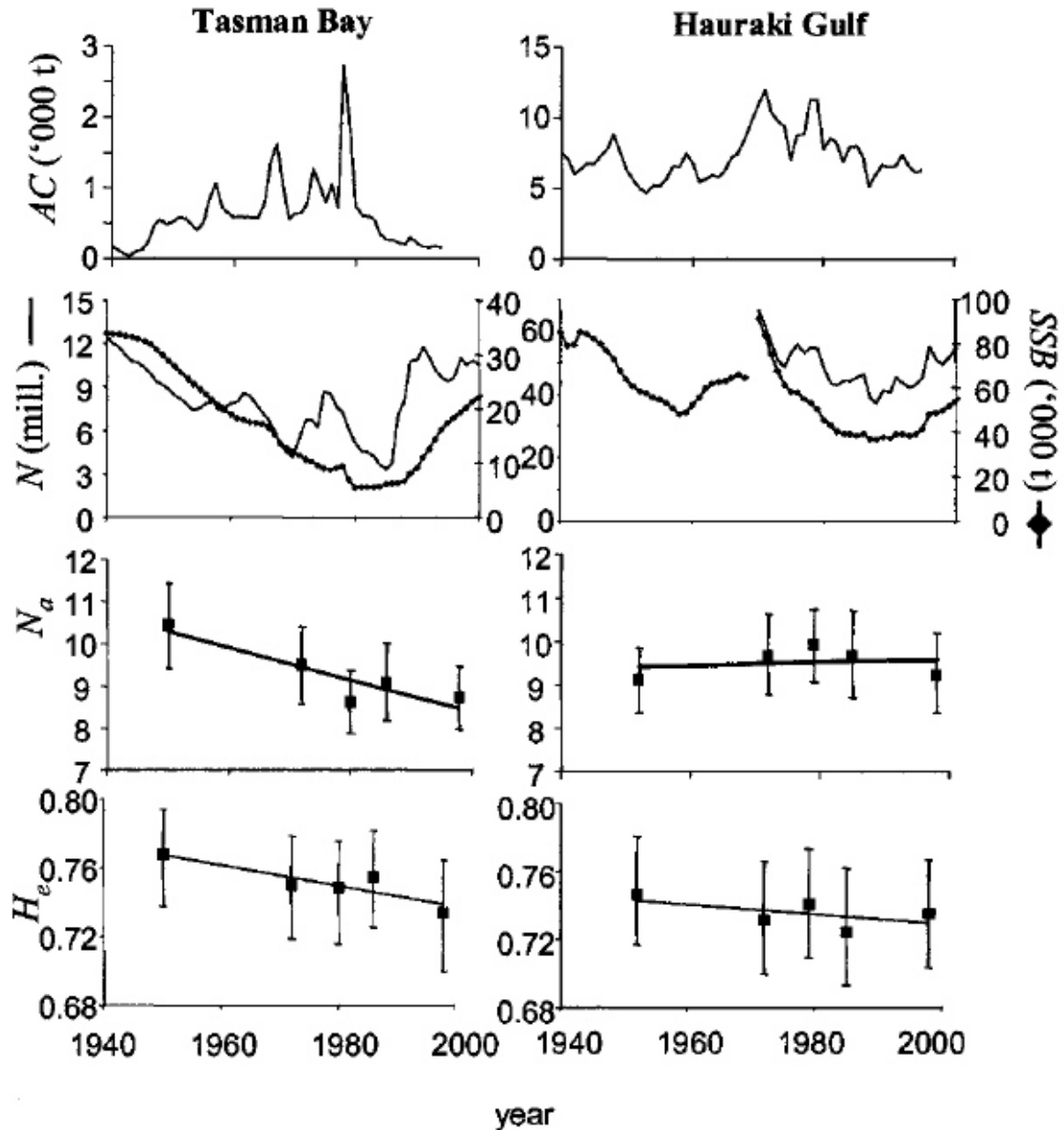
Community Changes on St. Pierre Bank



Change of Life History Traits with Exploitation



Loss of Genetic Diversity with Exploitation



Loss of populations with exploitation

- Extinction is when all populations are lost.
- Resilience is lost when the populations are eliminated that are adapted to the present environment.

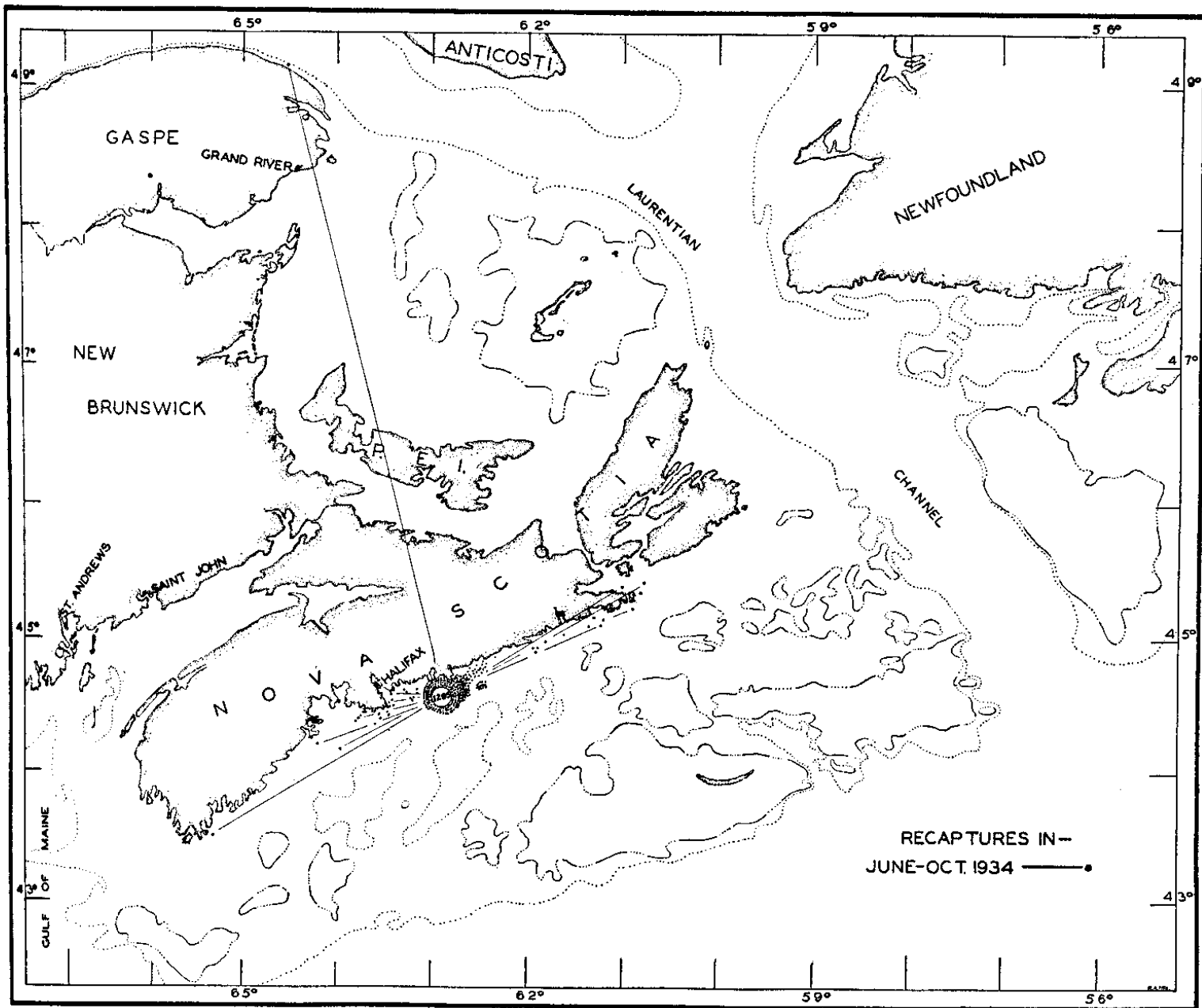


FIG. 21.—Recaptures to October, 1934, of cod tagged in the Jeddore Rock to Egg Island area, N.S., in May, 1934.

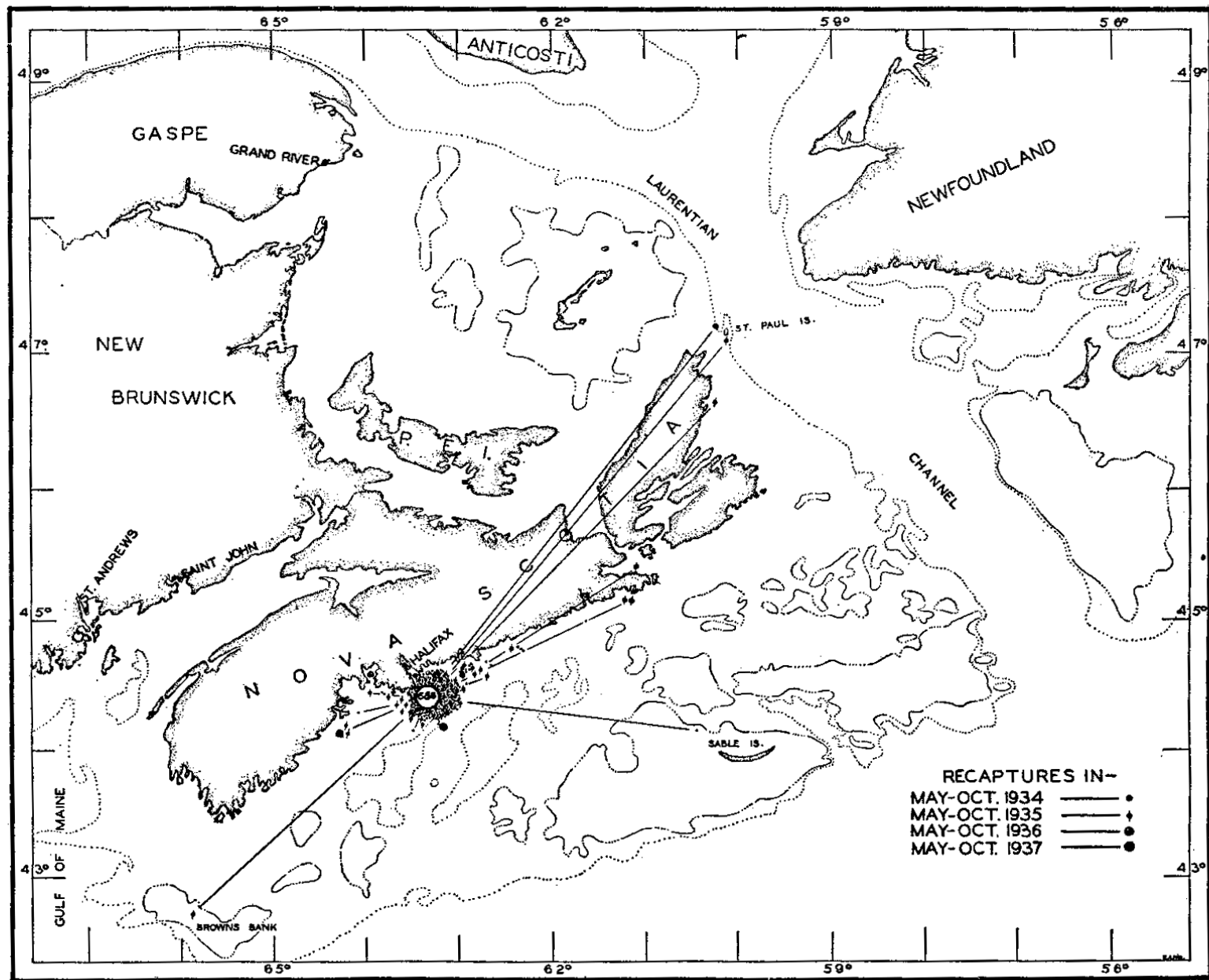


FIG. 18.—Recaptures in May to October, 1934, 1935, 1936 and 1937, of cod tagged near Halifax in June, 1934.

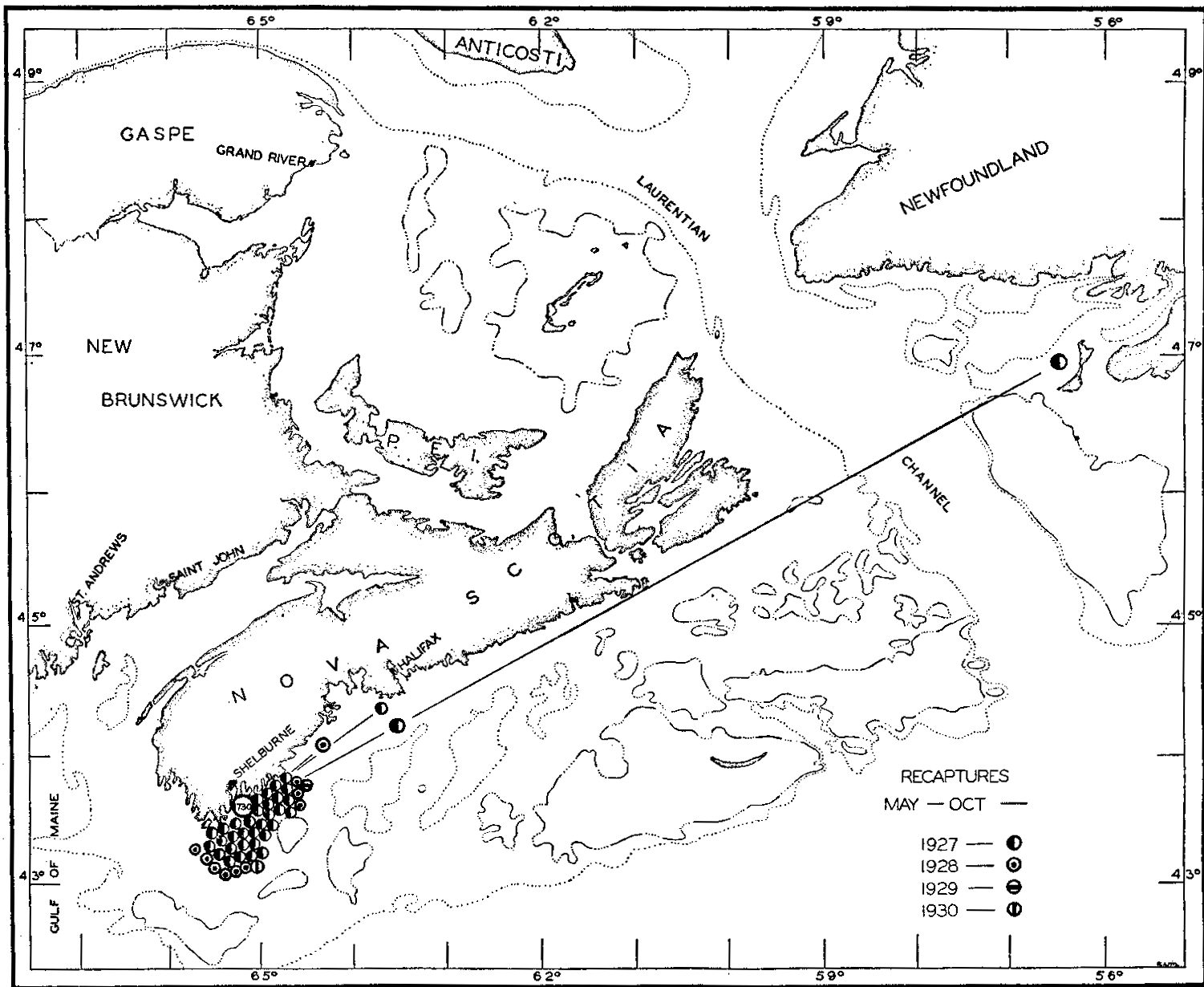
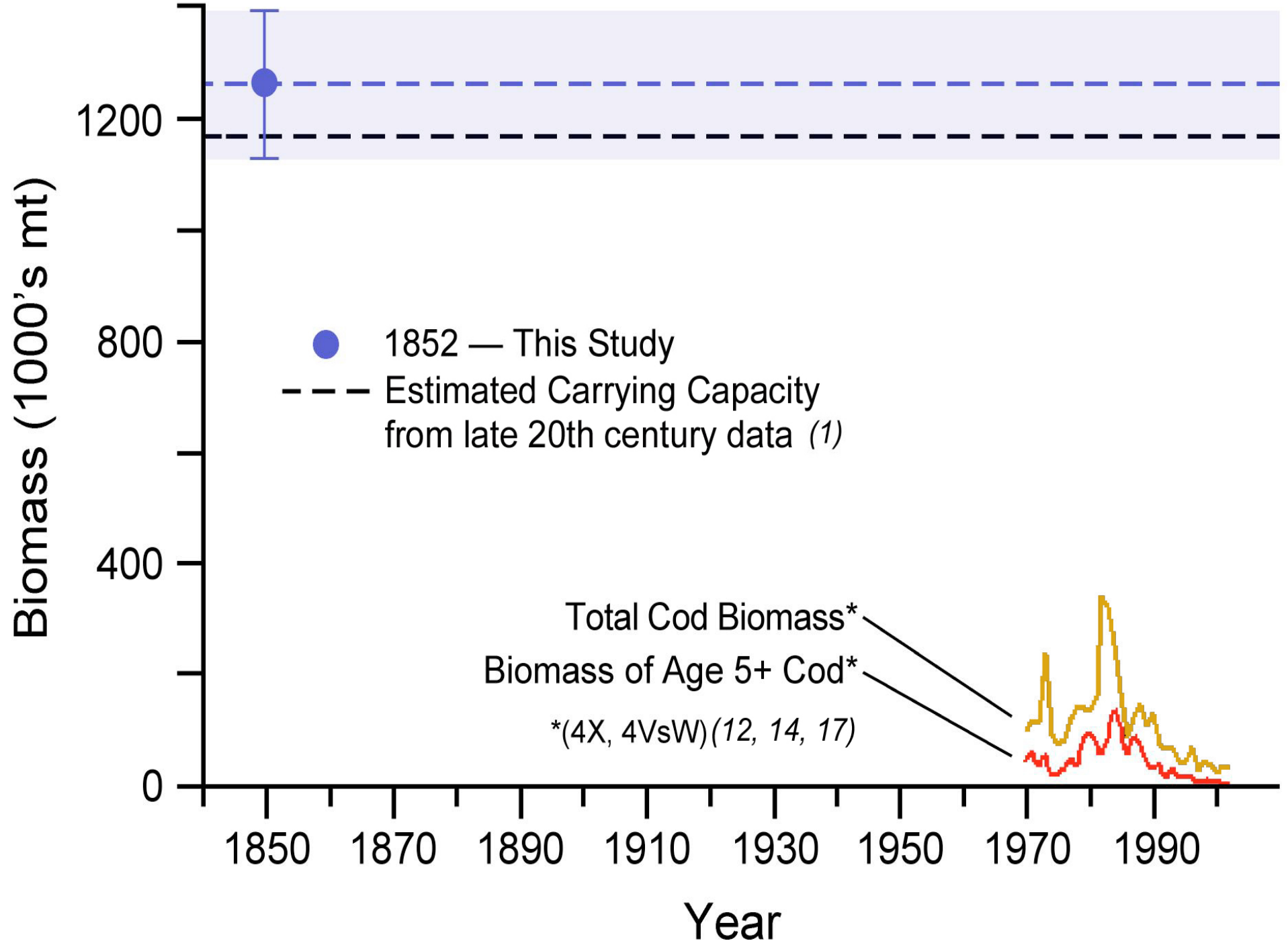
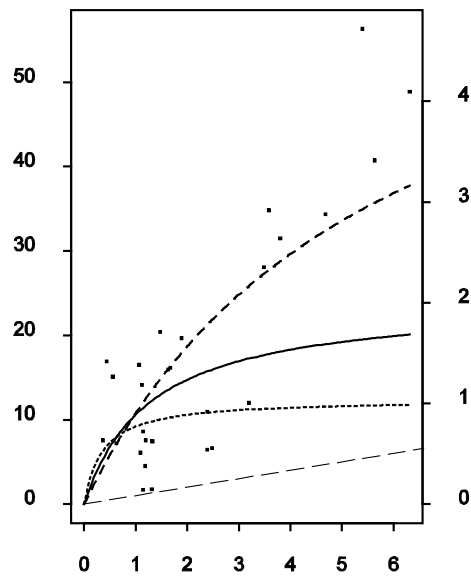


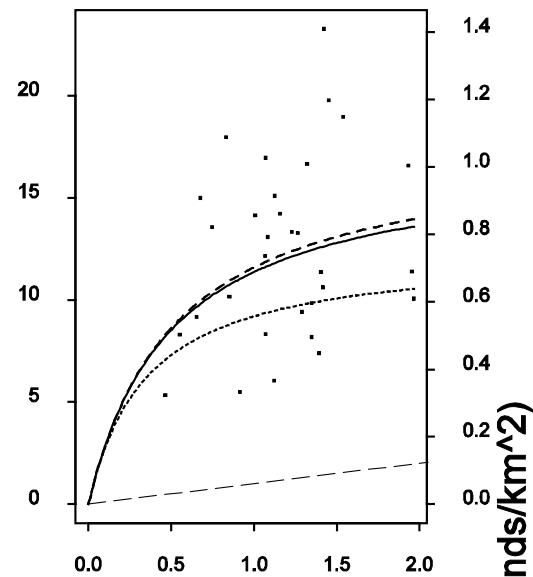
FIG. 15.—Recaptures during “summers” of 1927, 1928, 1929 and 1930 of cod tagged off Shelburne, N.S., during September and the first day of October, 1926.



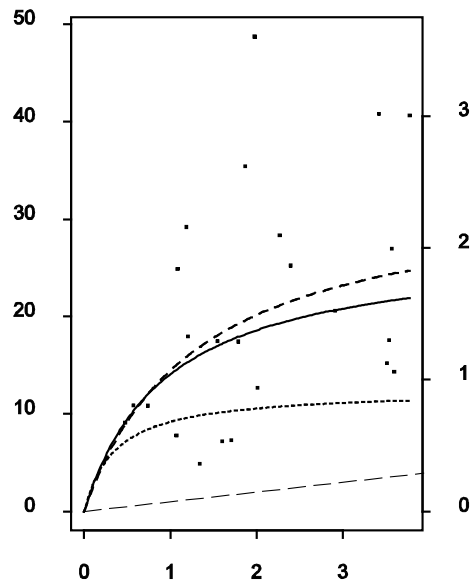
Labrador and N.E. Newfoundland



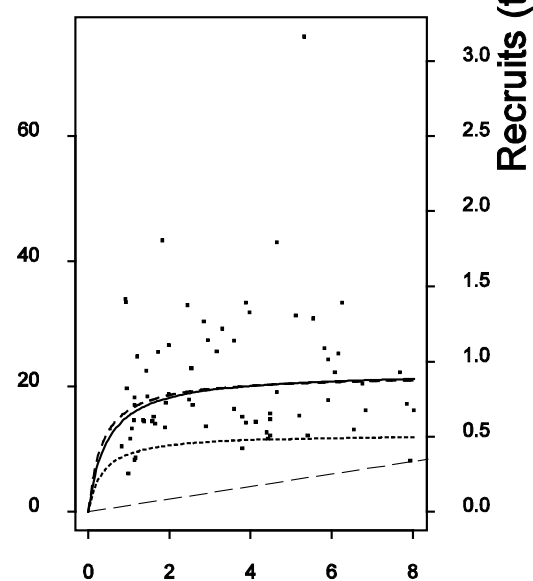
St. Pierre Bank



Central Baltic



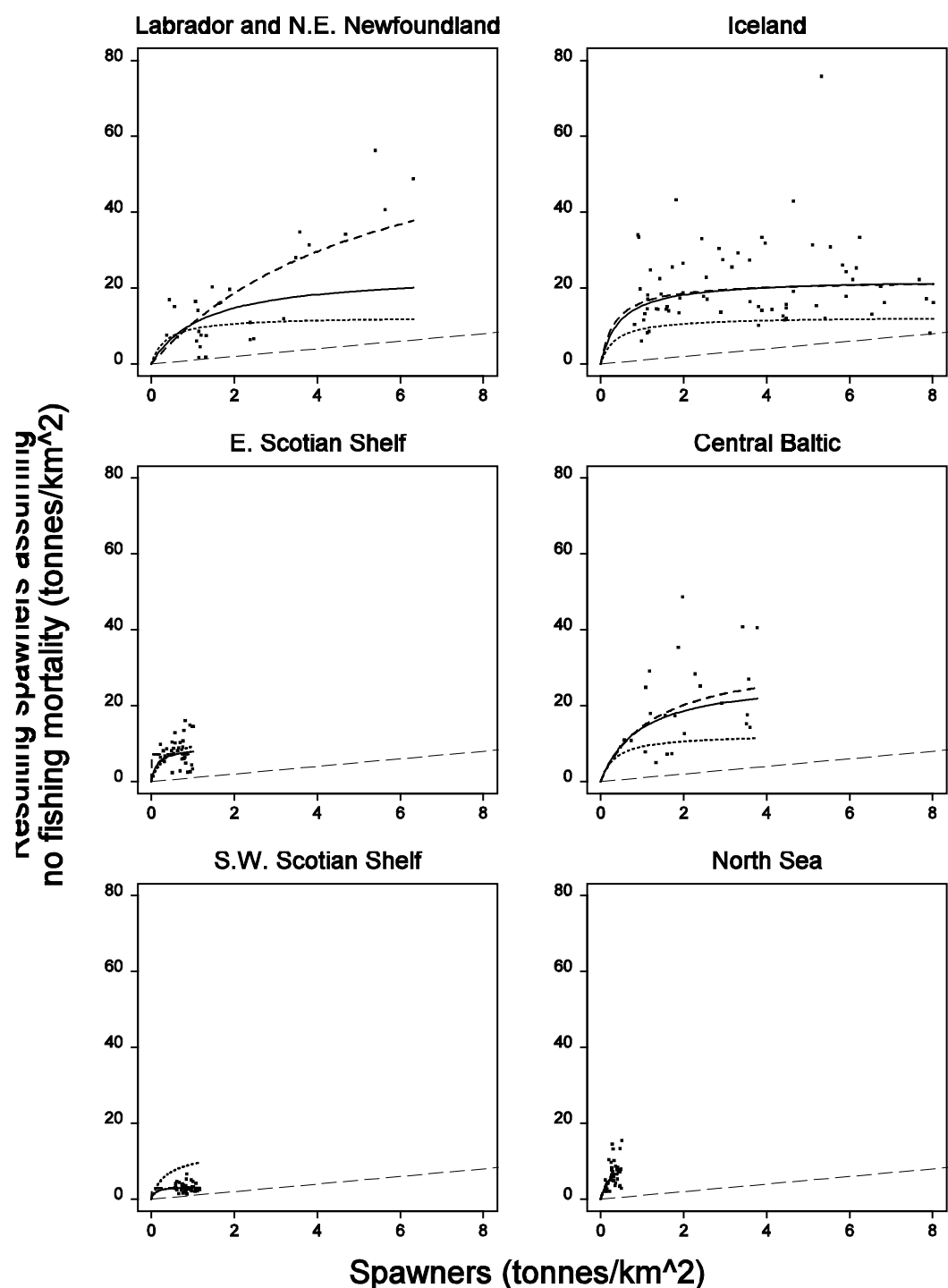
Iceland



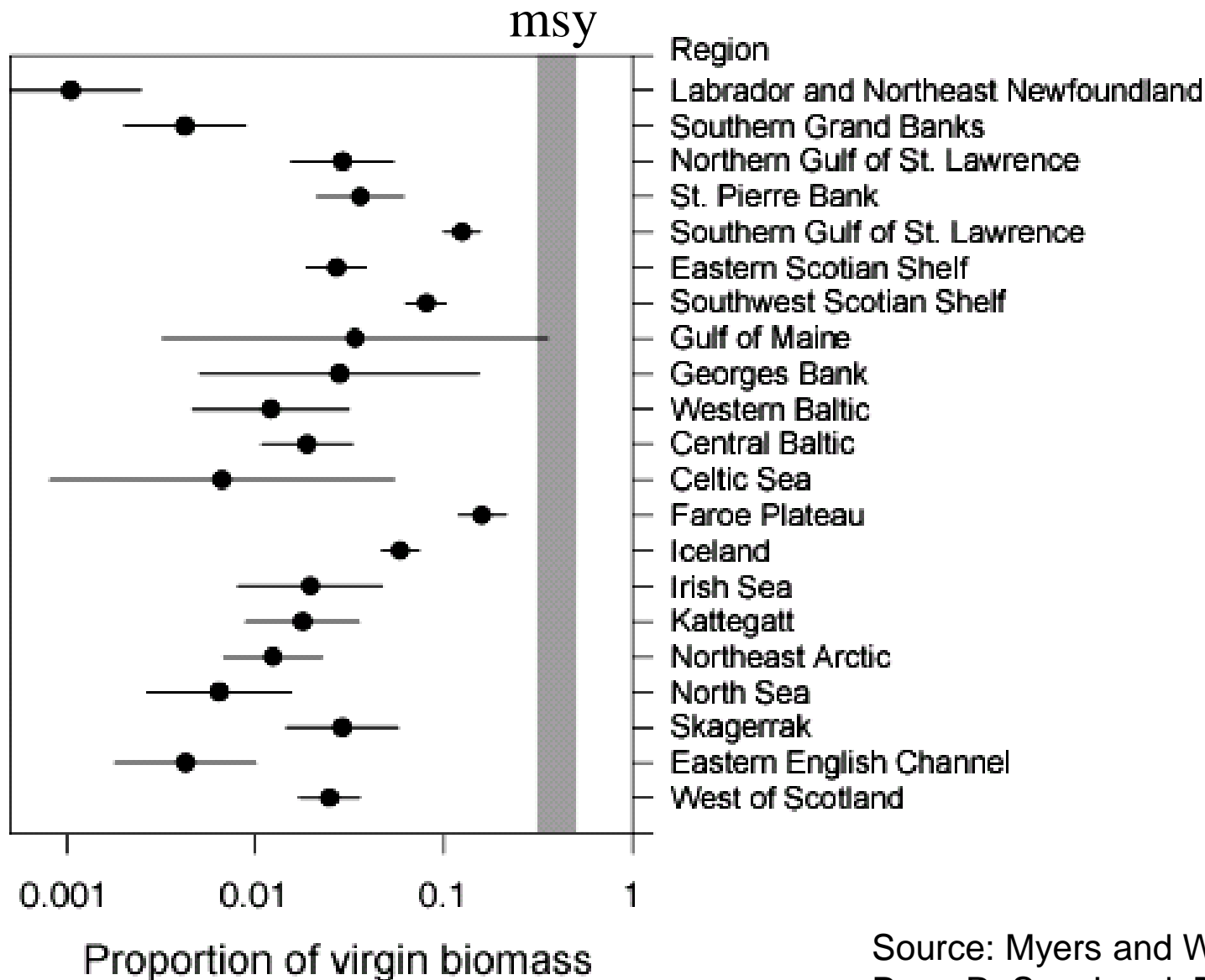
Resulting spawners assuming
no fishing mortality (tonnes/km²)

Recruits (thousands/km²)

Spawners (tonnes/km²)



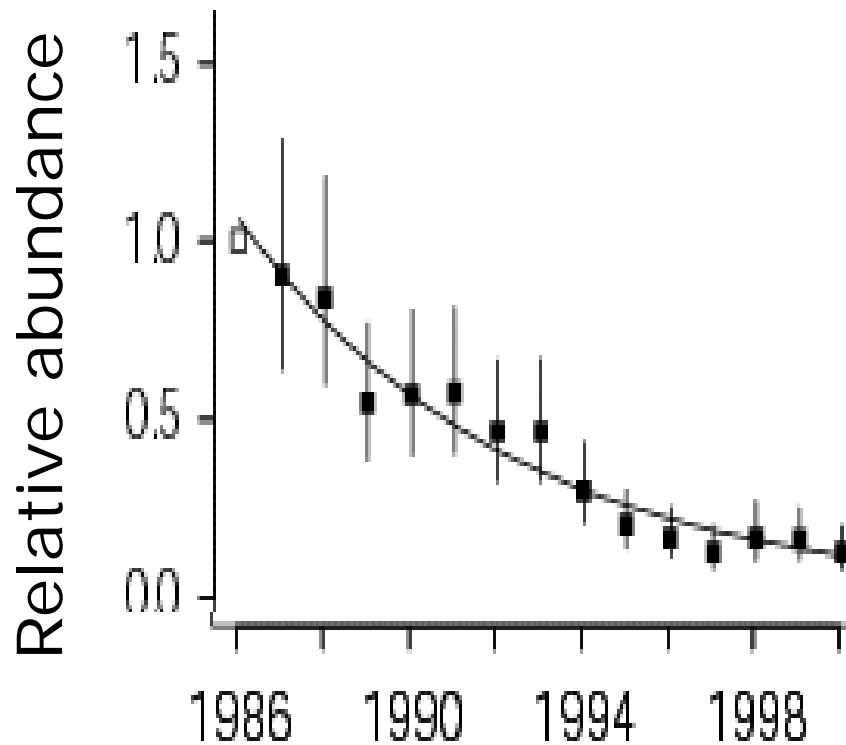
There is much less than 10% of cod left -



Source: Myers and Worm 2005.
Proc. R. Soc. Lond. B

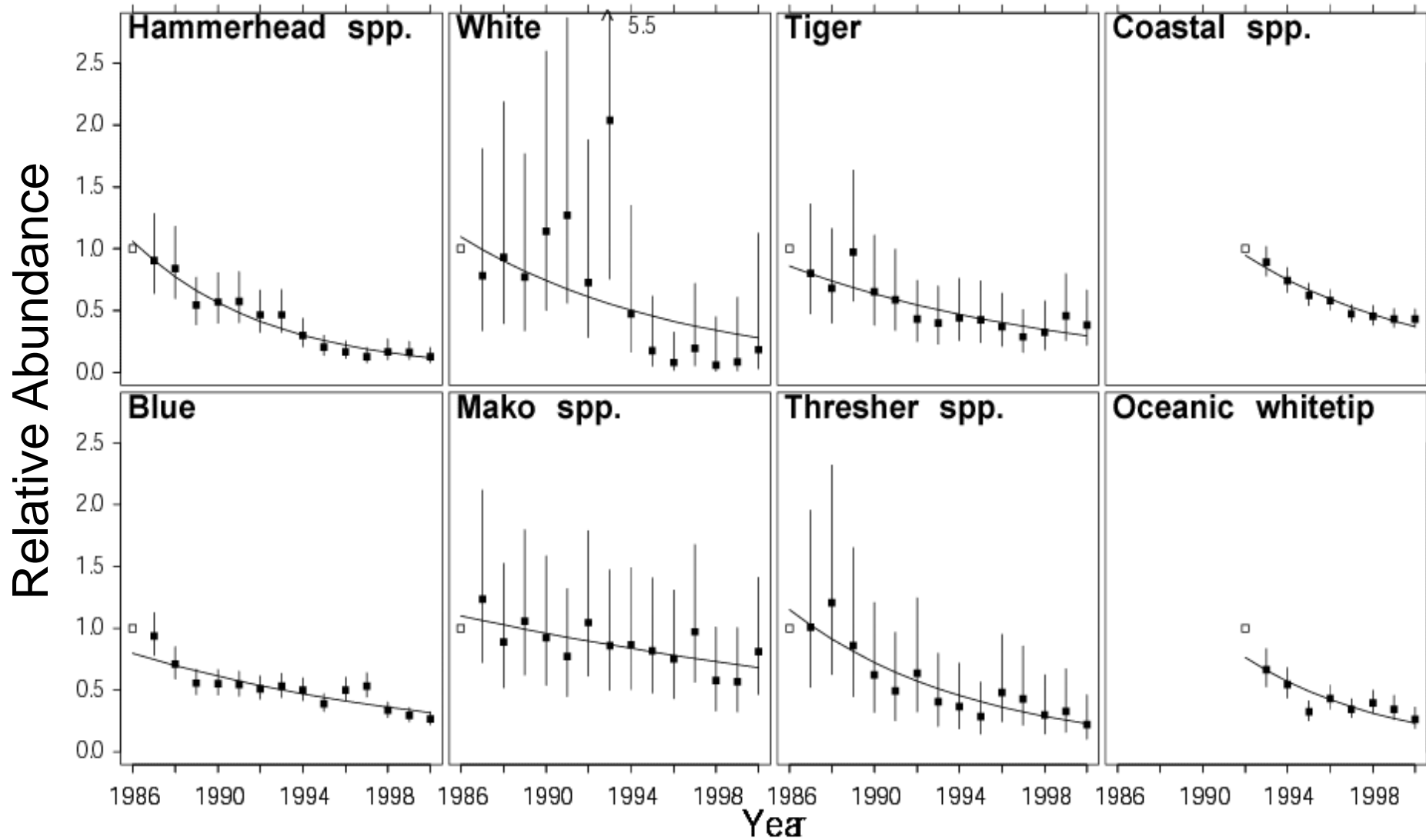
Hammerhead sharks

Sphyrna lewini

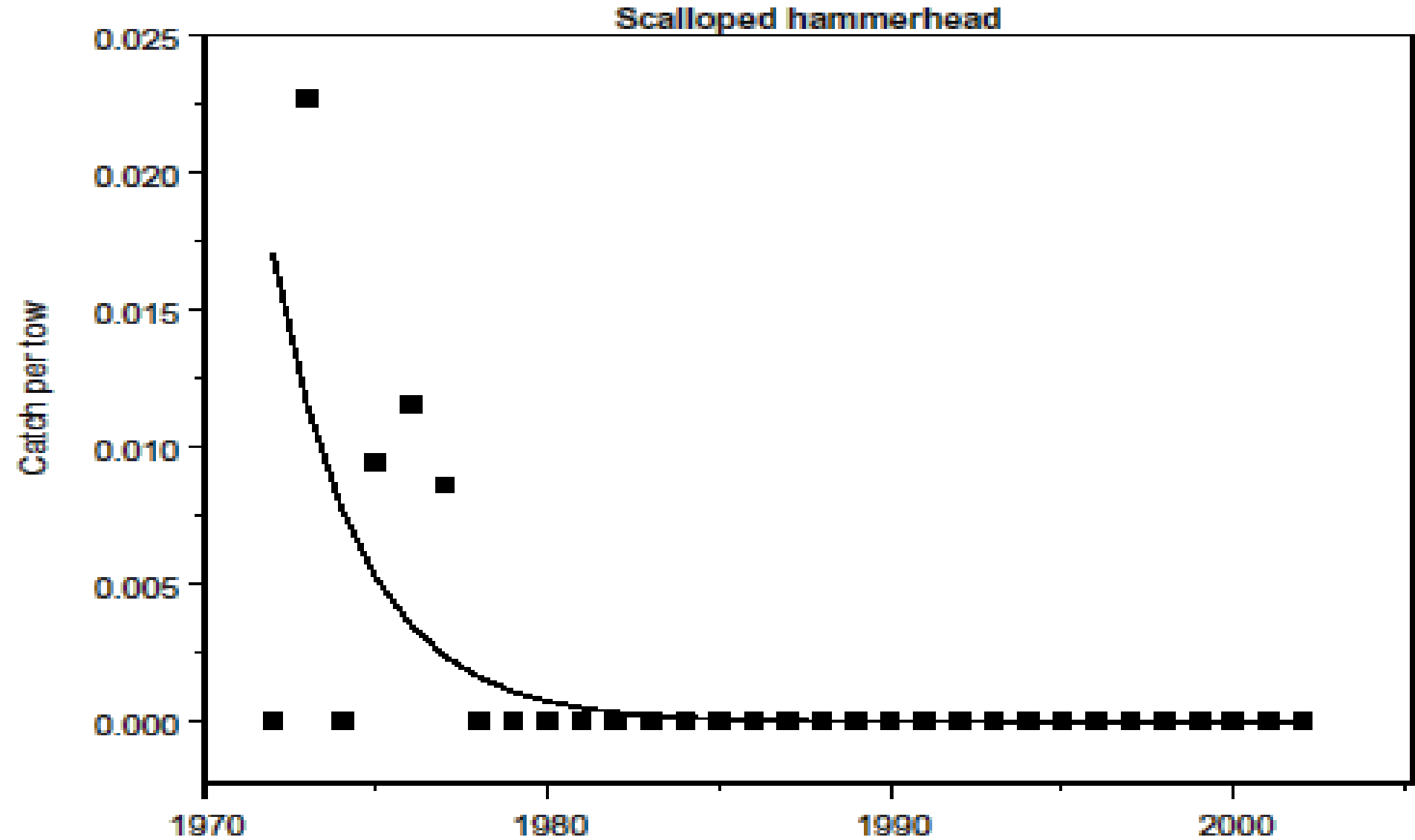


Science. Jan. 2003. J.K. Baum, R.A. Myers, D.G. Kehler, B. Worm, S.J. Harley, P.A. Doherty

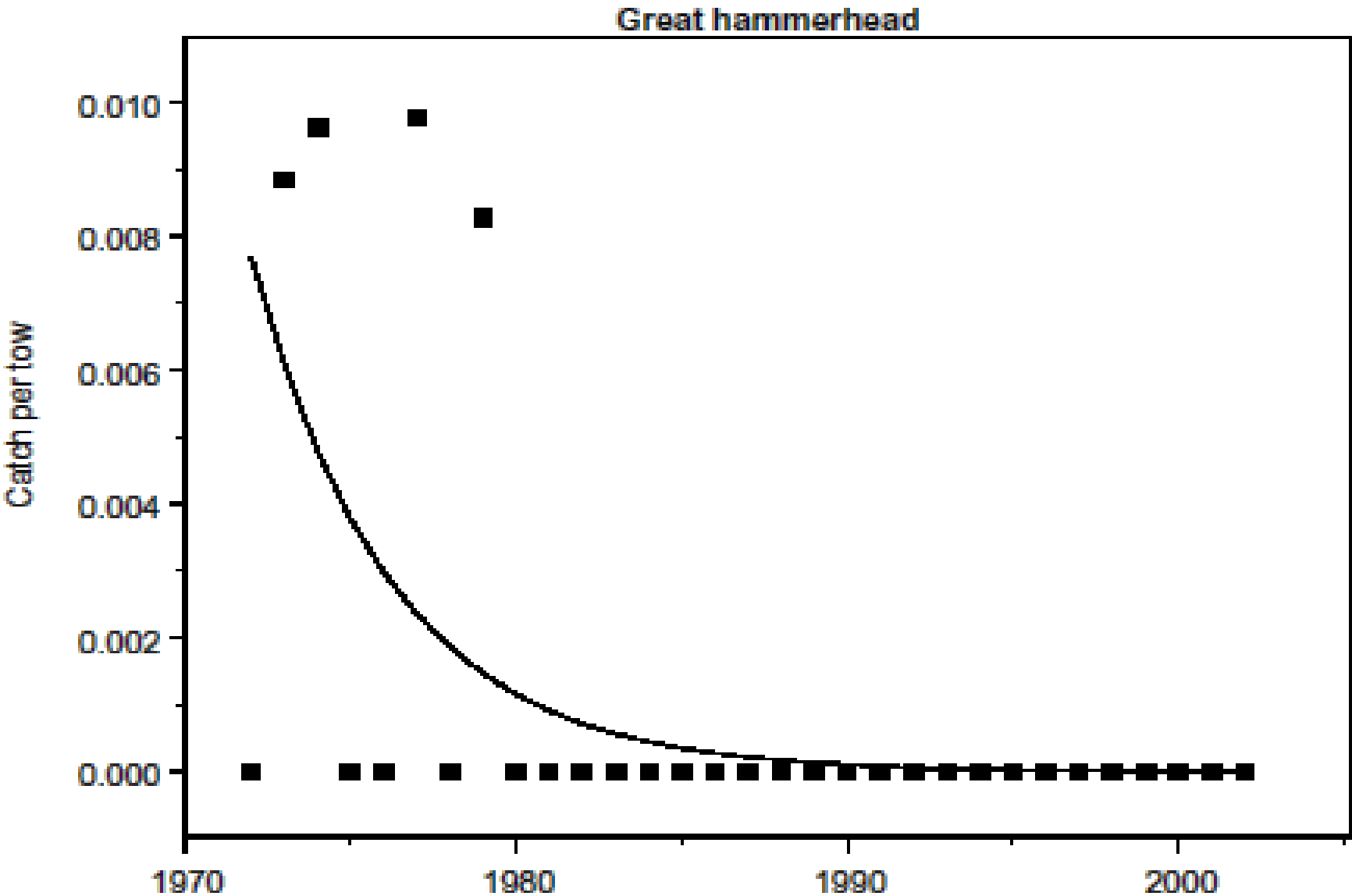
Results



Same results for trawl surveys in Gulf of Mexico



Same results for trawl surveys in Gulf of Mexico

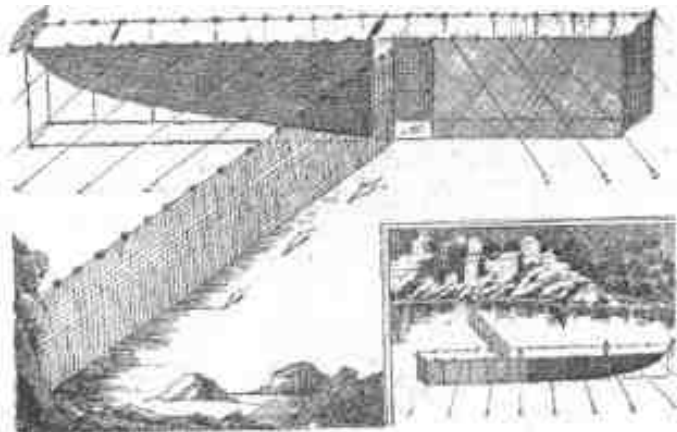


Decline of Mediterranean Sharks

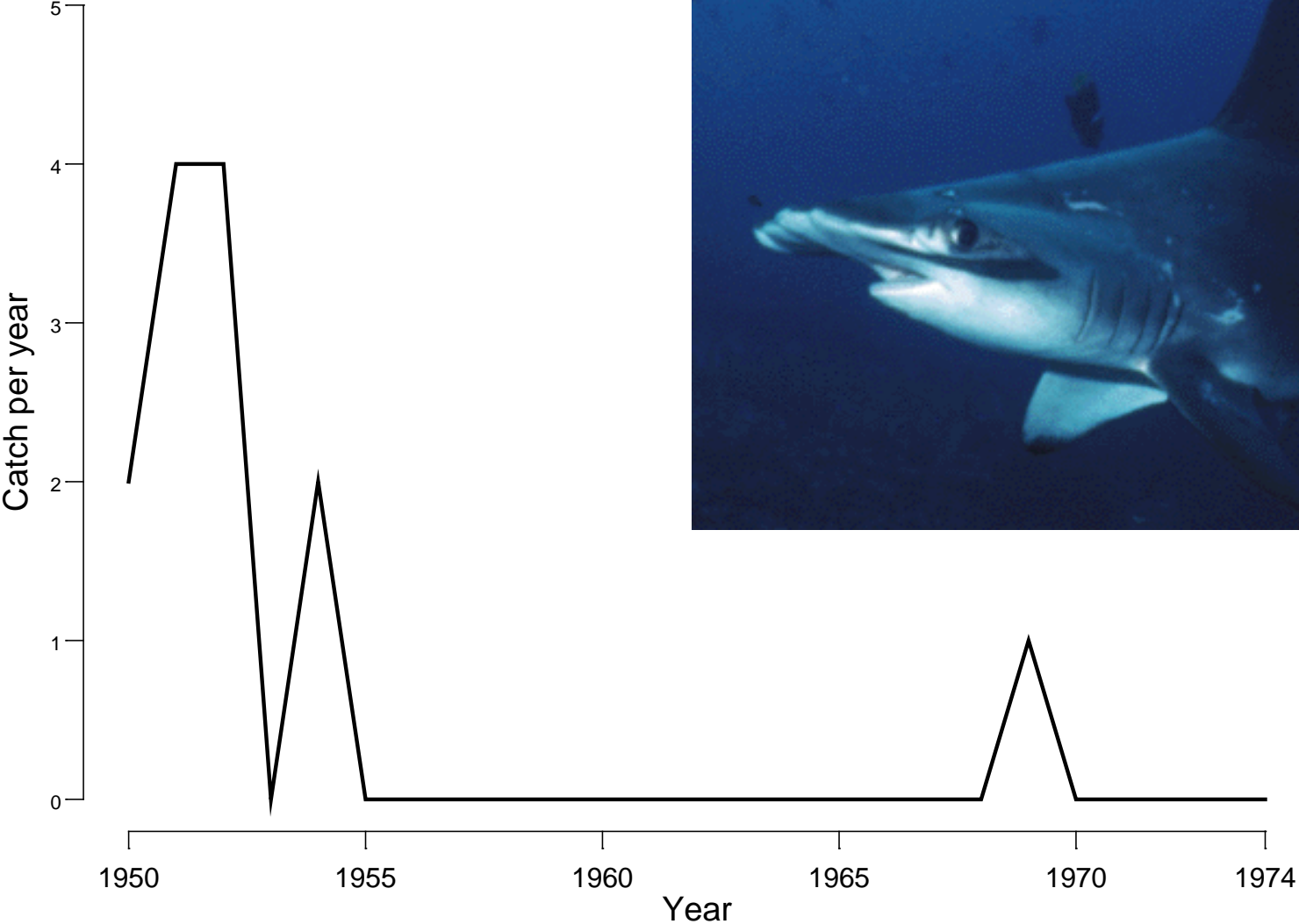
By catch associated with a Tuna Trap

In Ligurian Sea

“Tonnara di Camogli”



Decline of Hammarhead sharks



Decline of Mediterranean Sharks

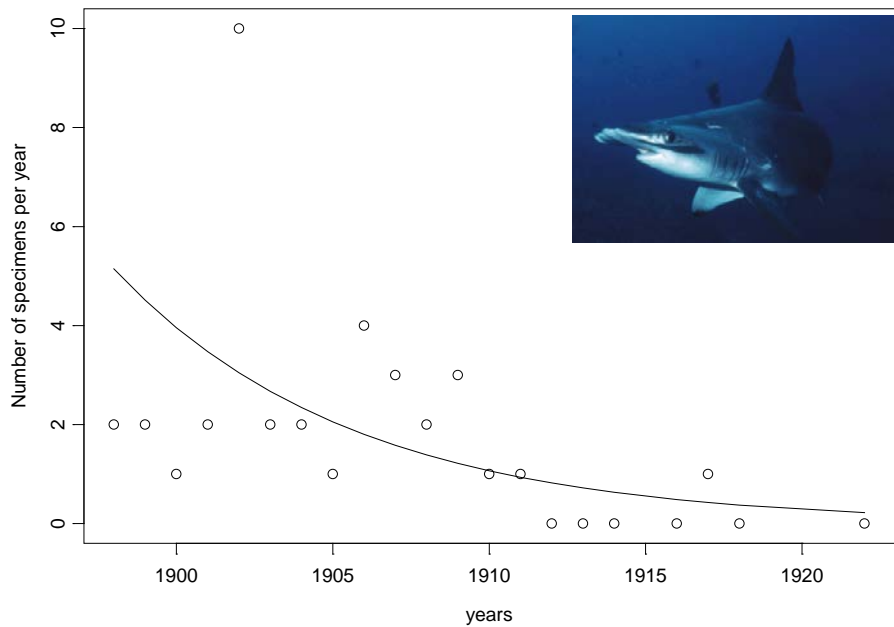
By catch associated with a Tuna Trap
In Tirrenian Sea



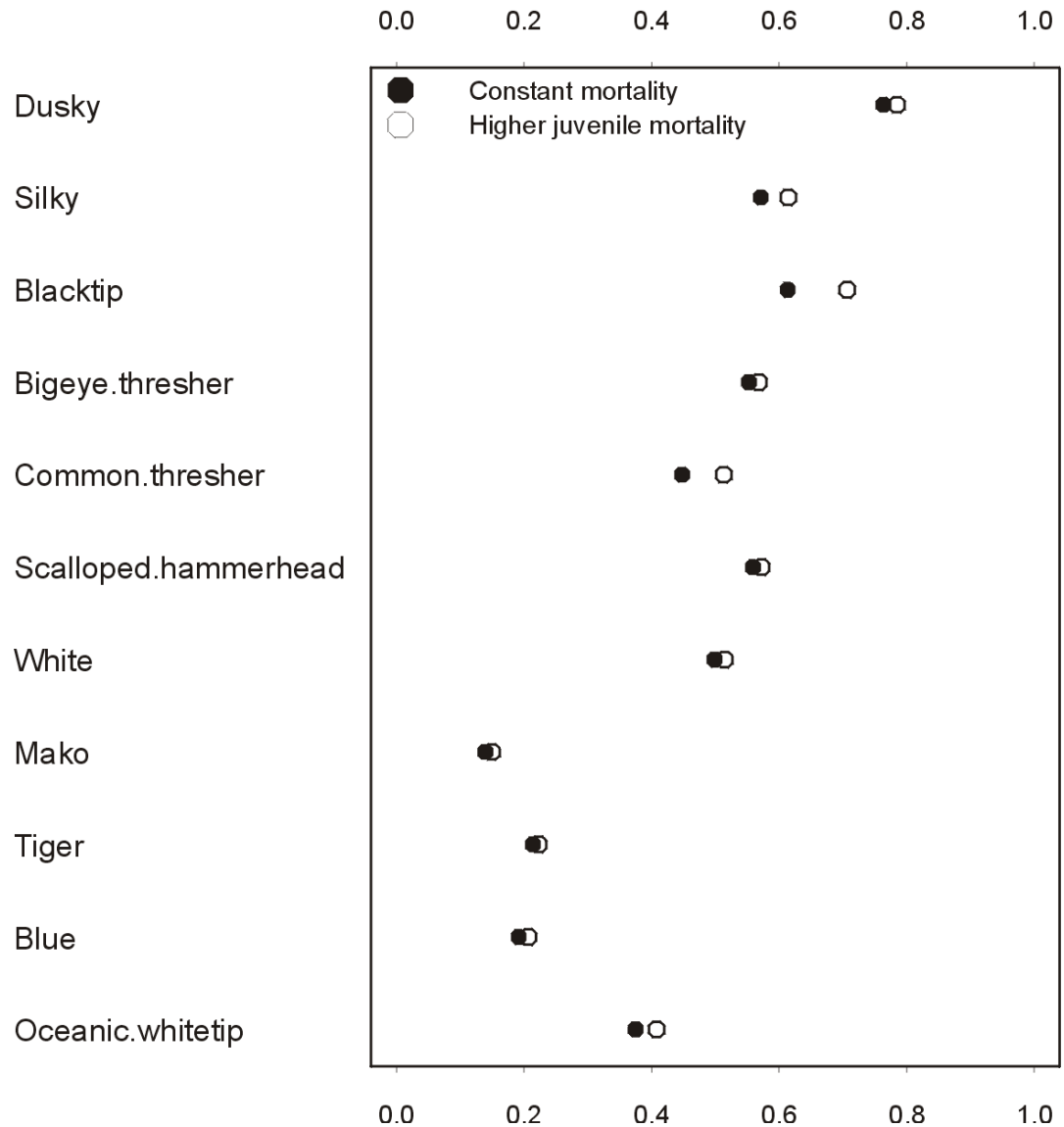
“Tonnarella di Baratti”



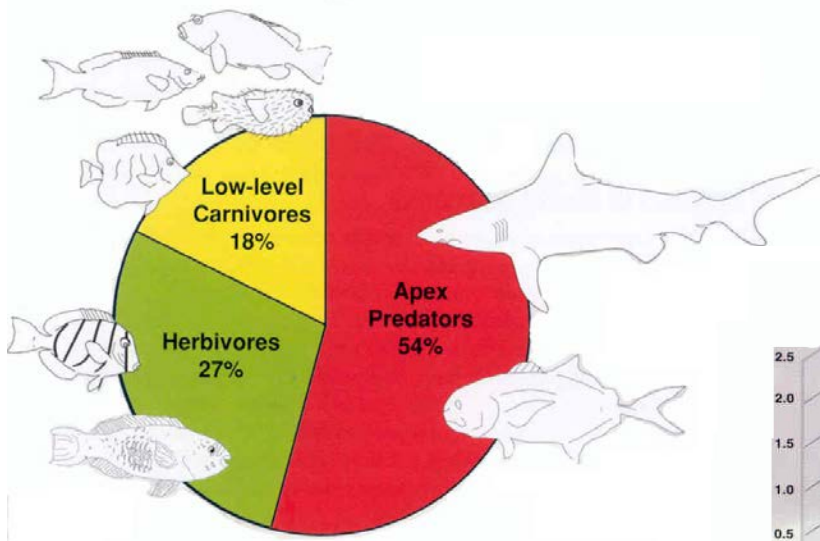
Hammerhead shark



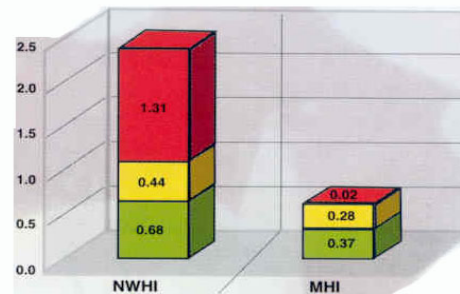
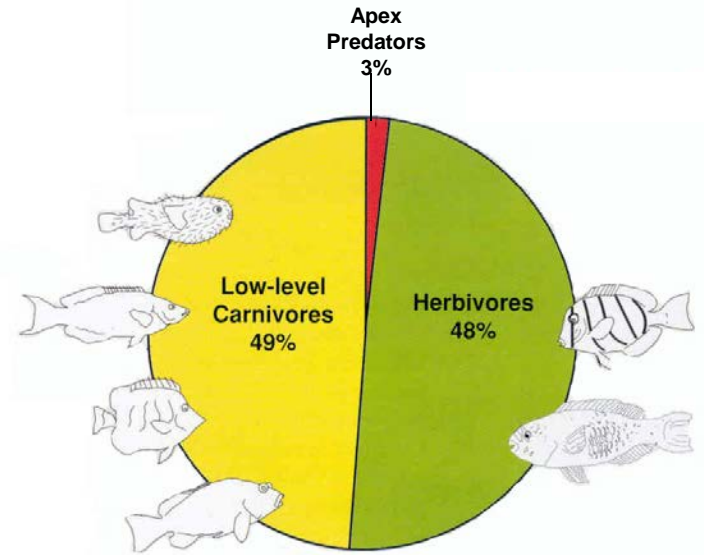
Proportional reduction in current fishing mortality needed to ensure survival of shark populations



NW Hawaiian Islands



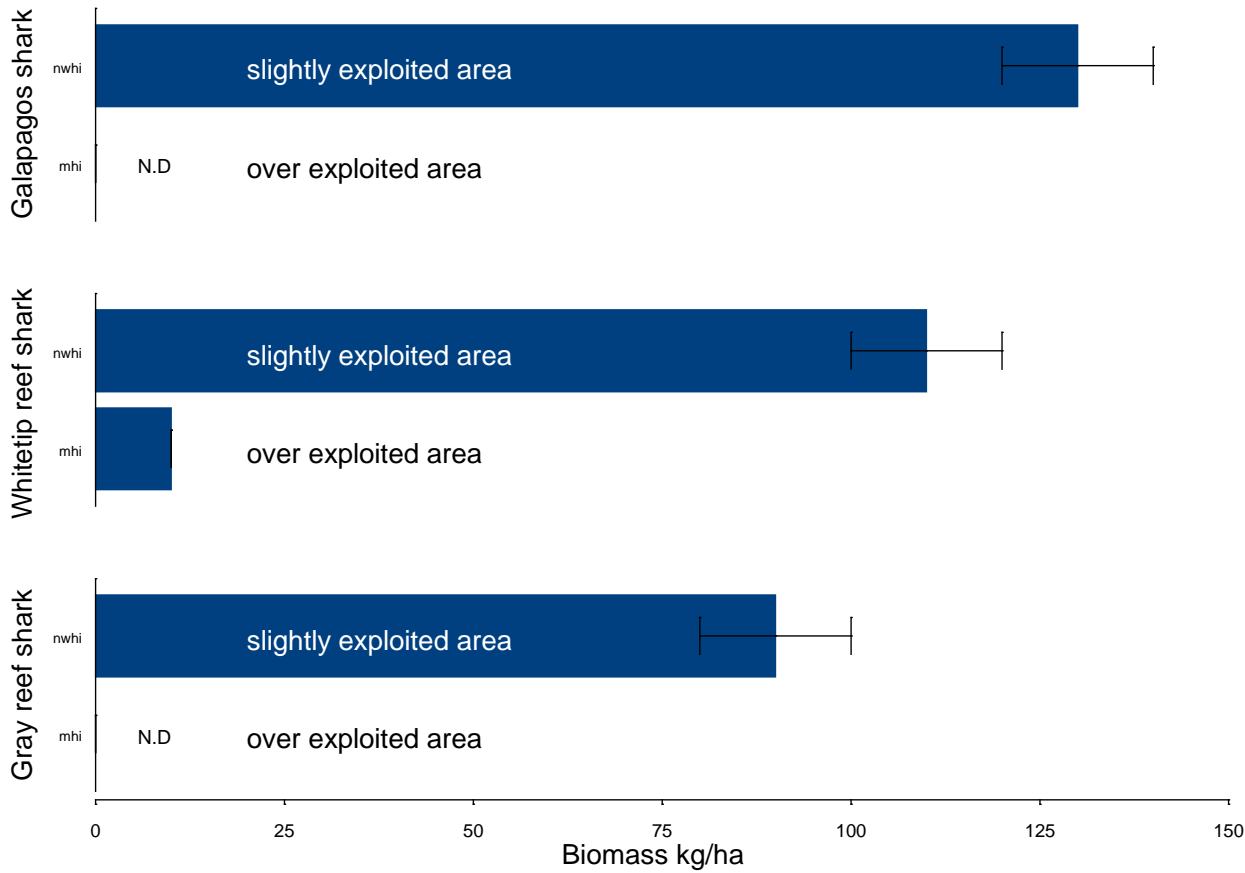
Main Hawaiian Islands

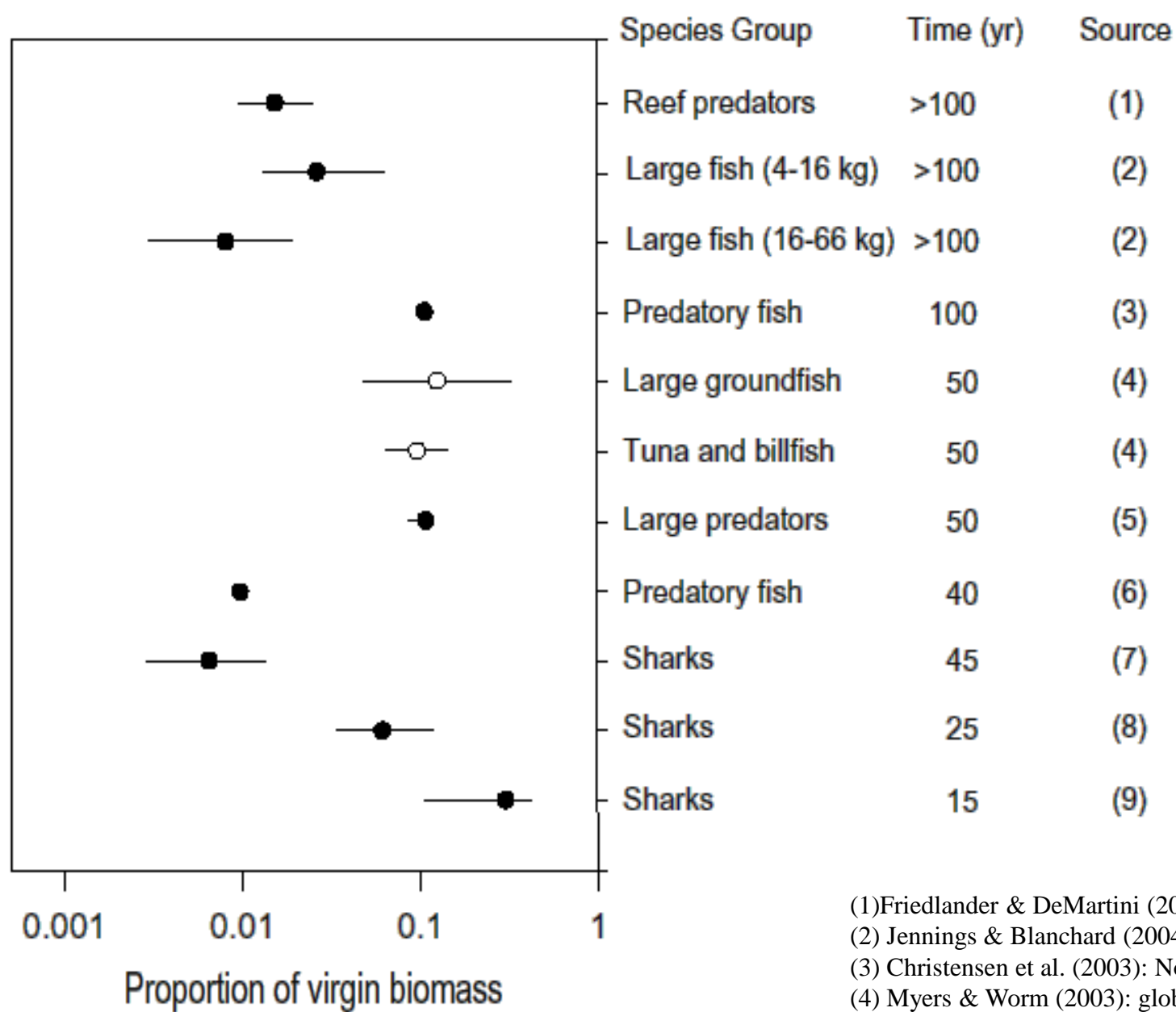


Comparative fish biomass (mT/ha)

Loss of Reef Sharks in the Hawaiian Islands

N.W.Hawaiian Islands vs Main Hawaiian Islands





- (1) Friedlander & DeMartini (2002): Hawaiian reefs;
 (2) Jennings & Blanchard (2004): North Sea;
 (3) Christensen et al. (2003): North Atlantic;
 (4) Myers & Worm (2003): global;
 (5) Ward & Myers (2003): North Pacific;
 (6) Tang et al. (2003): Bohai Sea;
 (7) Baum & Myers (2004): Gulf of Mexico;
 (8) Vacchi et al. (2000): Mediterranean Sea;
 (9) Baum et al. (2003): Northwest Atlantic.

Source: Myers and Worm 2005.

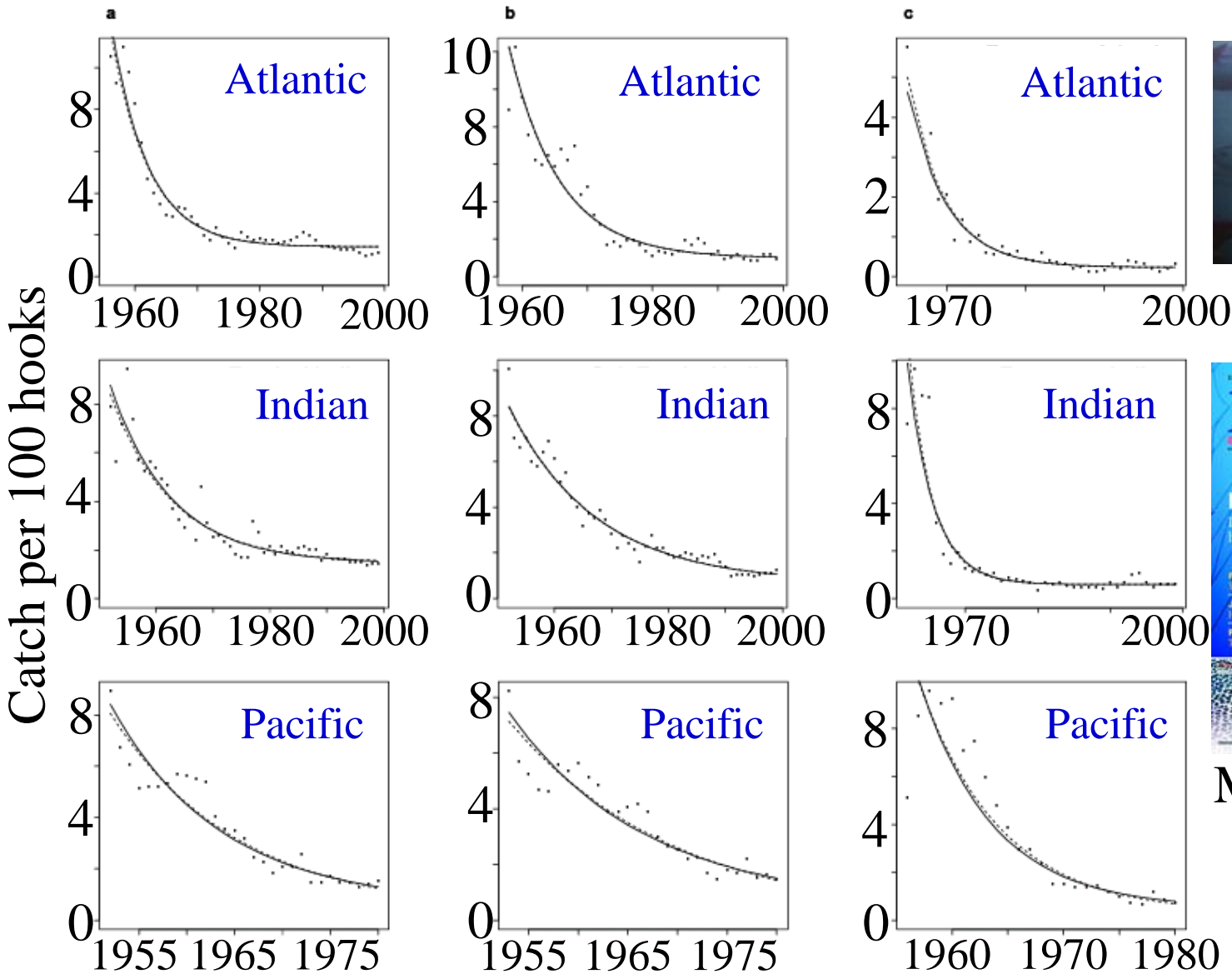
Proc. R. Soc. Lond. B



555
lbs.
Cabo Blanco

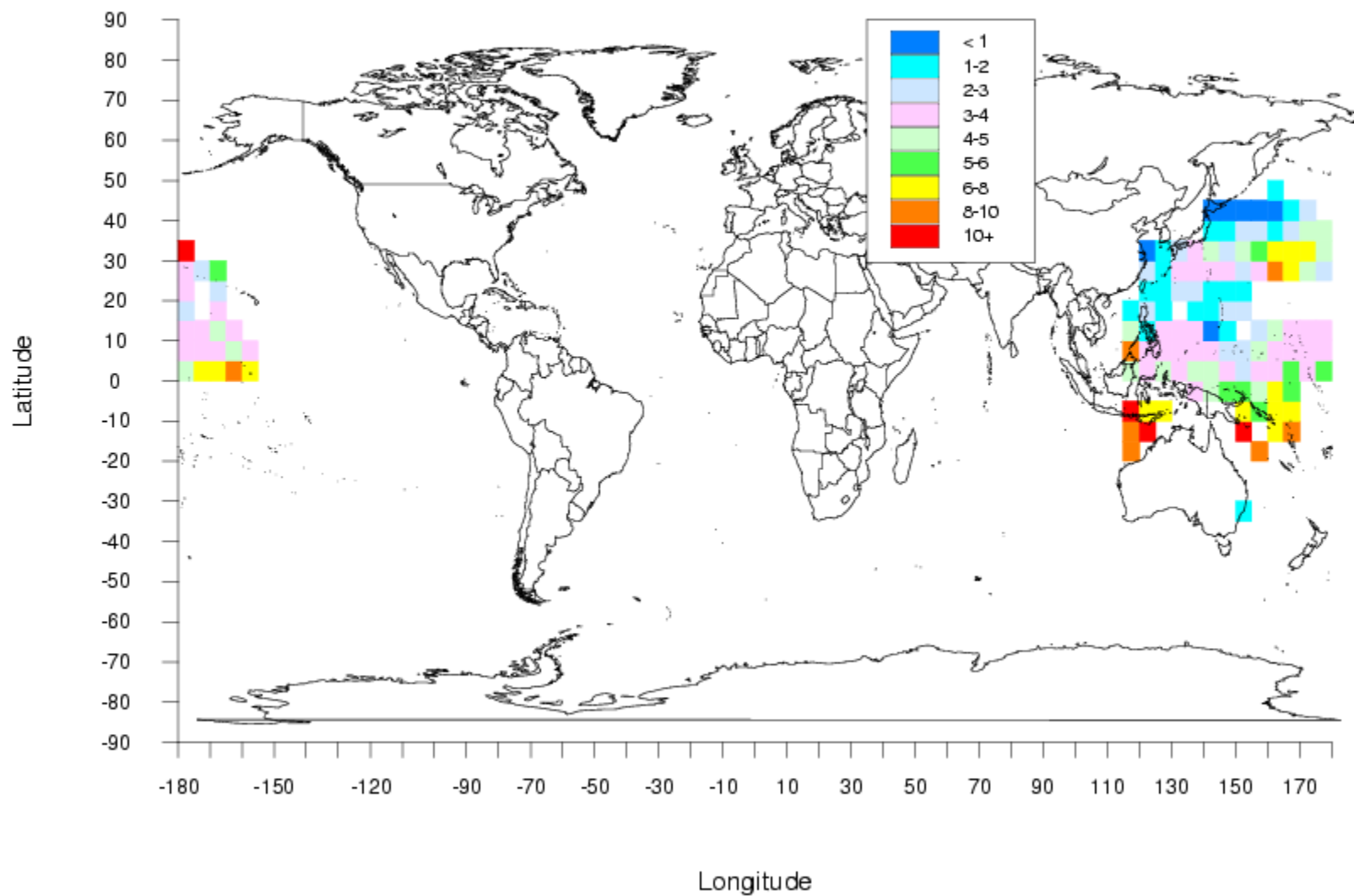
LBS.
1135
CABO
BLANCO

Common patterns of decline

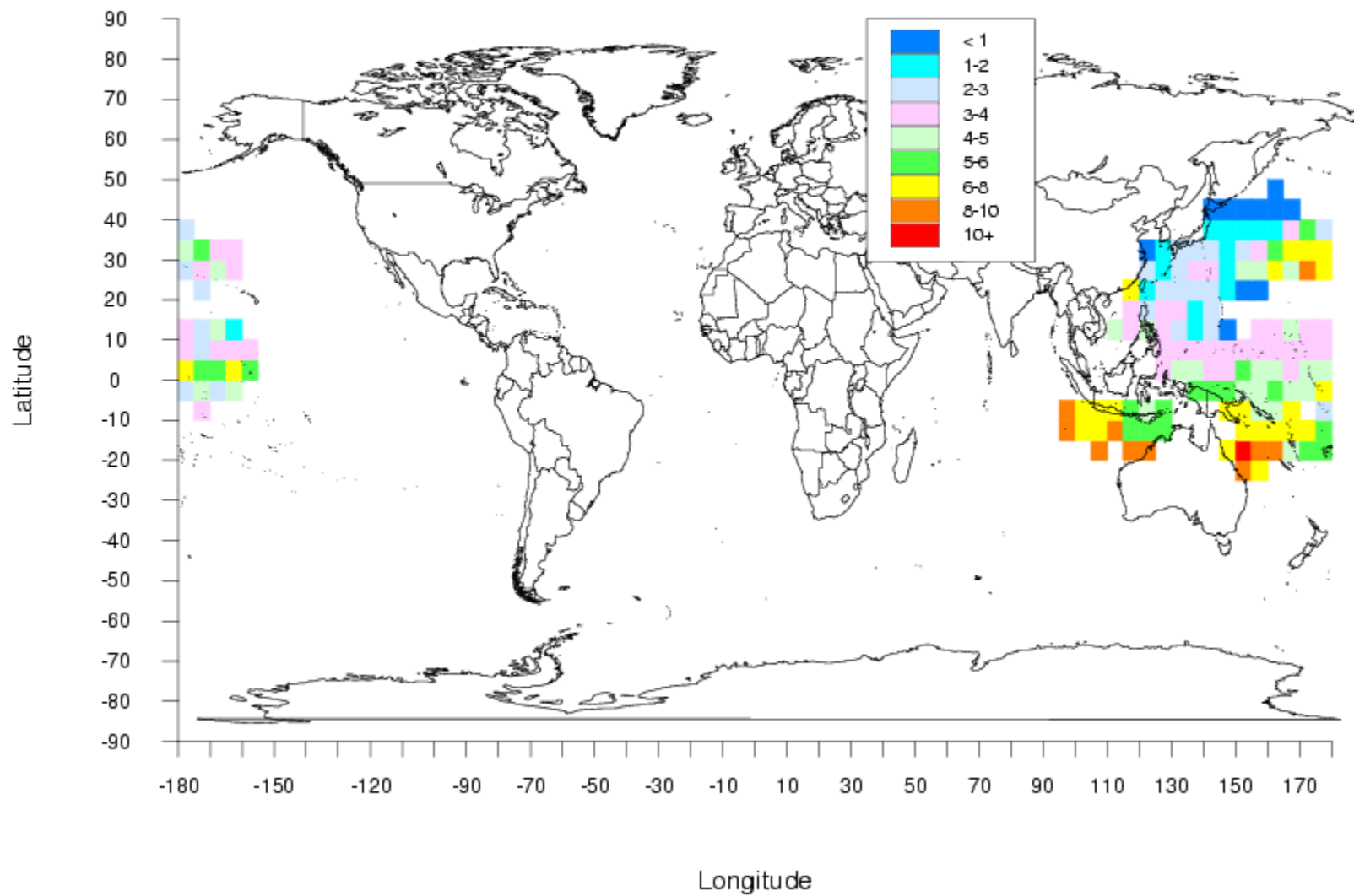


Myers and Worm (2003)

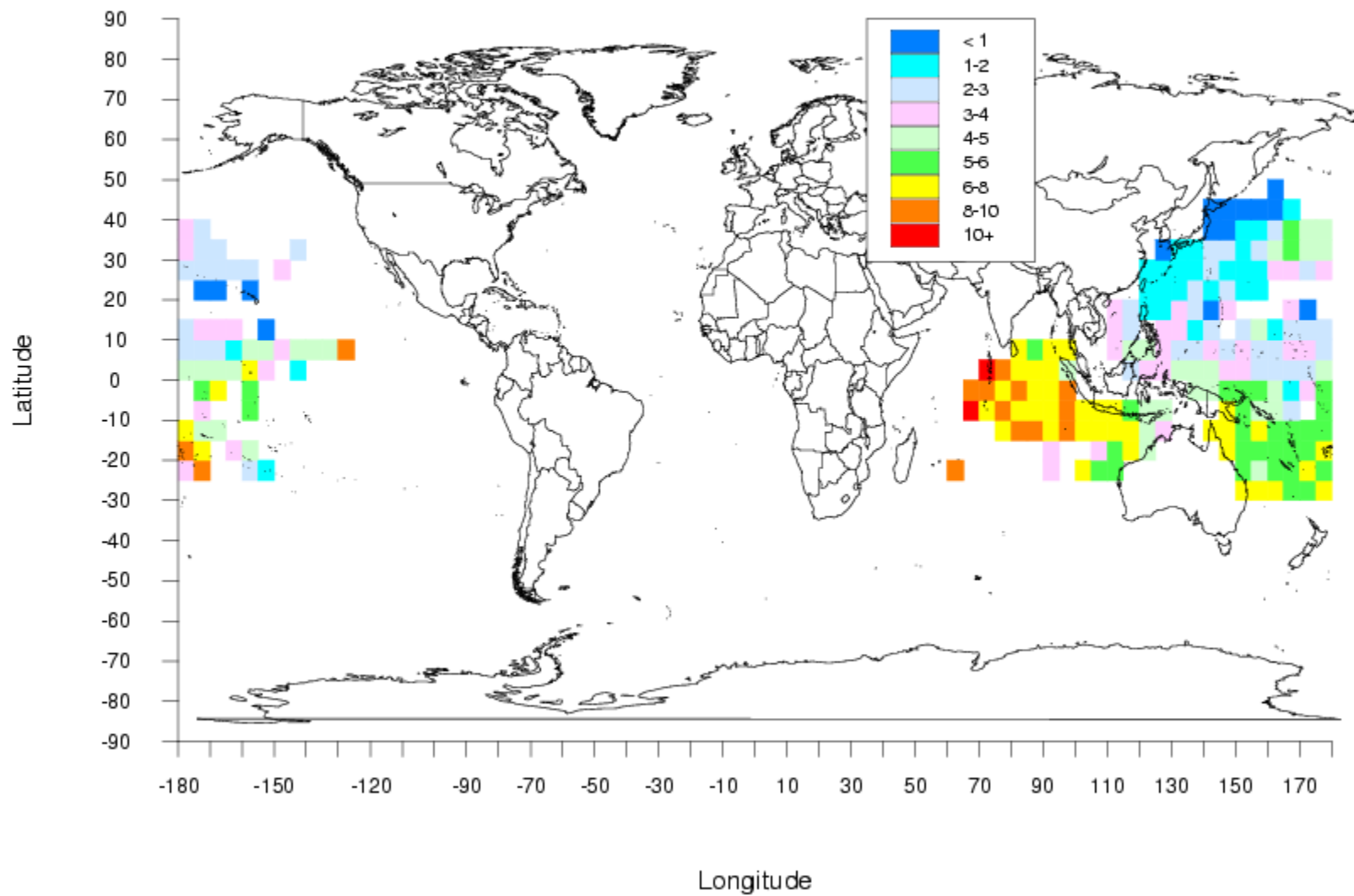
Catch Per Hundred Hooks, Year = 1952



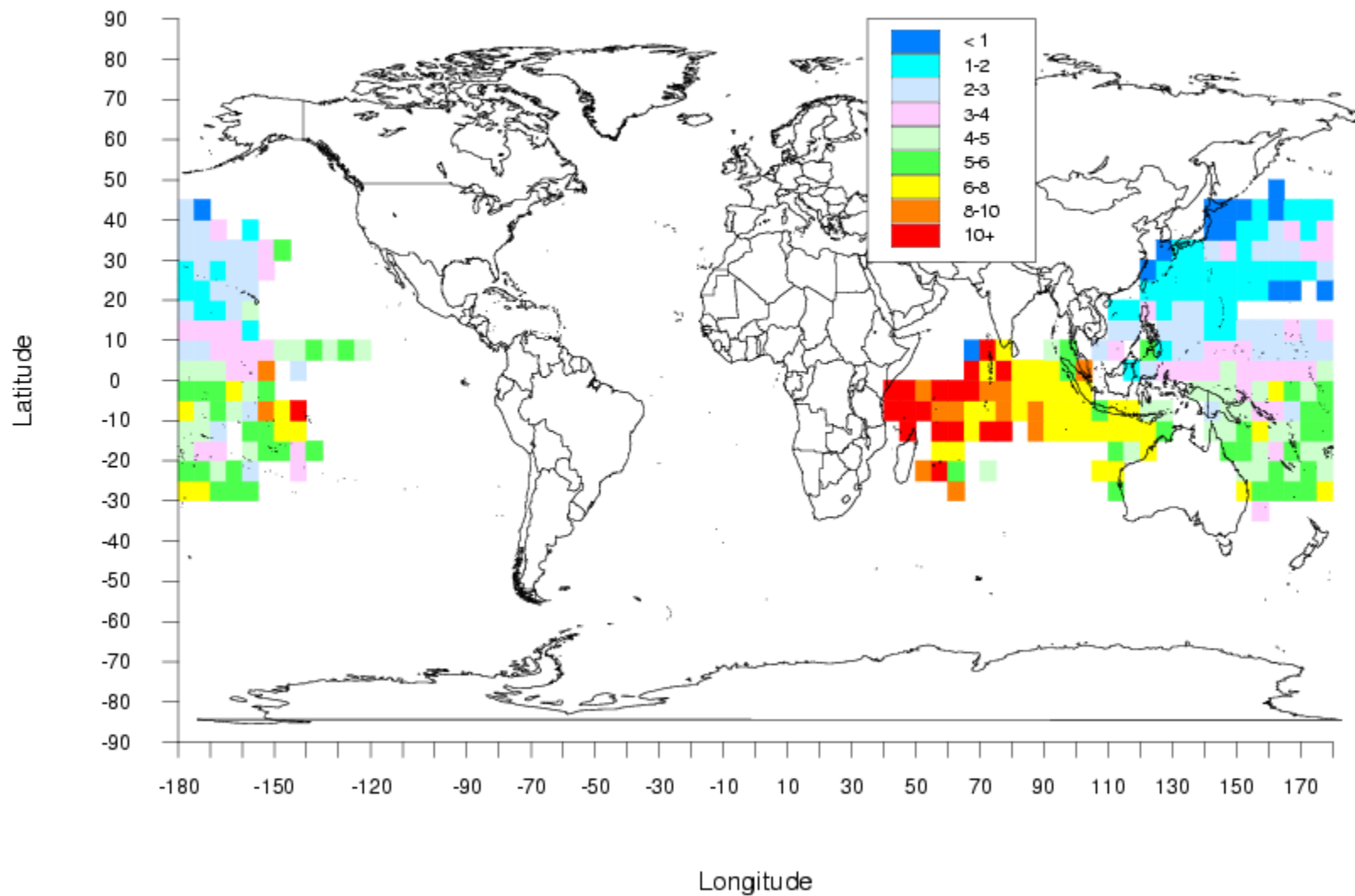
Catch Per Hundred Hooks, Year = 1953



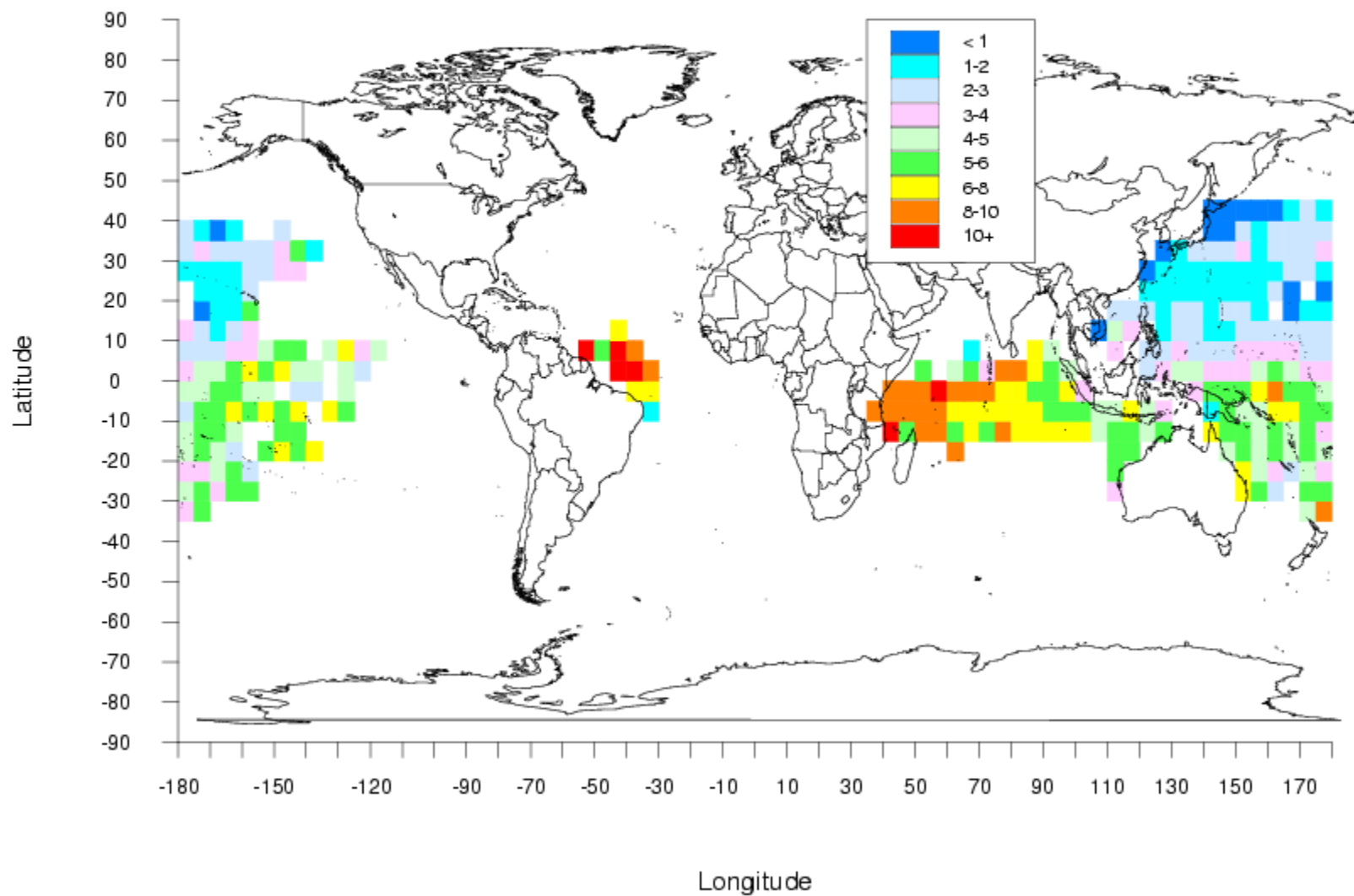
Catch Per Hundred Hooks, Year = 1954



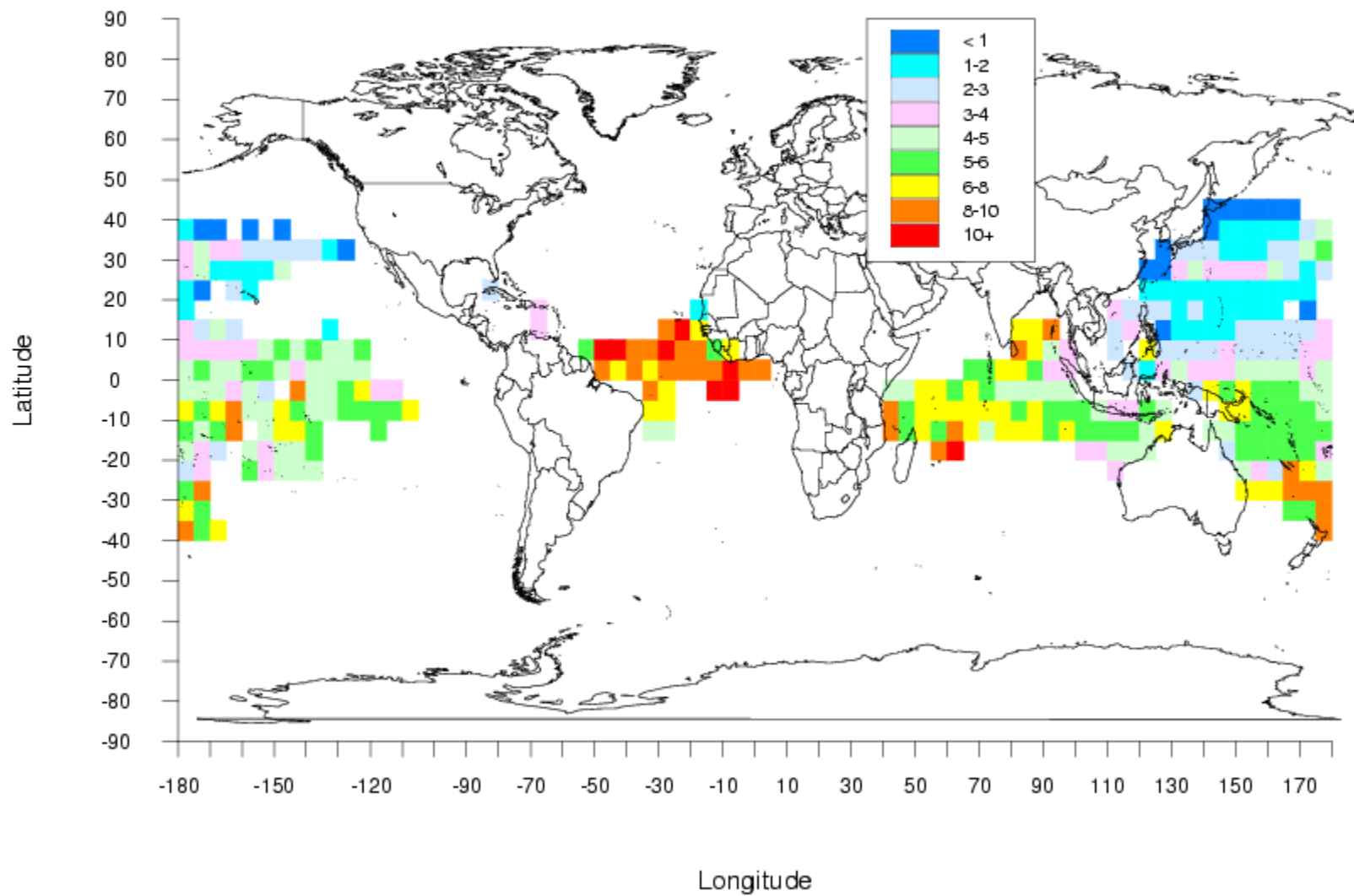
Catch Per Hundred Hooks, Year = 1955



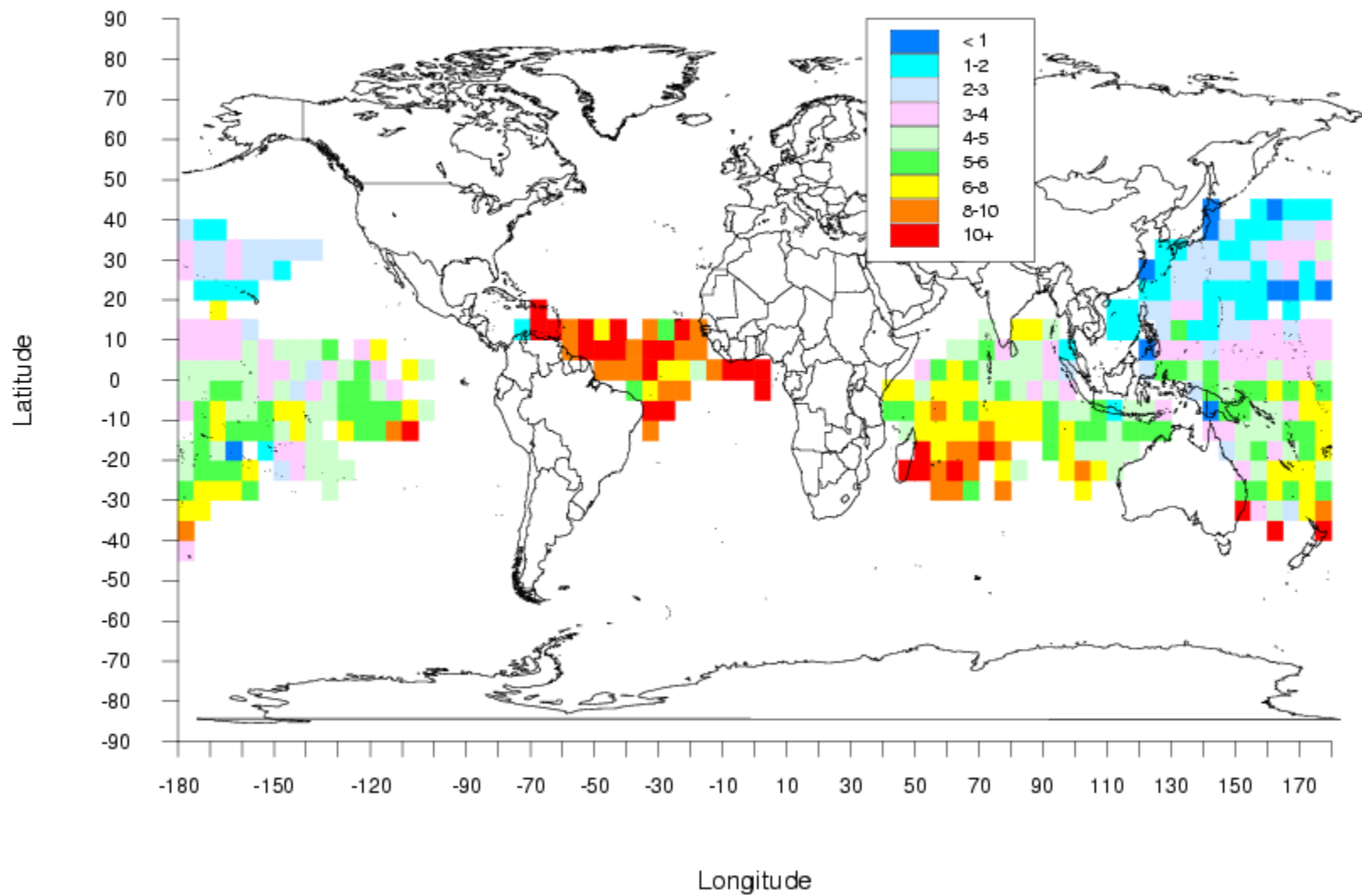
Catch Per Hundred Hooks, Year = 1956



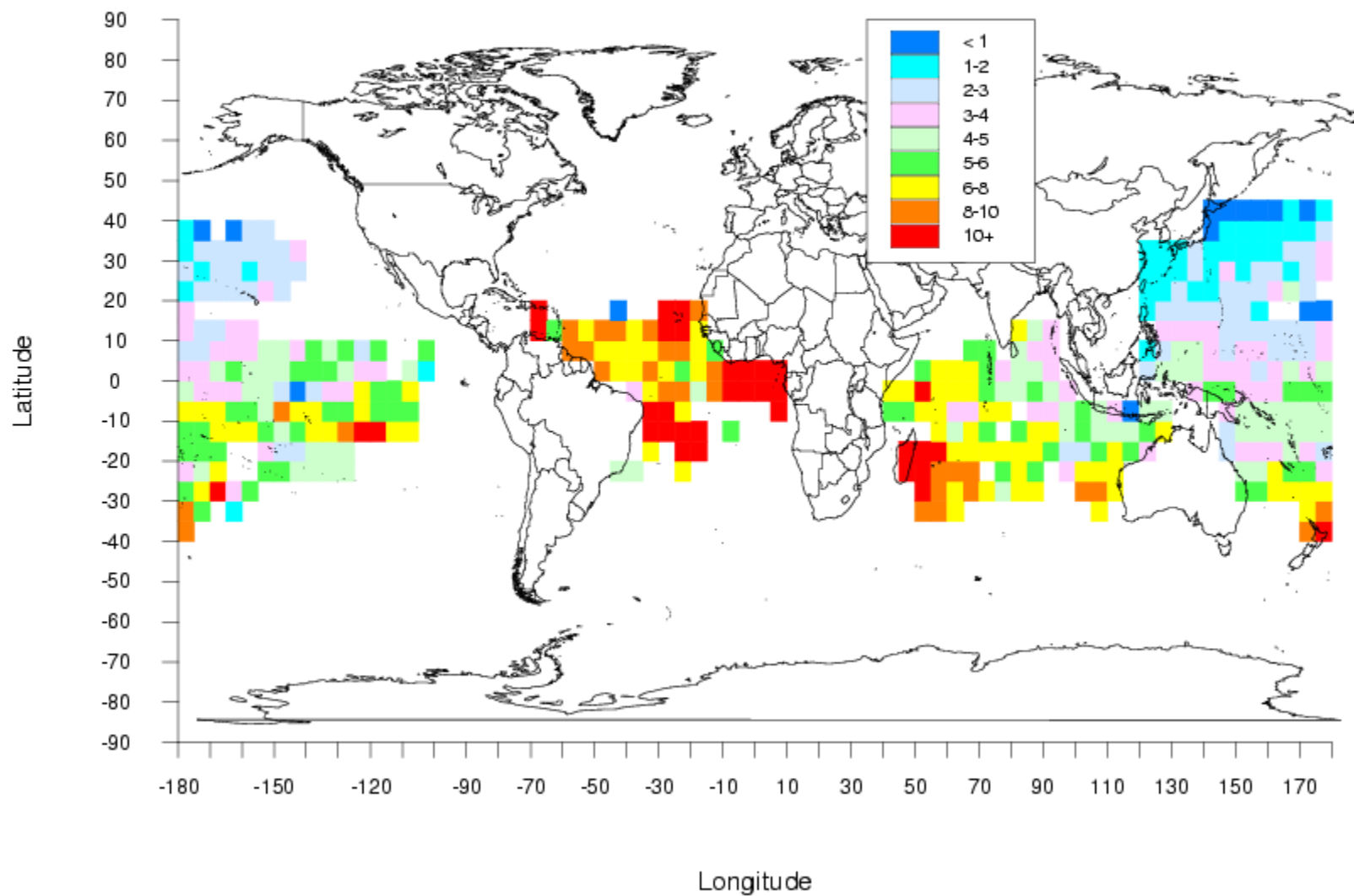
Catch Per Hundred Hooks, Year = 1957



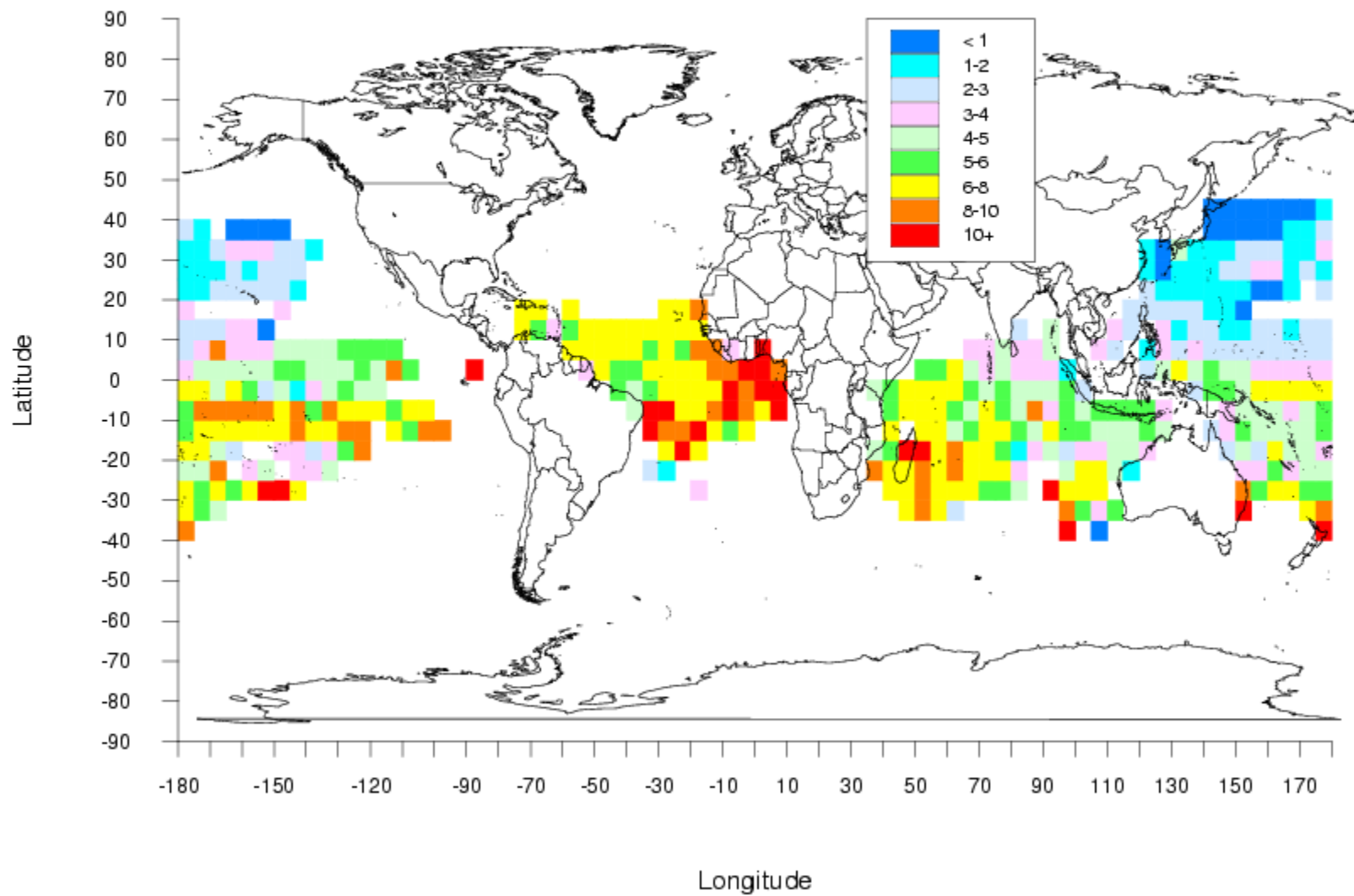
Catch Per Hundred Hooks, Year = 1958



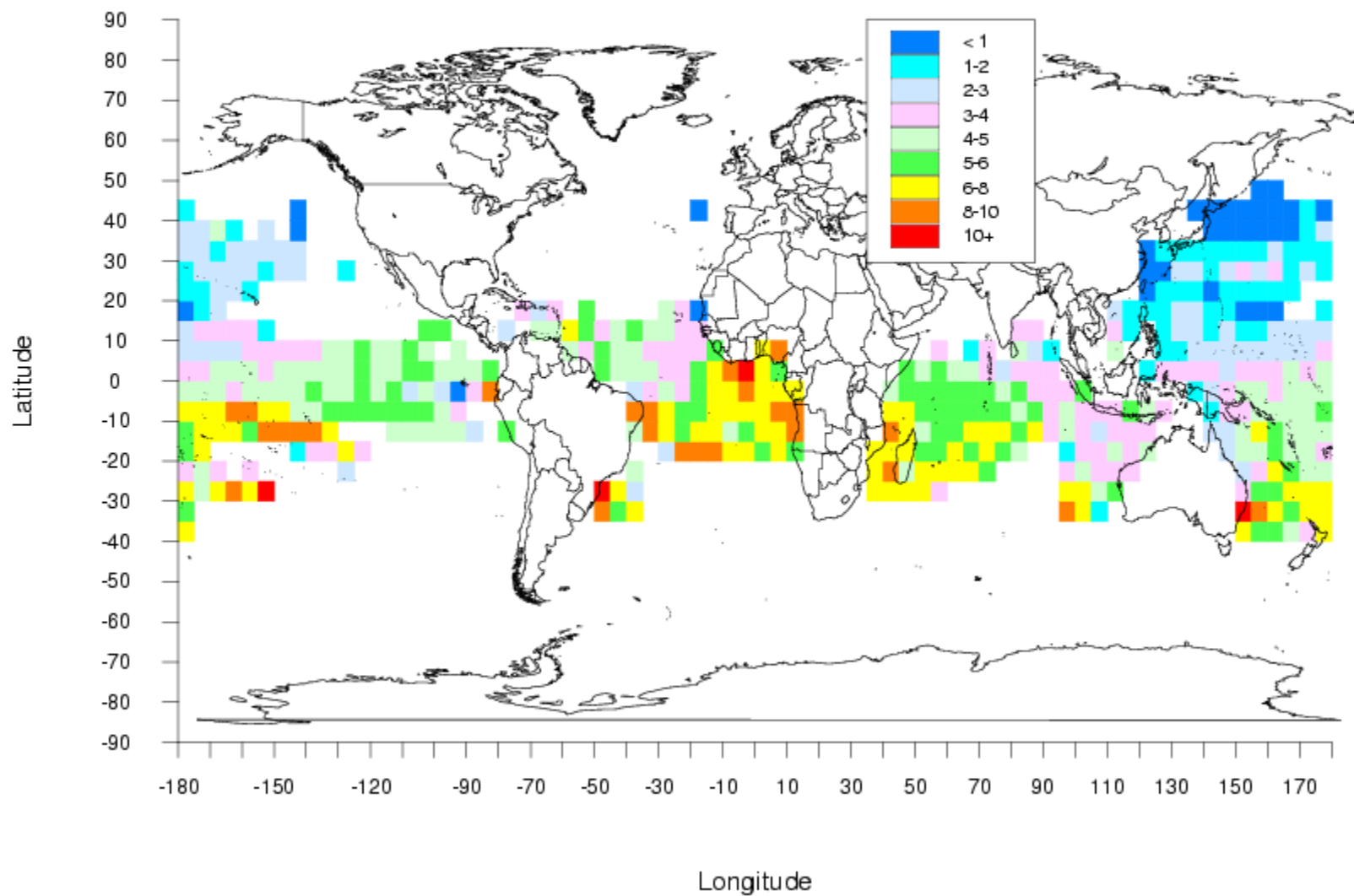
Catch Per Hundred Hooks, Year = 1959



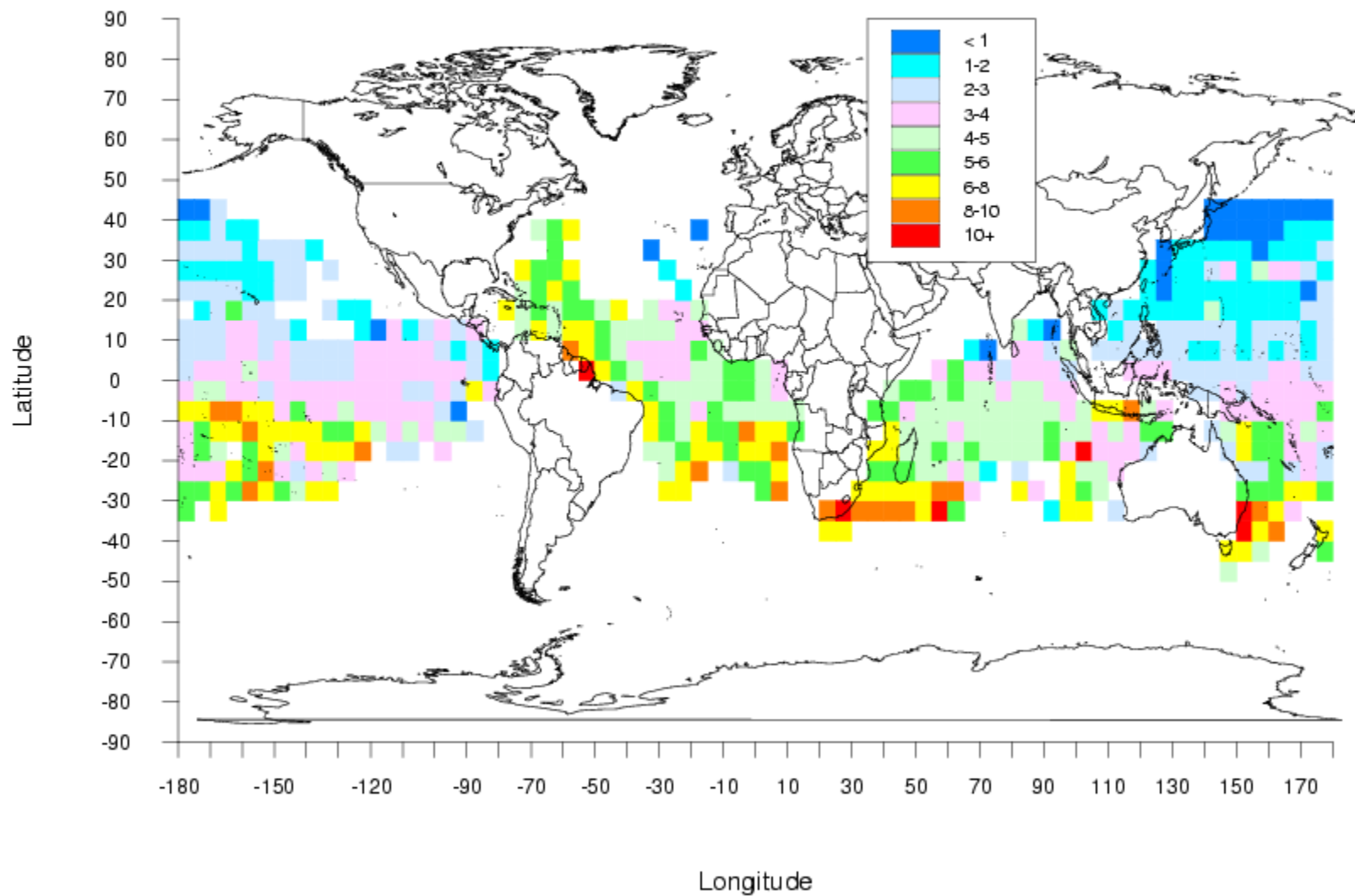
Catch Per Hundred Hooks, Year = 1960



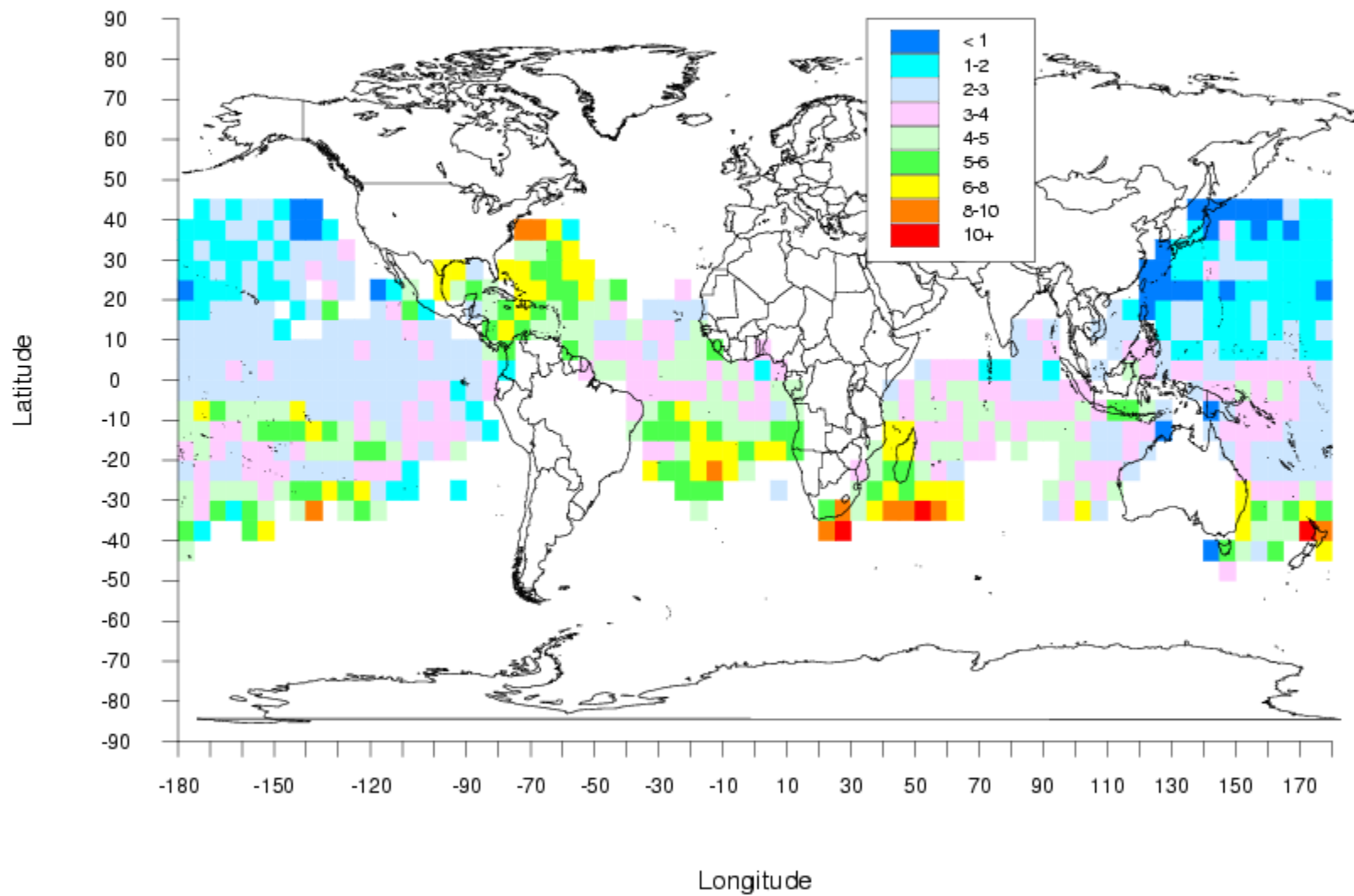
Catch Per Hundred Hooks, Year = 1961



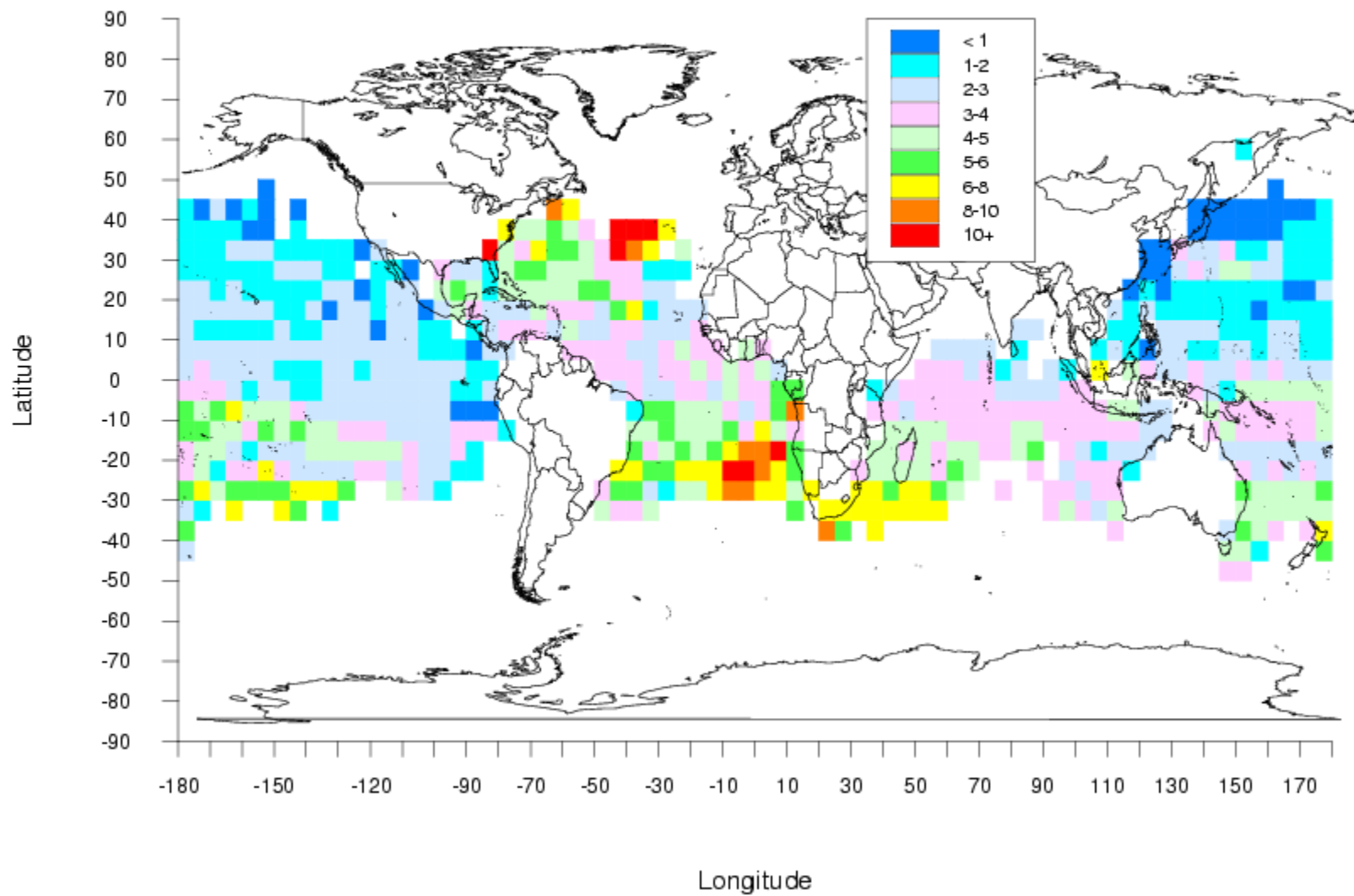
Catch Per Hundred Hooks, Year = 1962



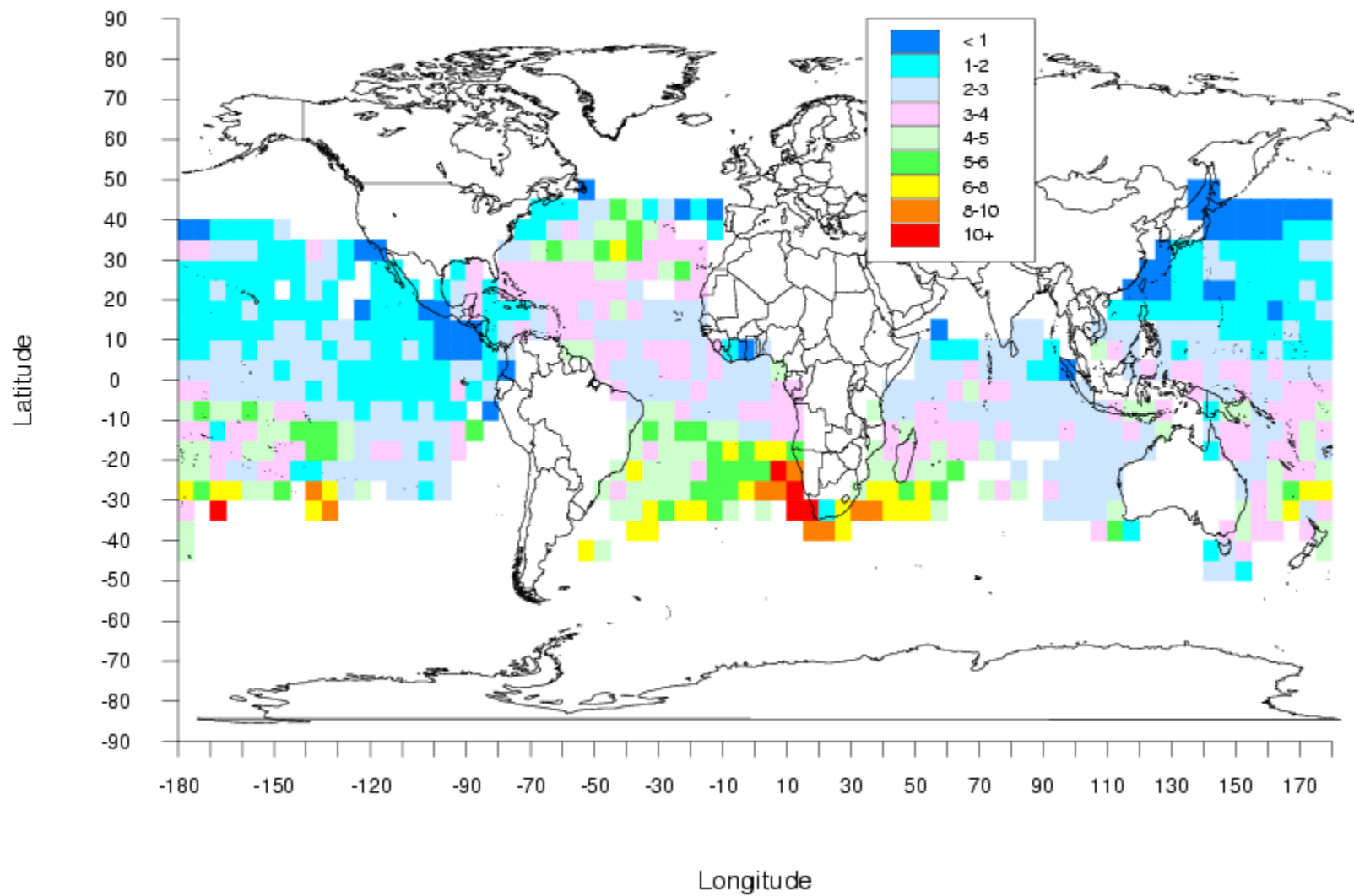
Catch Per Hundred Hooks, Year = 1963



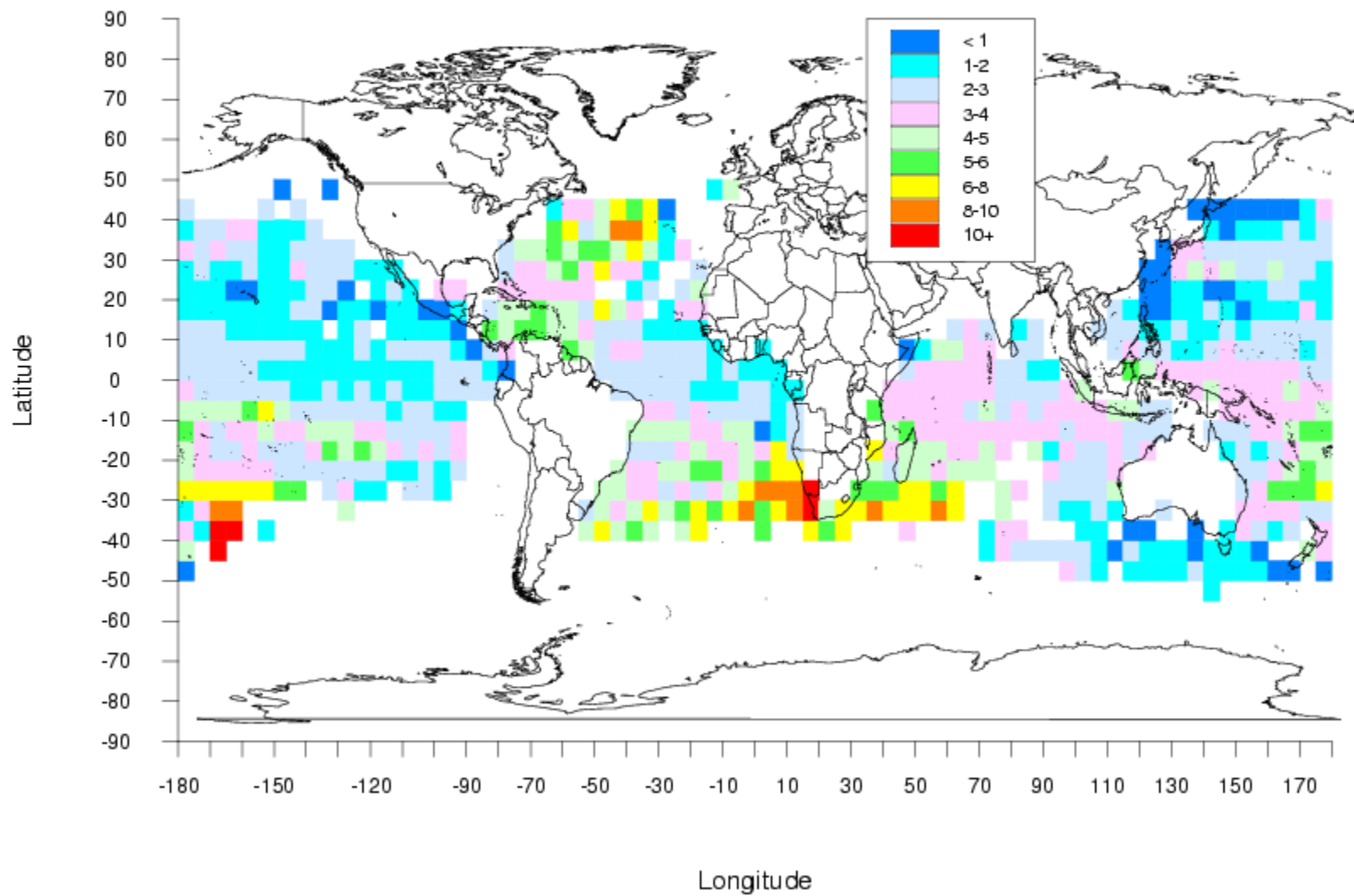
Catch Per Hundred Hooks, Year = 1964



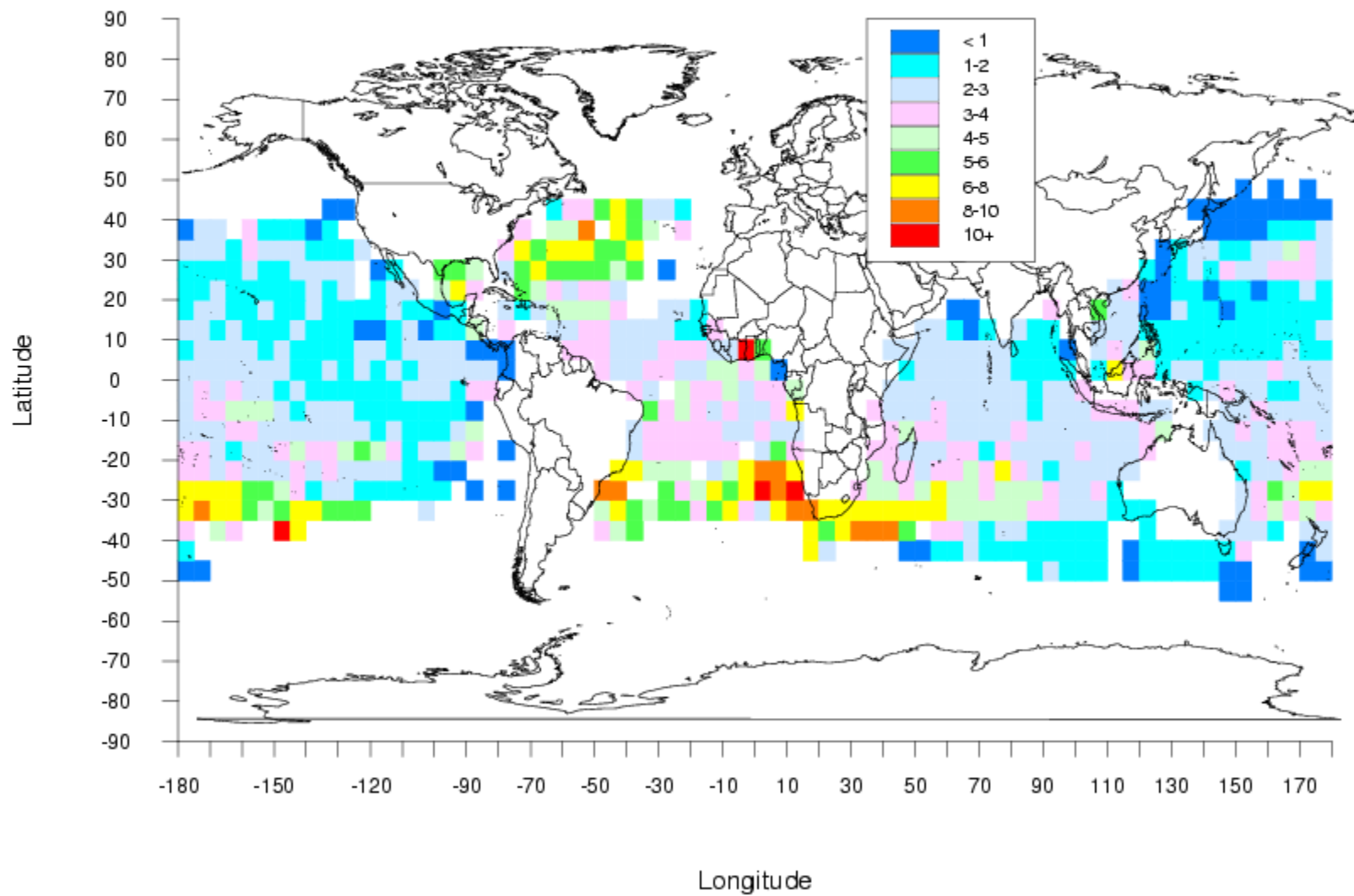
Catch Per Hundred Hooks, Year = 1965



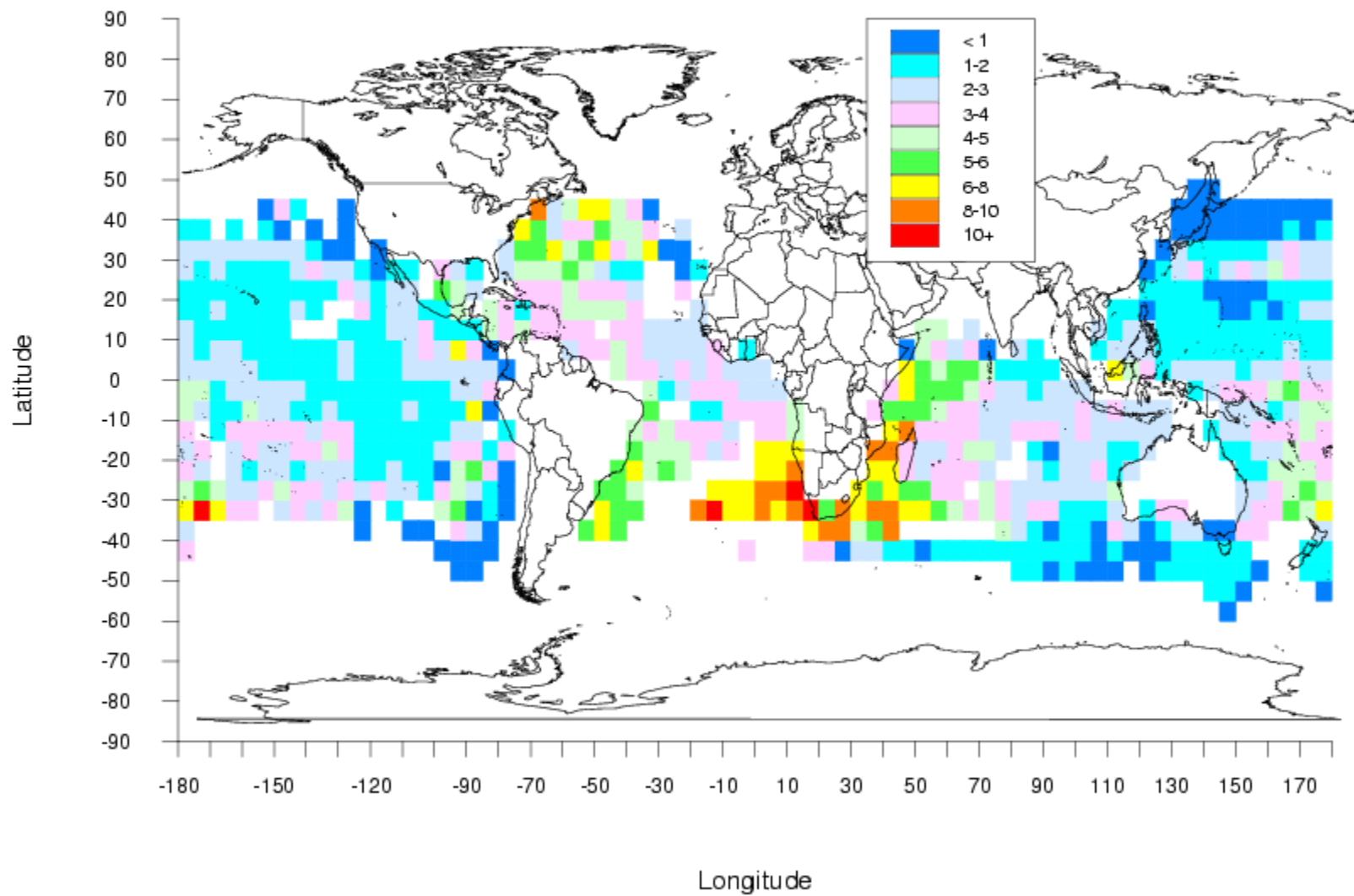
Catch Per Hundred Hooks, Year = 1966



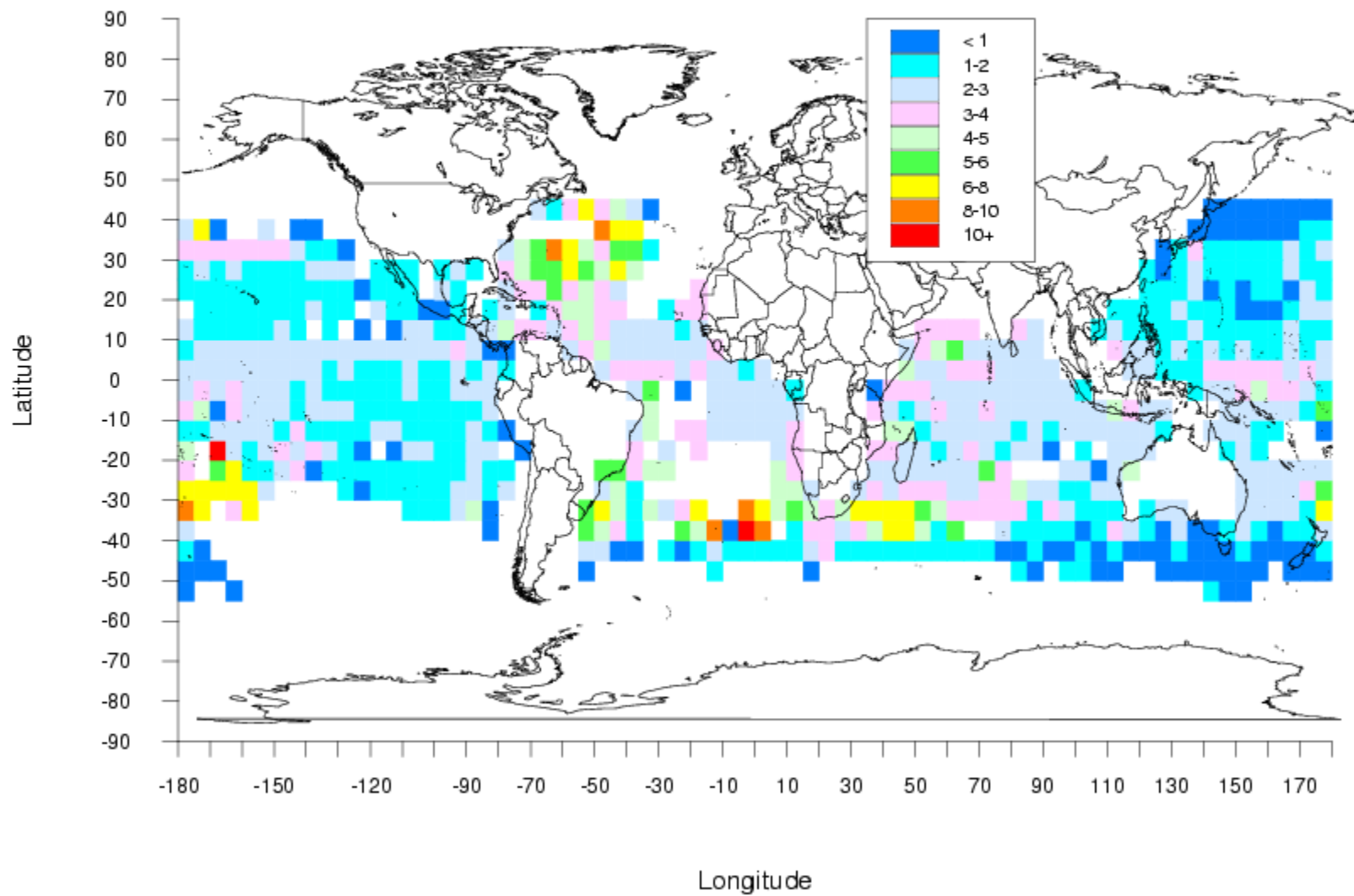
Catch Per Hundred Hooks, Year = 1967



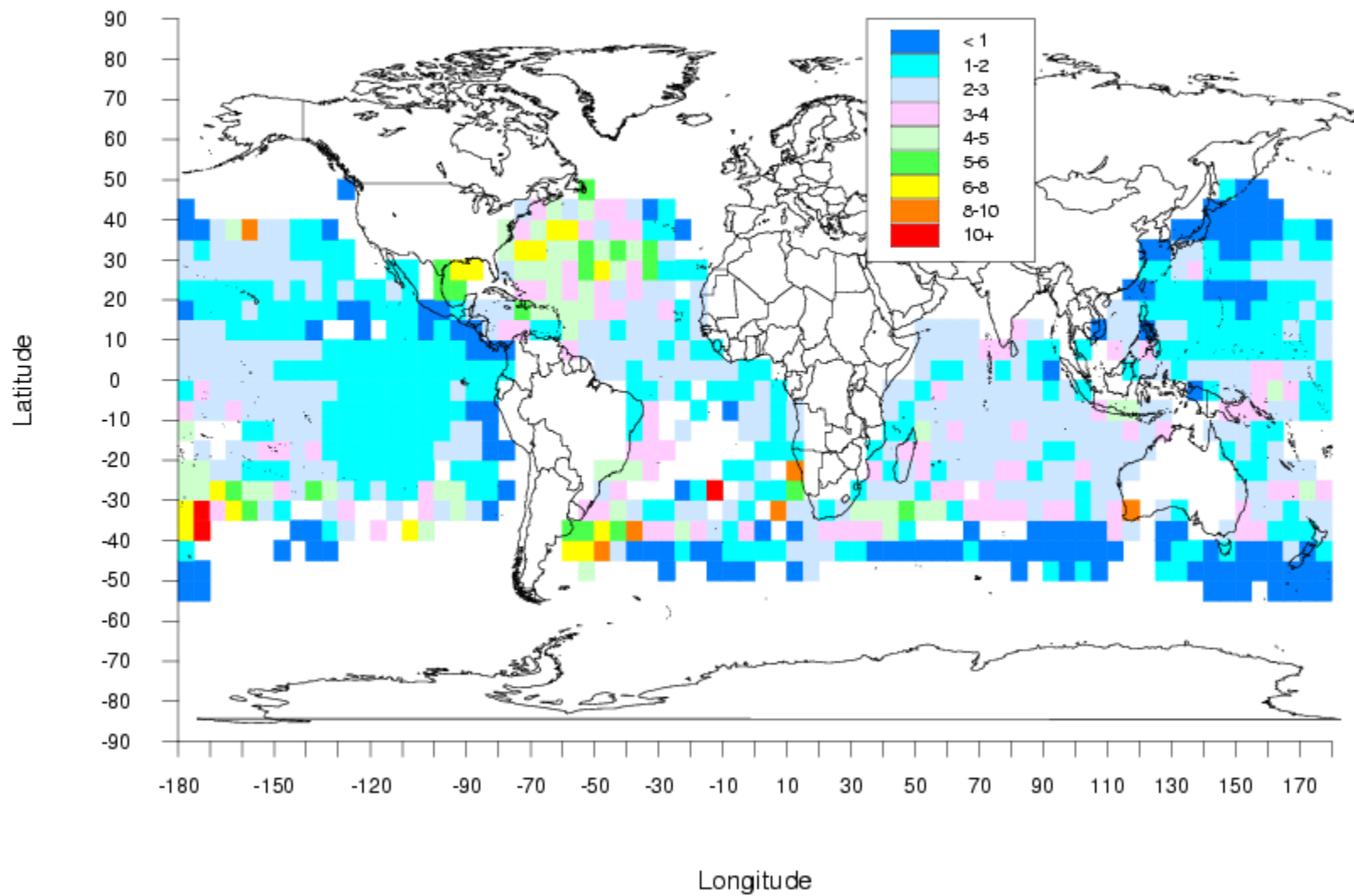
Catch Per Hundred Hooks, Year = 1968



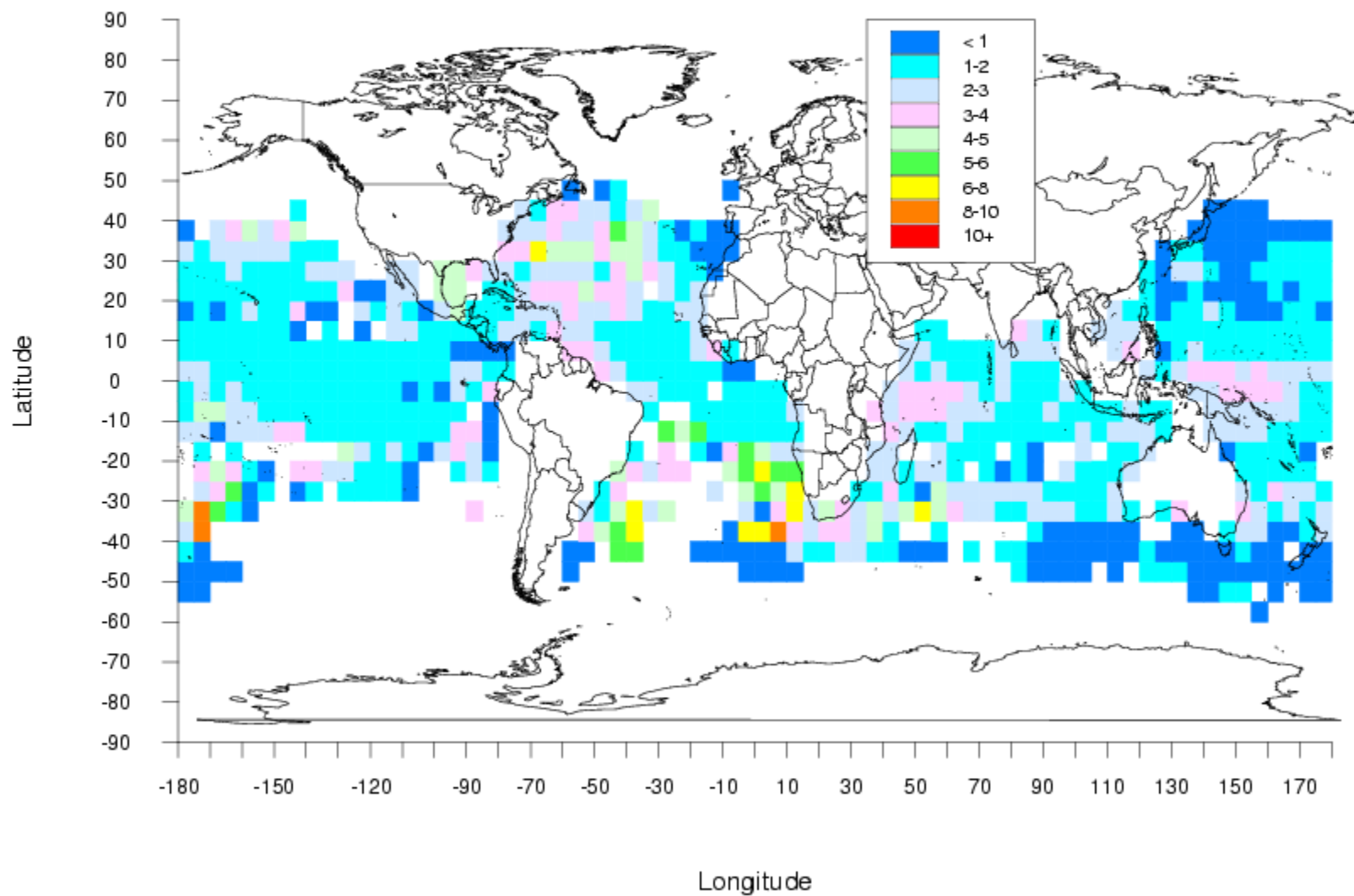
Catch Per Hundred Hooks, Year = 1969



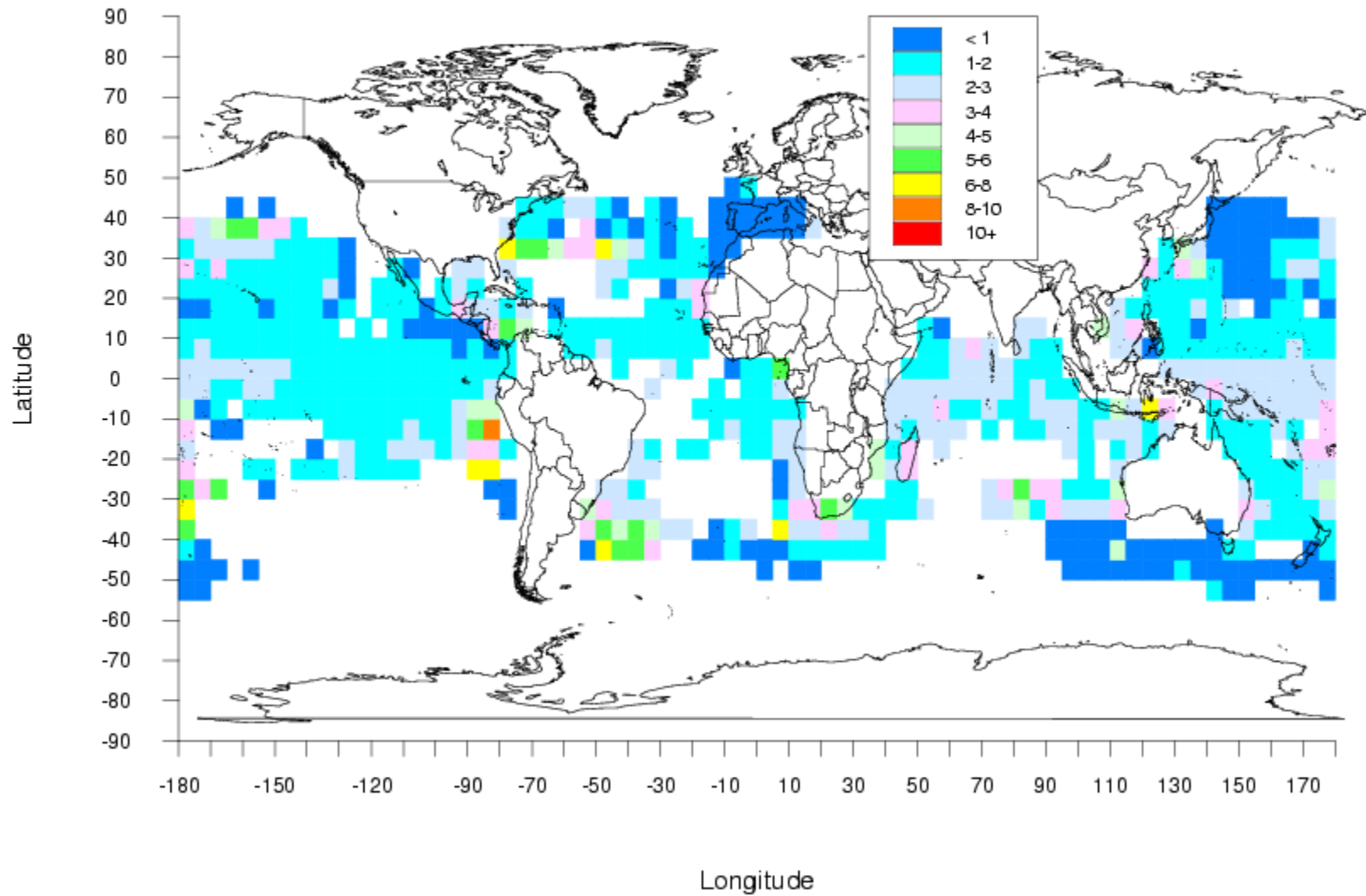
Catch Per Hundred Hooks, Year = 1970



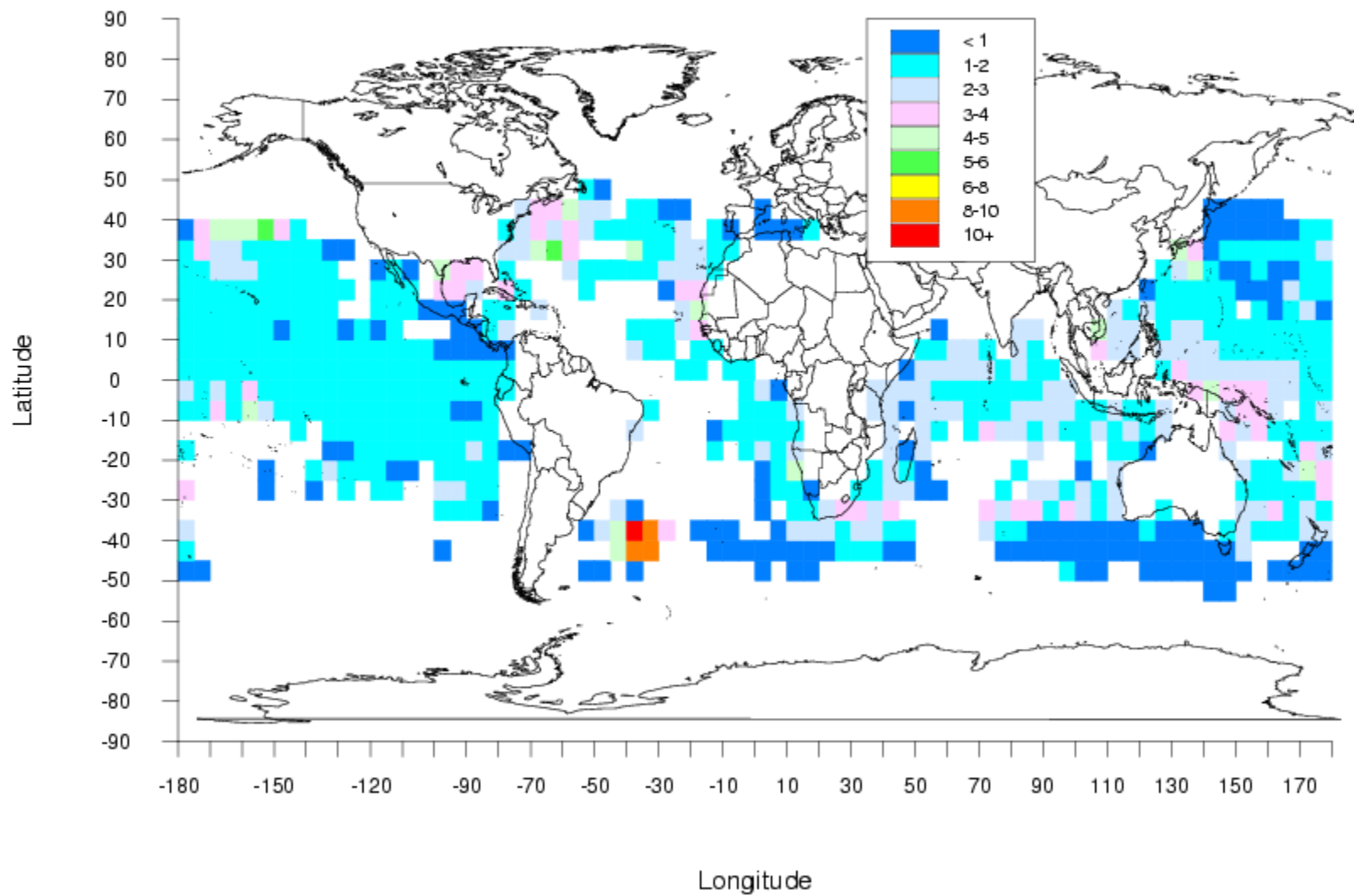
Catch Per Hundred Hooks, Year = 1971



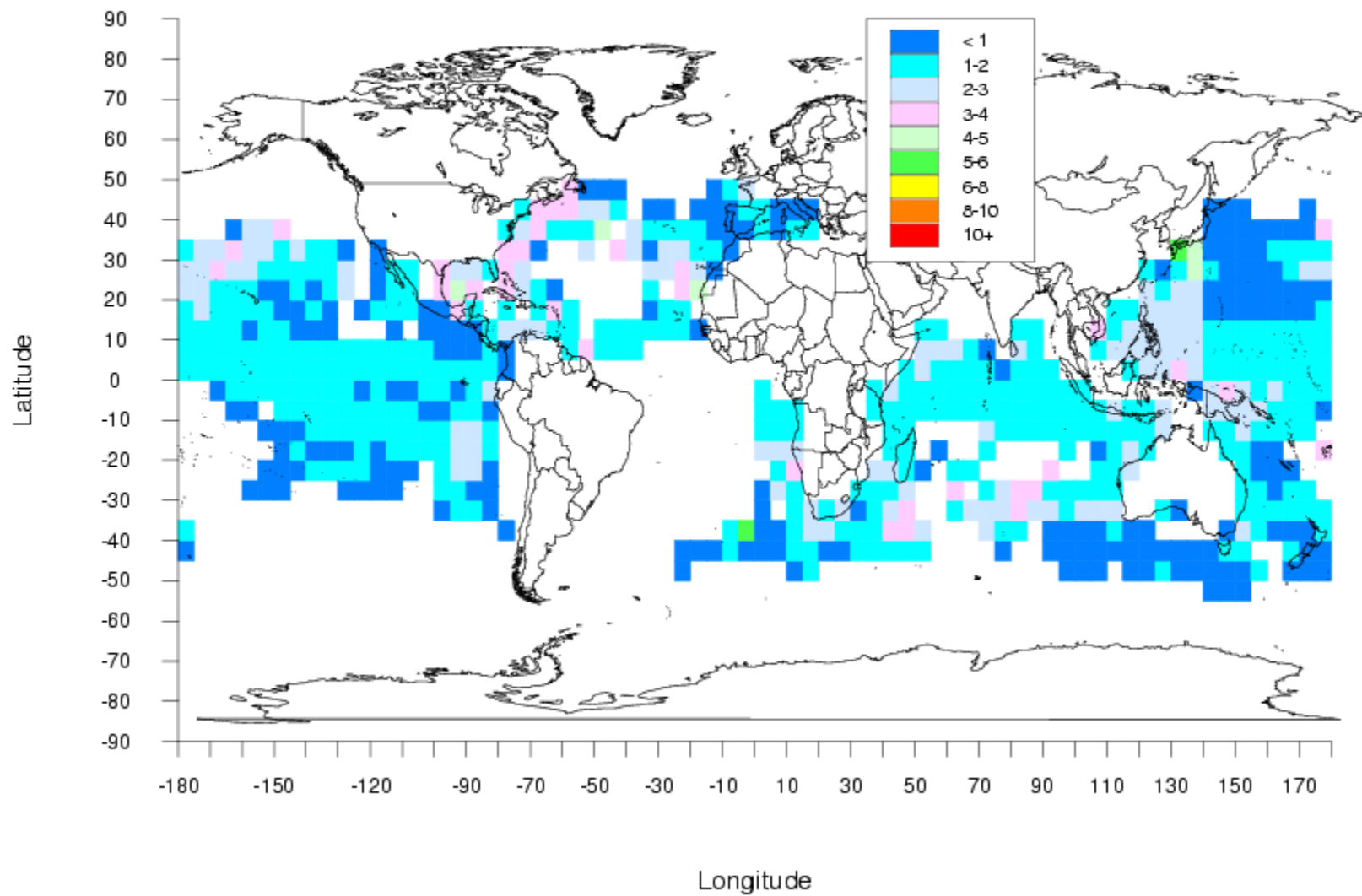
Catch Per Hundred Hooks, Year = 1972



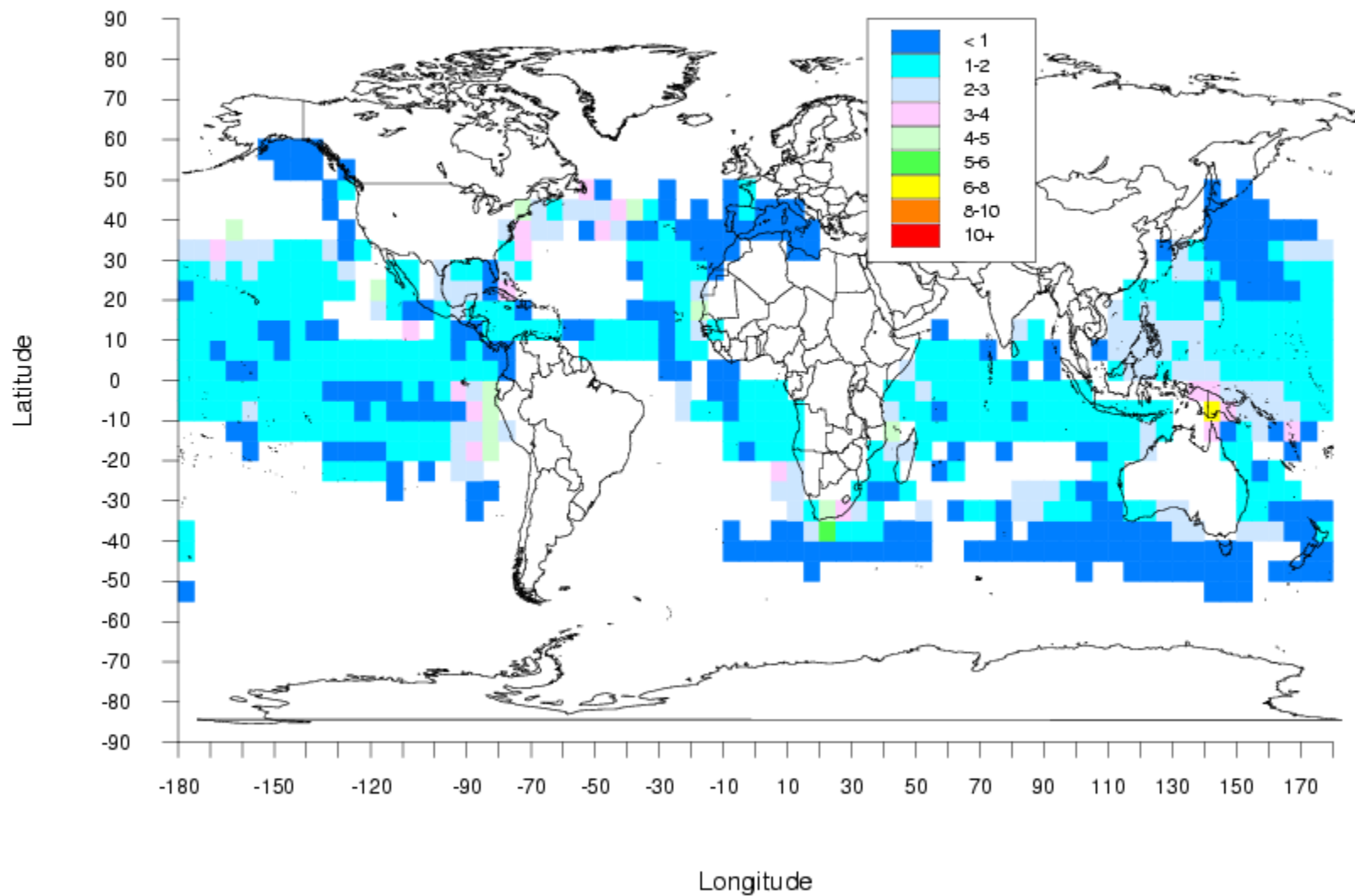
Catch Per Hundred Hooks, Year = 1973



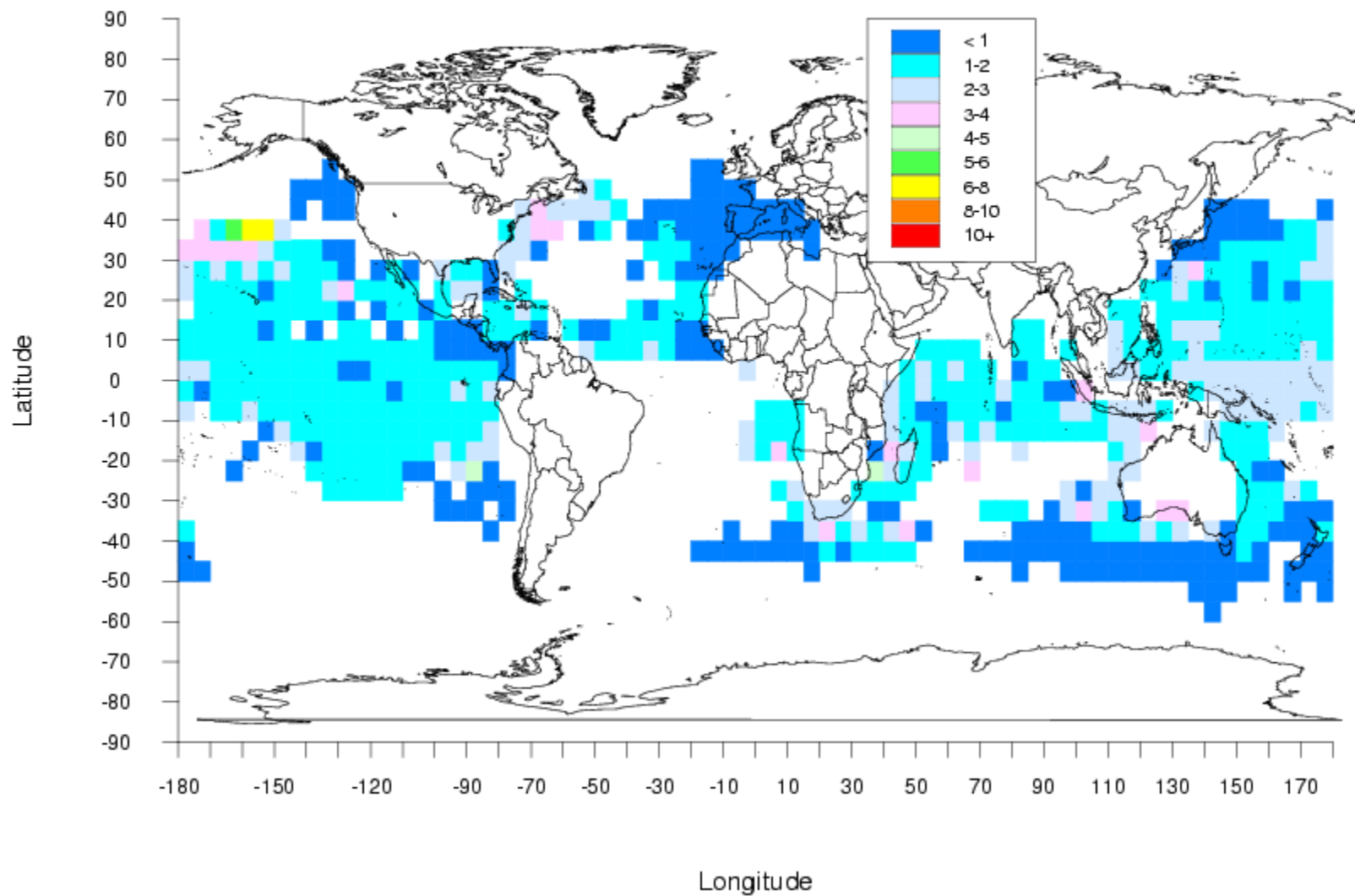
Catch Per Hundred Hooks, Year = 1974



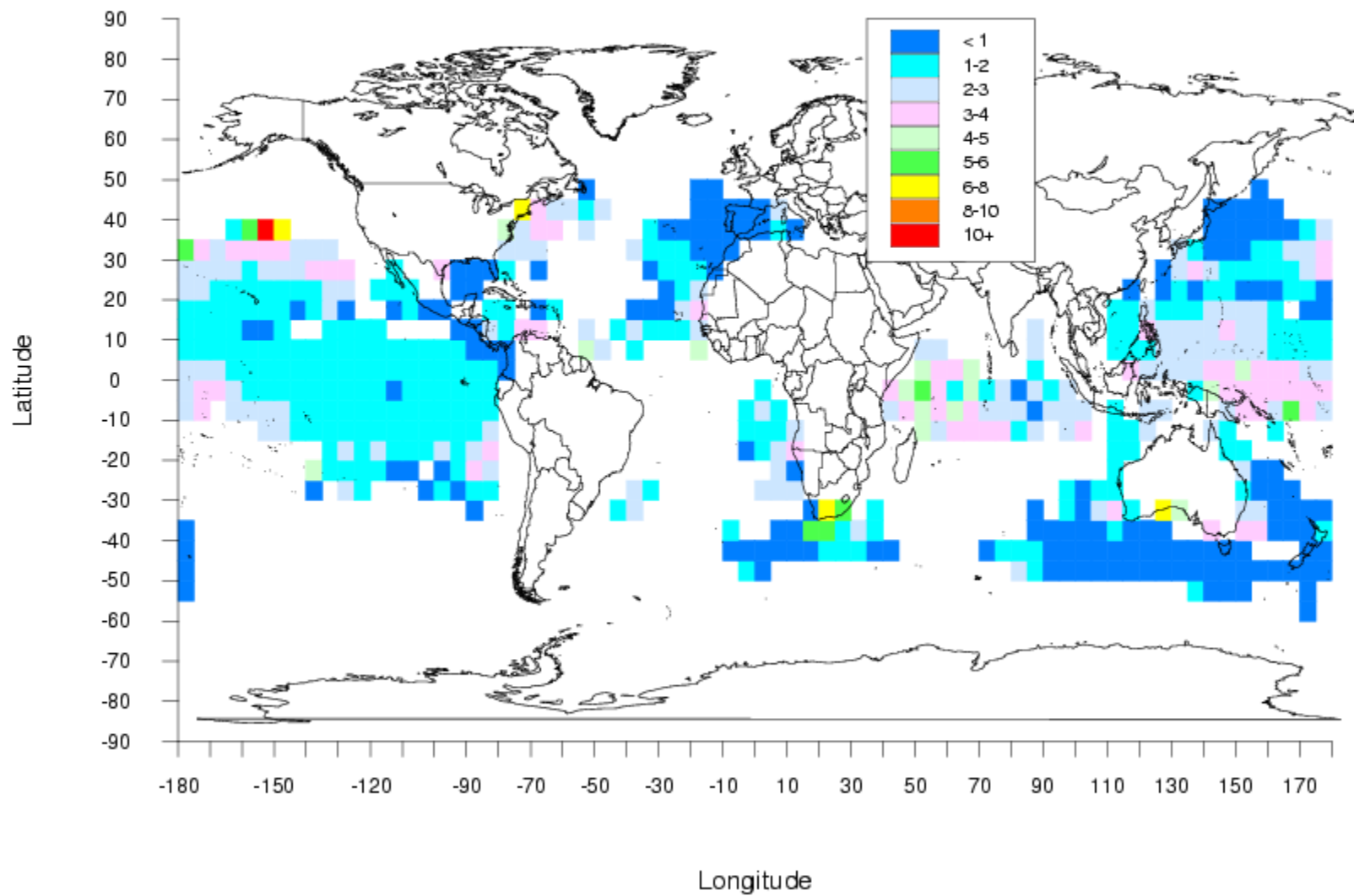
Catch Per Hundred Hooks, Year = 1975



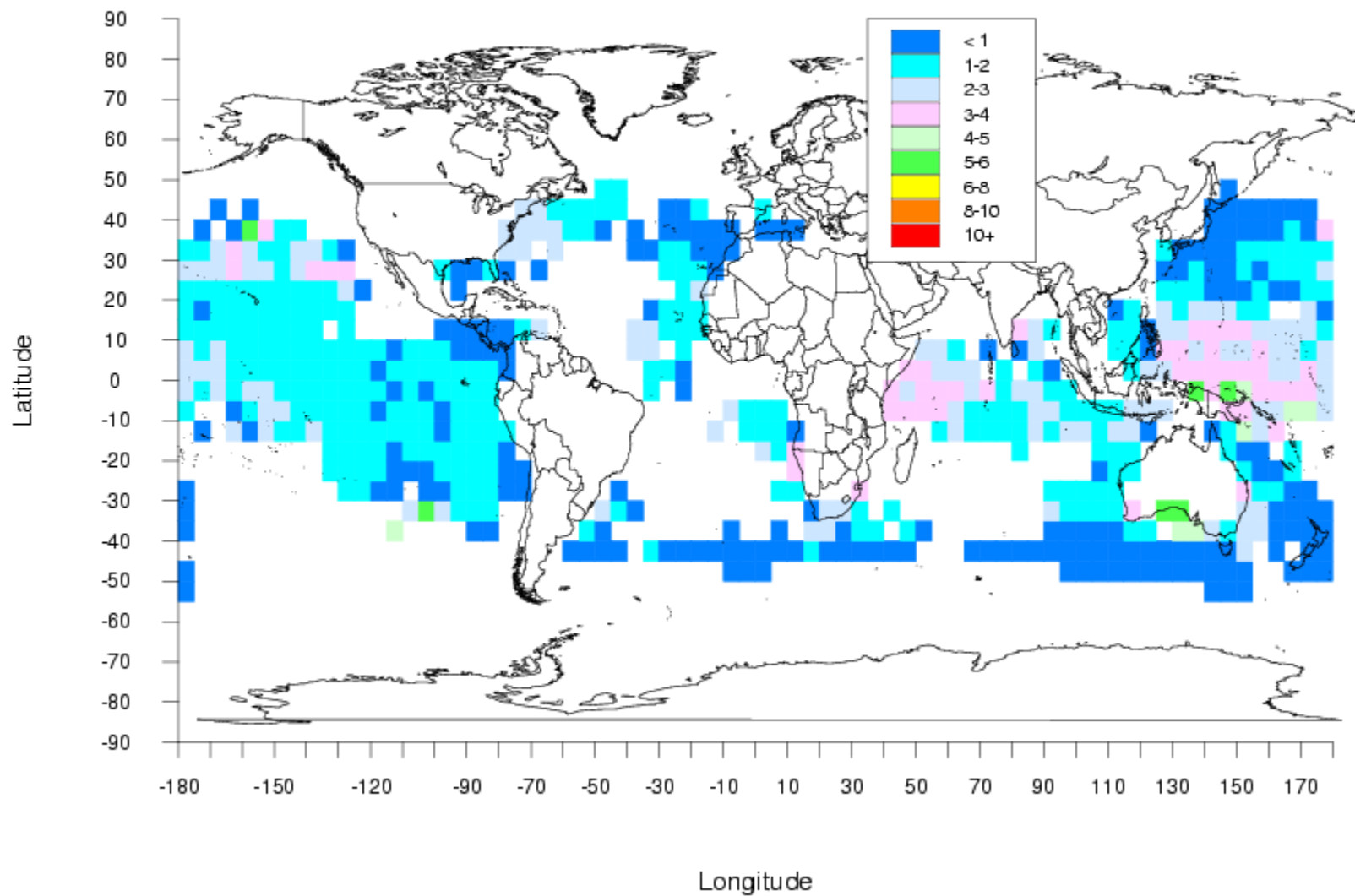
Catch Per Hundred Hooks, Year = 1976



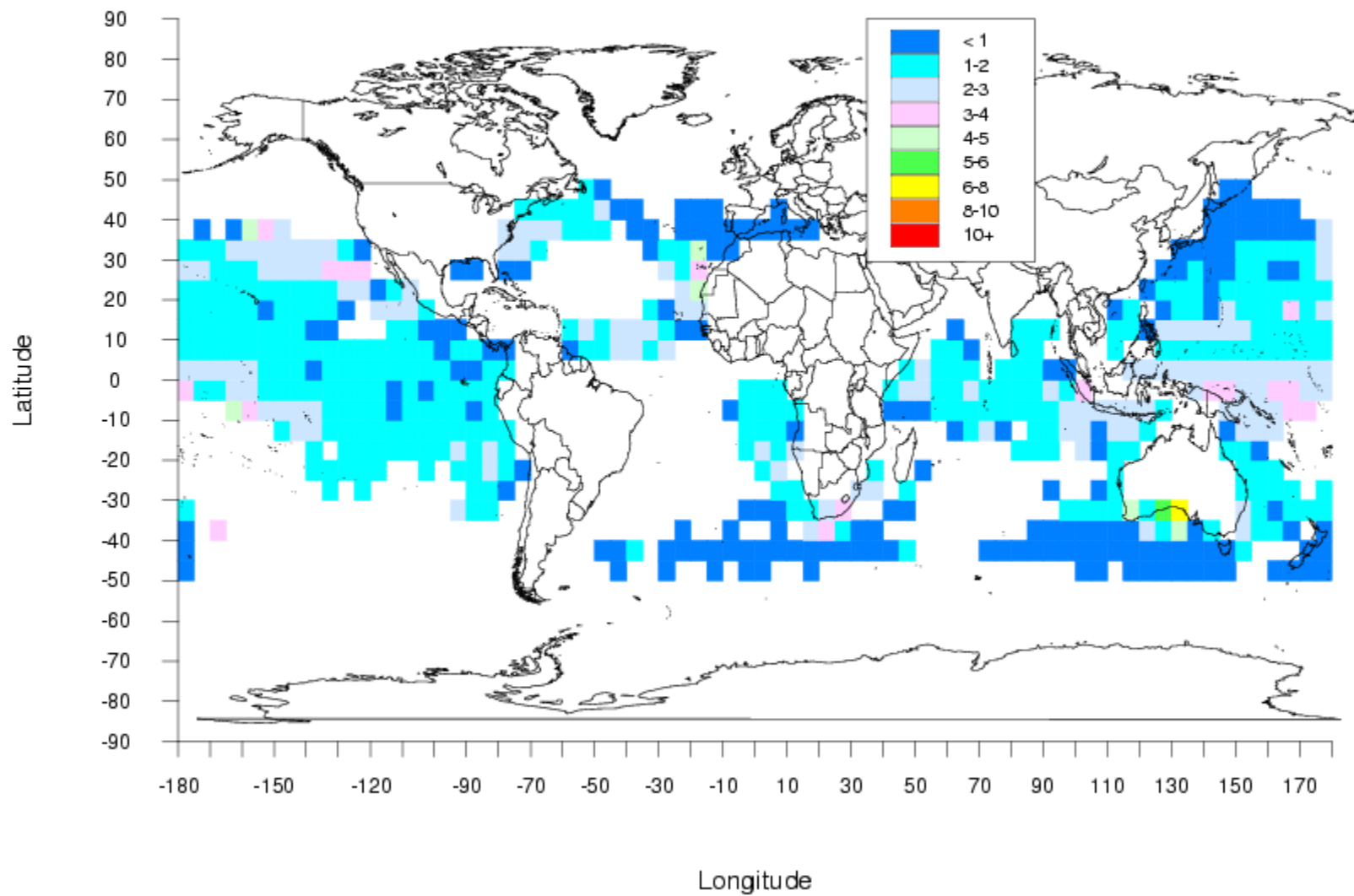
Catch Per Hundred Hooks, Year = 1977



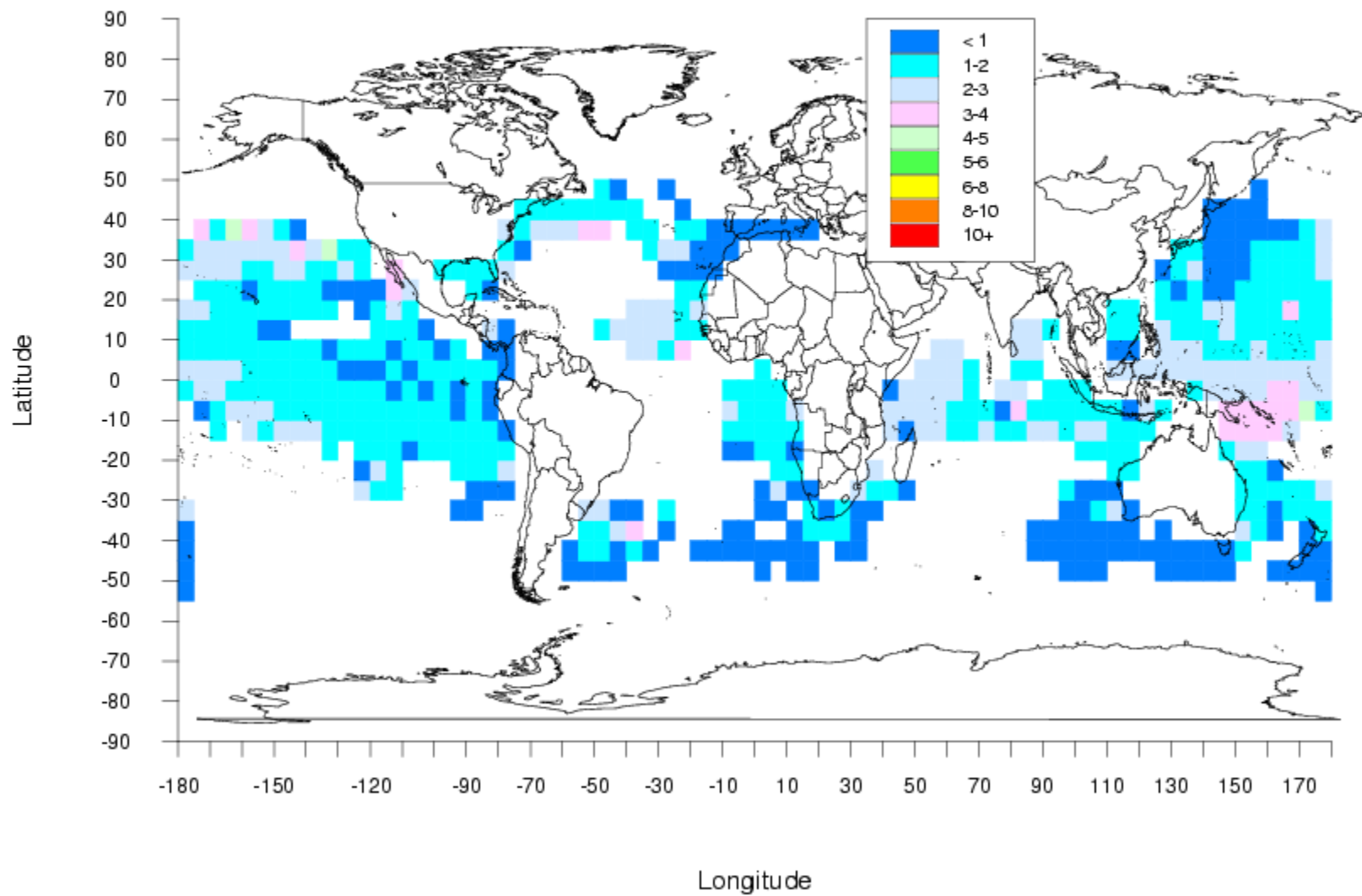
Catch Per Hundred Hooks, Year = 1978



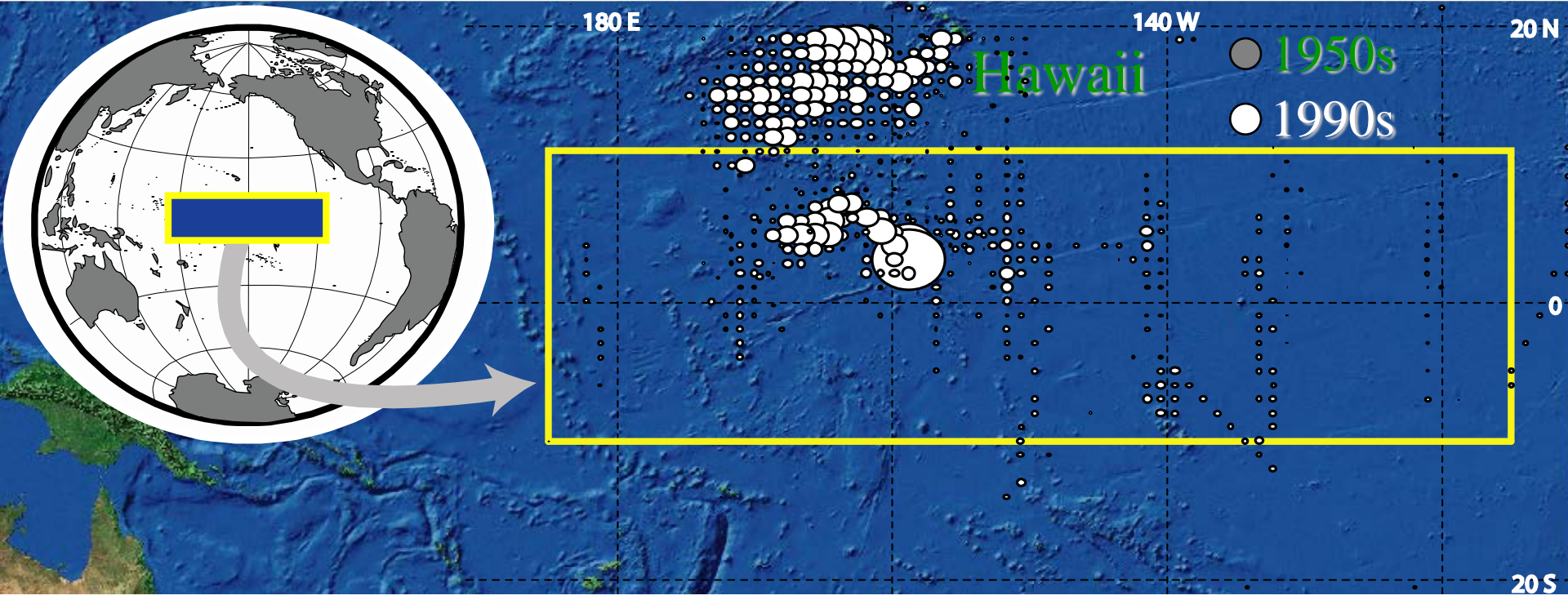
Catch Per Hundred Hooks, Year = 1979



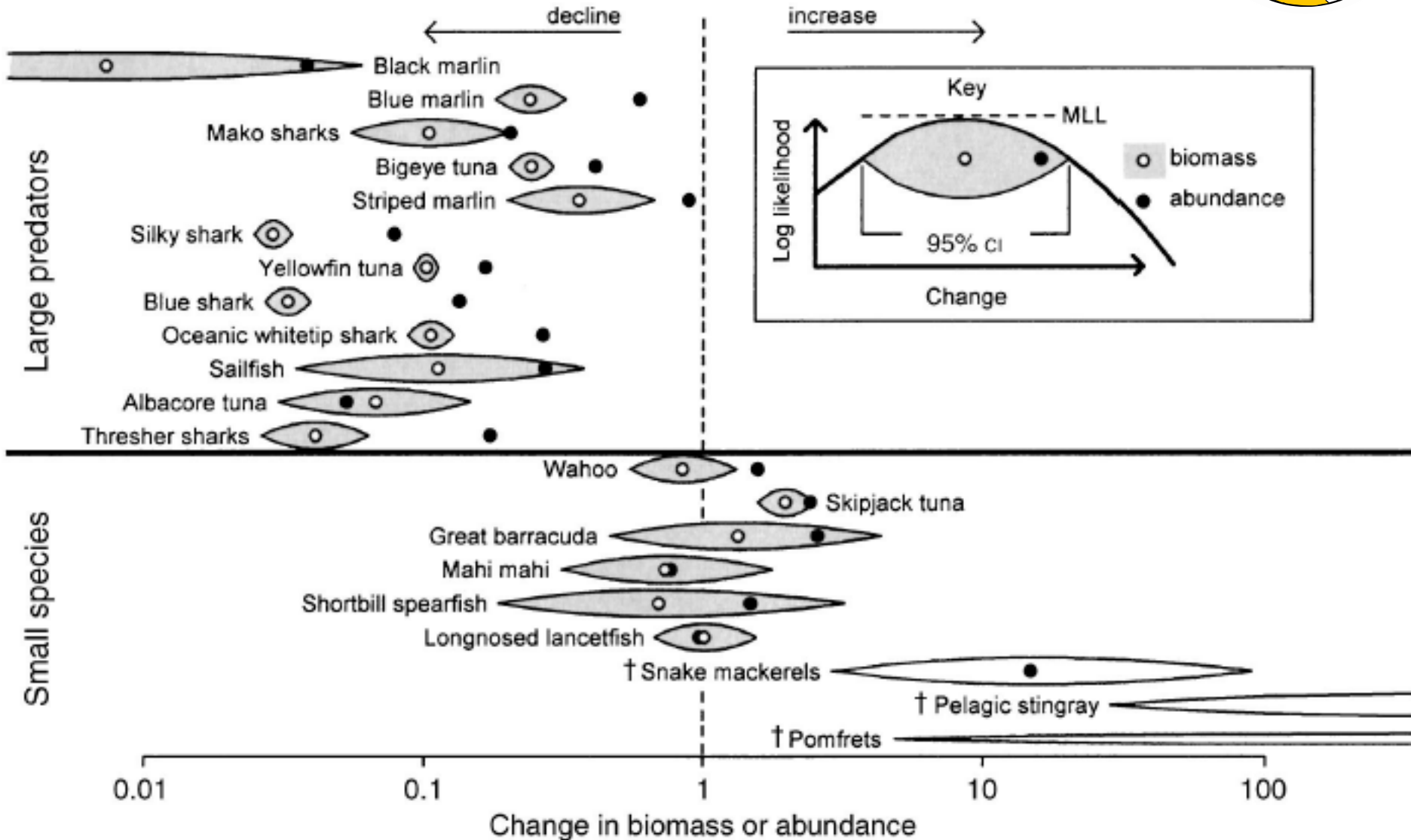
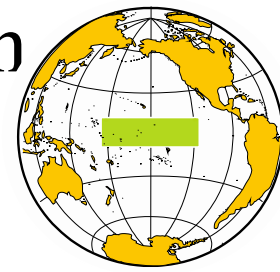
Catch Per Hundred Hooks, Year = 1980



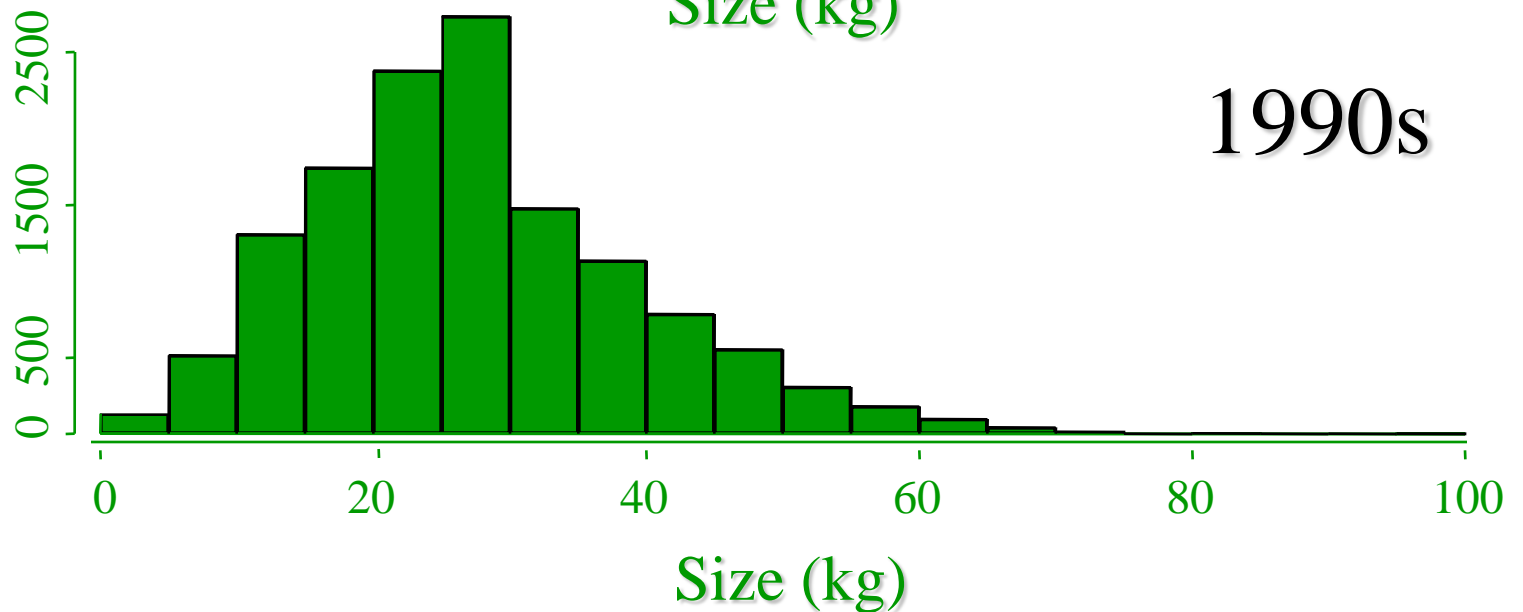
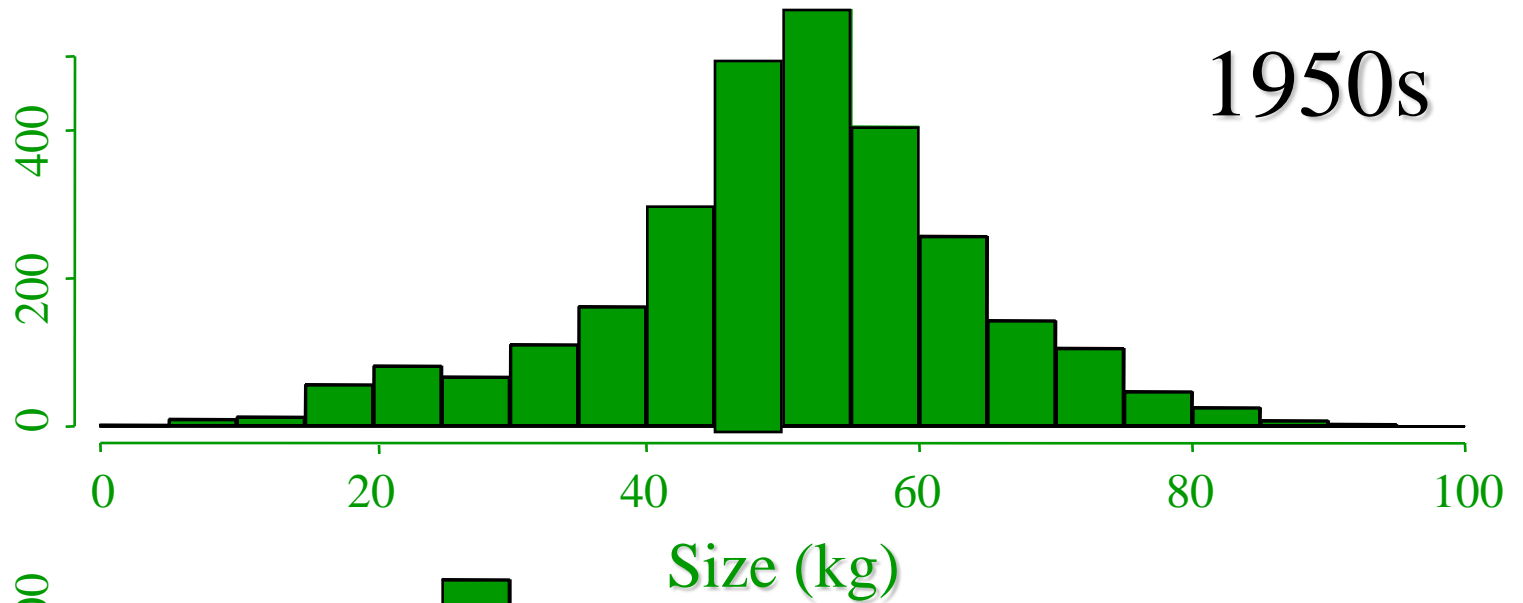
Study area



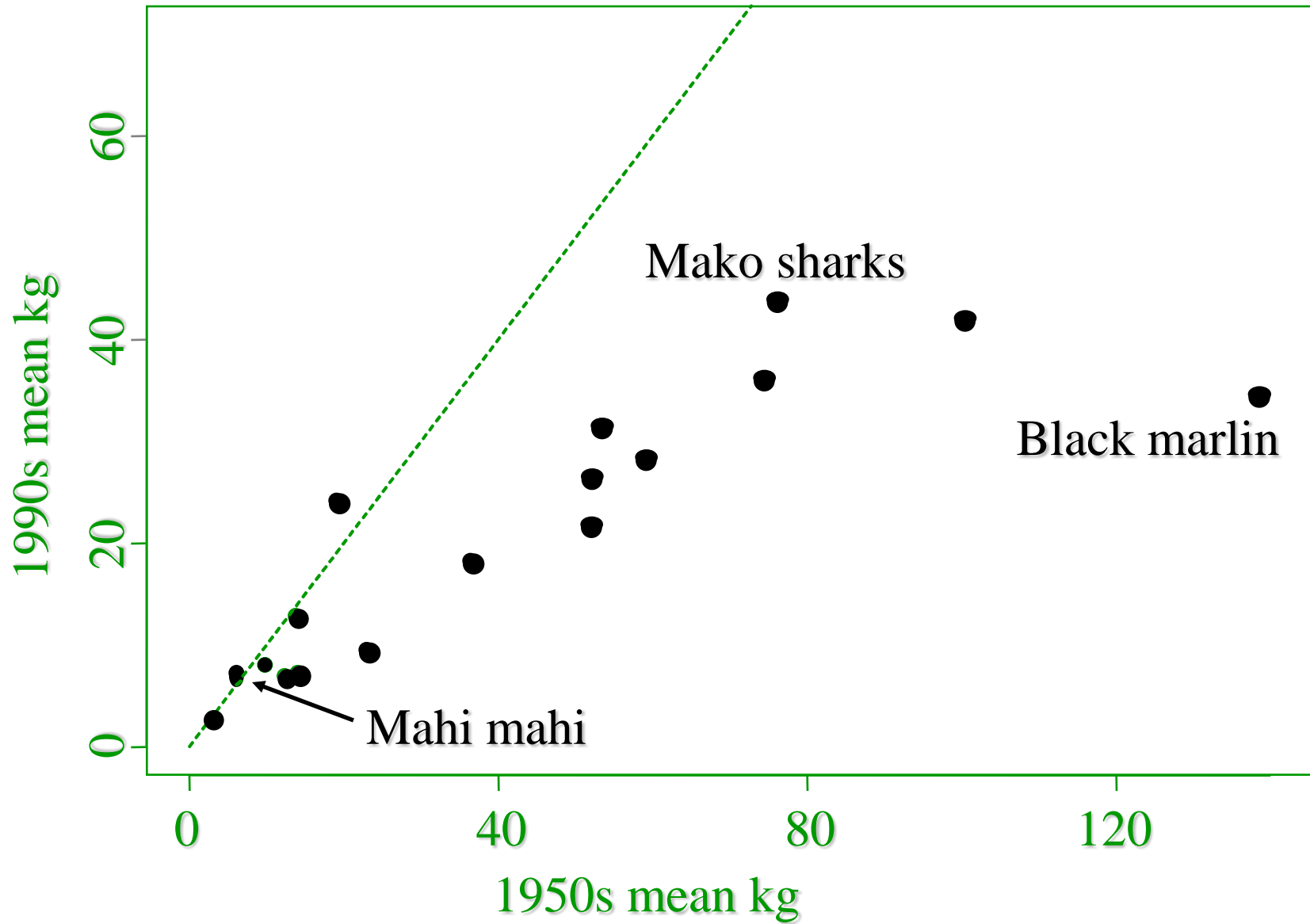
Analysis repeated using independent research data

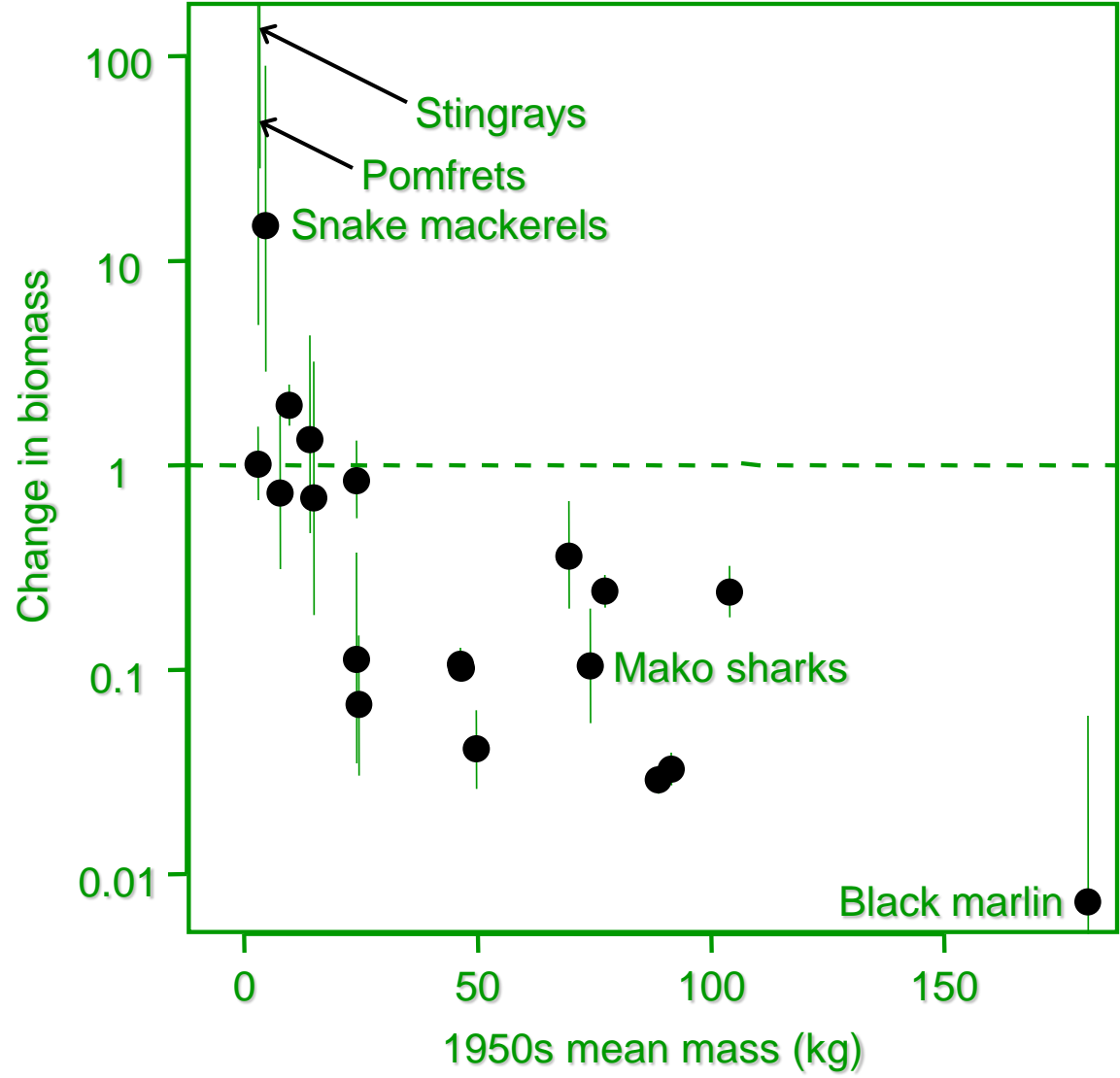


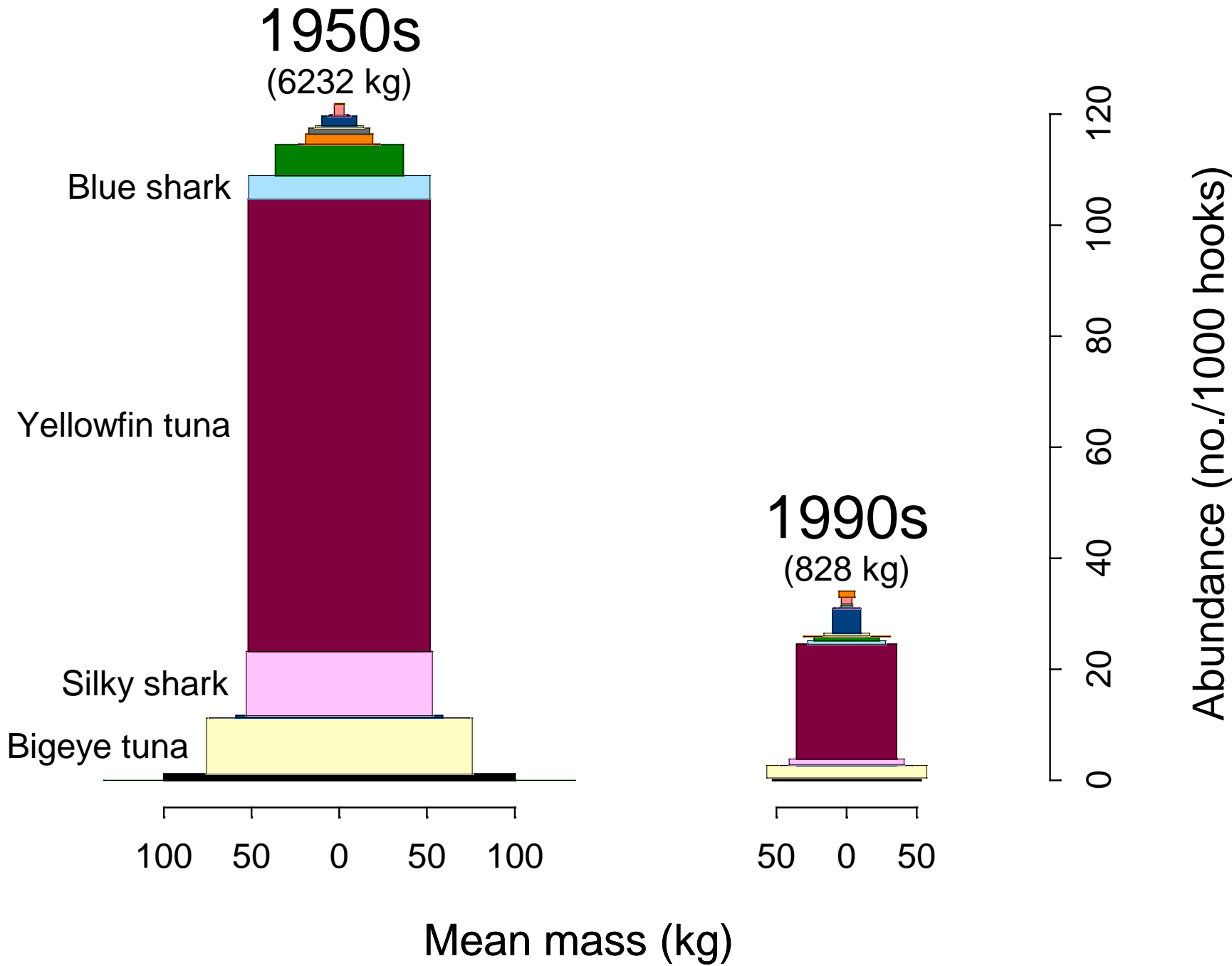
These estimates are conservative: 2 (fish are smaller)



Change in body size





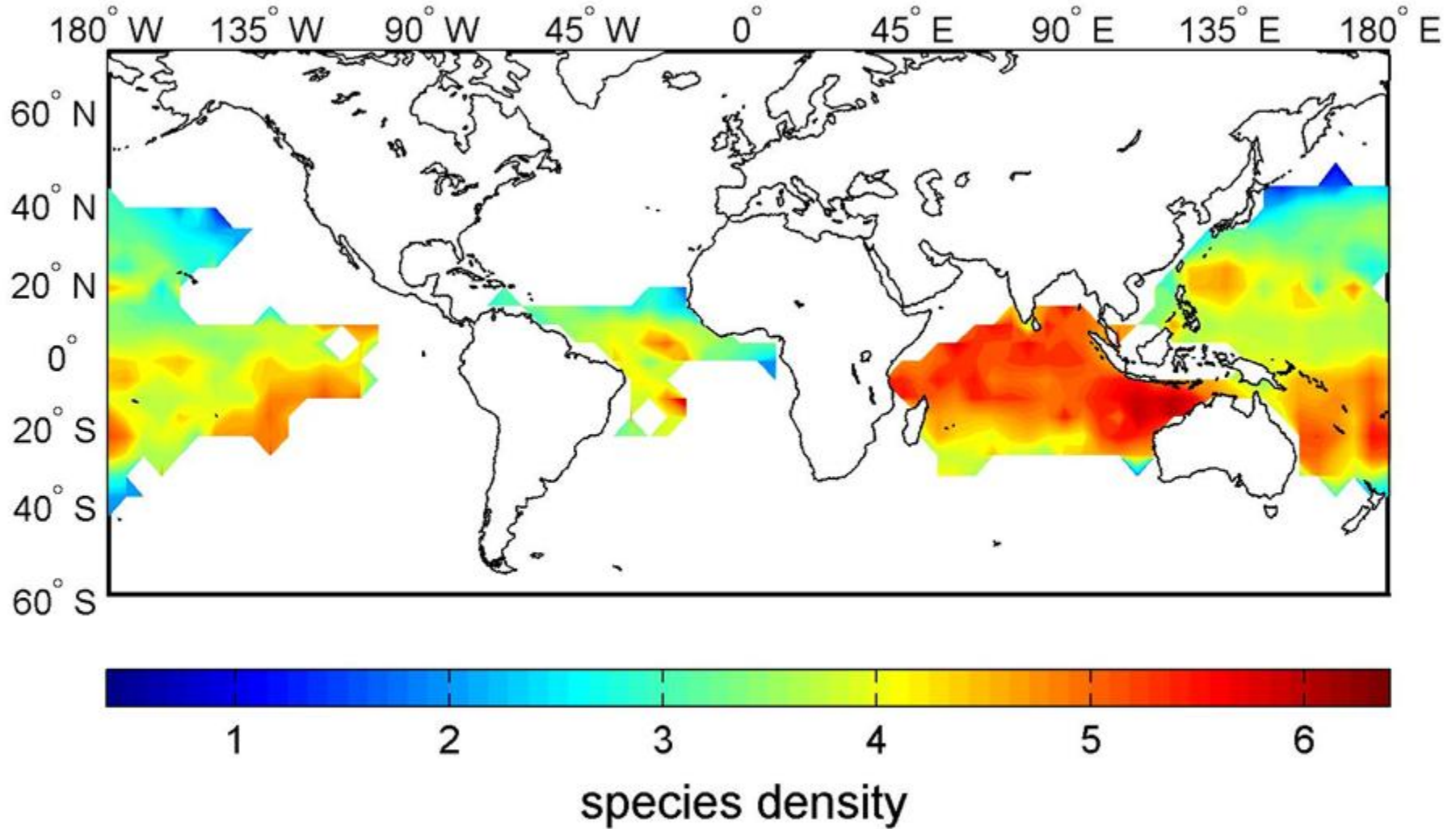


Loss of species density per decade

- Displayed is the number of tuna and billfish species that are found on a standard longline with 1000 hooks
- The time series runs from 1952-1999
- It shows how large hotspots are disappearing over time and how few concentrations of diversity remain today

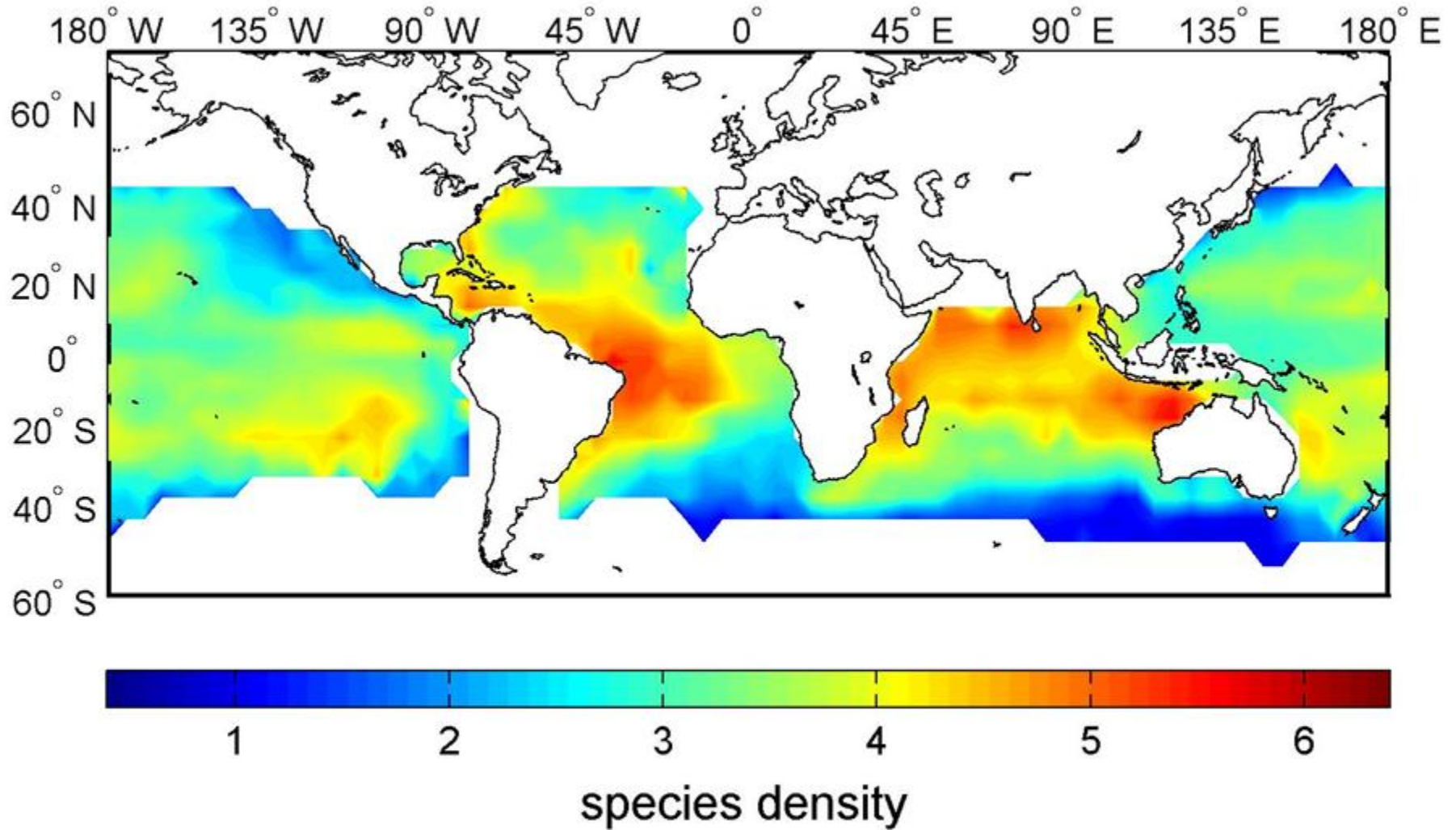
After data from: Worm B, Sandow M, Oschlies A, Lotze HK, Myers RA (2005) Global patterns of predator diversity in the open oceans. **Science** Aug. 2005.

1950s



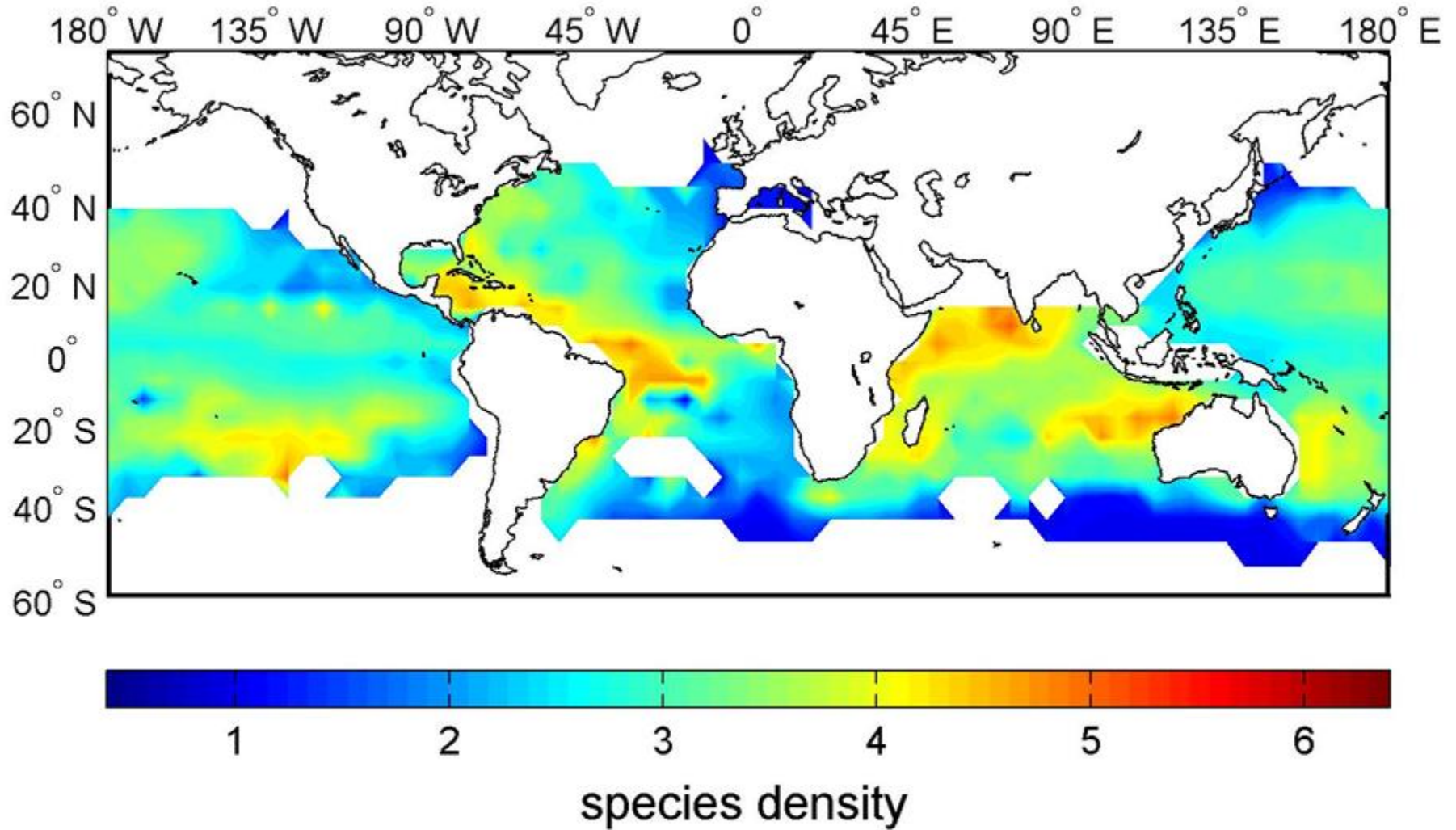
Worm B, Sandow M, Oschlies A, Lotze HK, Myers RA (Science Aug. 2005)

1960s



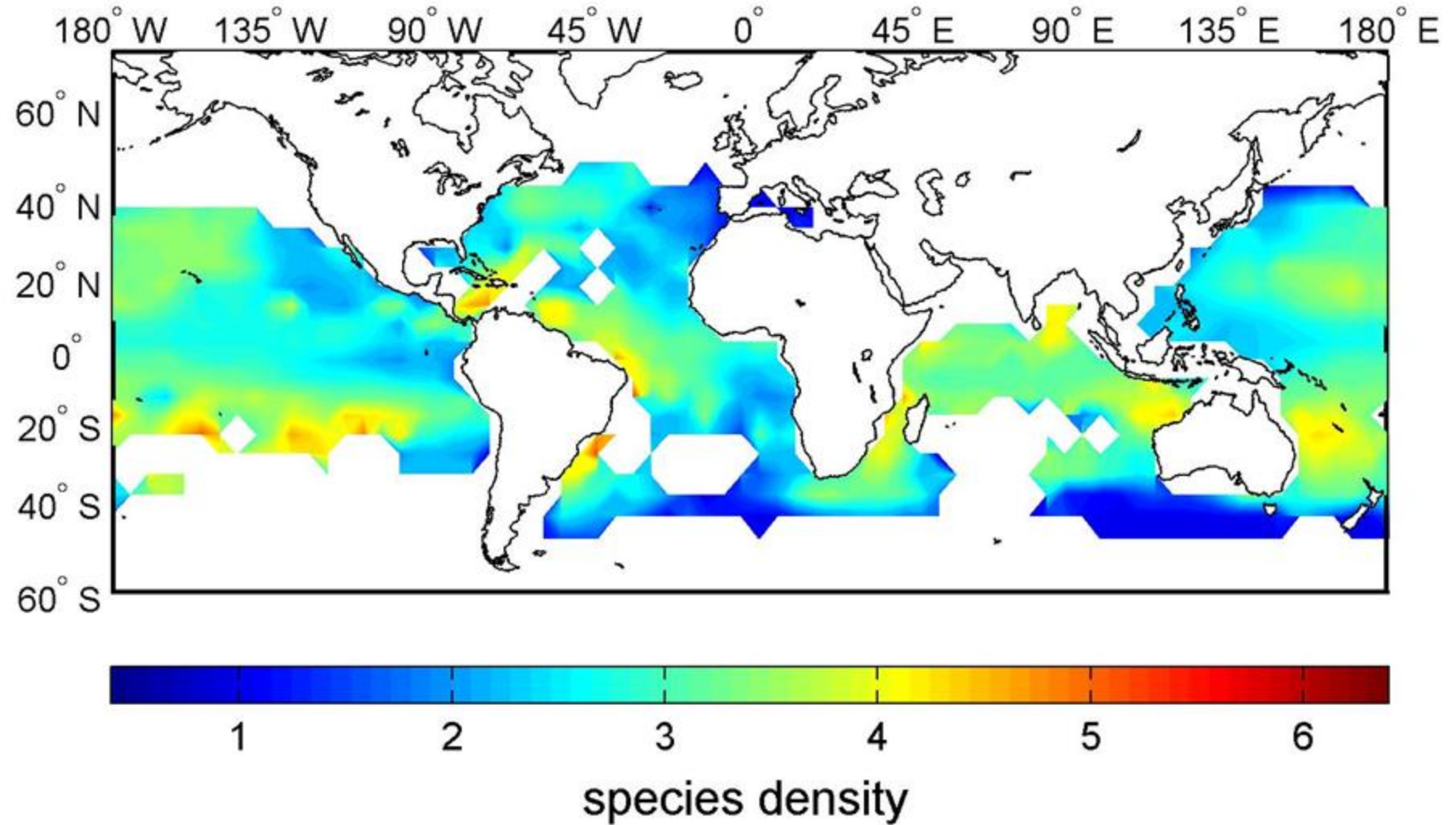
Worm B, Sandow M, Oschlies A, Lotze HK, Myers RA (Science Aug. 2005)

1970s



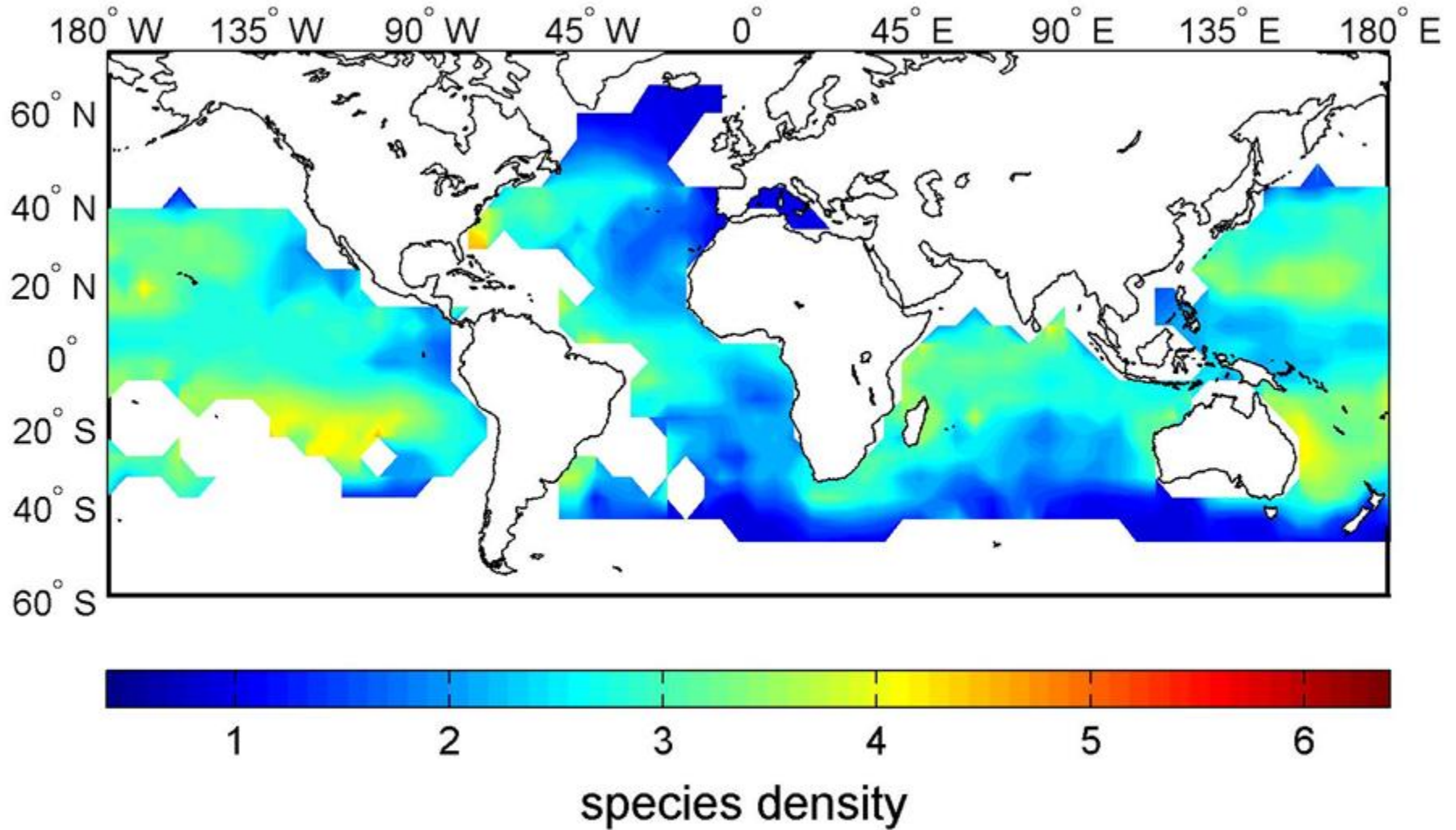
Worm B, Sandow M, Oschlies A, Lotze HK, Myers RA (Science Aug. 2005)

1980s



Worm B, Sandow M, Oschlies A, Lotze HK, Myers RA (Science Aug. 2005)

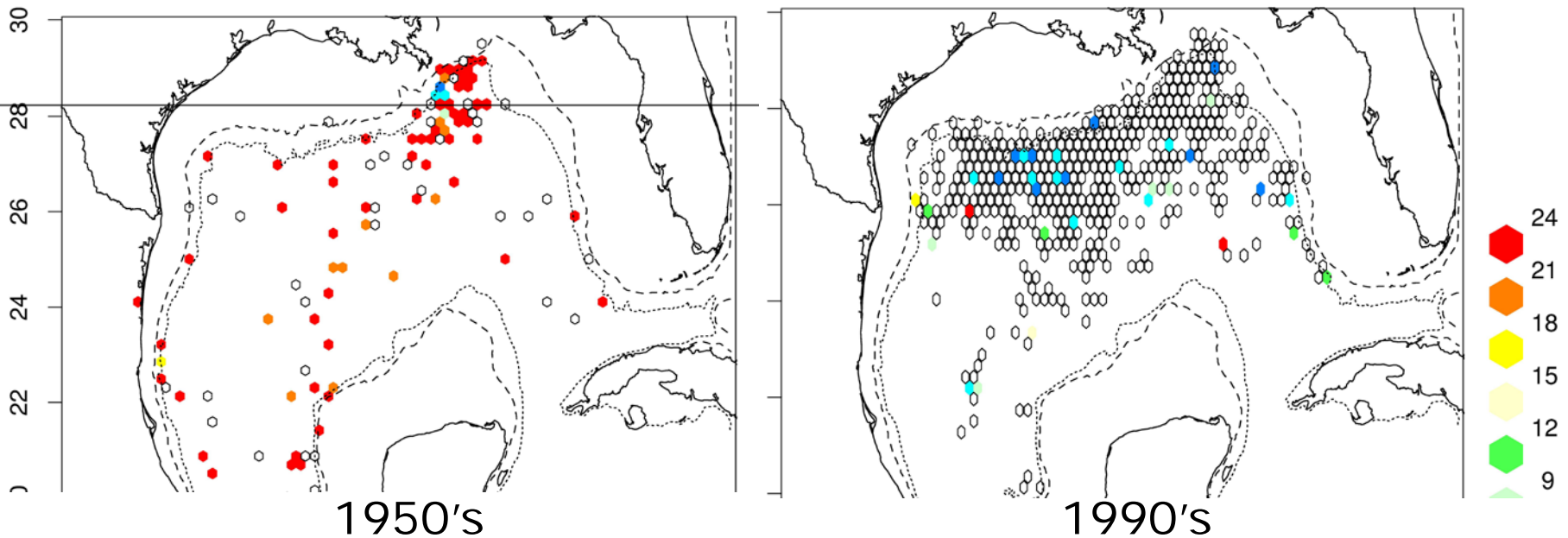
1990s



Worm B, Sandow M, Oschlies A, Lotze HK, Myers RA (Science Aug. 2005)

Loss of sharks in the Gulf of Mexico

300 fold decline – no one noticed



Oceanic Whitetip captures per 10,000 hooks

Many thanks to NMFS for data and advice

What about prey fish?

Brama brama
Atlantic pomfret

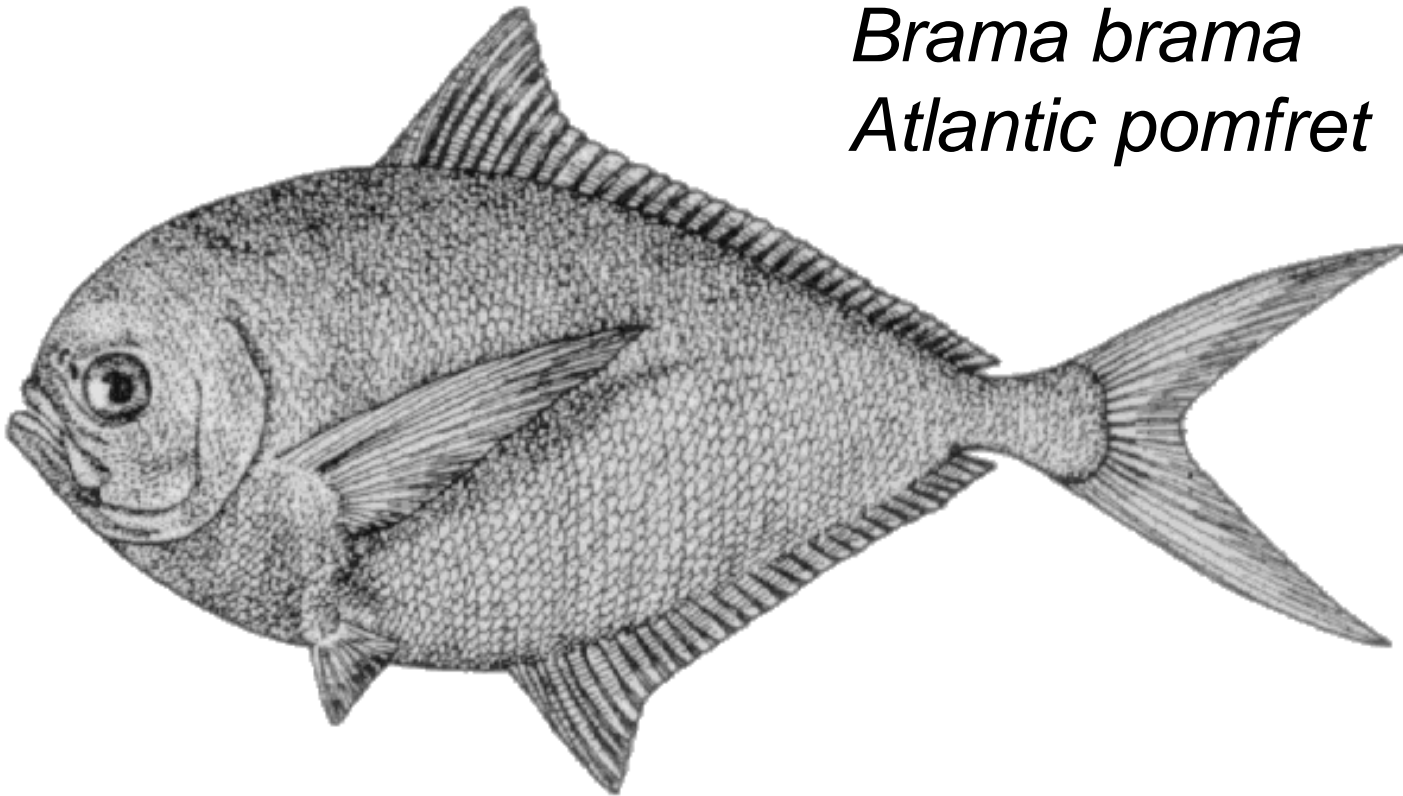
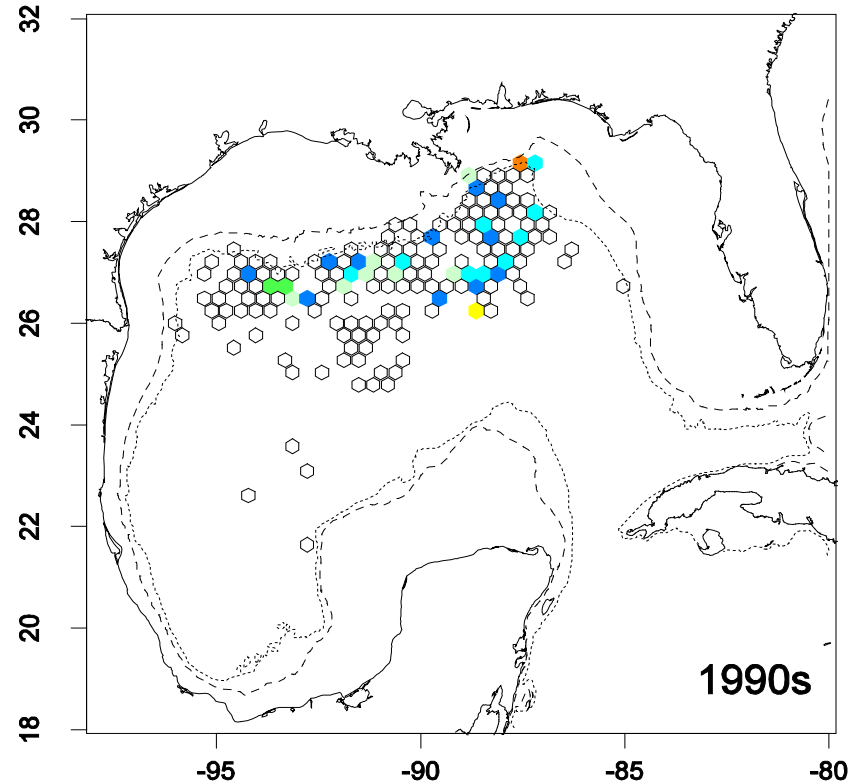
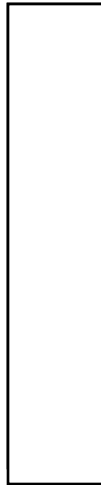
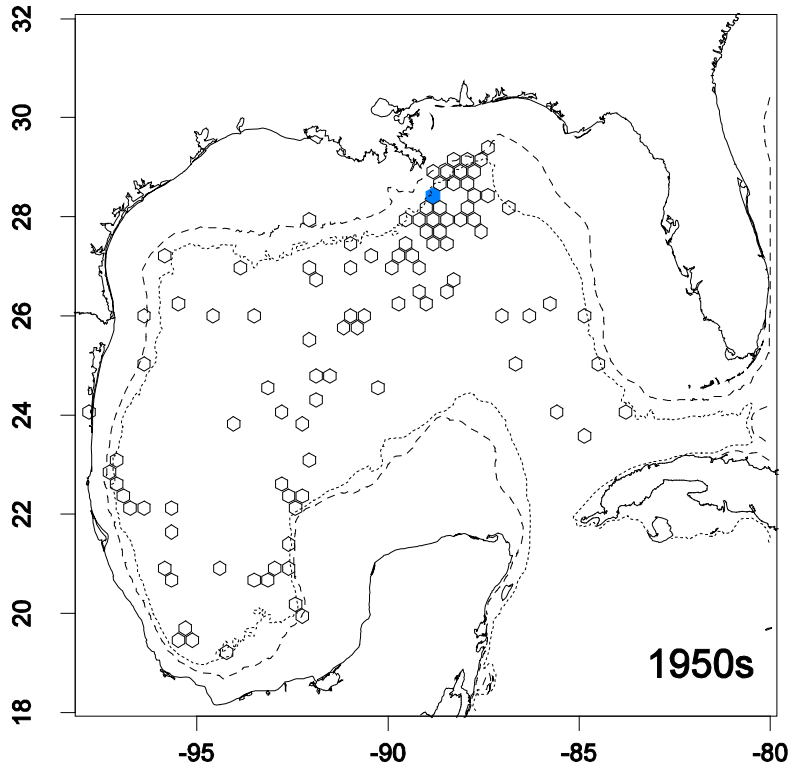


Illustration taken from the book "Encyclopedia of Canadian Fishes" by Brian W. Coad with Henry Waszczuk and Italo Labignan, 1995,

Explosion of Pomfrets in the Gulf of Mexico ~ 1000 fold increase – no one noticed



1950's

1990's

Pomfret captures per 10,000 hooks

The Rise of the Marine Mesopredators

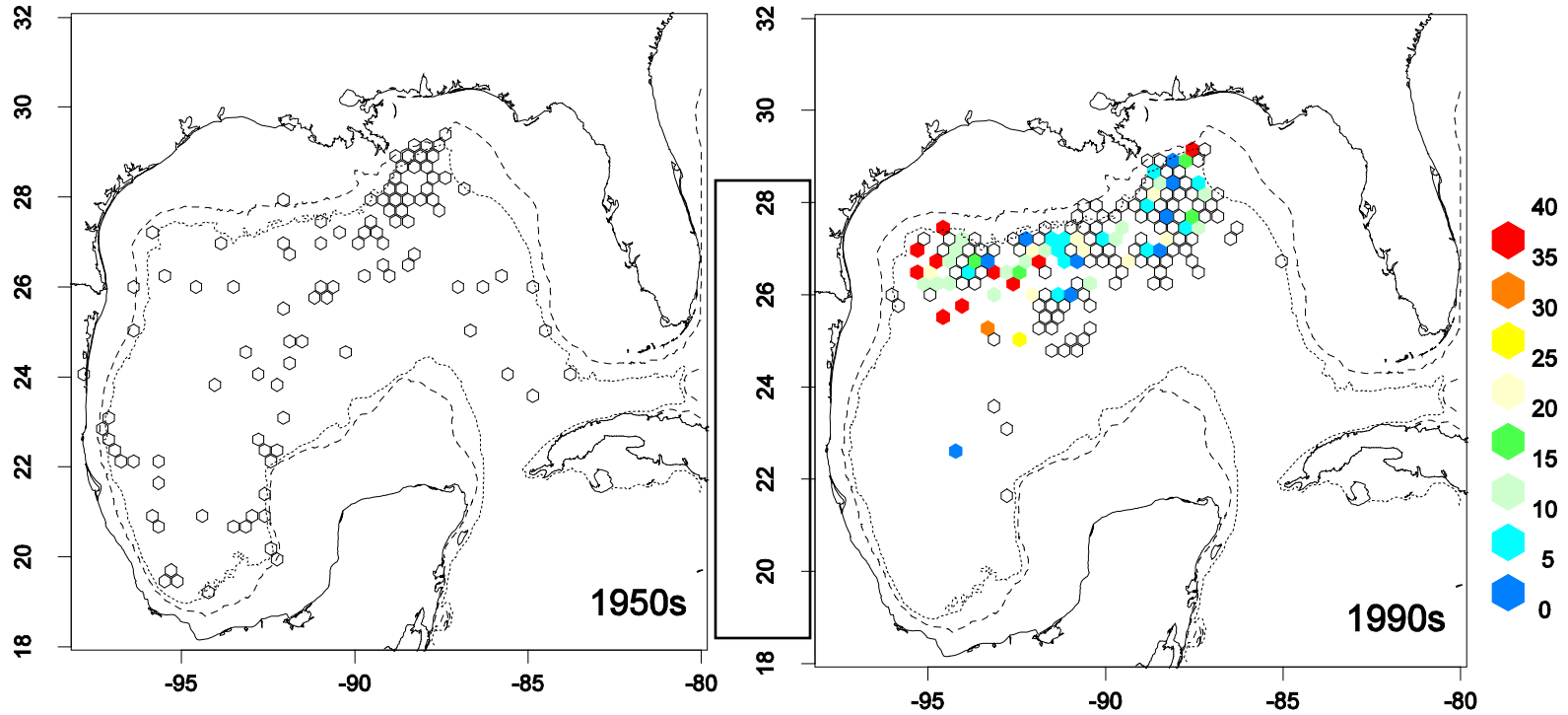


Pelagic Sting Ray
Pteroplatytrygon violacea



Photos from Phillip Colla, photography

Explosion of Pelagic Stingrays in the Gulf of Mexico ~ 1000 fold increase – no one noticed

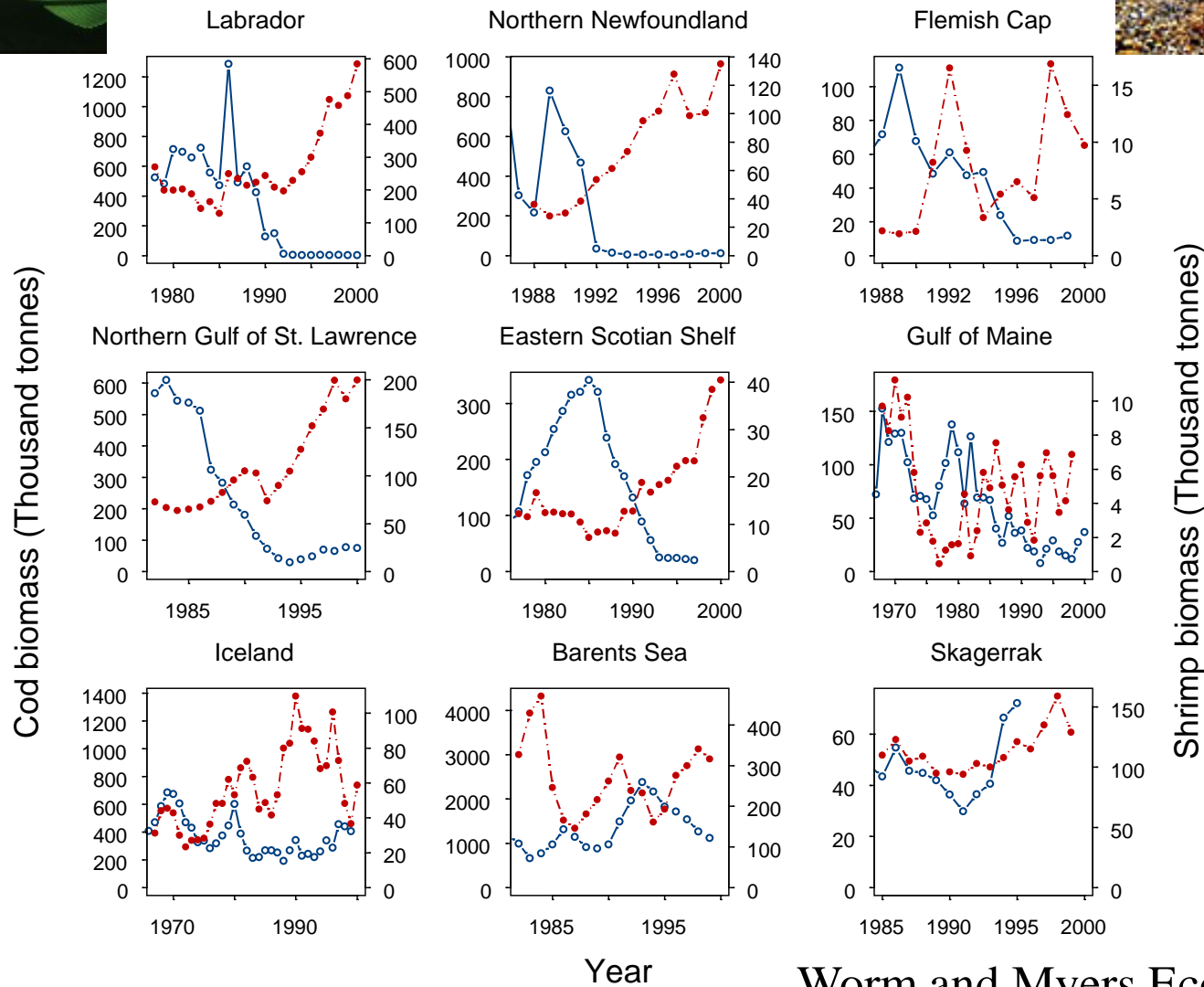


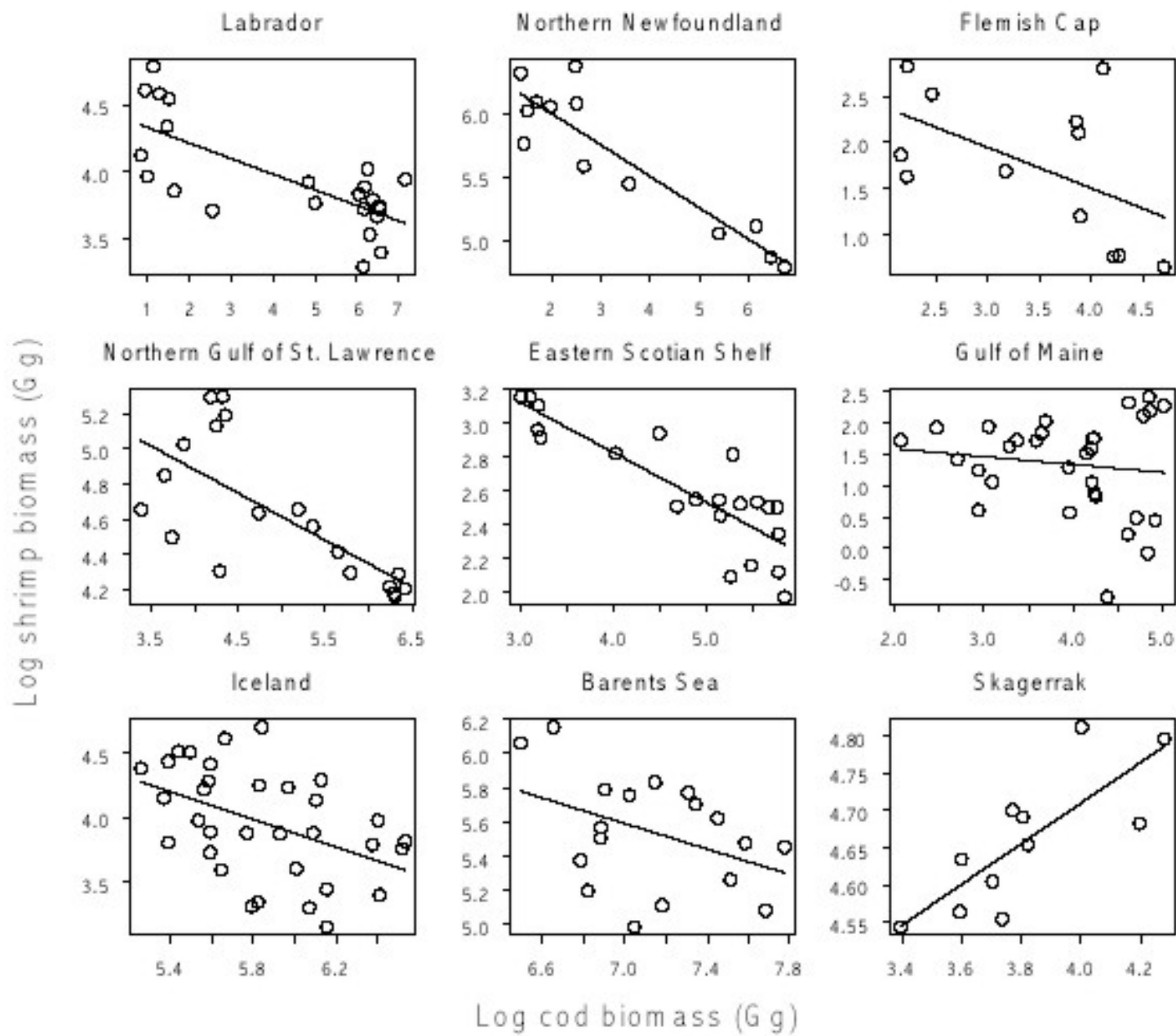
1950's

1990's

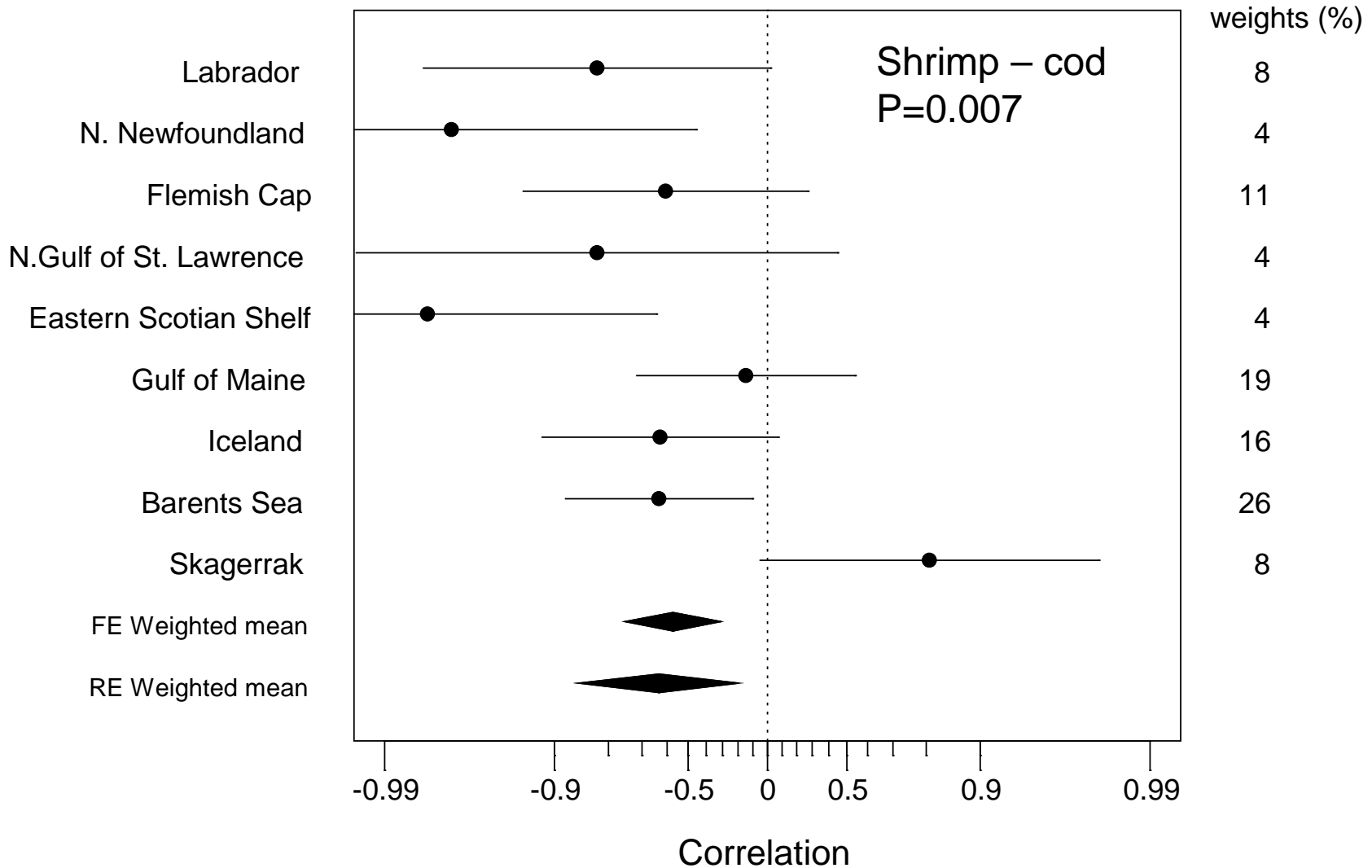
Pelagic stingray captures per 10,000 hooks

Cod and shrimp biomass in the North Atlantic: time series





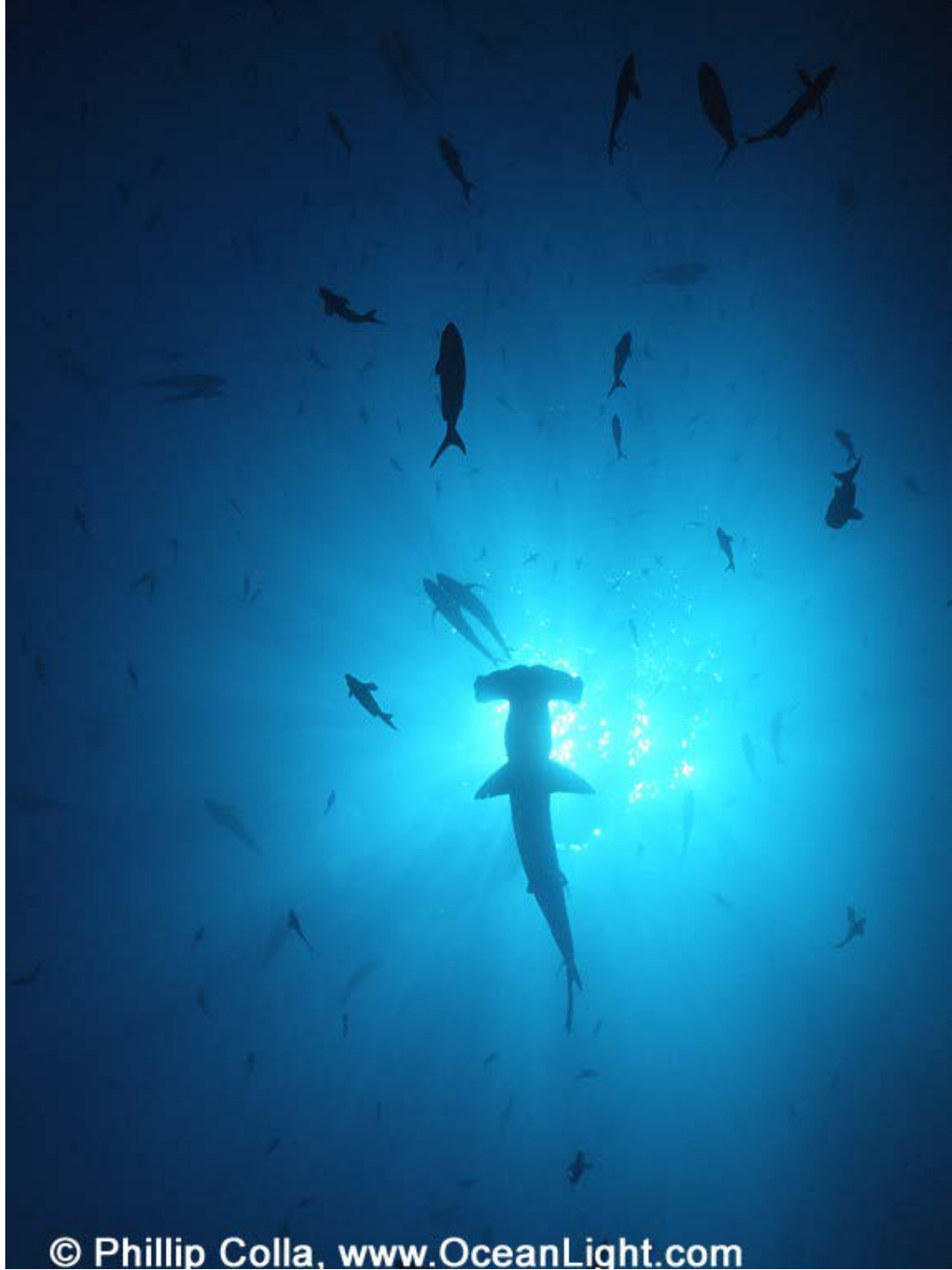
Step 2: Random-effects meta-analysis

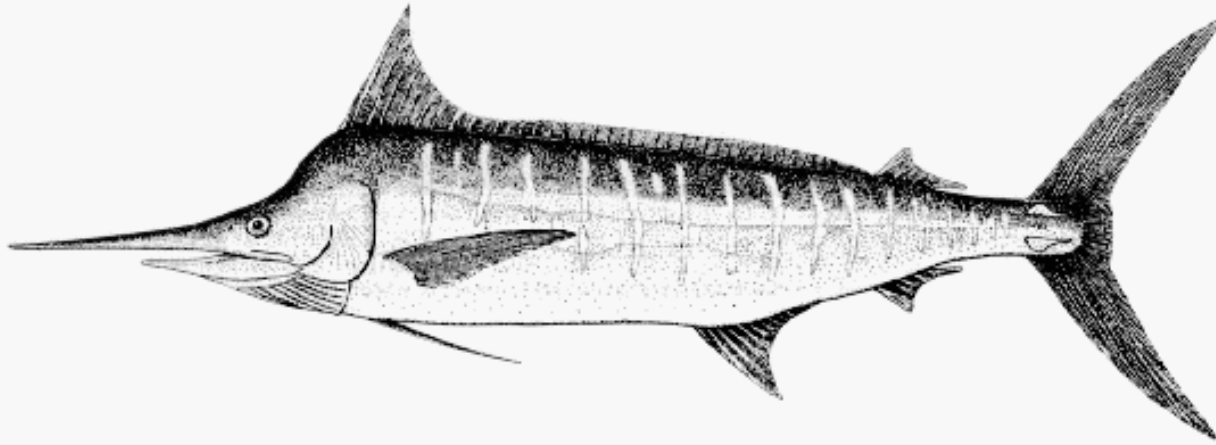


***The First Collective Act of
Humanity was to save the
great whales –***

despite massive denial

***– we can do
the same for the remaining
virgin areas of the oceans
and for the great sharks.***

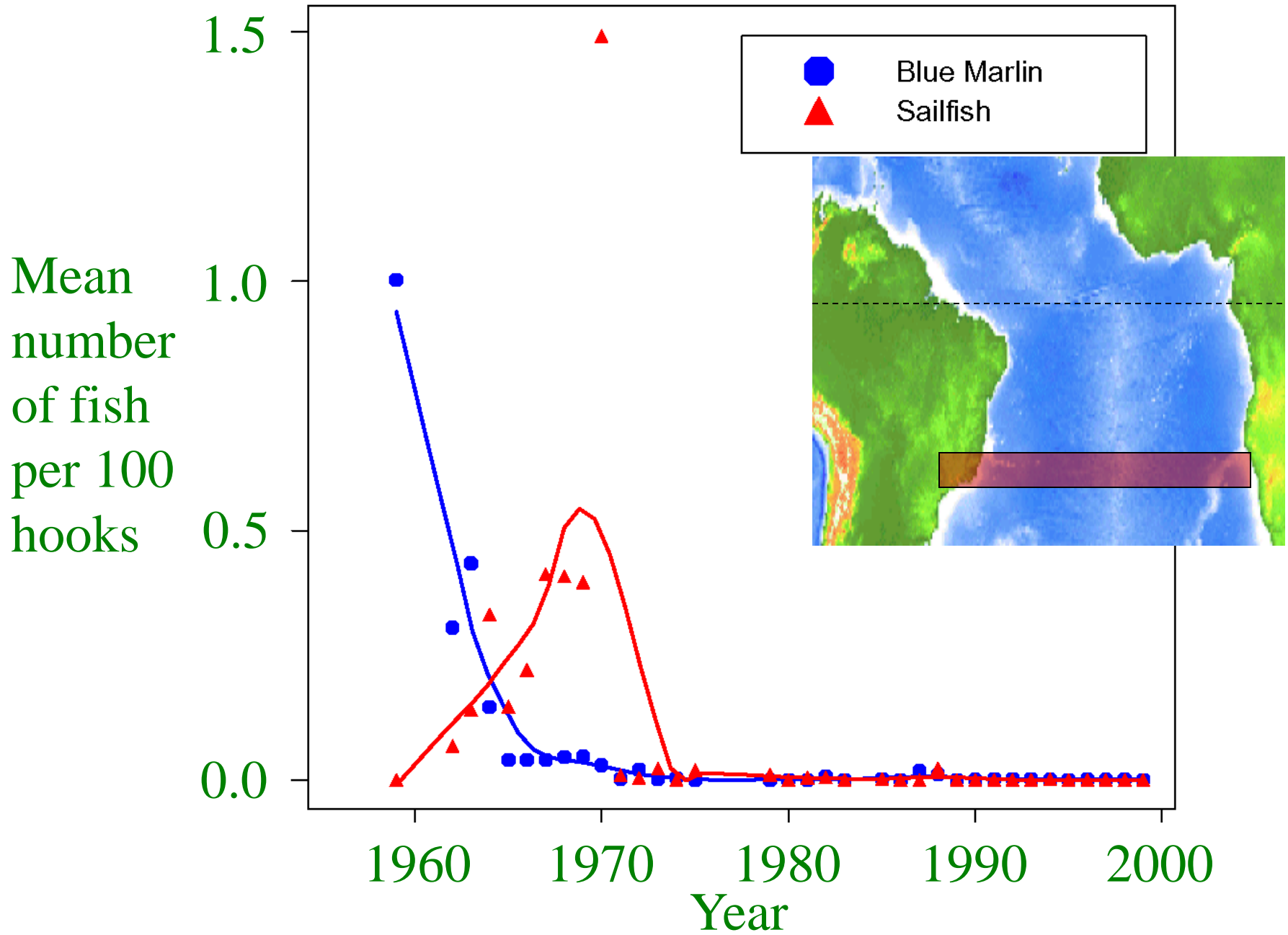




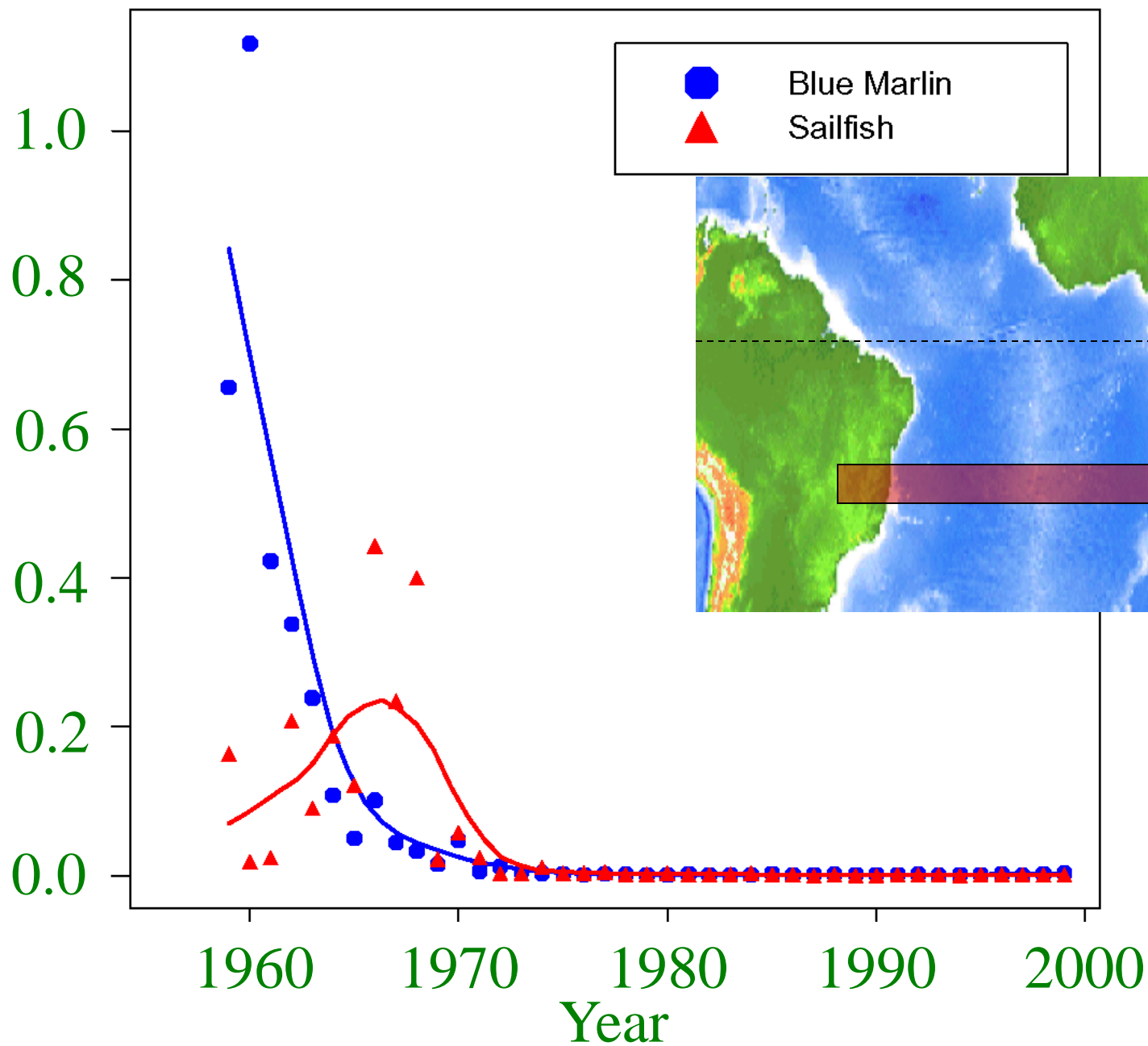
Blue marlin
(*Makaira
nigricans*)

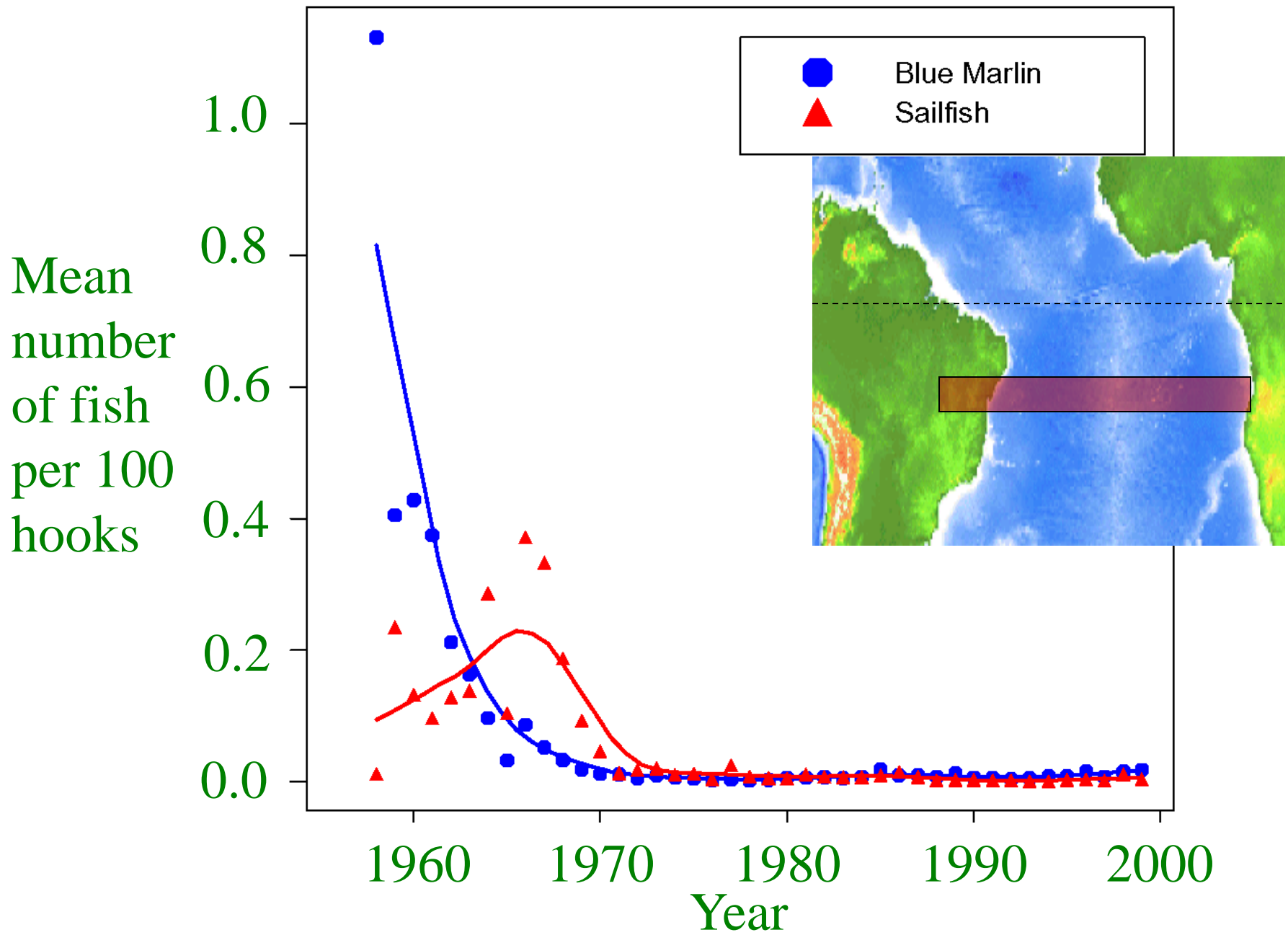


Sailfish
(*Istiophorus
albicans*)

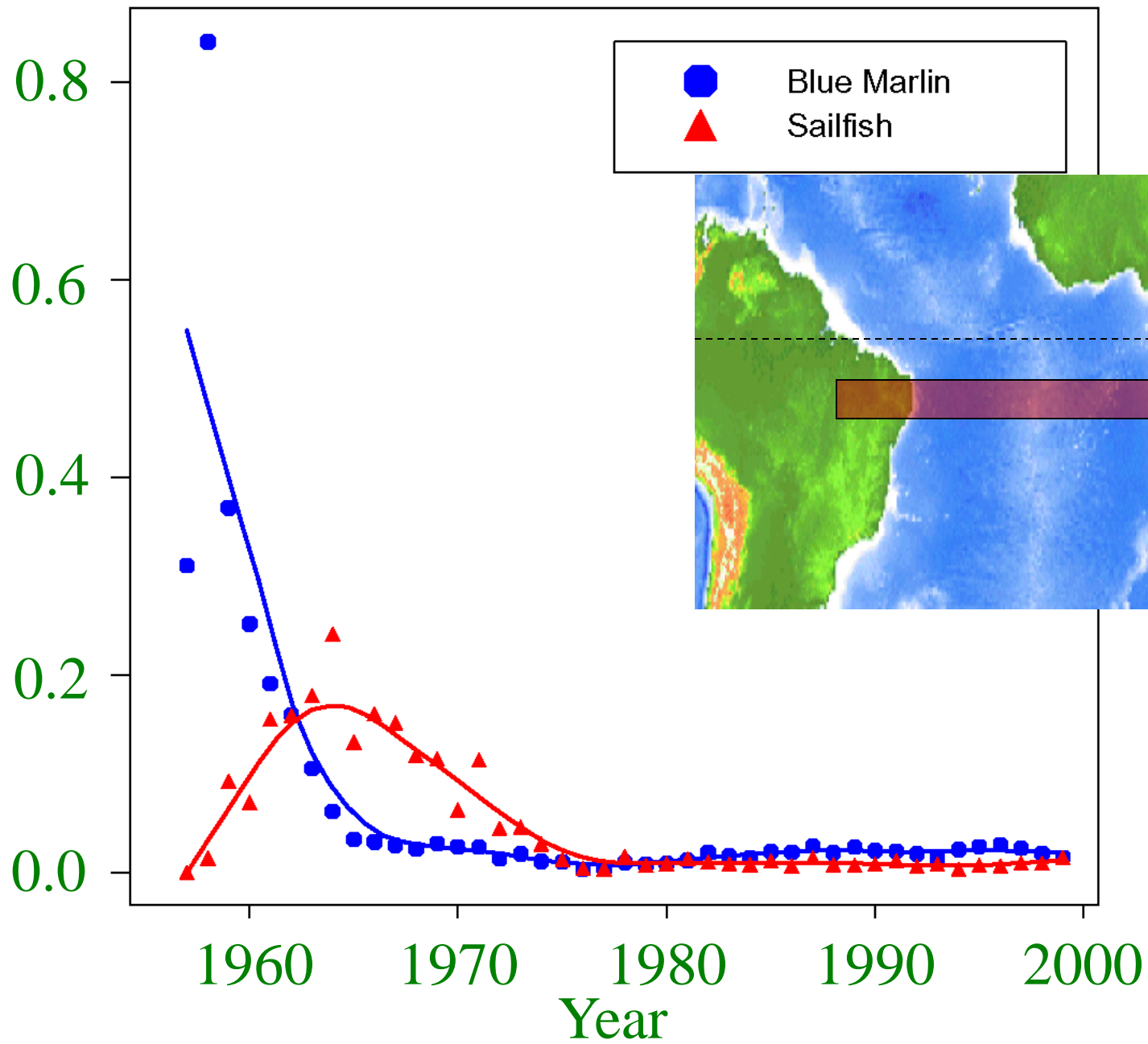


Mean
number
of fish
per 100
hooks

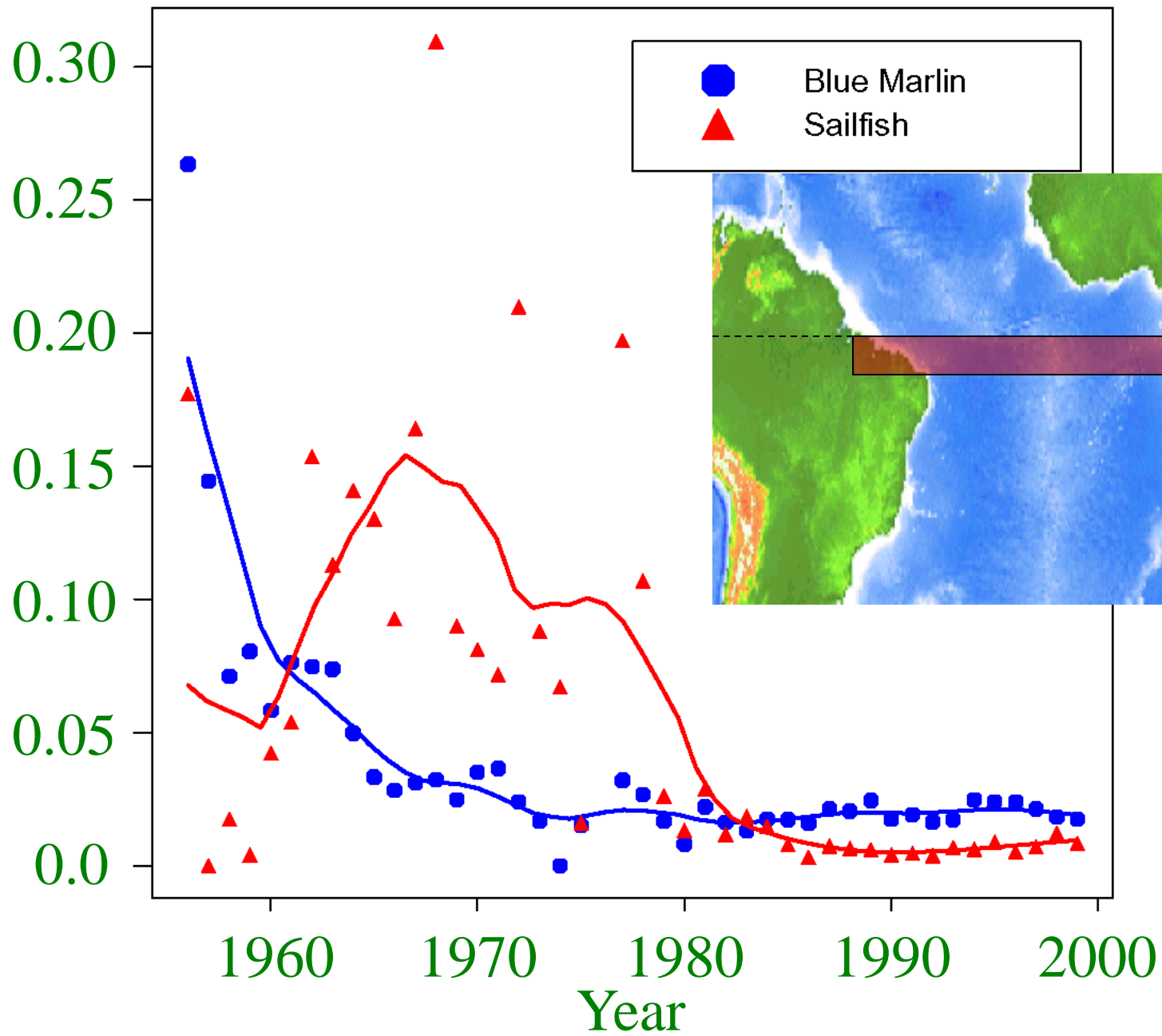




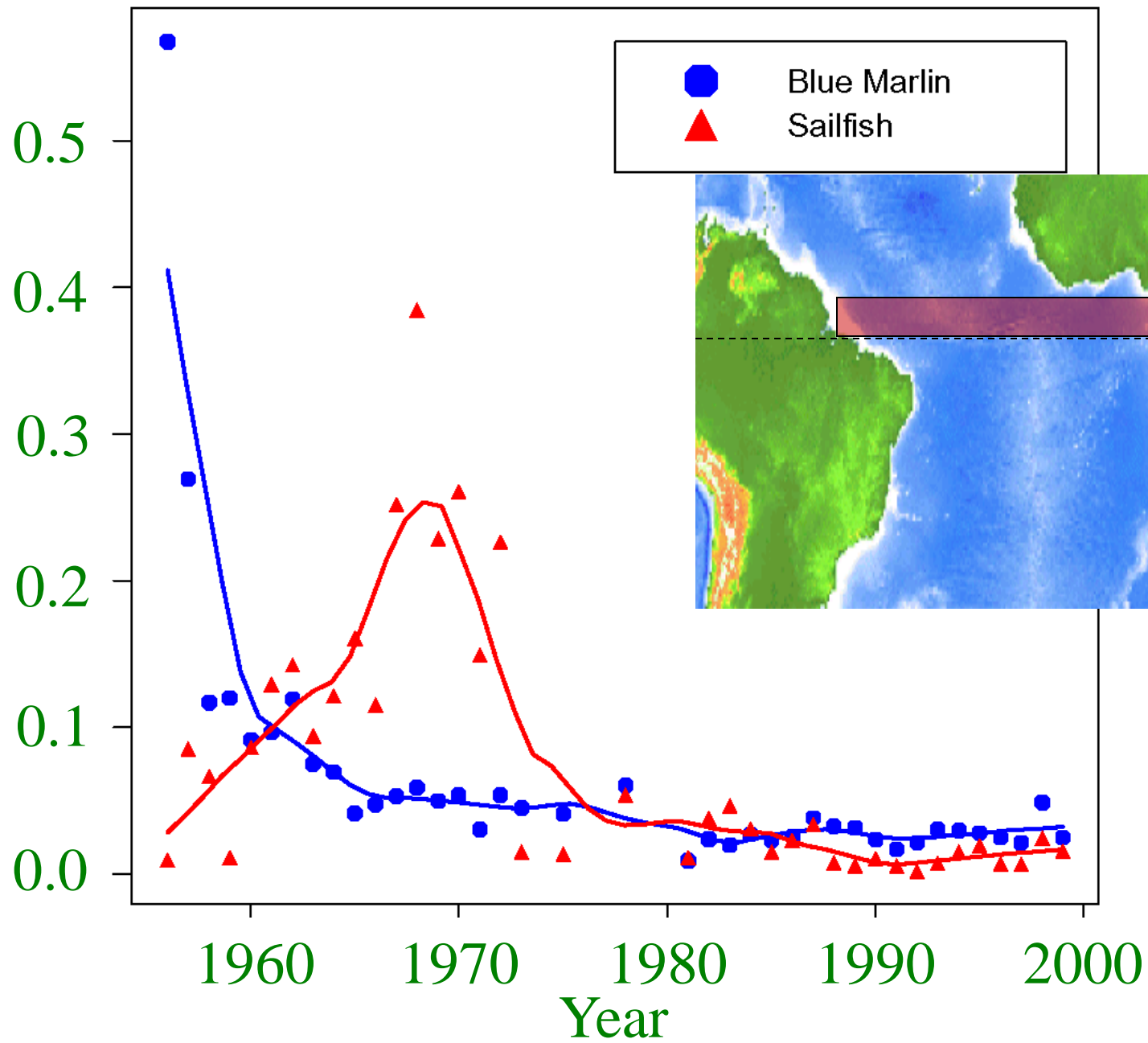
Mean
number
of fish
per 100
hooks



Mean
number
of fish
per 100
hooks



Mean
number
of fish
per 100
hooks



Not only have large predators declined by at least a factor of 10, but mesopredators have often increased by at least a factor of 10.



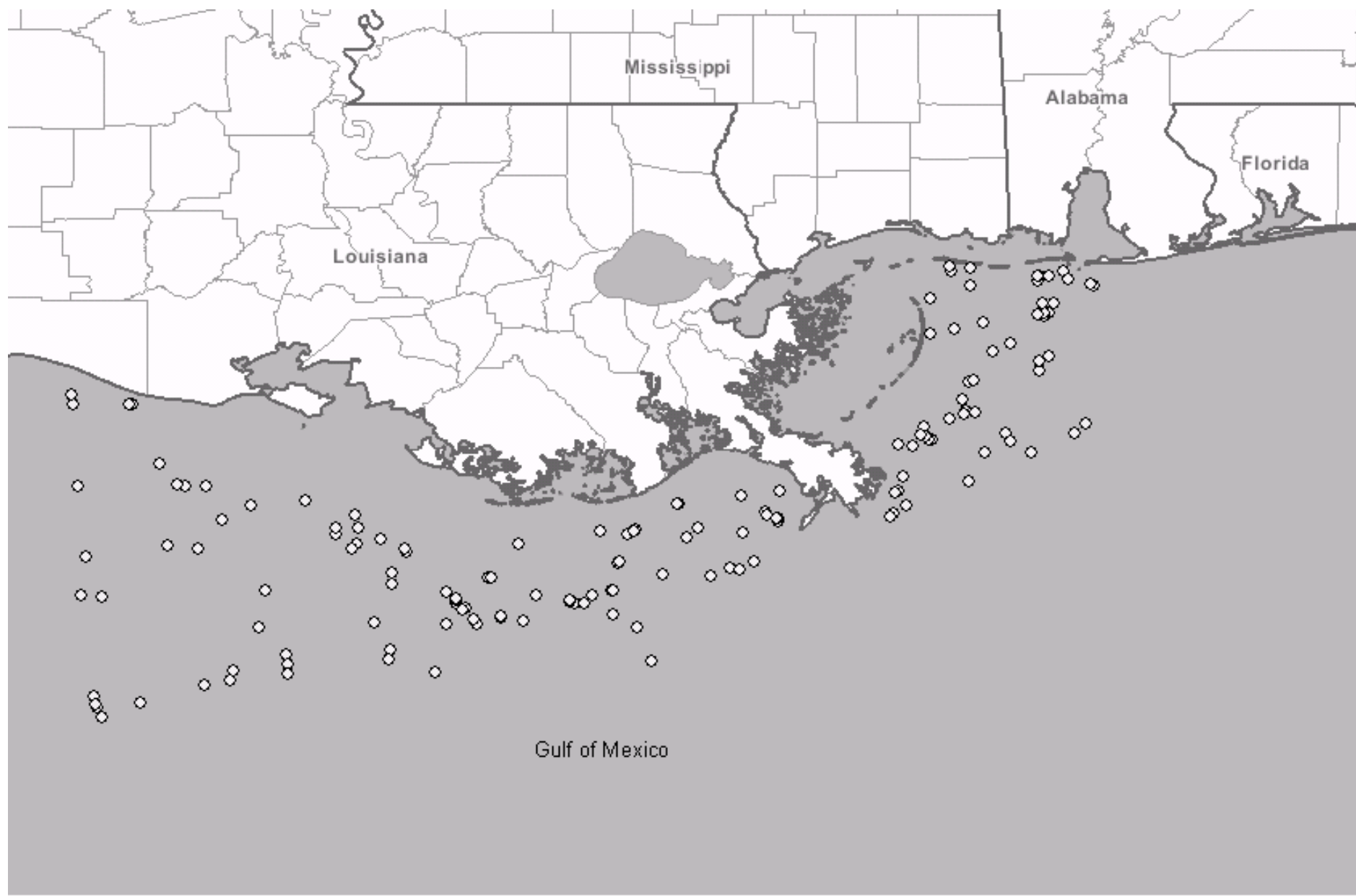
FMAP (Future of Marine Animal Populations)

part of the Sloan Census of Life <http://www.fmap.ca>

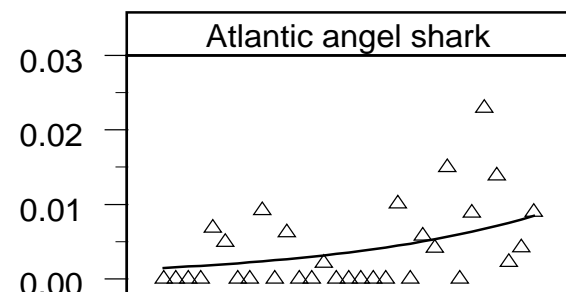
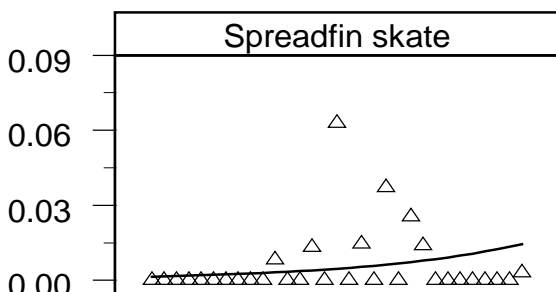
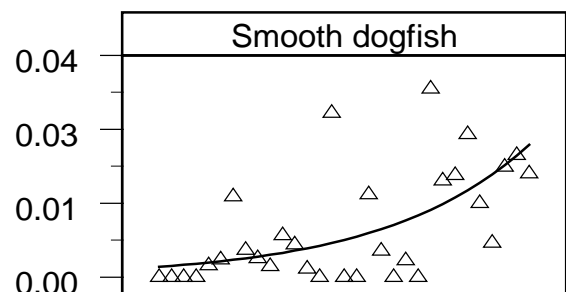
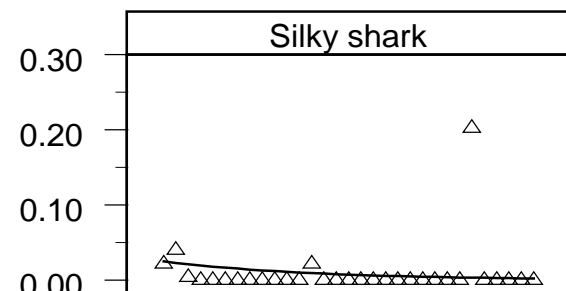
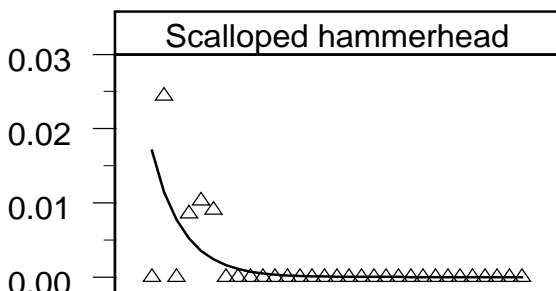
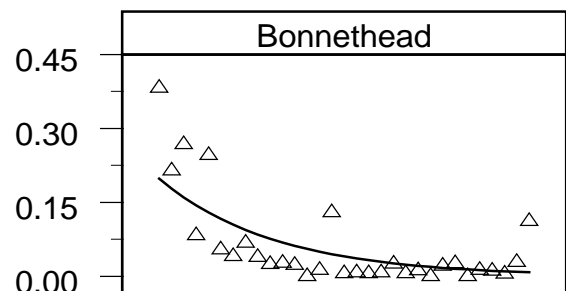
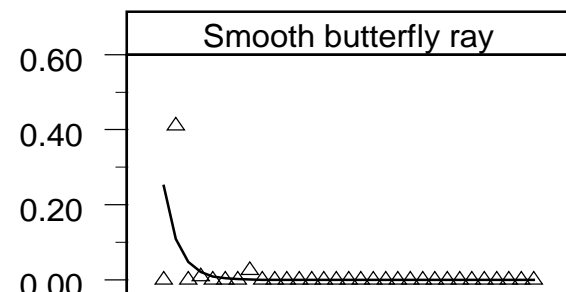
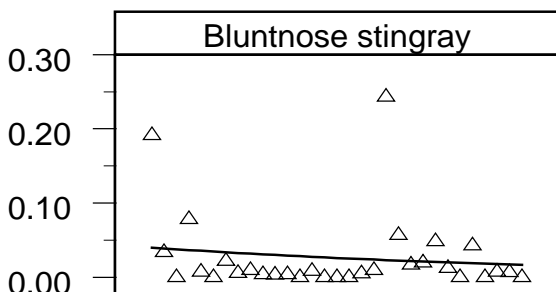
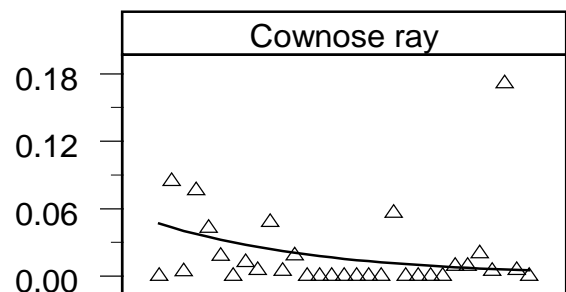
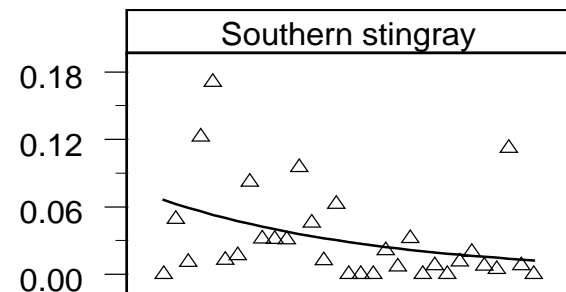
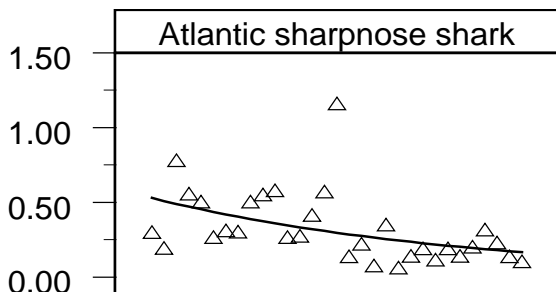
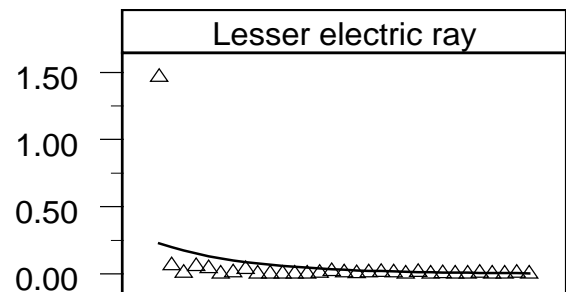
Pew Global Sharks Assessment

<http://www.globalsharks.ca>

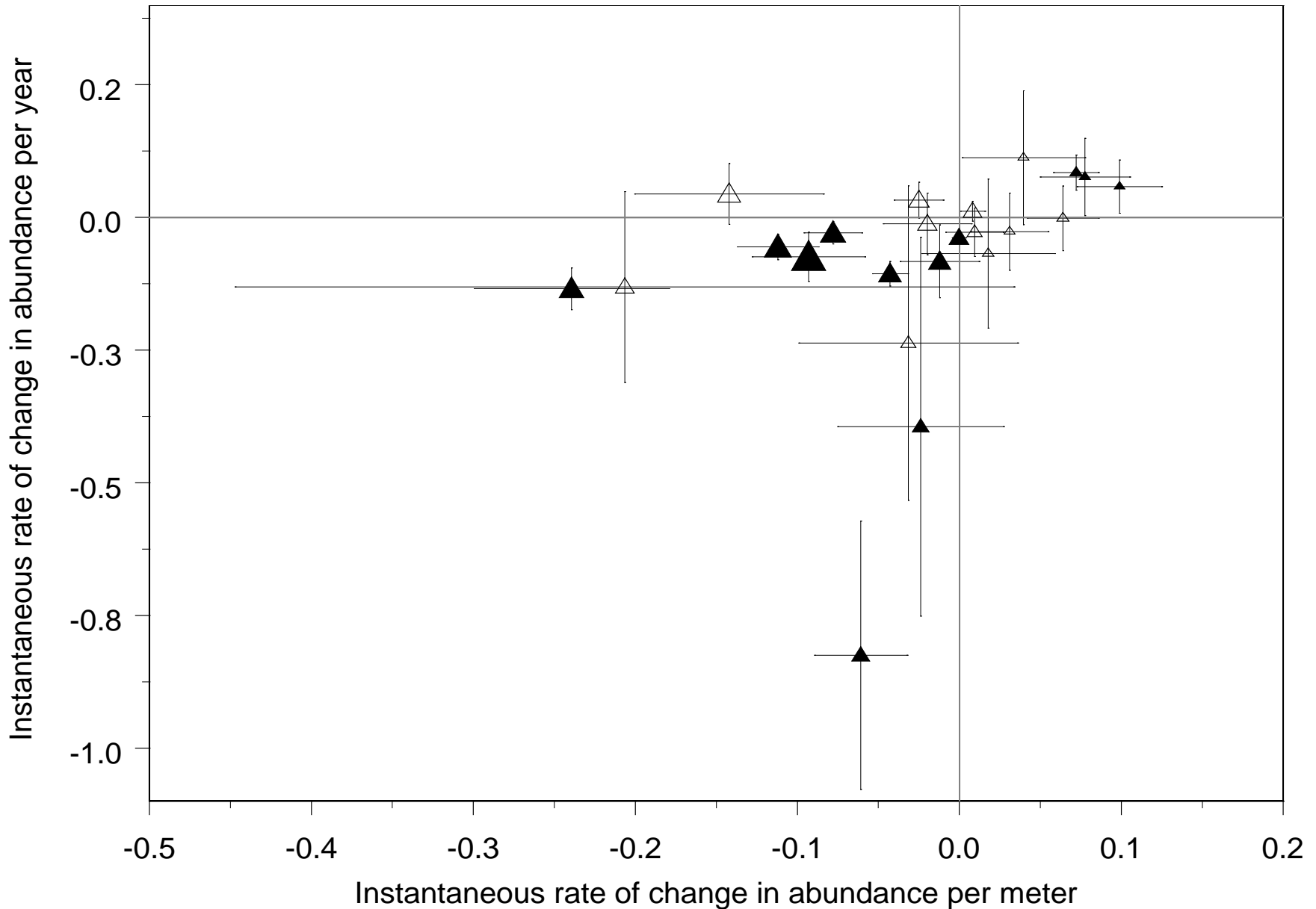
Is shrimp trawling driving sharks and rays extinct?

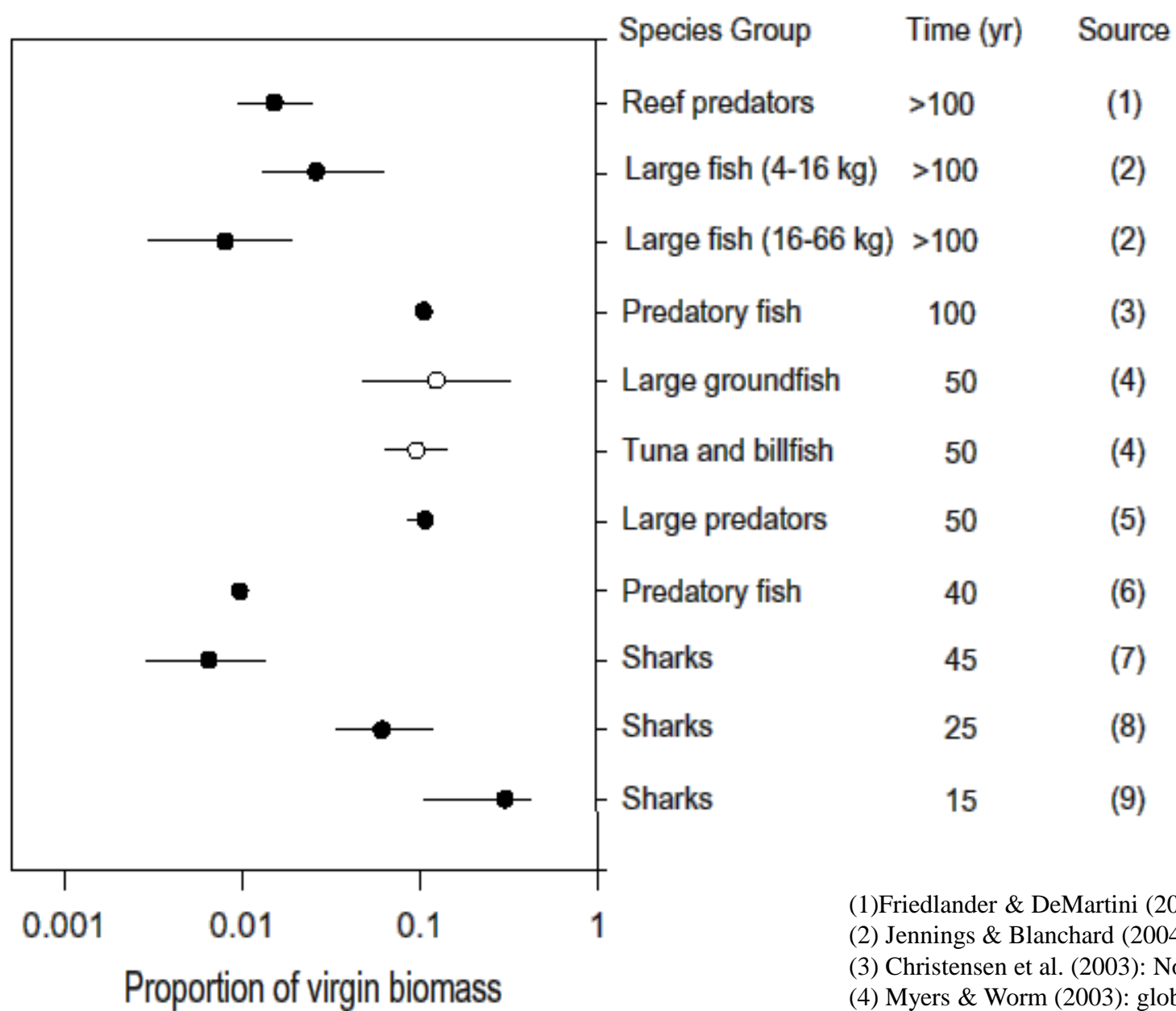


Mean standardized catch per tow



Shallow species are going extinct
Deep species are increasing





- (1) Friedlander & DeMartini (2002): Hawaiian reefs;
 (2) Jennings & Blanchard (2004): North Sea;
 (3) Christensen et al. (2003): North Atlantic;
 (4) Myers & Worm (2003): global;
 (5) Ward & Myers (2003): North Pacific;
 (6) Tang et al. (2003): Bohai Sea;
 (7) Baum & Myers (2004): Gulf of Mexico;
 (8) Vacchi et al. (2000): Mediterranean Sea;
 (9) Baum et al. (2003): Northwest Atlantic.

Source: Myers and Worm 2005.

Proc. R. Soc. Lond. B (2005)

Not only have large predators declined by at least a factor of 10, but mesopredators have often increased by at least a factor of 10.



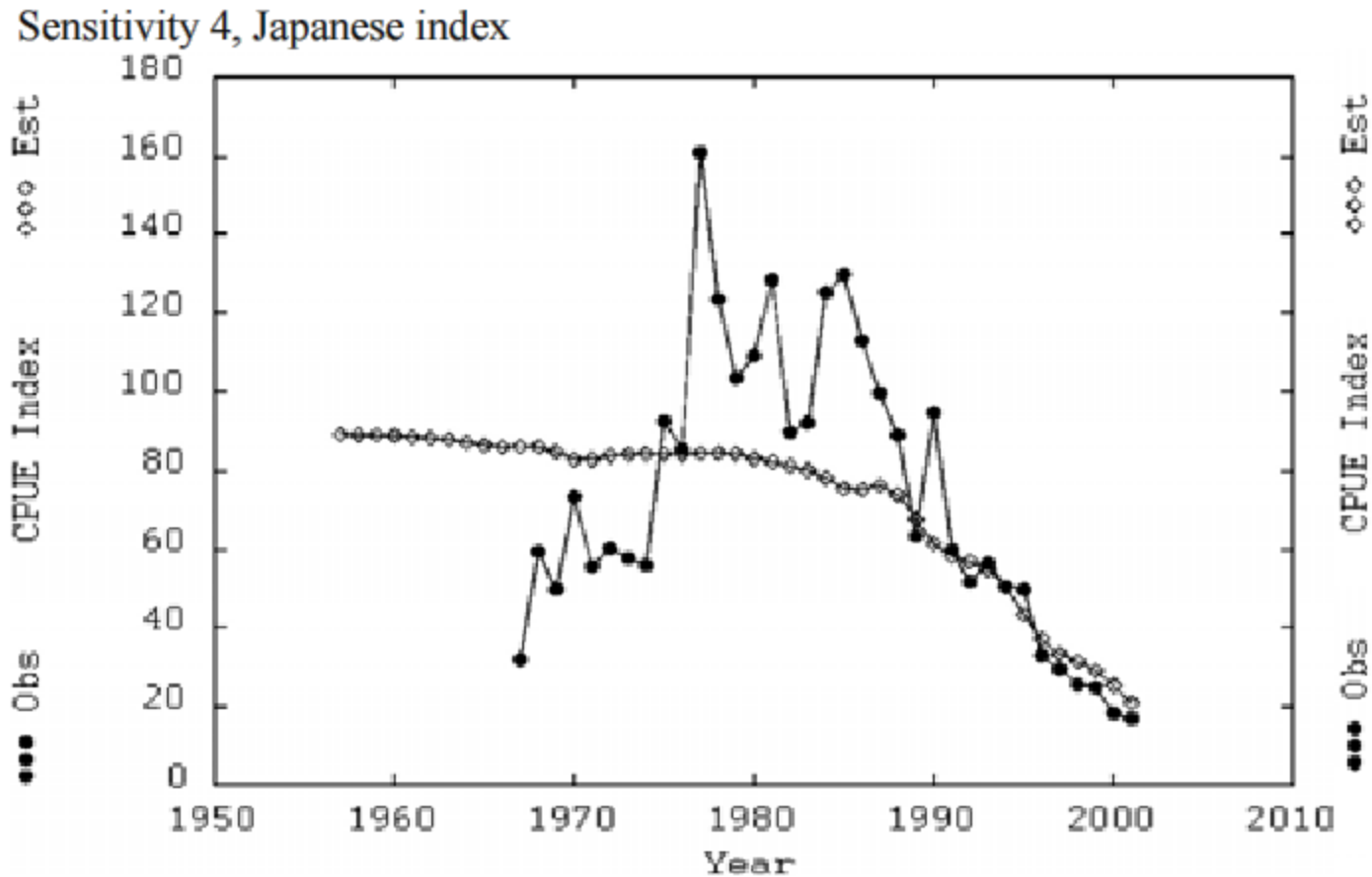
FMAP (Future of Marine Animal Populations)

part of the Sloan Census of Life <http://www.fmap.ca>

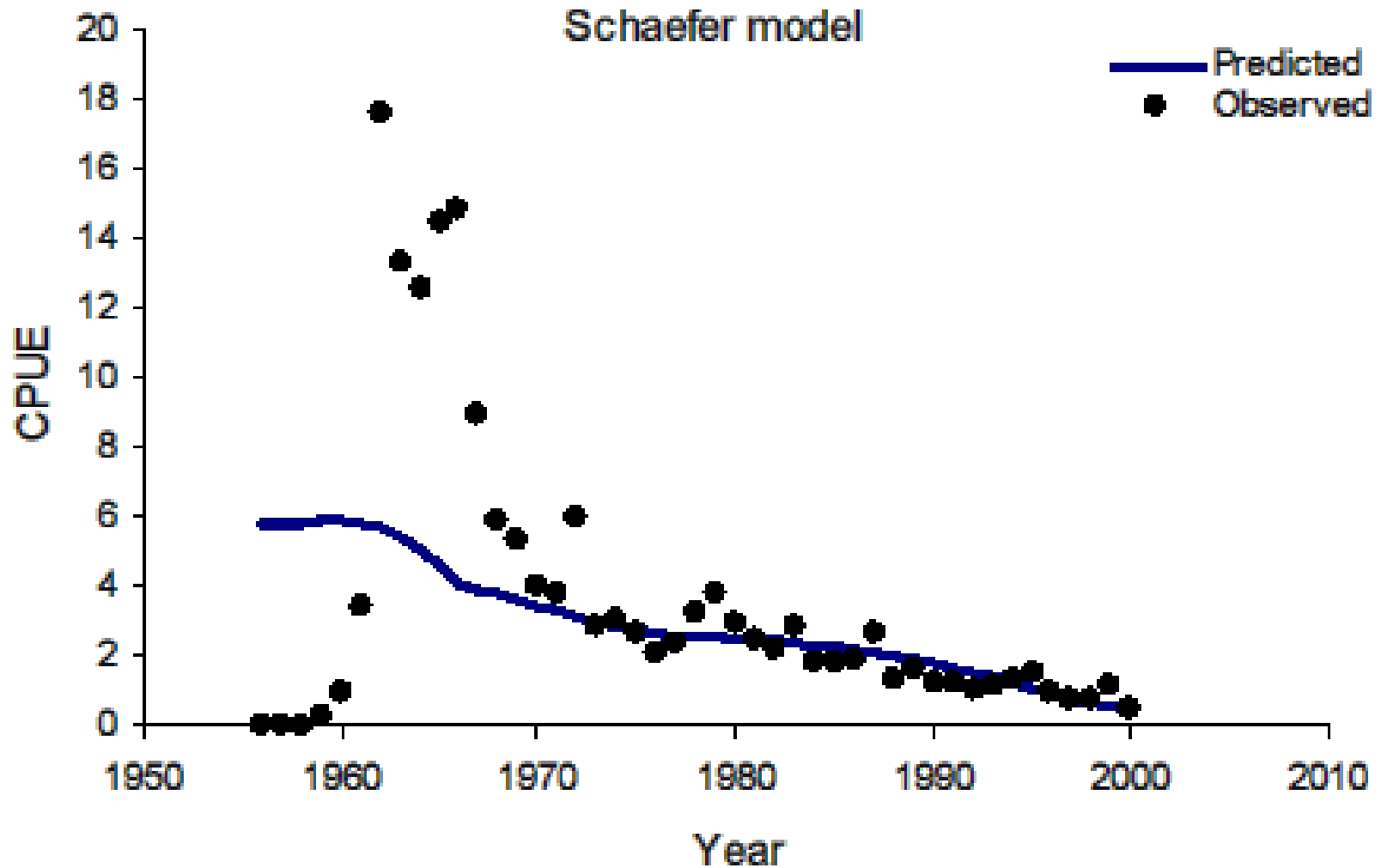
Pew Global Sharks Assessment

<http://www.globalsharks.ca>

Single species models are not even remotely consistent with the data, e.g. Swordfish from the South Atlantic



White Marlin: Atlantic, single species models do not work
Very well.



ICCAT shark assessments in the Atlantic don't even remotely fit reliable data:
Similar pattern for US government research surveys.

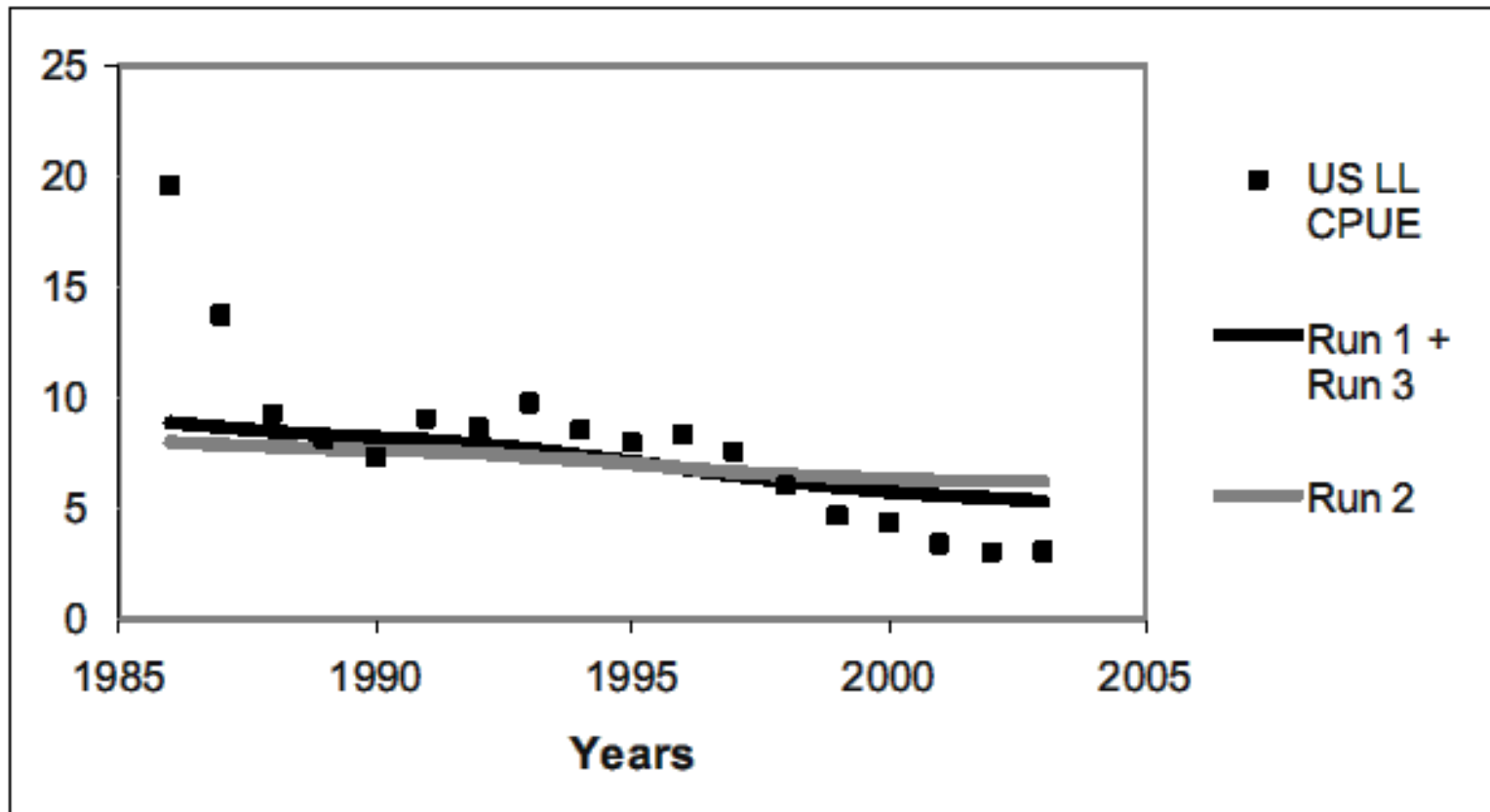
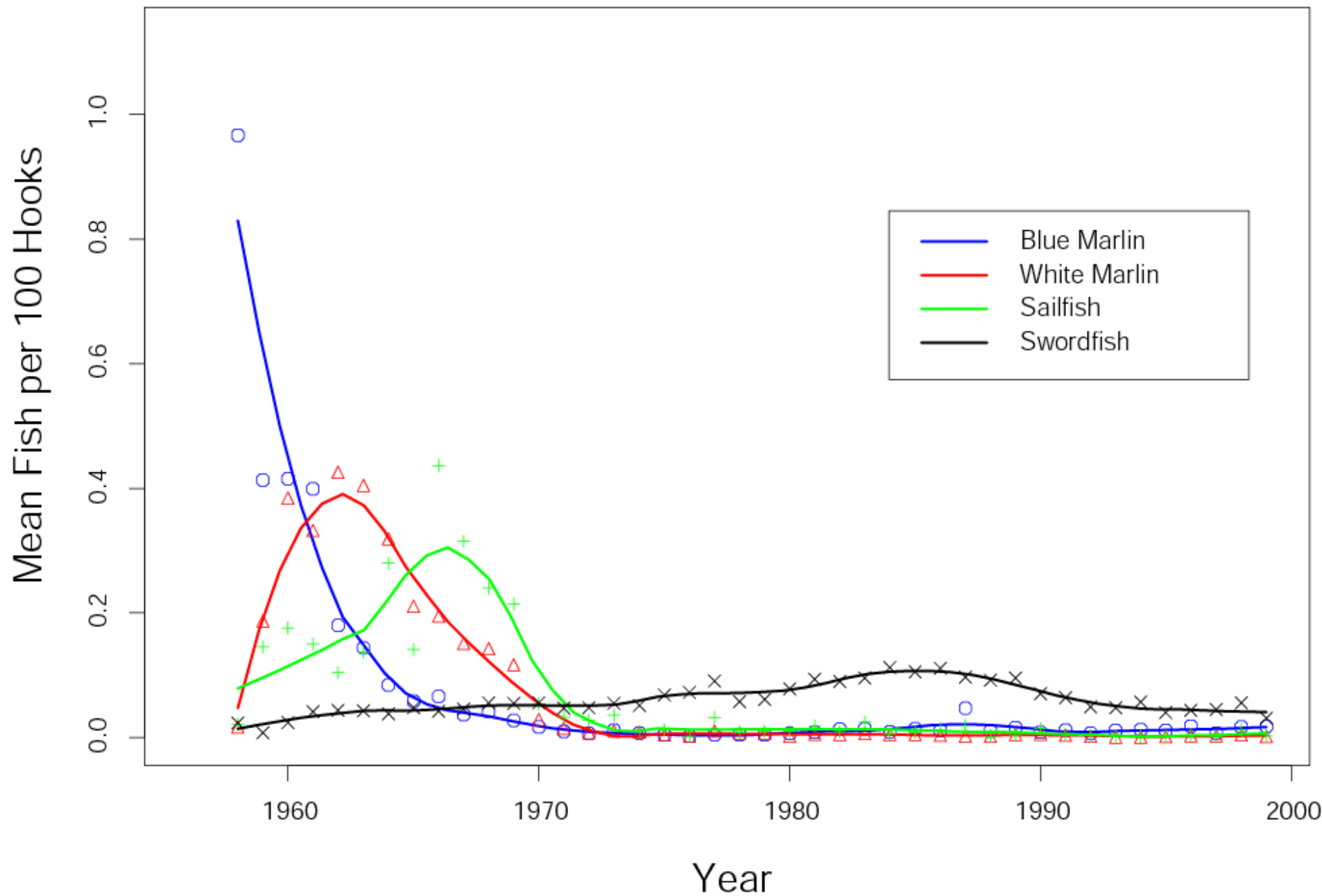
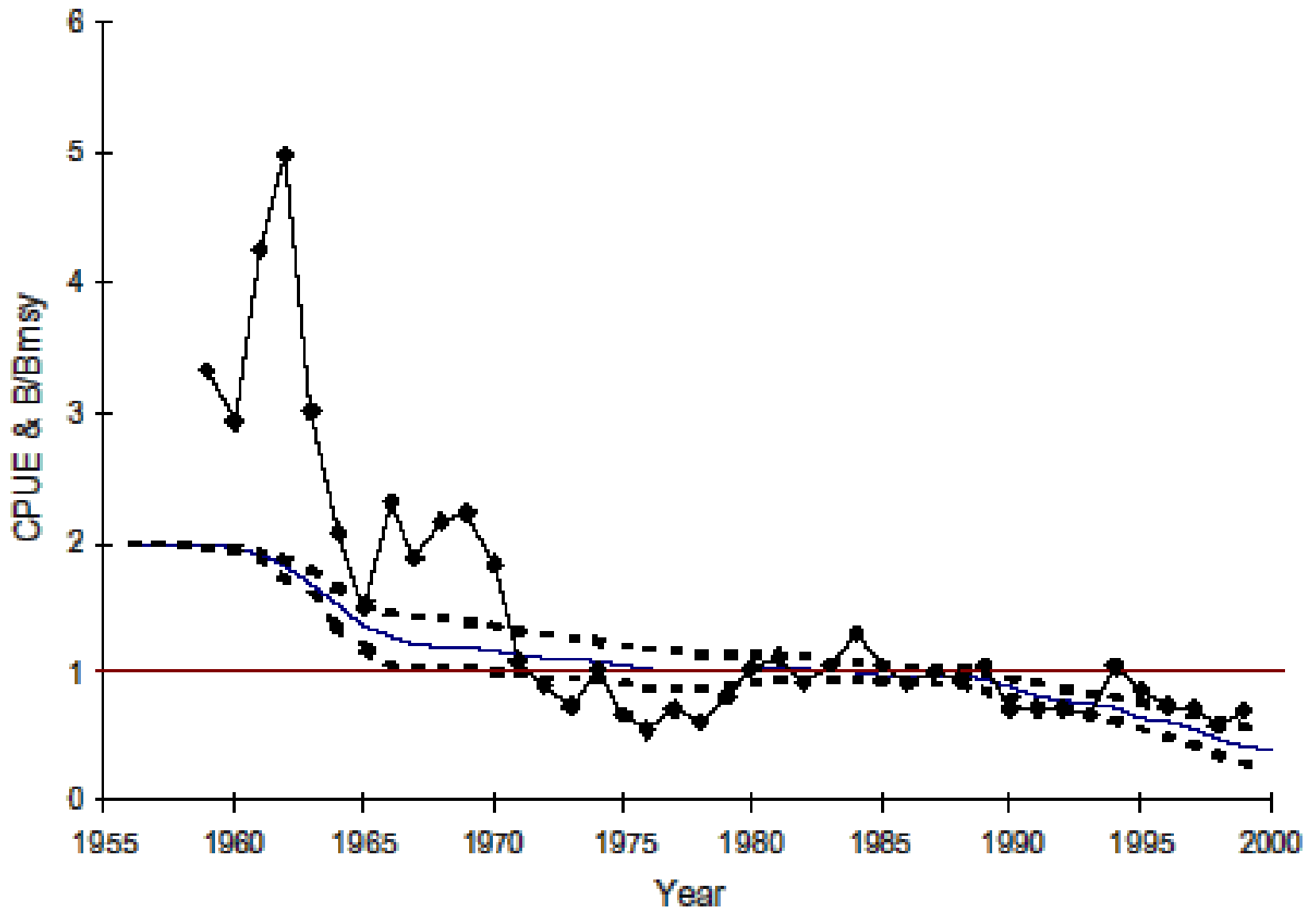


Figure 10 (above). Fit of the model to the North Atlantic blue shark CPUE data for each of the runs considered.

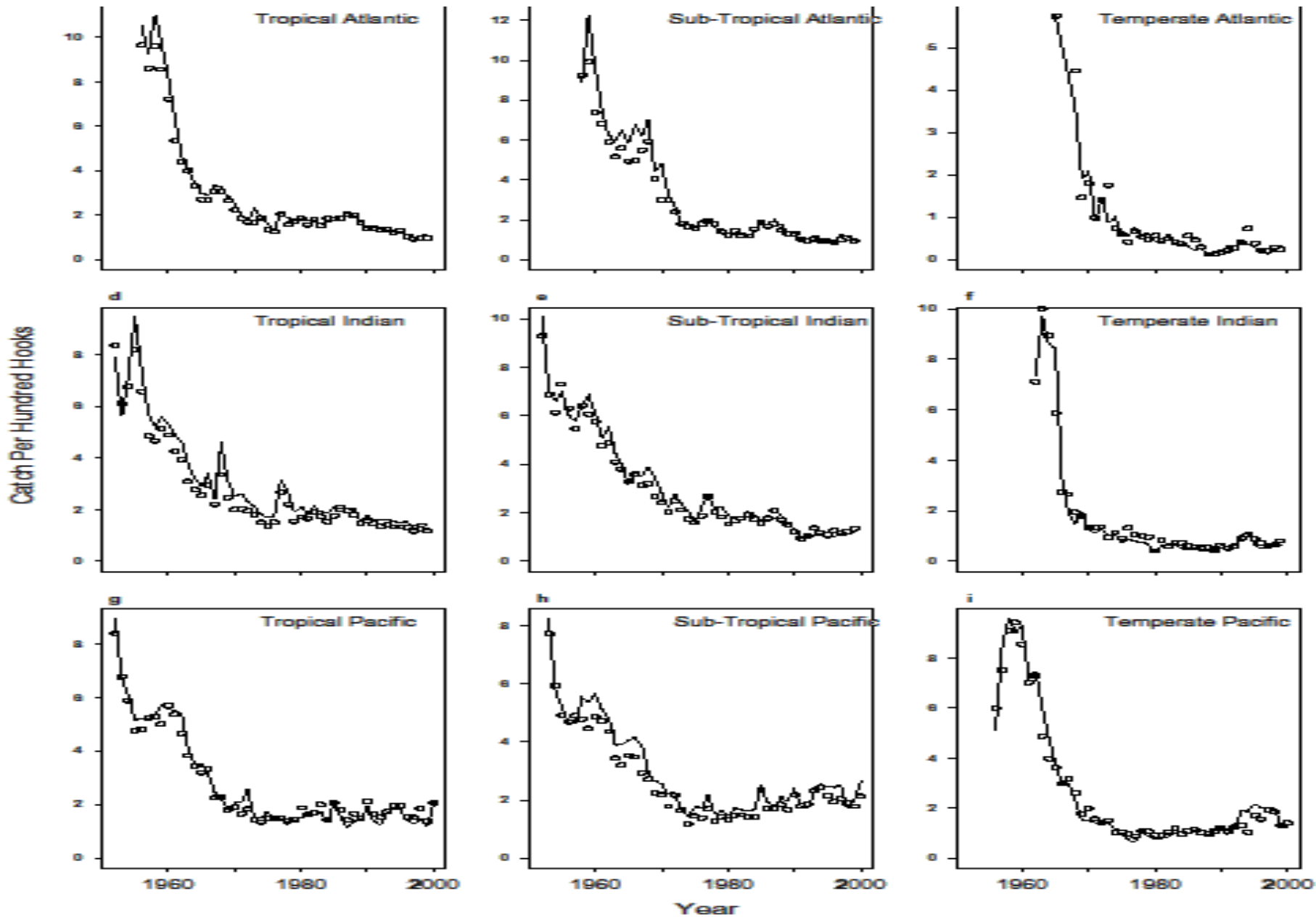
Atlantic, Latitude = -15 to -10



Bluefine tuna (observed diamonds) and modeled – not a very good fit.

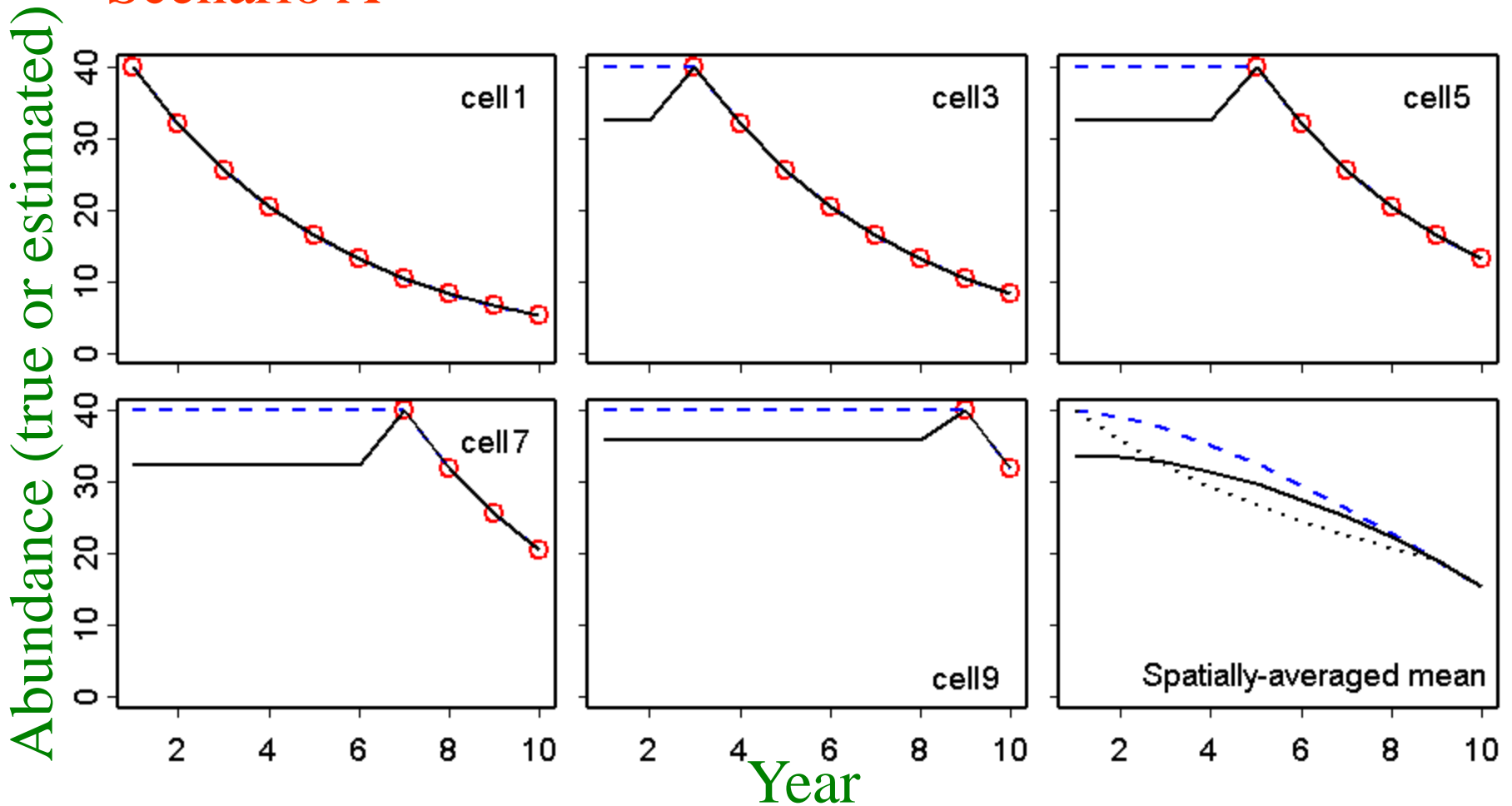


RED HERRING 1: RATIO ESTIMATION



RED HERRING 2: SPATIAL ESTIMATION

Scenario A



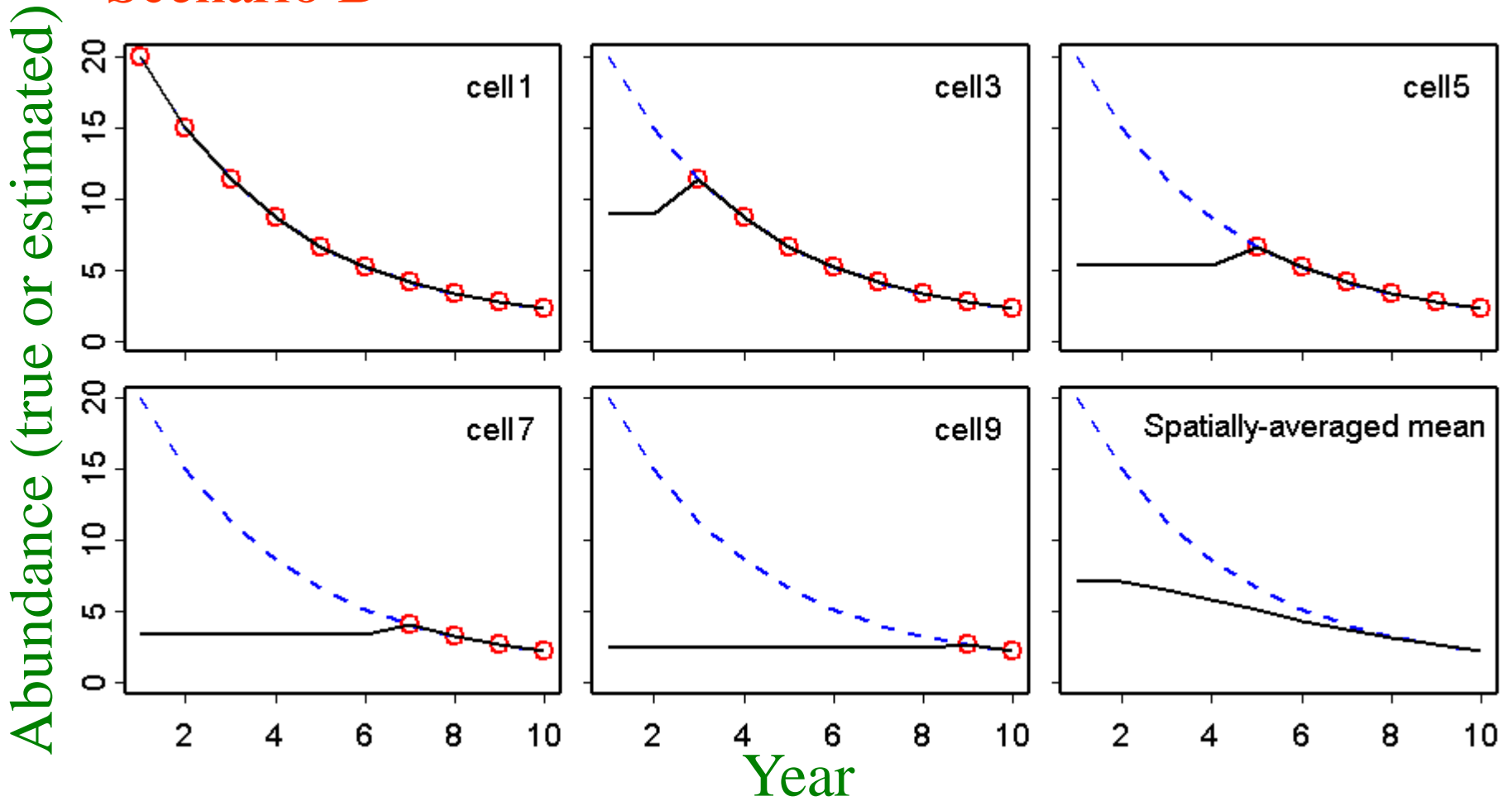
----- True population

○ Abundance estimate from CPUE

———— Abundance estimate, Walters' method

..... Spatial estimate, Myers and Worm's method

Scenario B



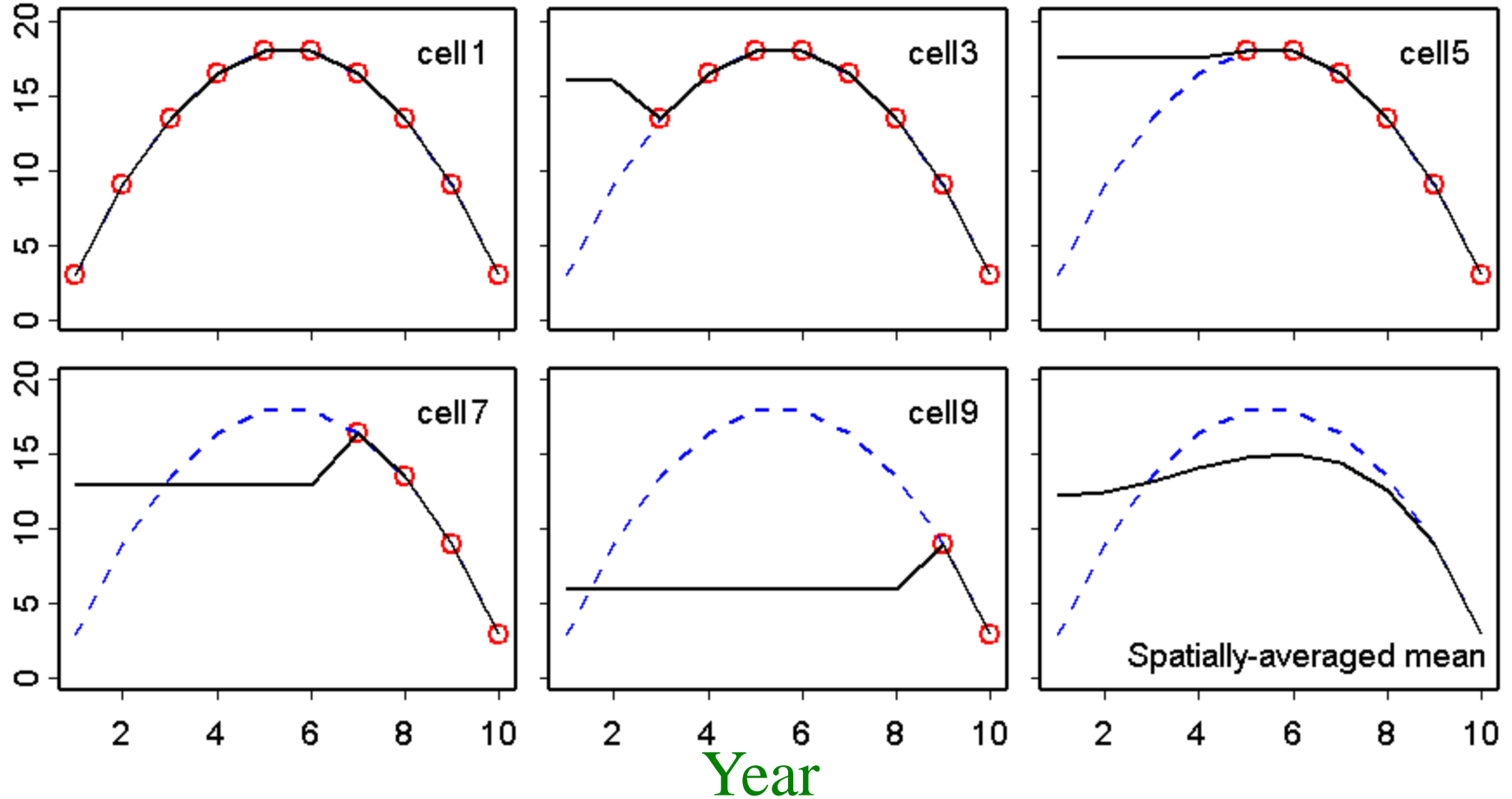
----- True population

○ Abundance estimate from CPUE

———— Abundance estimate, Walters' method

Scenario C

Abundance (true or estimated)



----- True population

○ Abundance estimate from CPUE

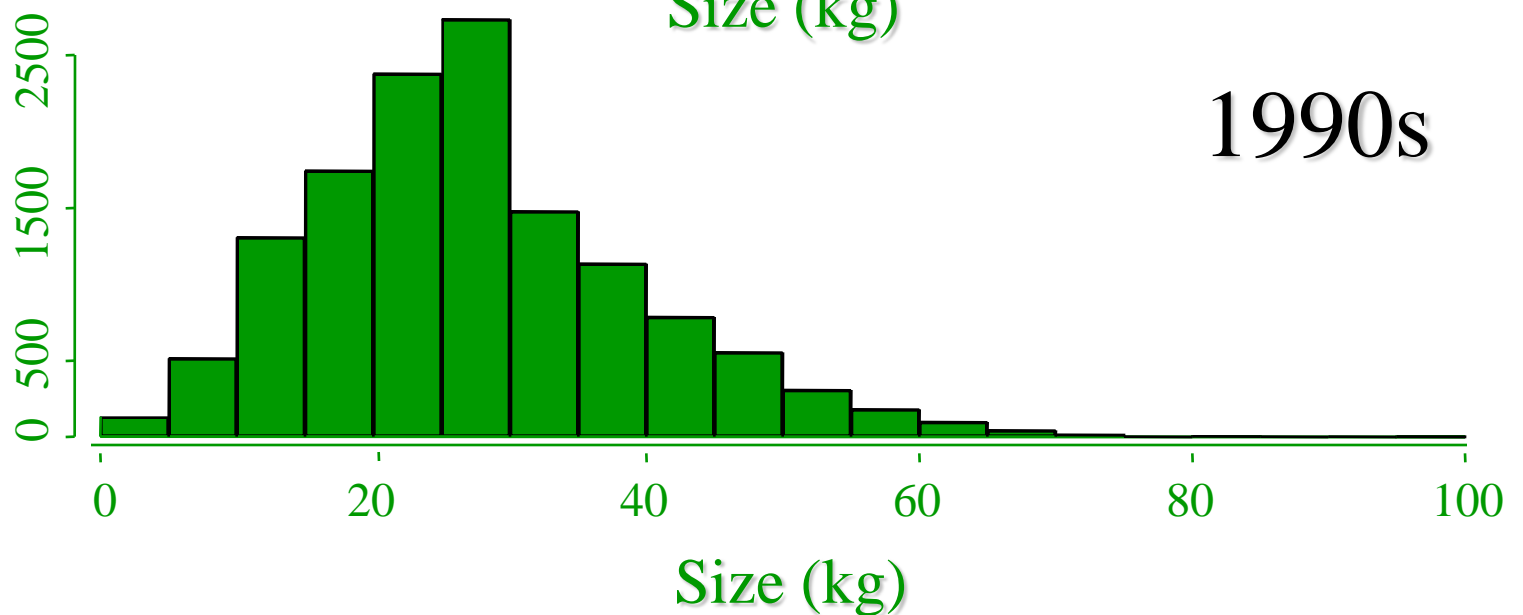
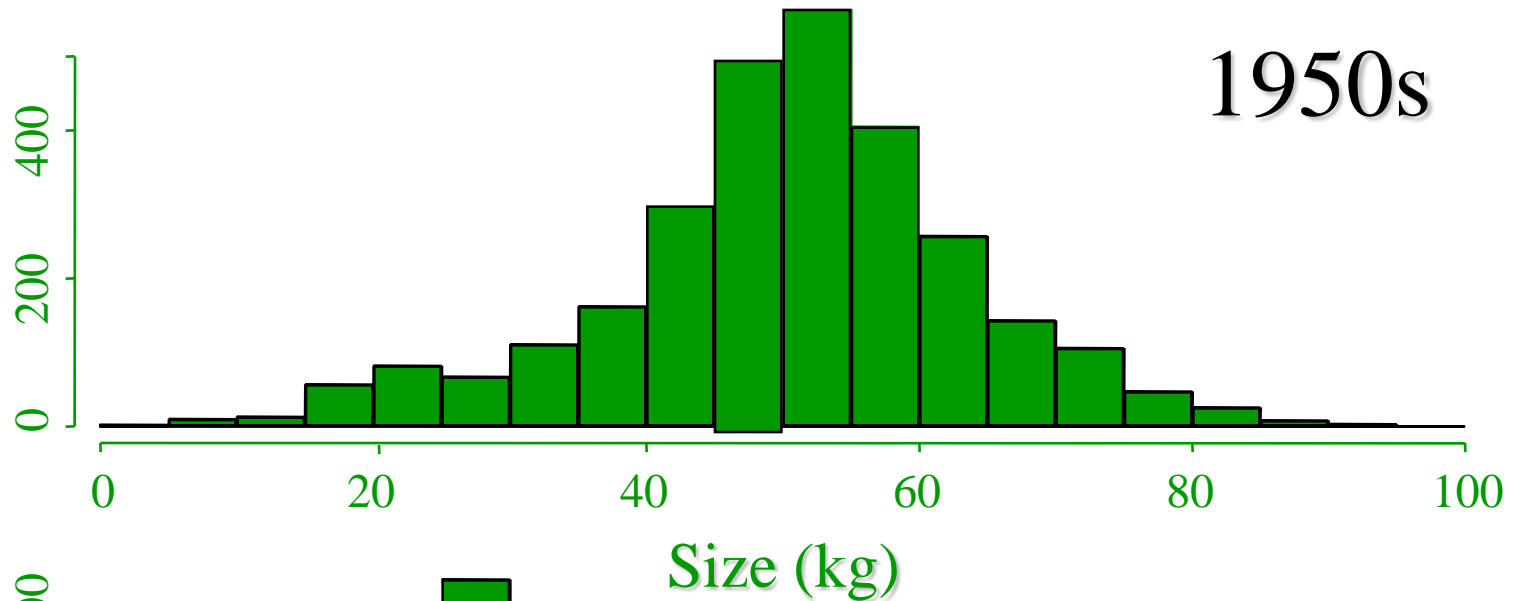
———— Abundance estimate, Walters' method

These estimates are conservative: 1.

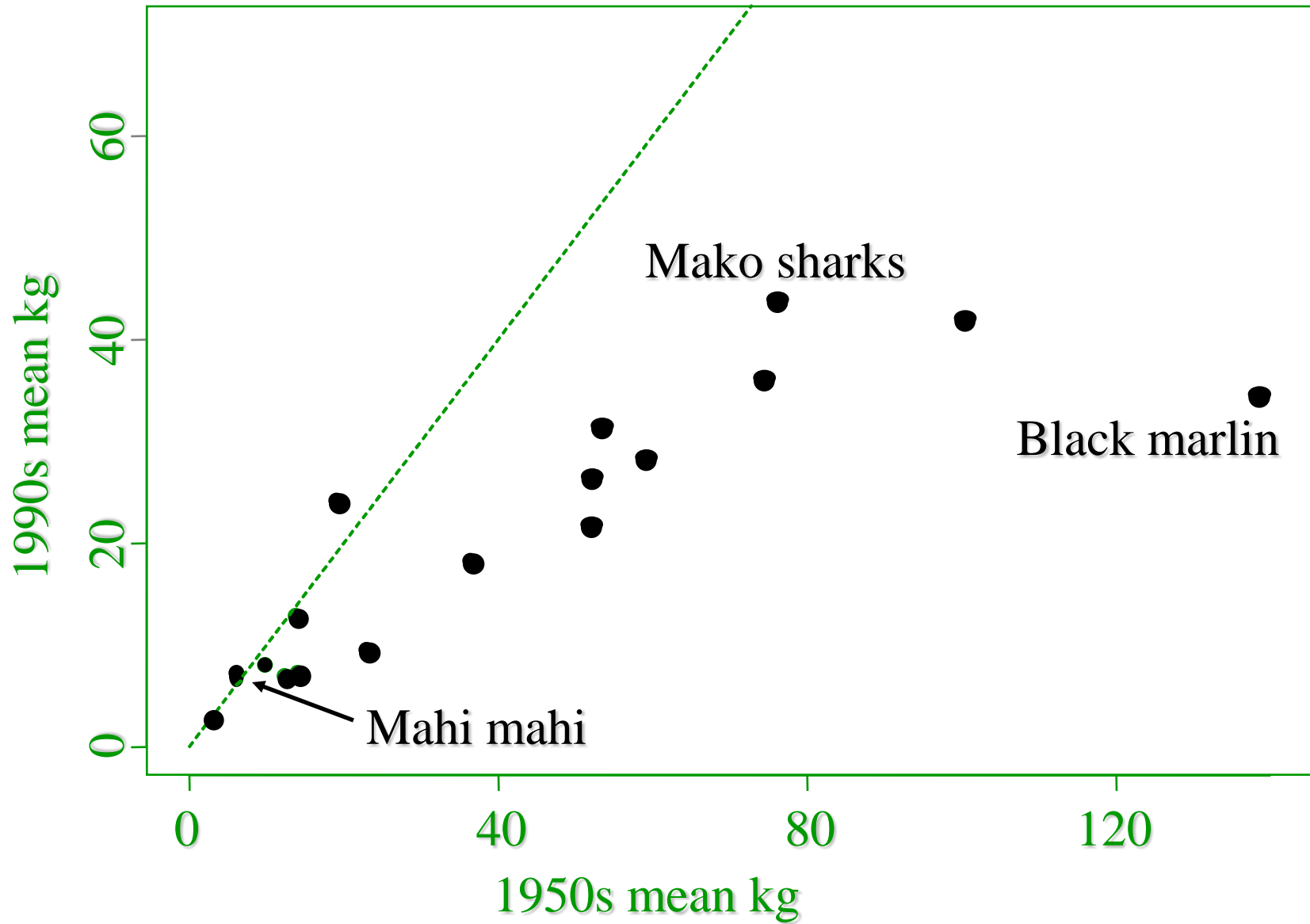
Bits of tuna did not count;
~25-30% of tropical tunas were initially not counted because of shark damage.



These estimates are conservative: 2 (fish are smaller)

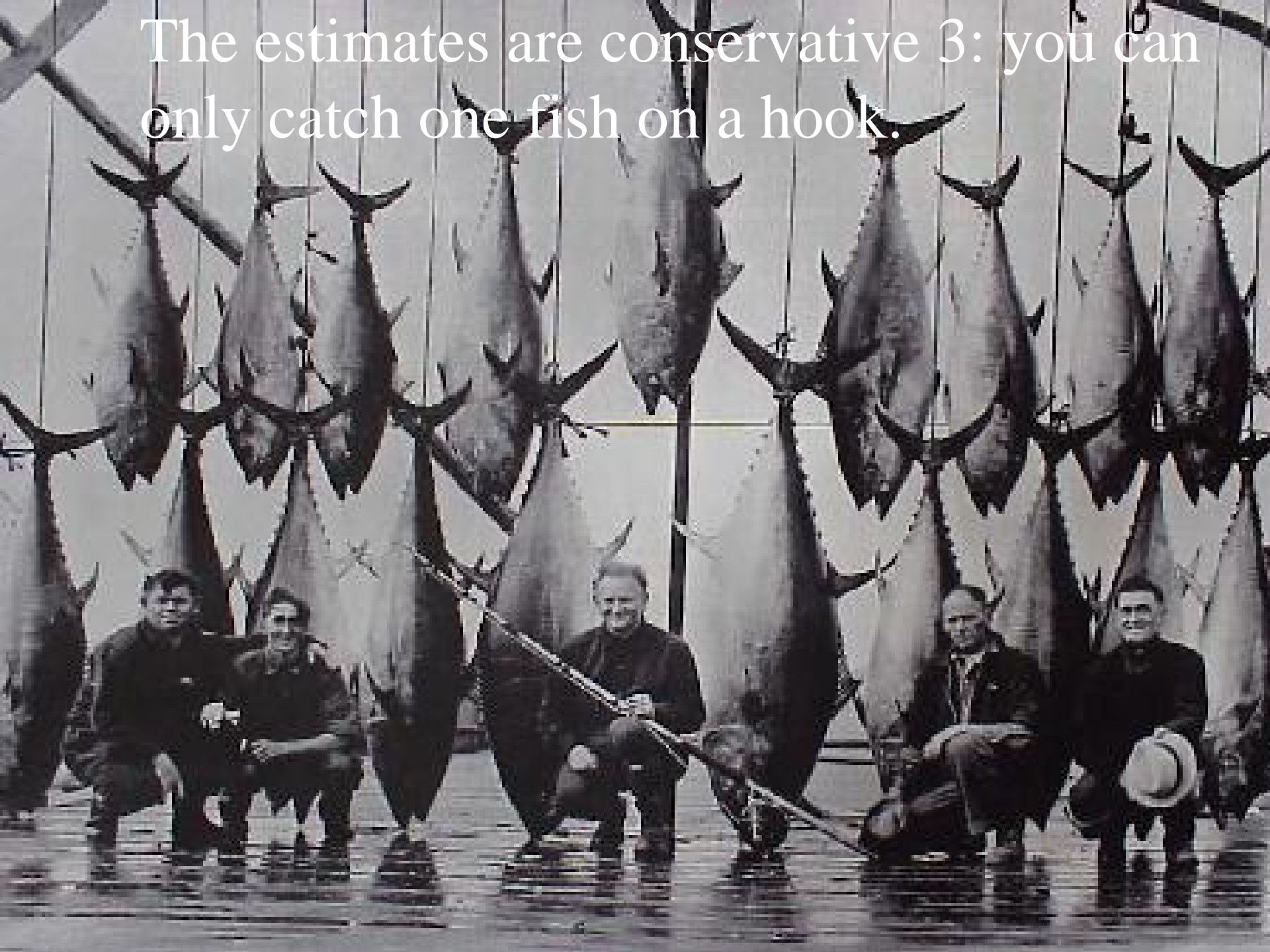


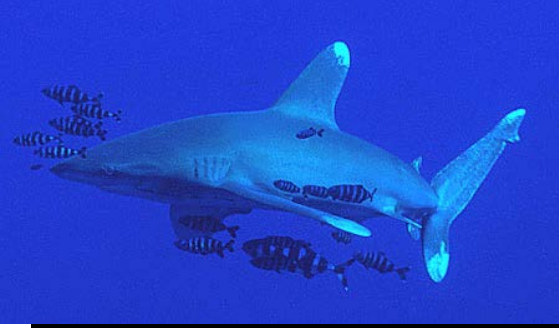
Change in body size



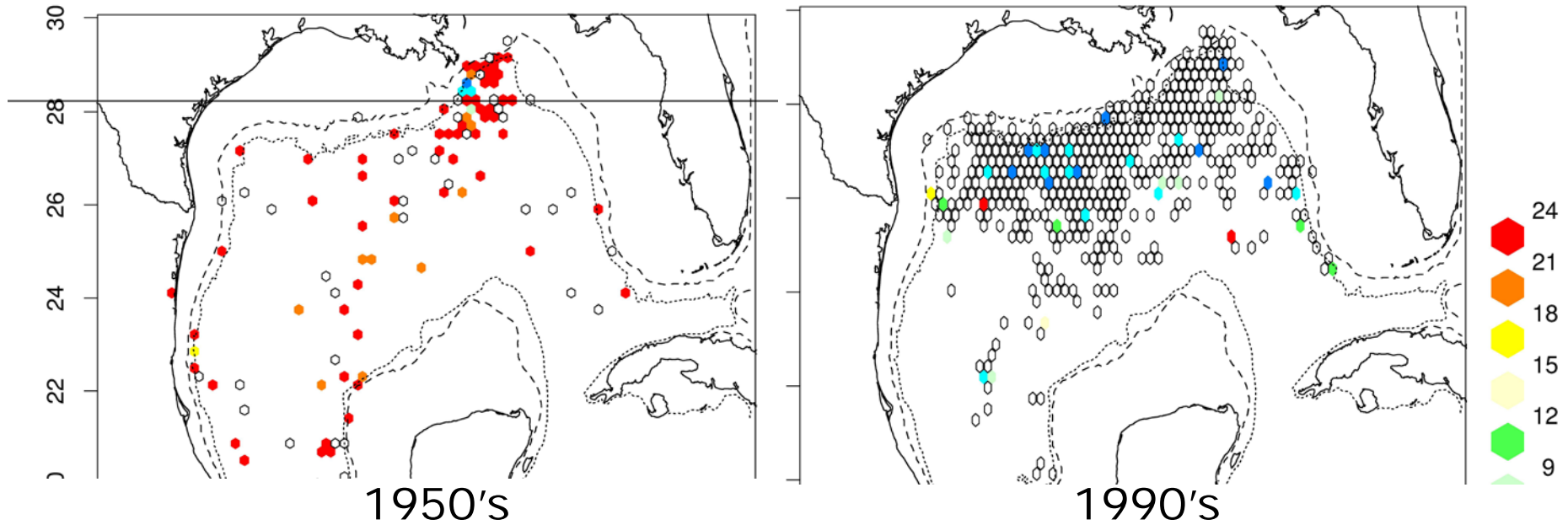


The estimates are conservative 3: you can only catch one fish on a hook.





These estimates are conservative
4: The sharks probably declined
more.

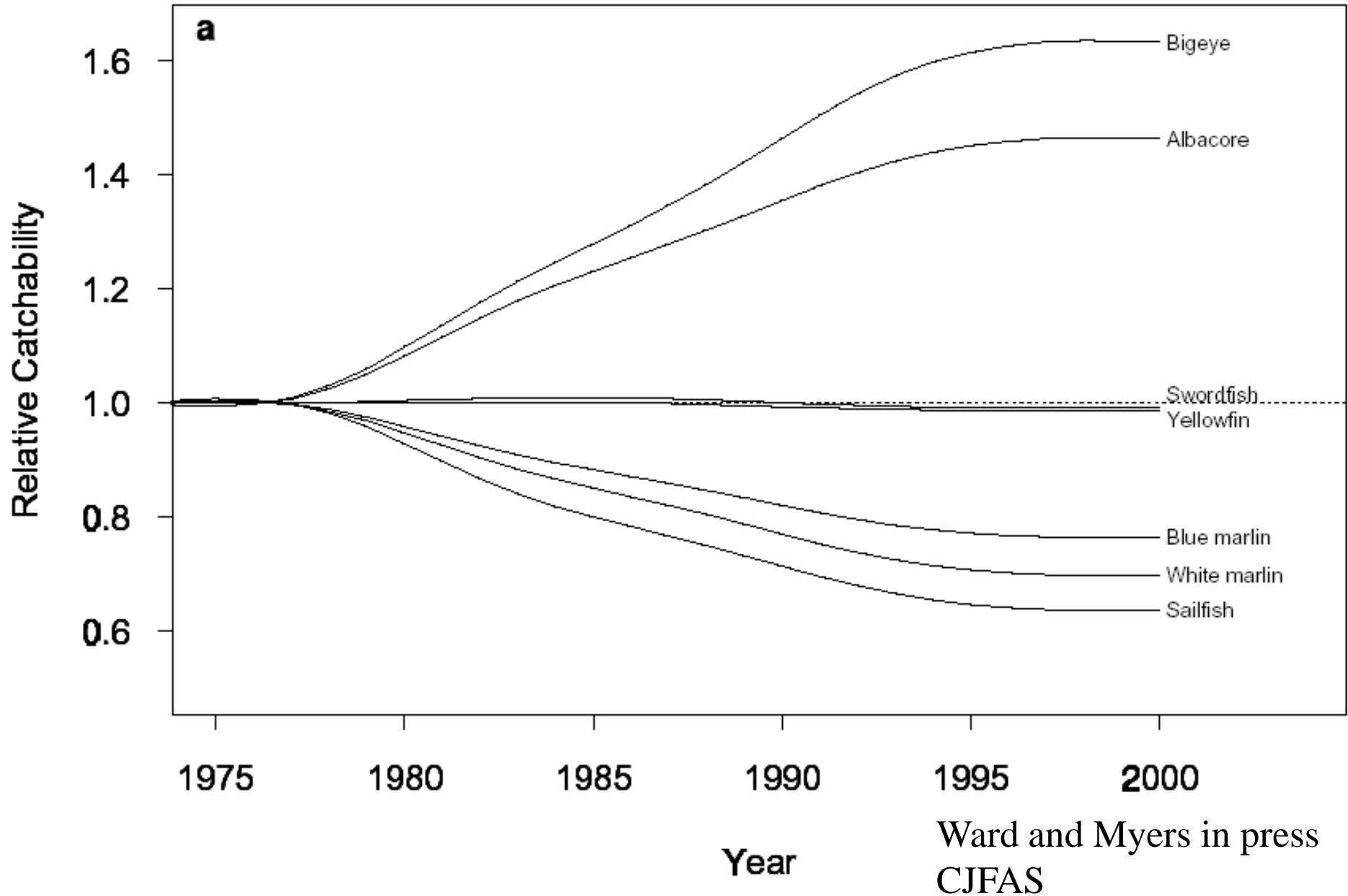


Oceanic Whitetip captures per 10,000 hooks

These estimates are conservative 5: The oceans were not virgin.

- Japan harvested ~1,000,000 tons of tuna and marlin in the 5 years before WWII.
- In 1950 the US harvested ~170,000 tons.
- The 1950 harvest of albacore by Spain was greater than the total recent harvest in the North Atlantic.
- Species that migrate long distances (e.g. southern bluefin tuna, northern bluefin tuna, and albacore) would have reduced by these harvests.

These estimates are conservative 7:
changes in depth increases overall efficiency.

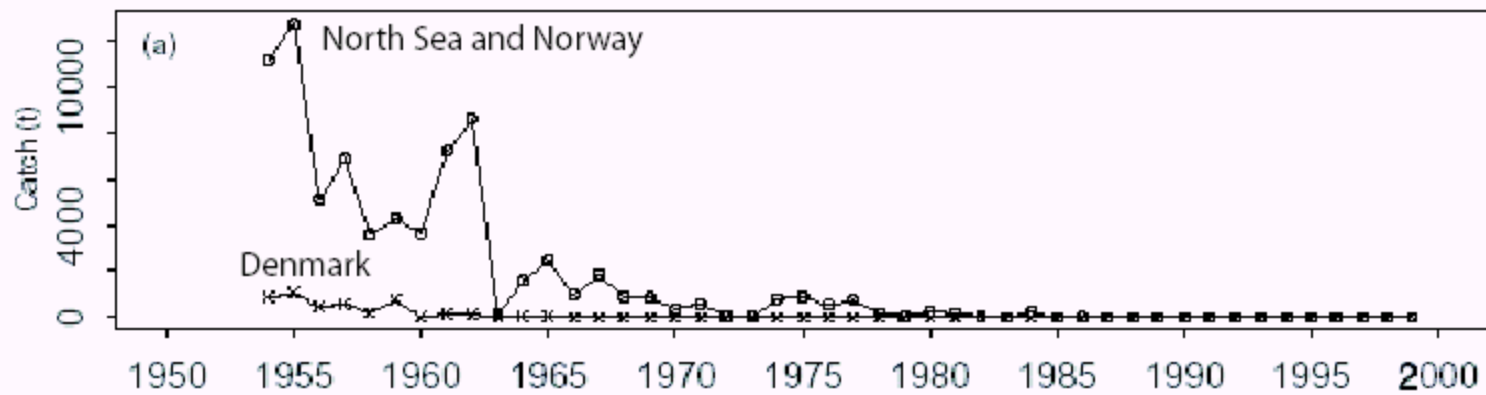


Declines confirmed by independent data:

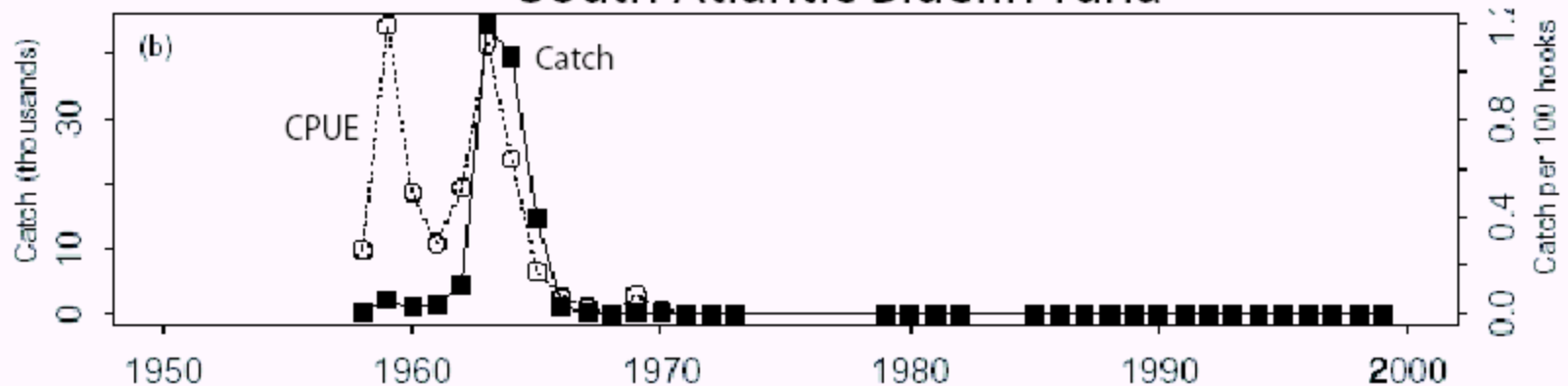
- The initial high catch rates were seen in early research surveys by Japan and US.
- Declines seen in harpoon fisheries for swordfish and tuna.
- Most tuna traps in the Mediterranean have largely been abandoned, Italy there is a decline from 100 to 3 tuna traps.
- Complete loss of species in some areas.

Loss of Bluefin Tuna Populations in the Atlantic

North Sea Bluefin Tuna



South Atlantic Bluefin Tuna

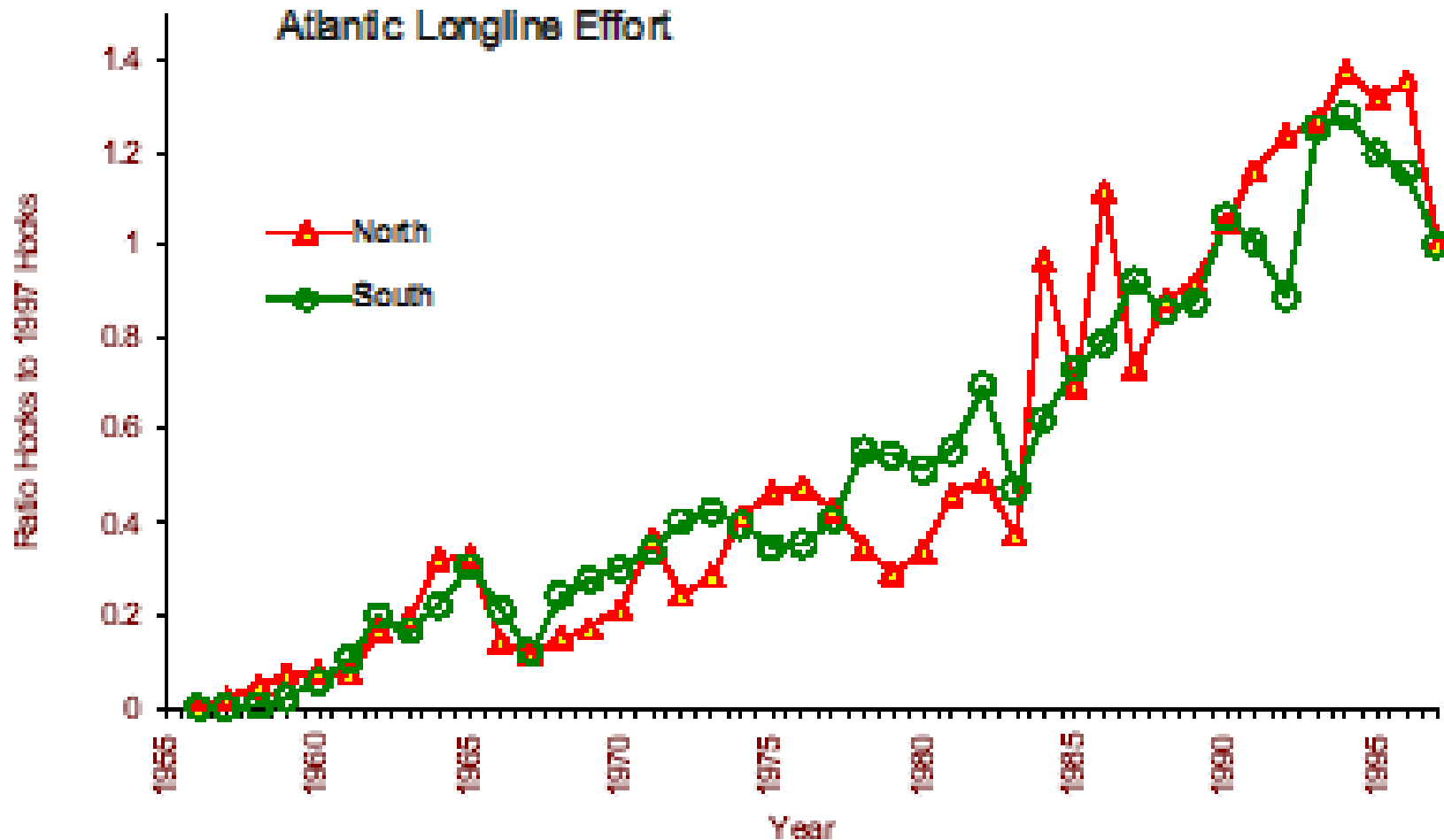


Perceived Contradiction in Initial Rapid Decline in CPUE

- 1. Large declines occurred when effort was relatively small

Perceived Contradiction in Initial Rapid Decline in CPUE

2. Present effort is much higher.



Perceived Contradiction in Initial Rapid Decline in CPUE

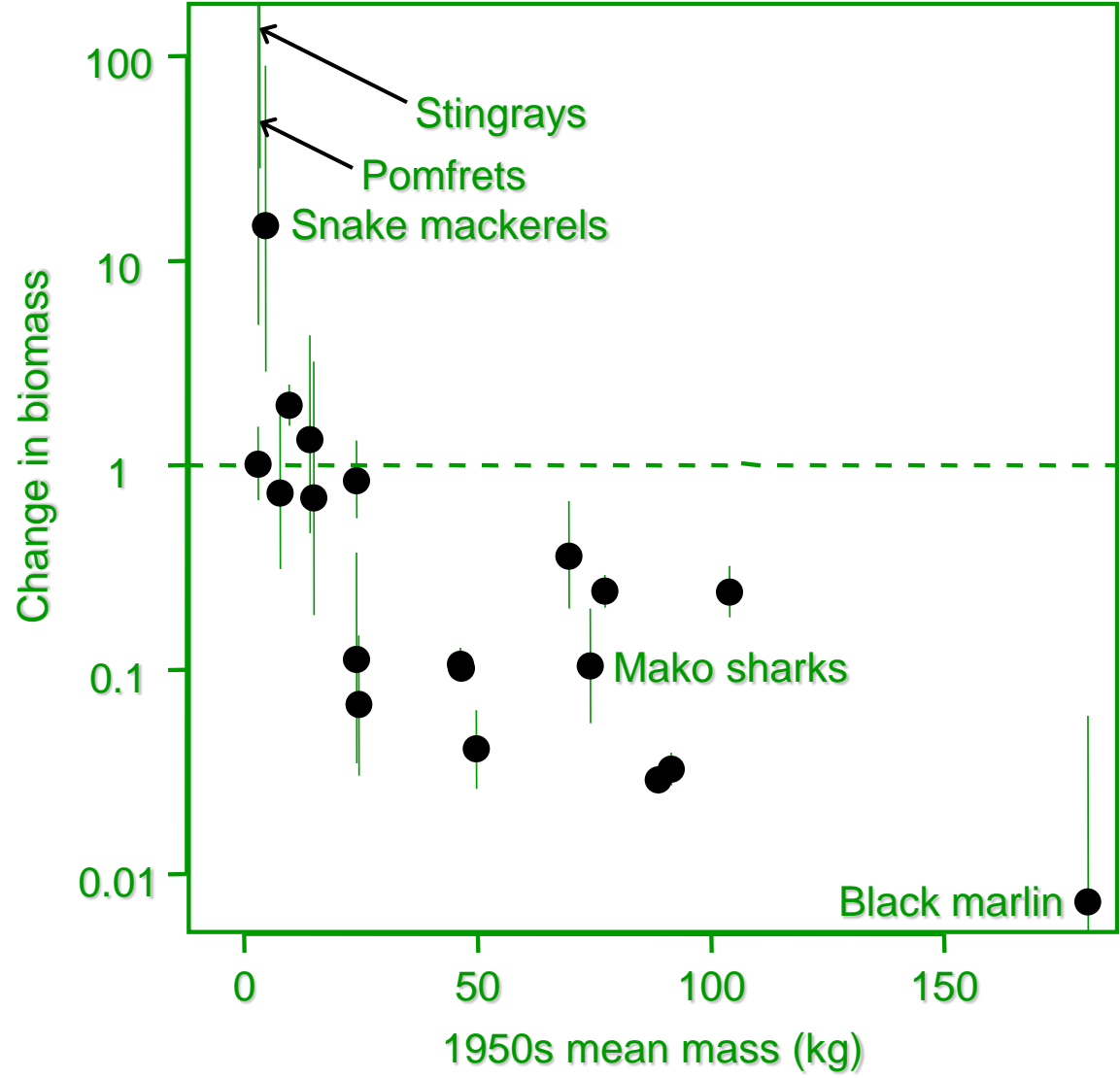
3. Present fishing mortality due to longlines is
around 0.6

Perceived Contradiction in Initial Rapid Decline in CPUE

IF catchability is constant

THEN the population dynamics are impossible.

However, catchability decreases with size and size
has declined





555
lbs.
Cabo Blanco

LBS.
1135
CABO
BLANCO

A Toy Model

- Recruitment constant
- Longline effort increases linearly over 35 years
- Catchability is proportional to the product of: (a) a cumulative normal and (b) food intake (respiration is proportional to the $2/3$'s power of mass)
- Present fishing mortality is around 0.6.

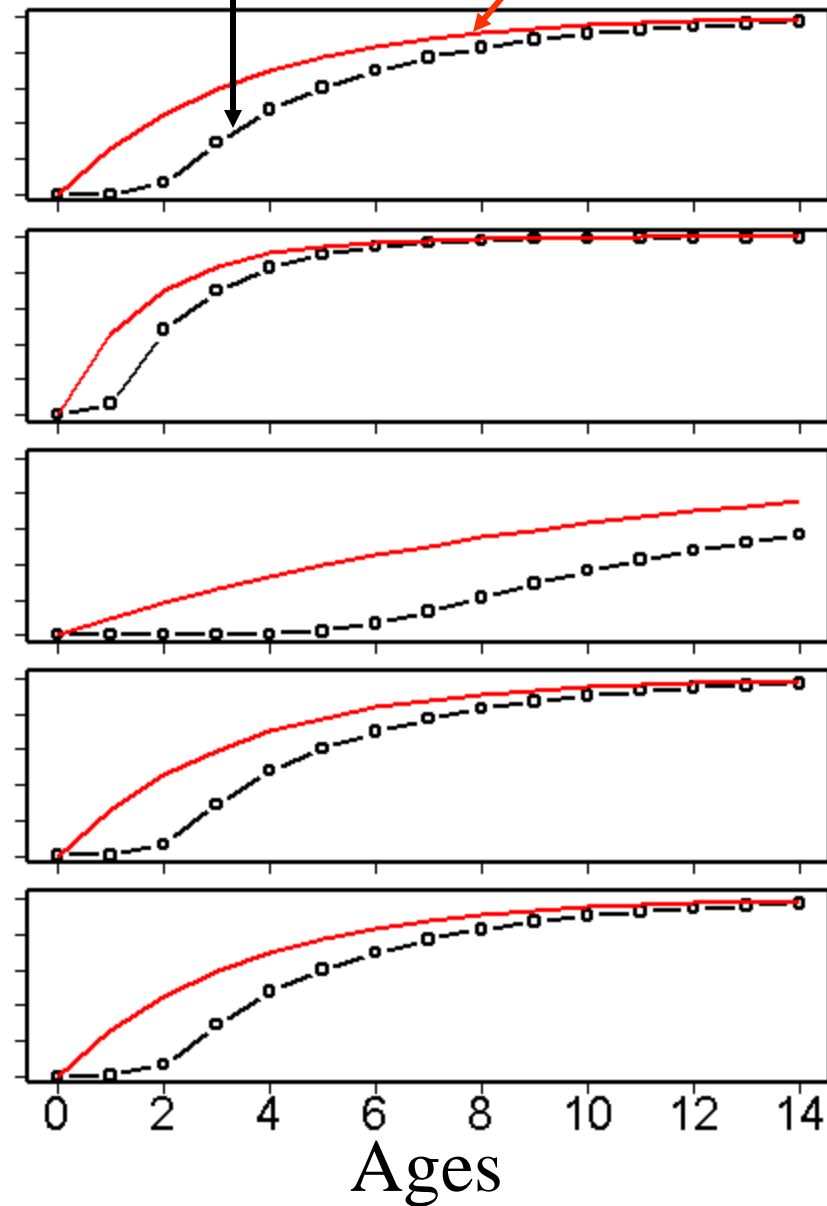
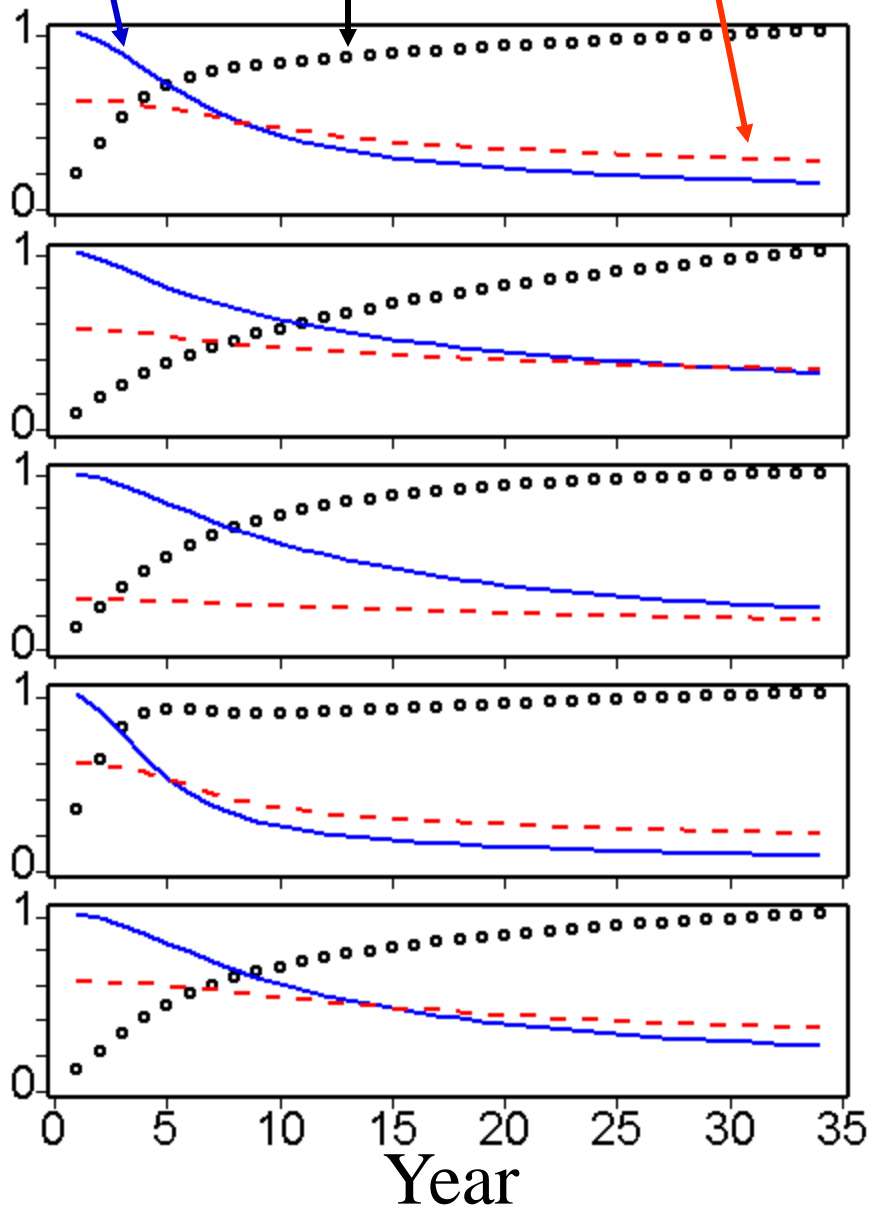
CPUE

Catch

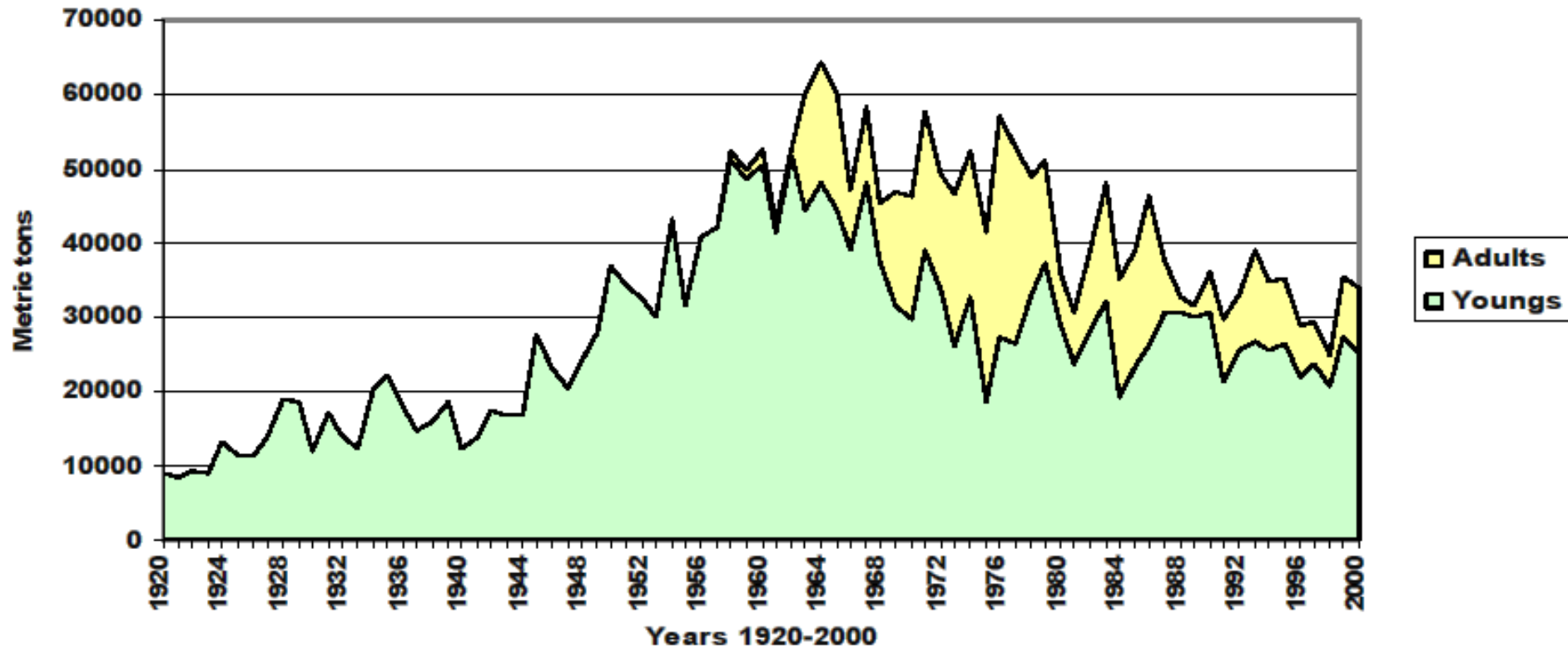
Avg wt

Selectivity

Length




North Atlantic albacore cumulated catches of youngs and adults fish



Conclusion

- Immediate action needed to protect some sharks, leatherbacks, loggerheads, and some tuna (Atlantic northern bluefin)
- Productivity (juvenile survival) has increased with exploitation.
- Rapid declines in CPUE reflect real declines in large fish
- Reduced effort is needed to achieve greater economic yield

Acknowledgements

- **Boris Worm, Peter Ward, Leah Gerber, Julia Baum, Dan Kehler, Francesco Ferretti**
 - **Pew Charitable Trusts**
 - **Sloan Foundation – Census of Marine Life, Future of Marine Animal Populations (FMAP)**
 - **NSERC**
 - **Pelagic Fisheries Research Program**
 - **German Research Council**
 - **Killam Foundation**
 - **Numerous colleagues who shared data**
- 
- A blue marlin is captured in mid-leap, its long, pointed snout and dorsal fin cutting through the deep blue water. The fish is angled upwards and to the right, with its tail still partially submerged, creating a splash of white water. The background is a vast expanse of clear, deep blue ocean under a bright sky.

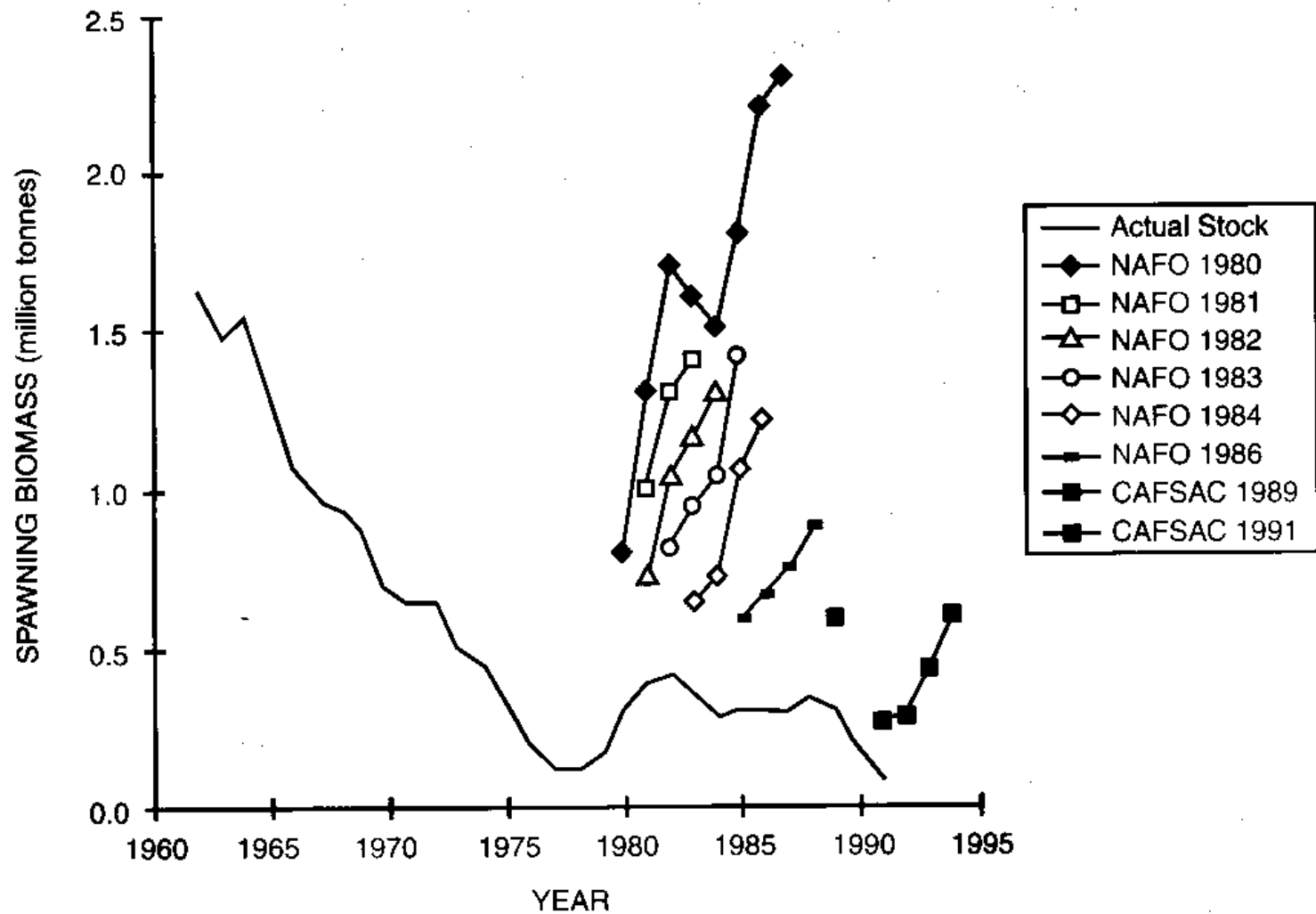


Fig. 3. Recent reconstruction, using virtual population analysis, of the Newfoundland northern cod decline, compared with estimates and projections published in various years after Canada took over the fishery under extended jurisdiction. VPA estimates based on data in Baird *et al.* (1992) (see also Hutchings and Myers, 1994). NAFO estimates from annual reports for years indicated of North Atlantic Fisheries Organization Scientific Council Reports, Dartmouth, NS. CAFSAC estimates from Canadian Atlantic Fisheries Scientific Advisory Committee Advisory Documents 89/1 and 91/1.

Rapid decline in older albacore.

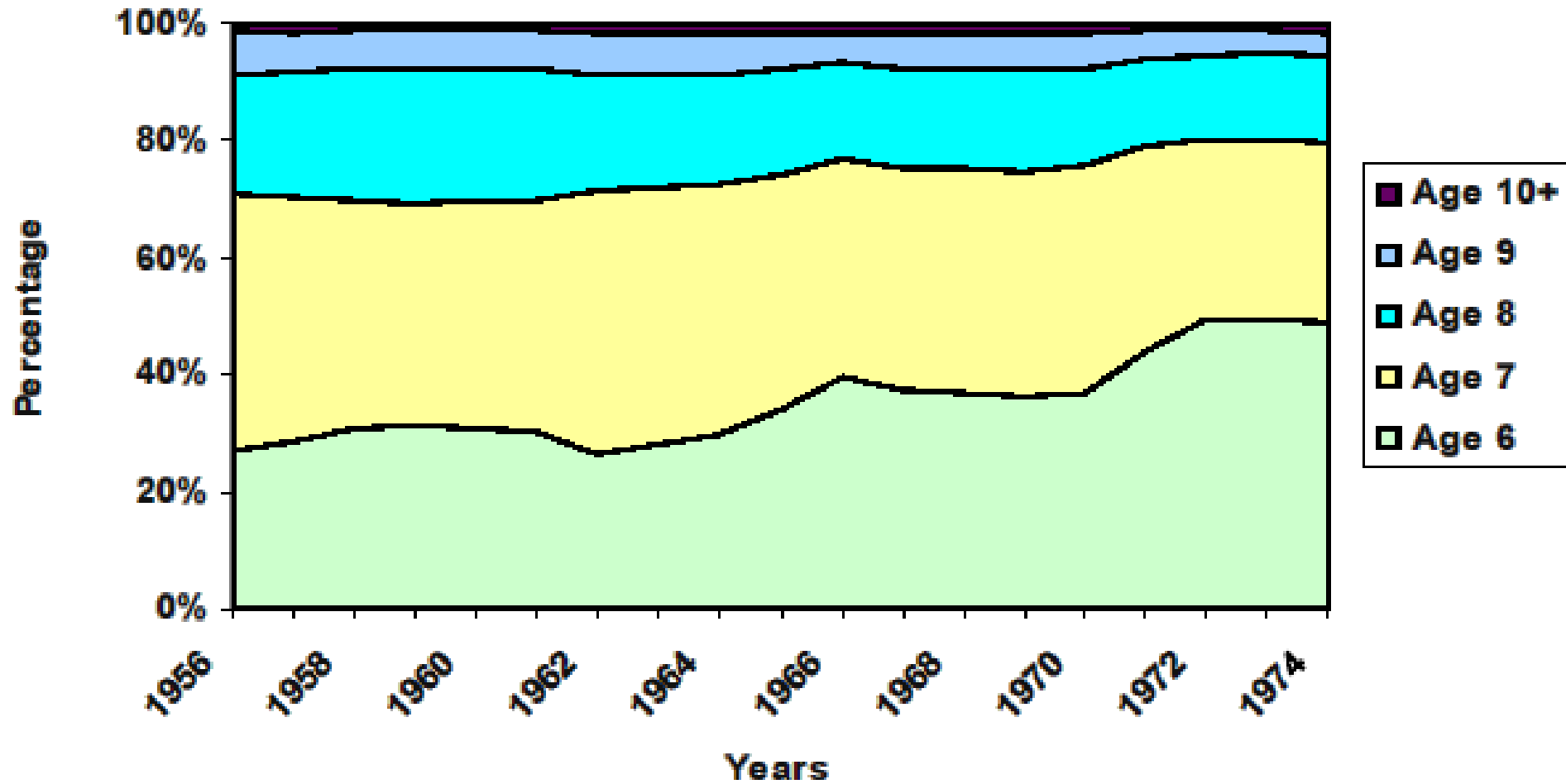
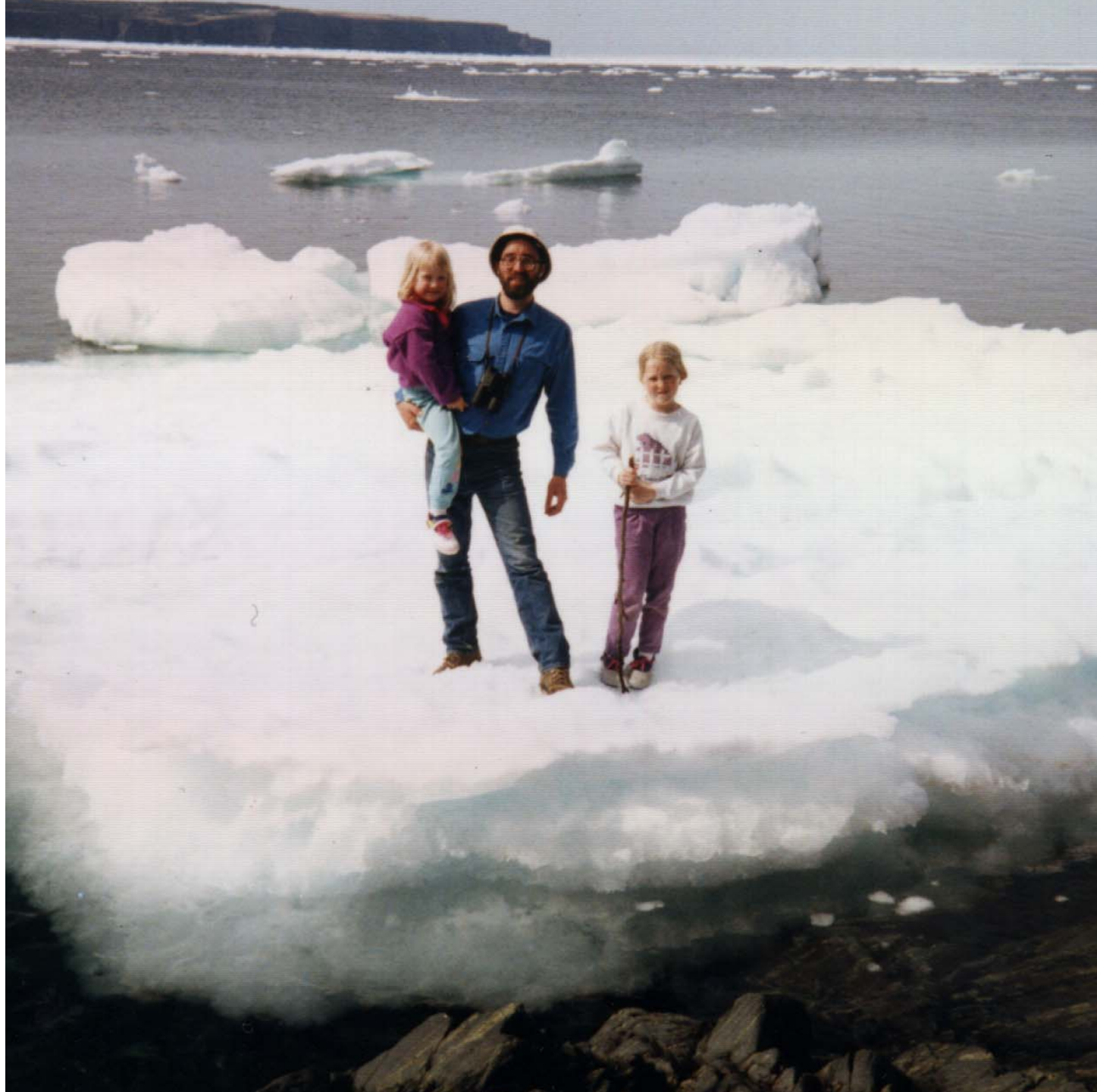


Figure 7 : Evolution of contribution of age classes 6 to 10+ computed by Morita (1977) in longliners albacore catches, 1956-1974.



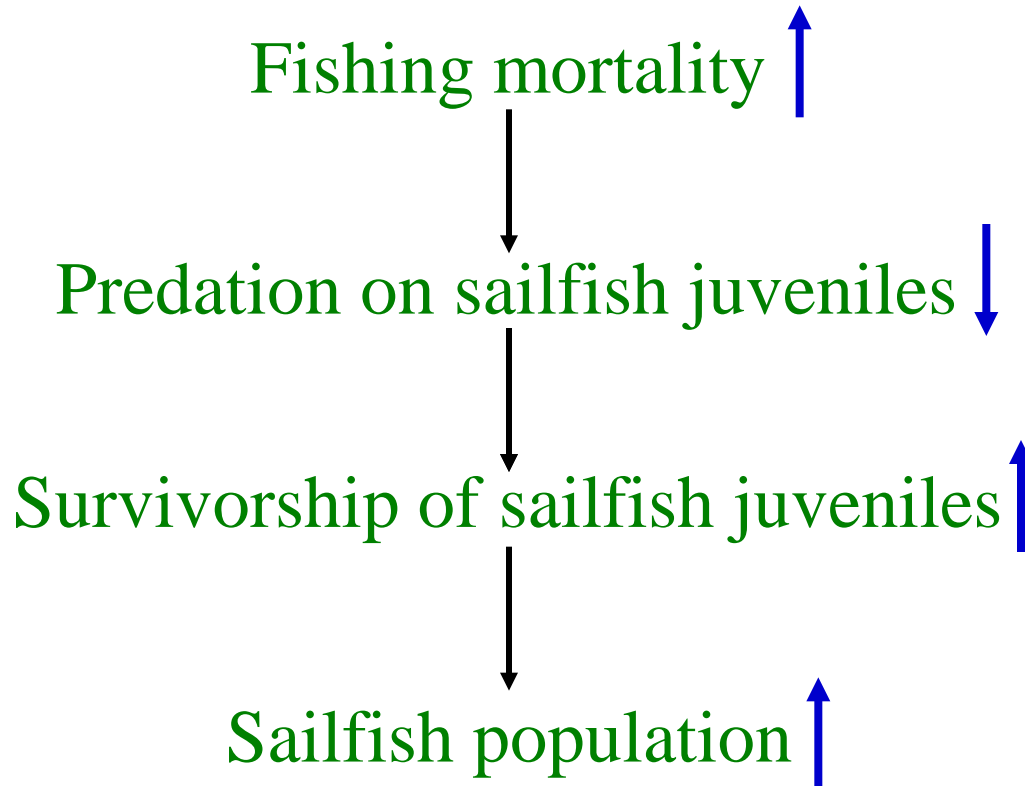
A large school of fish swimming in a circular pattern against a blue background. The fish are dark and silhouetted against the lighter blue water, creating a dense, swirling vortex effect. The background is a gradient of blue, darker at the edges and lighter in the center.

Marine ecosystem robustness and the collapse of marine fisheries

Ransom A. Myers (RAM)

**Dalhousie University, Halifax,
Canada**

One hypothesis:

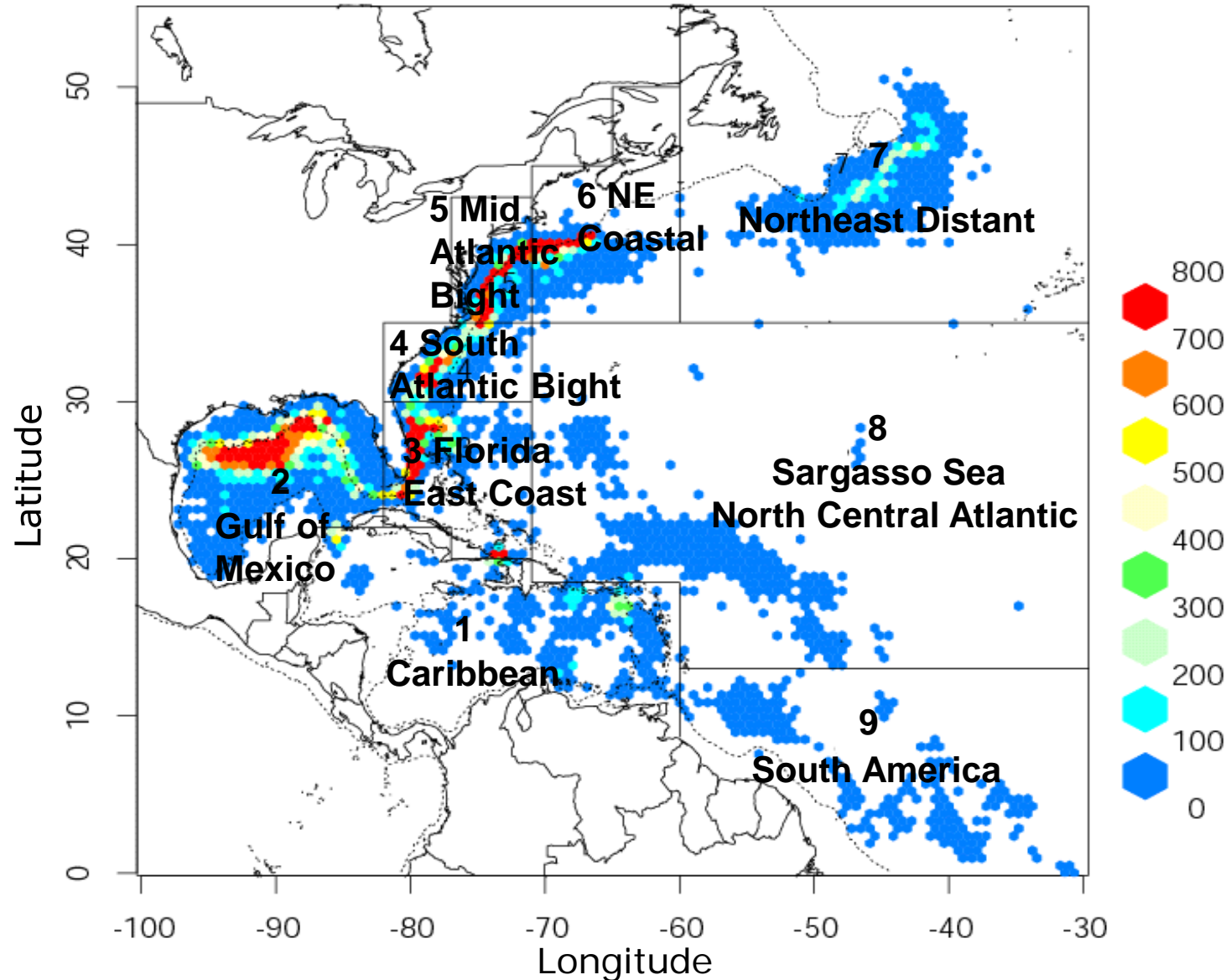


Collapse and Conservation of Shark Populations in the Northwest Atlantic



Science. Jan. 2003. J.K. Baum, R.A. Myers, D.G. Kehler, B. Worm, S.J. Harley, P.A. Doherty

U.S. Atlantic pelagic longline sets 1986-2000

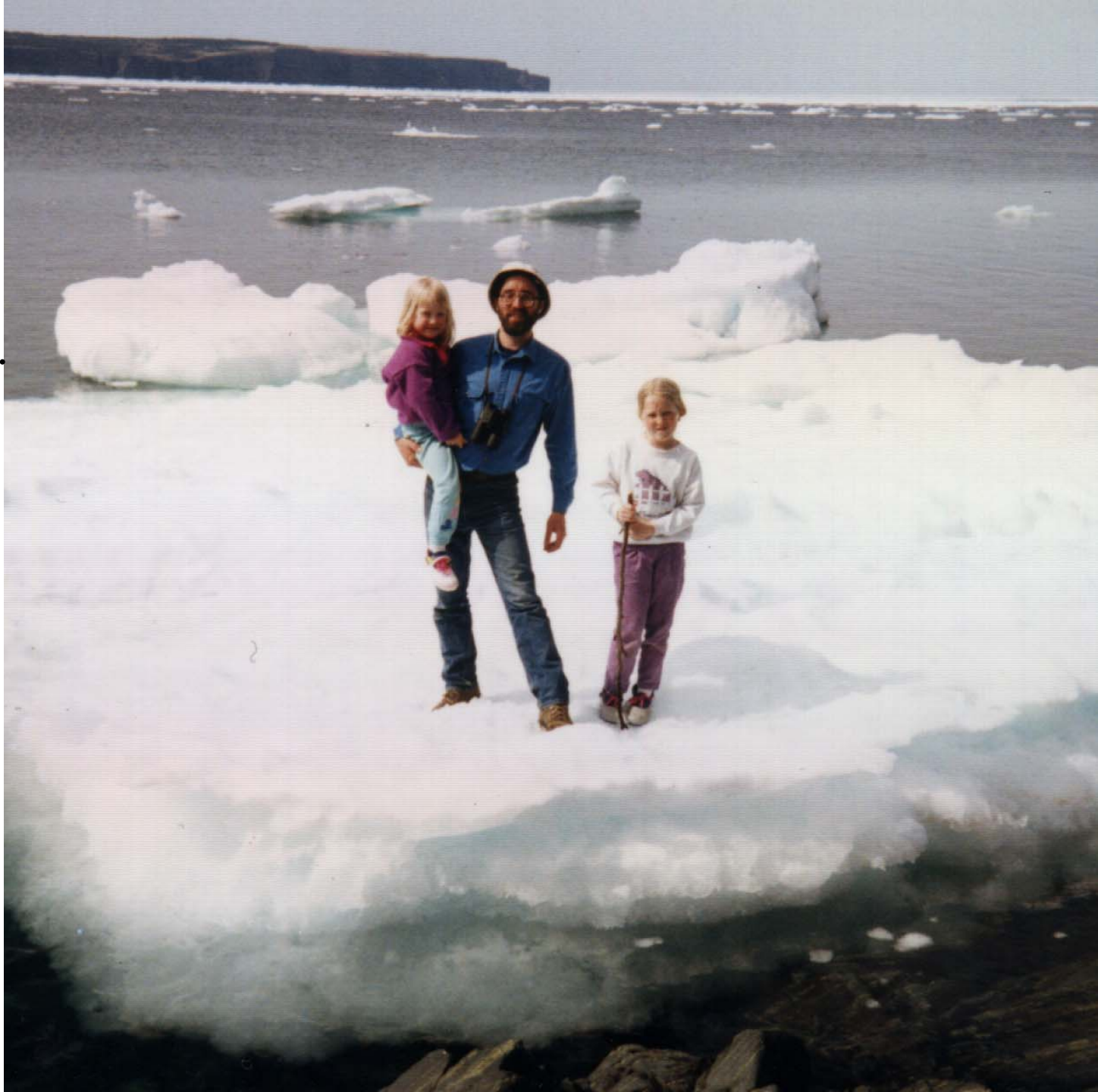


Political action is
costly for any
scientist.

However, it also
has great benefits.

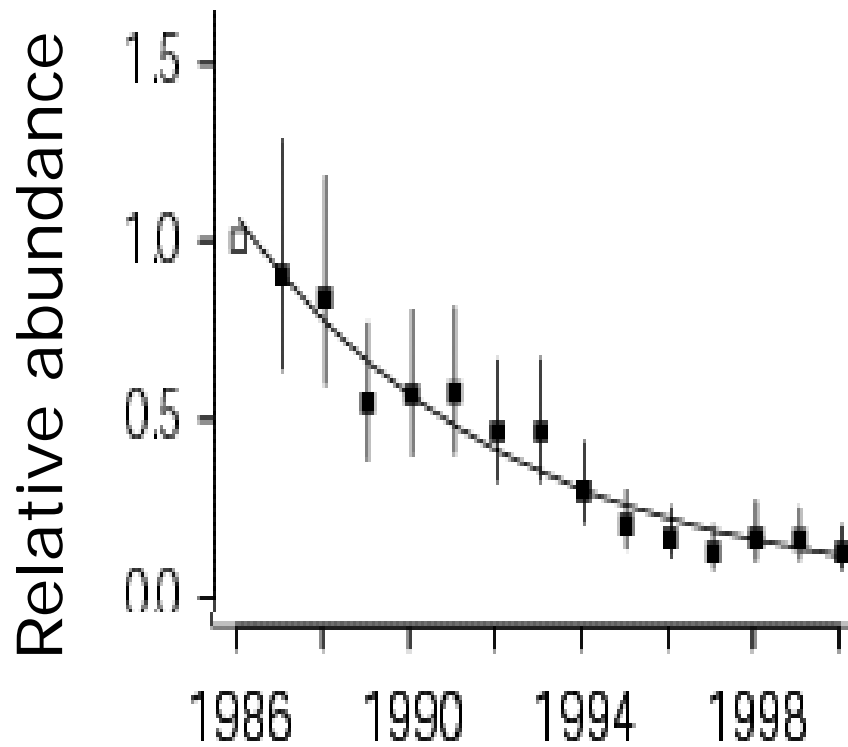
To act is to live.

To be suppressed
is to die.



Hammerhead sharks

Sphyrna lewini

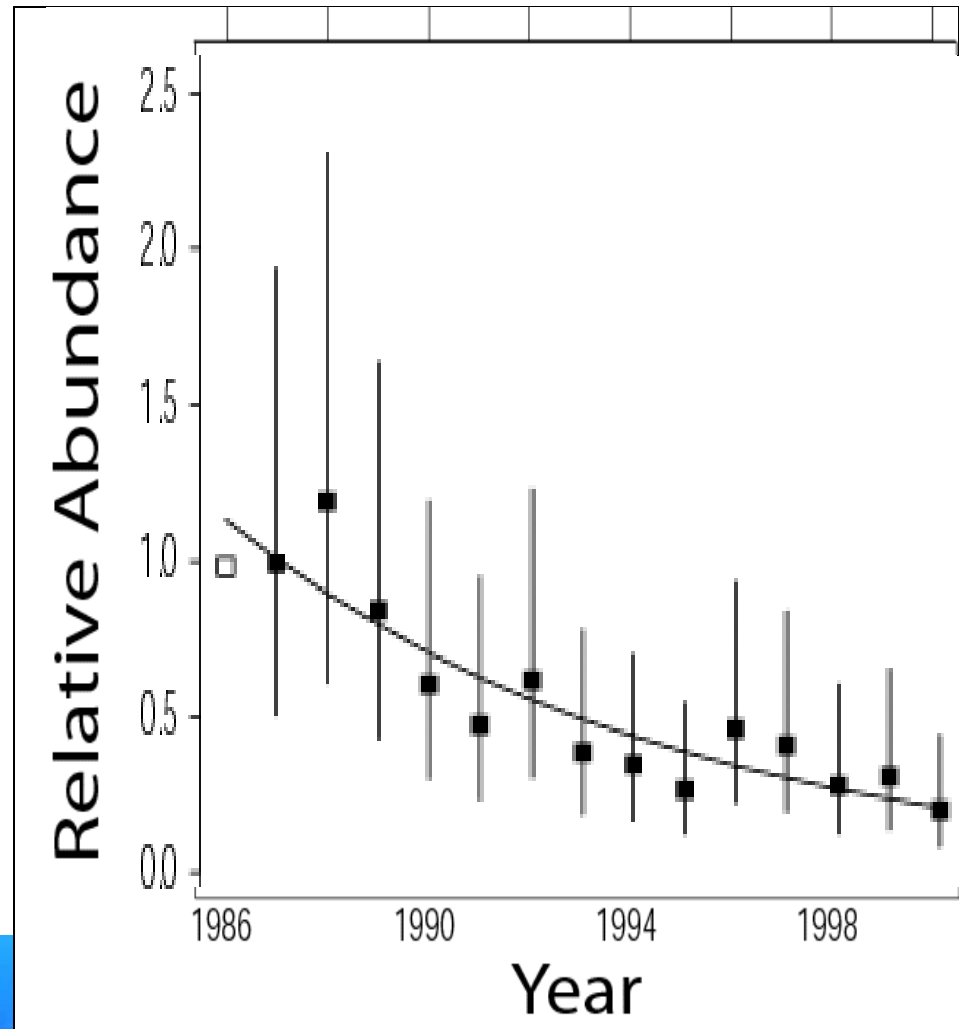


The rest of the slides are back up.



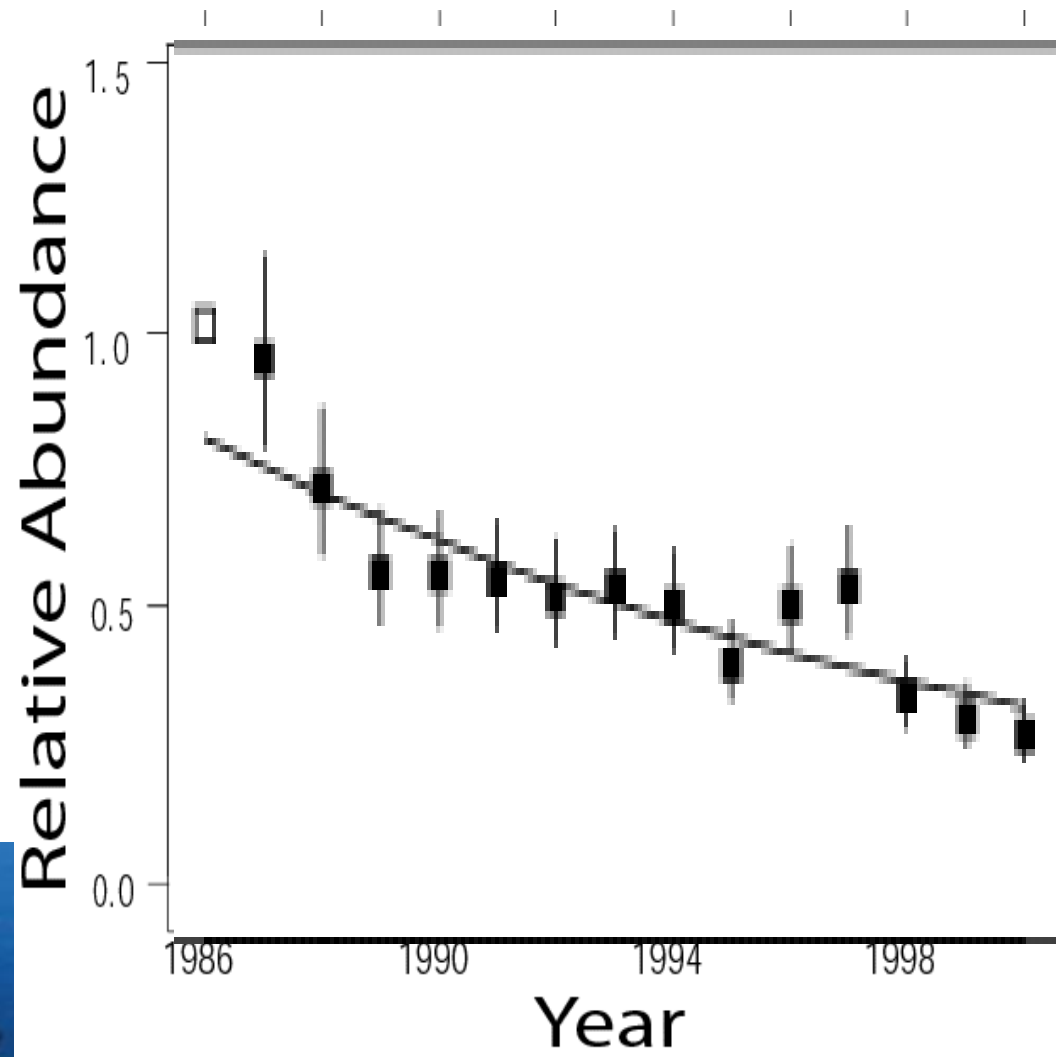
Thresher sharks

Alopias spp.

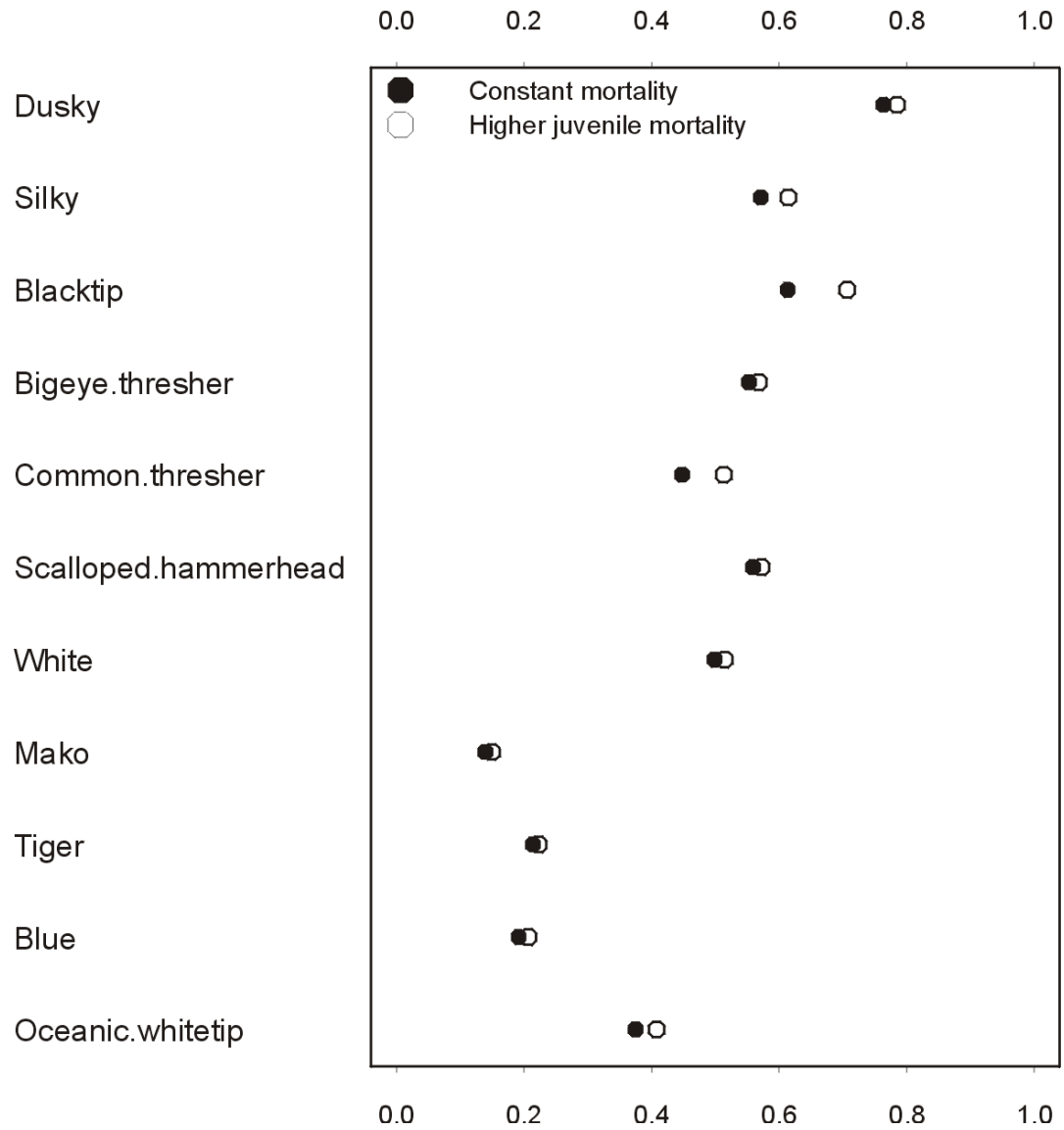


Blue sharks

Prionace glauca

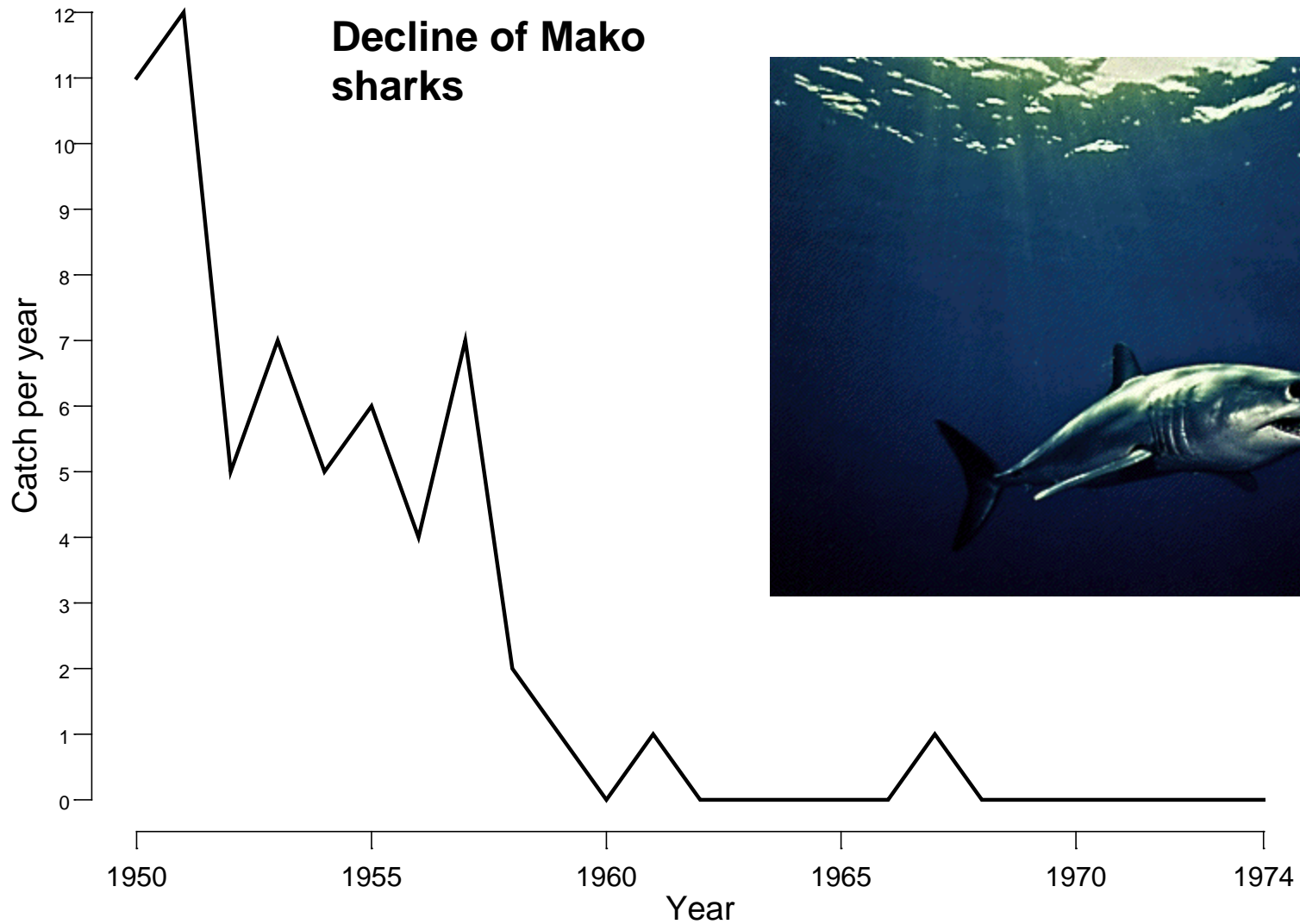


Proportional reduction in current fishing mortality needed to ensure survival of shark populations



Letter from senate

Put in cod

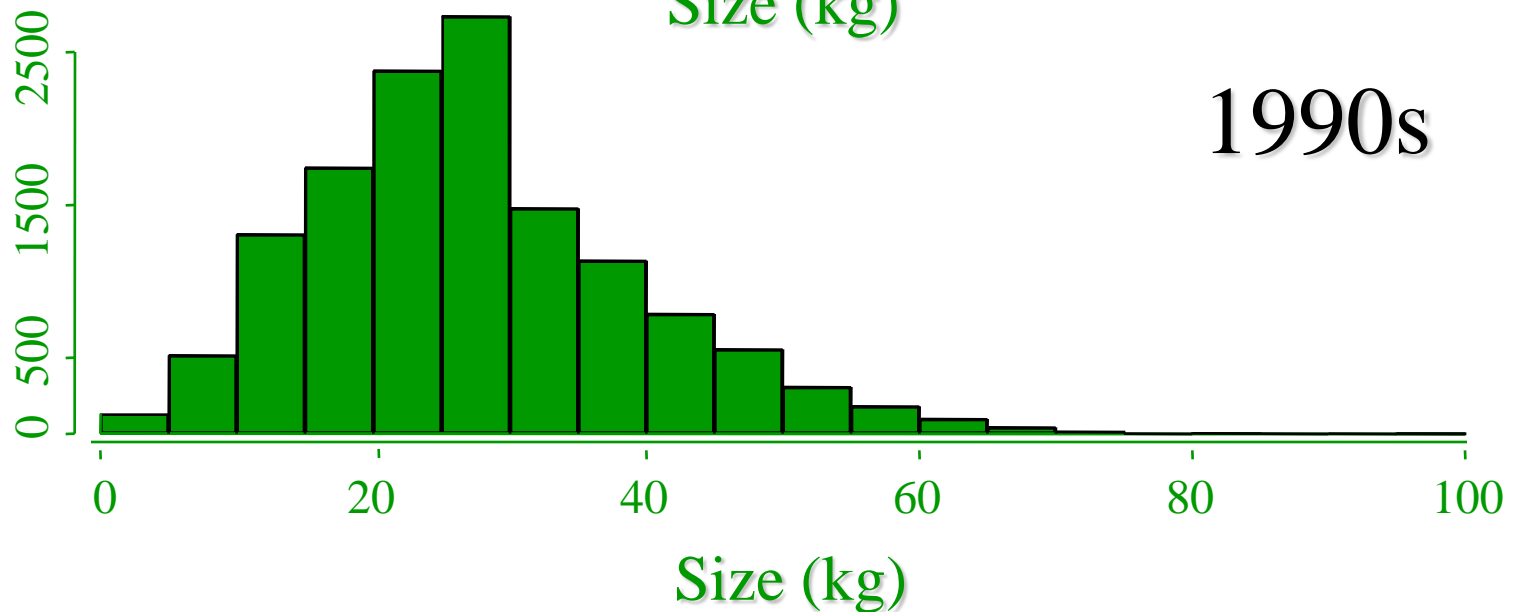
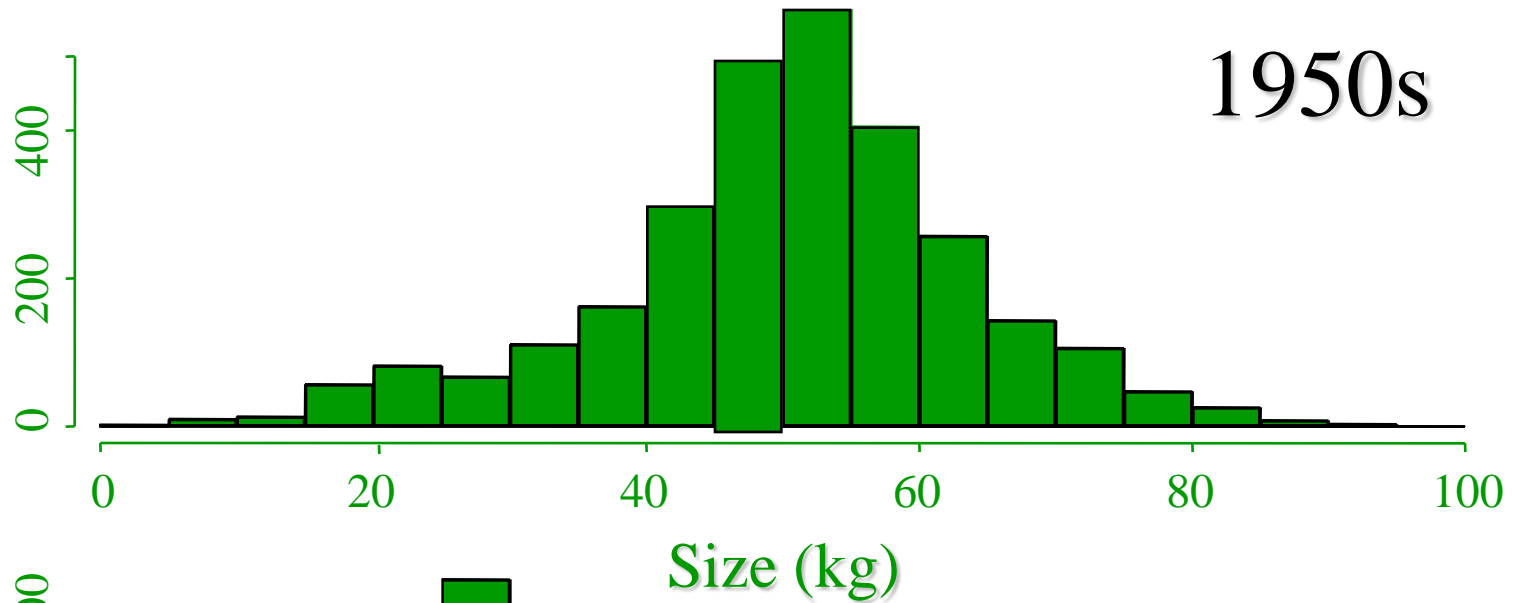


These estimates are conservative: 1.

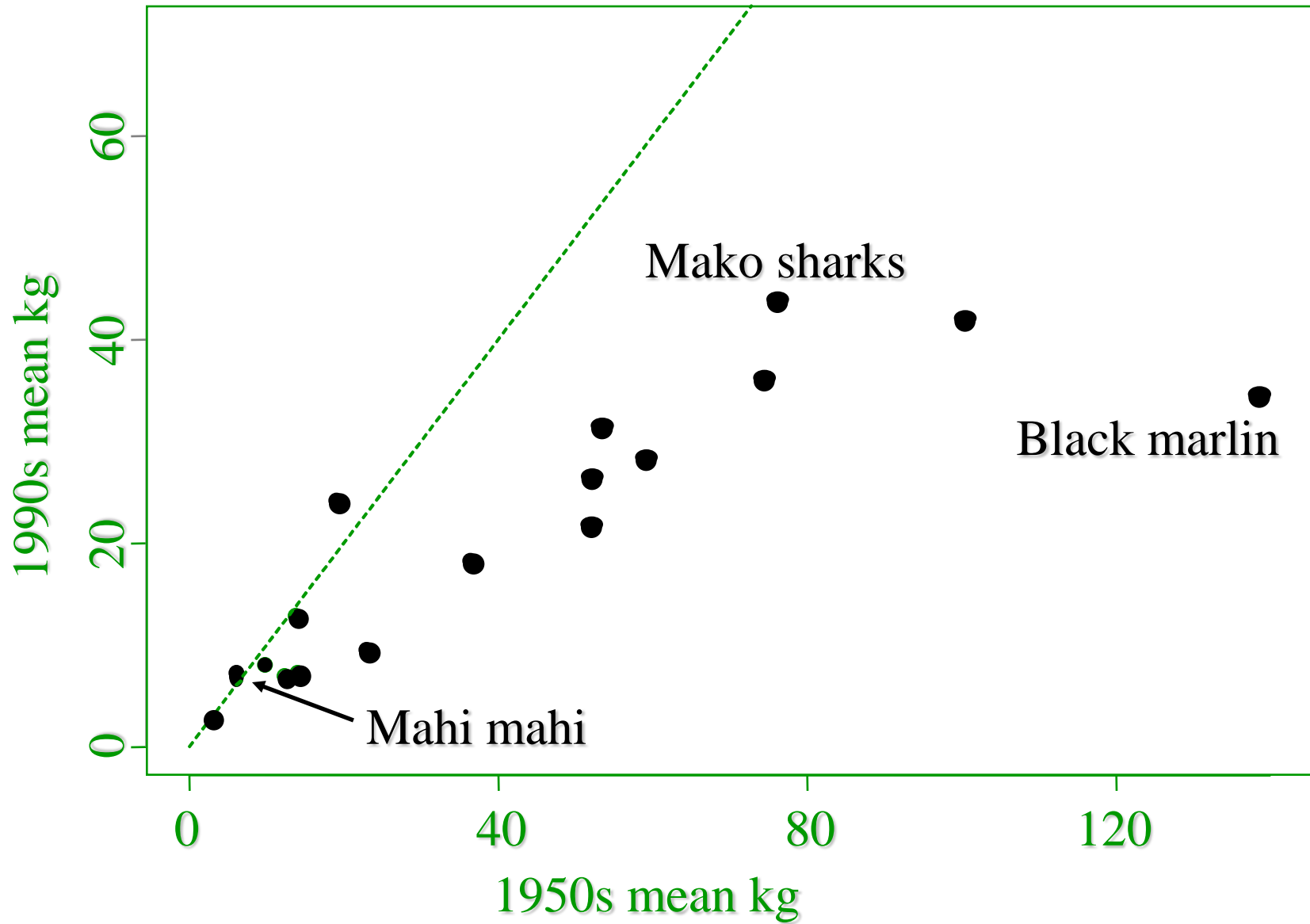
Bits of tuna did not count;
~25-30% of tropical tunas were initially
not counted because of shark damage.



These estimates are conservative: 2 (fish are smaller)

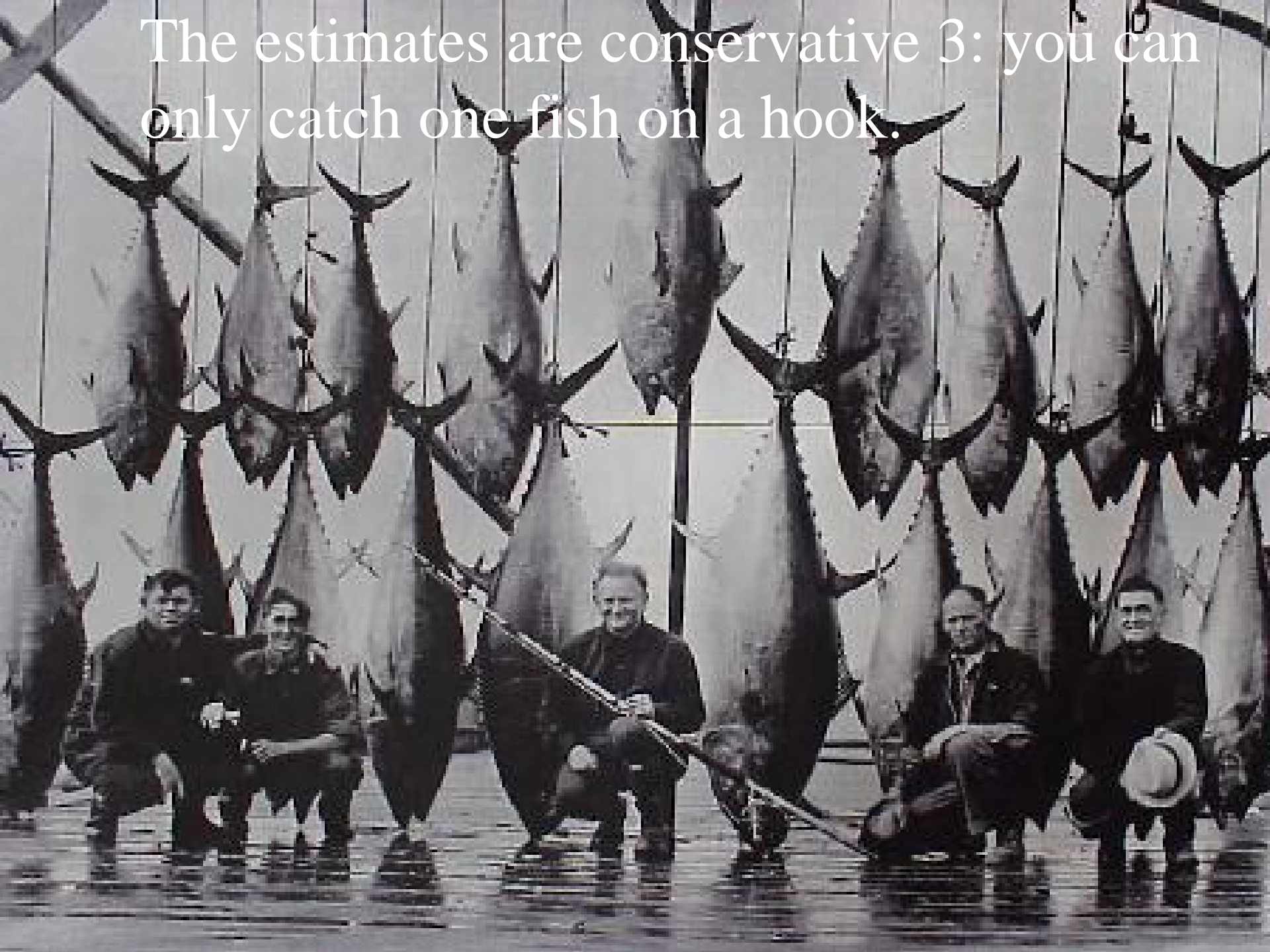


Change in body size





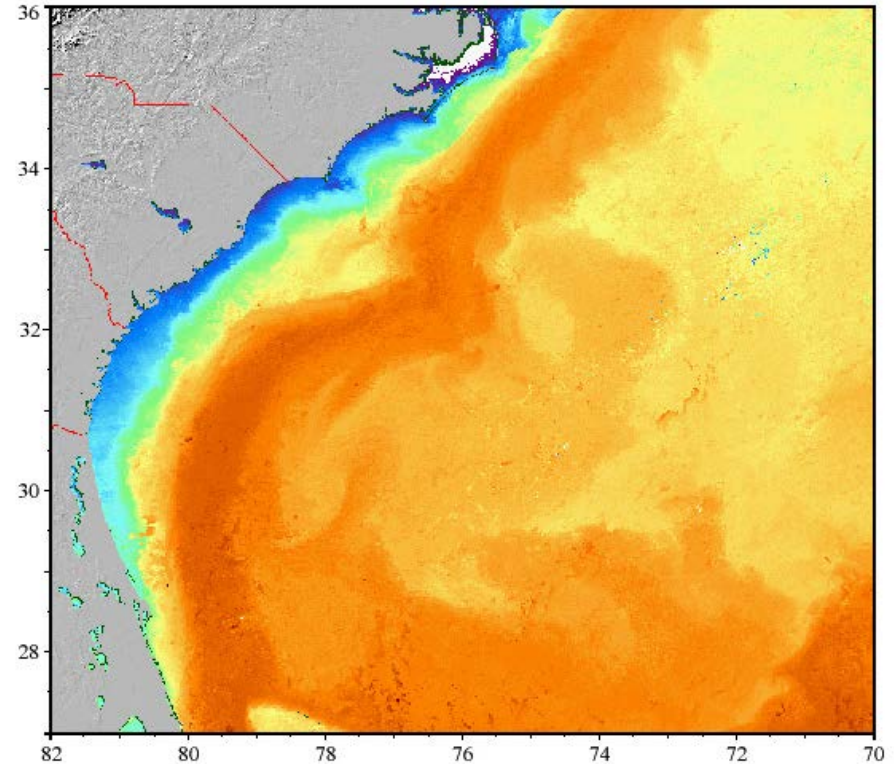
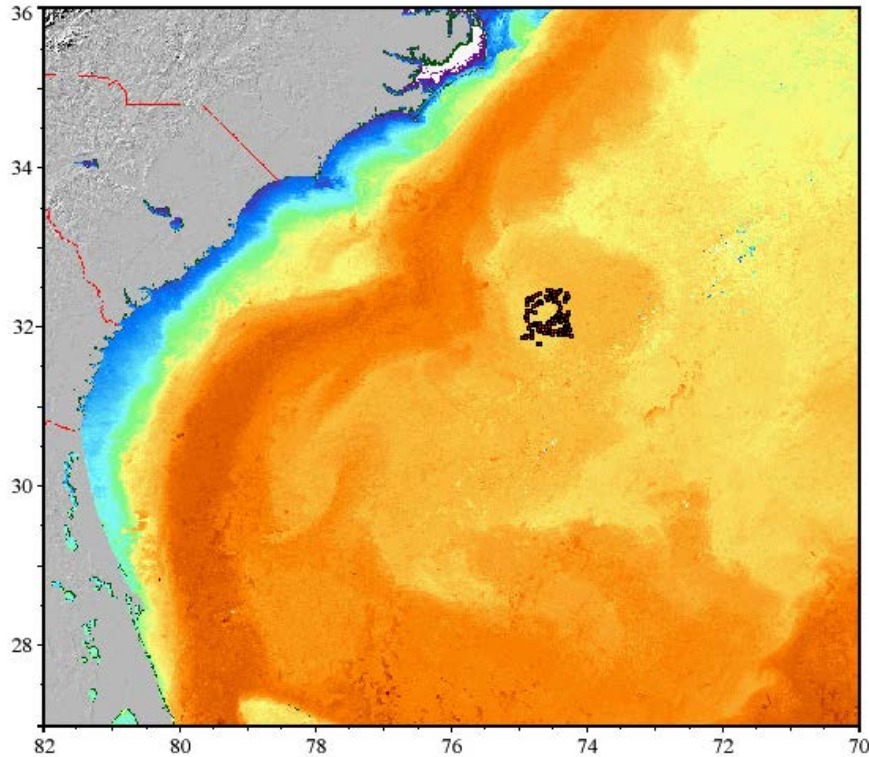
The estimates are conservative 3: you can only catch one fish on a hook.



These estimates are conservative 5: The oceans were not virgin.

- Japan harvested ~1,000,000 tons of tuna and marlin in the 5 years before WWII.
- In 1950 the US harvested ~170,000 tons.
- The 1950 harvest of albacore by Spain was greater than the total recent harvest in the North Atlantic.
- Species that migrate long distances (e.g. southern bluefin tuna, northern bluefin tuna, and albacore) would have reduced by these harvests.

These estimates are conservative: 6 Fishermen are smarter (gps, satellite information, **ACDP** (Acoustic Current Doppler Profiler)).



Locations of a leatherback turtle over a two week period tagged by my student Mike James that maintains its position within a cold core ring (somehow).

However, fish may be a lot smarter too (the stupid ones were caught).

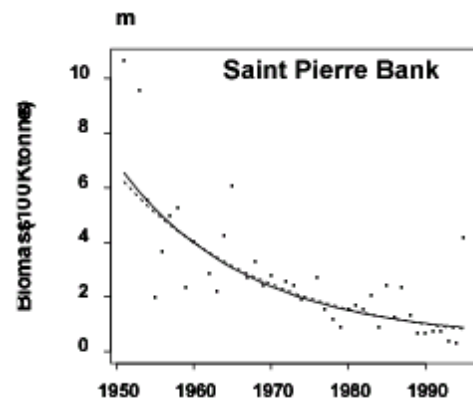
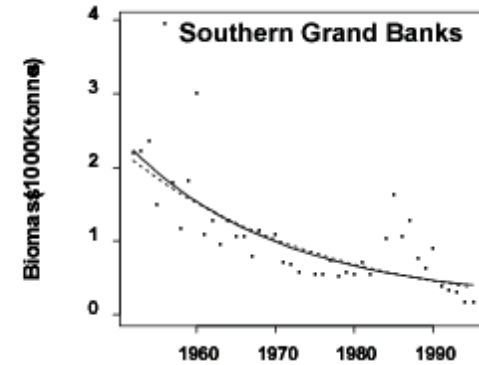
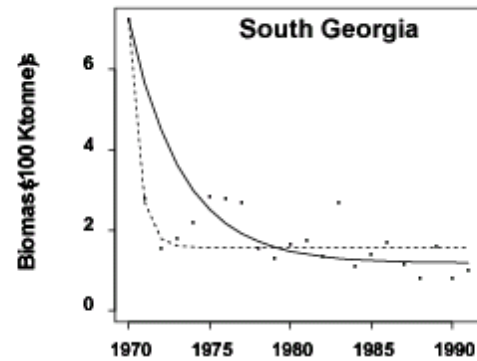
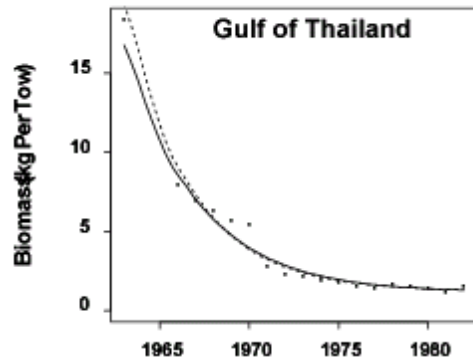
Step 8: You need emotional support. Support from colleagues and family is essential. You cannot do it (for long) by yourself.



Why is it so important.

What makes them work.

Shelf seas



Lessons I Learned from the Cod Disaster:

- Government constrained scientists may consistently ignore what the data tells them.
- Independence is key.
- Multiple, independent analyses are crucial; or else you will be dismissed.
- Speak clearly and honestly to the press, the politicians must know that someone is watching.
- Be proactive, once an animal is ecologically extinct it is too late.

15 May 2003

International weekly journal of science

nature

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www.nature.com/nature

Net losses

Industrialized fishing
hits fish stocks

Financial markets

You can't buck the physics

Jupiter's moons

Headed for a hundred

Functional genomics

The power of comparison



RAM's 12 step plan: From hard core math weenie
to passionate conservationist: A PERSONAL
ODYSSEY.



Reaching the heart through mathematics.

Final point: keep fighting, keep hoping!

This happened last week: Oceanic Whitetip declared critically endangered by ICUN

- Last year it was “species of least concern”.
- This change was not because we published one paper in Science, but papers based upon 3 independent datasets (plus 2 math/stats technical papers).
- Skeptics remain – more analyses are in prep from scuba surveys of jellyfish (one notices large sharks while diving in the clear open ocean).



Conclusion: The Factor of 10 Hypothesis

- Scientific investigations of marine fish stocks almost always begin after the fact.
- Here we compile data from which the size of the community of large predatory fishes can be estimated.
- New fisheries tend to deplete the biomass of large predators by at least a factor of 10 .
- These declines happen very rapidly, usually in a decade or less.

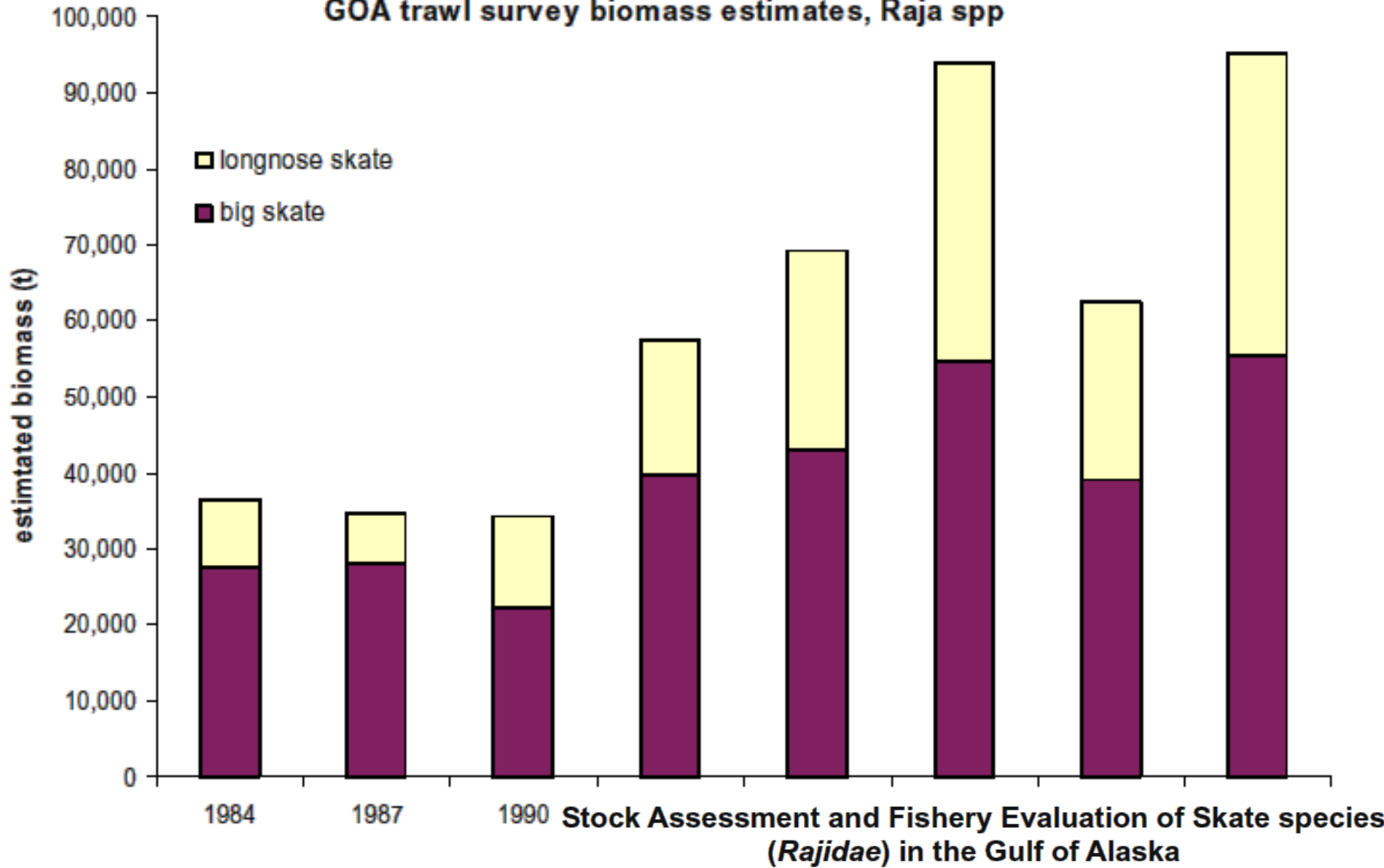


**Long - Term Changes In
The Gulf Of Alaska
Marine Ecosystem**

Figure stolen from Paul Anderson

- The Good -
 - Ban directed fisheries on sharks.
 - Control fishing on skates.
 - Keep a watch on bycatch.
-
- The Alaska Board of Fisheries prohibited all directed fisheries for sharks in 1998. In Southeast the bycatch rate for sharks and skates taken during other longline fisheries is 35% of the target species.

GOA trawl survey biomass estimates, Raja spp



by
Sarah Gaichas¹, Michael Ruccio², Duane Stevenson¹, and Rob Swanson³

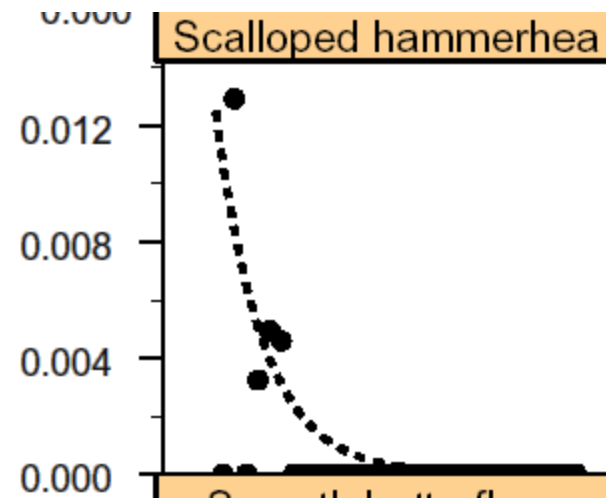
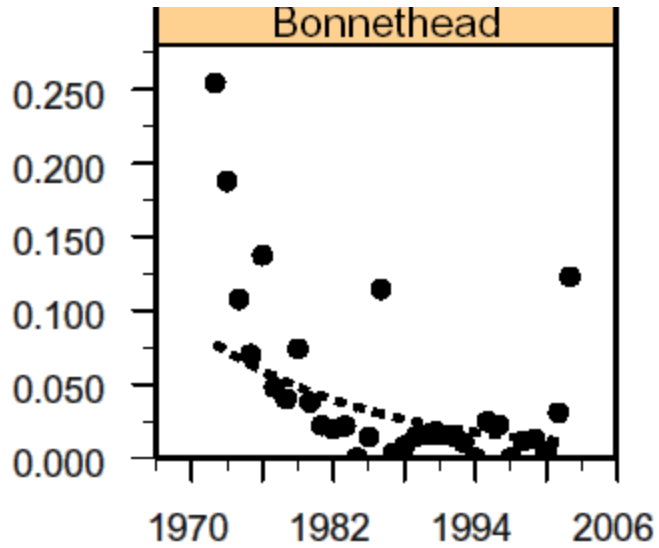


Figure 1. Big skate, *Raja binoculata*, with stock assessment author for scale.

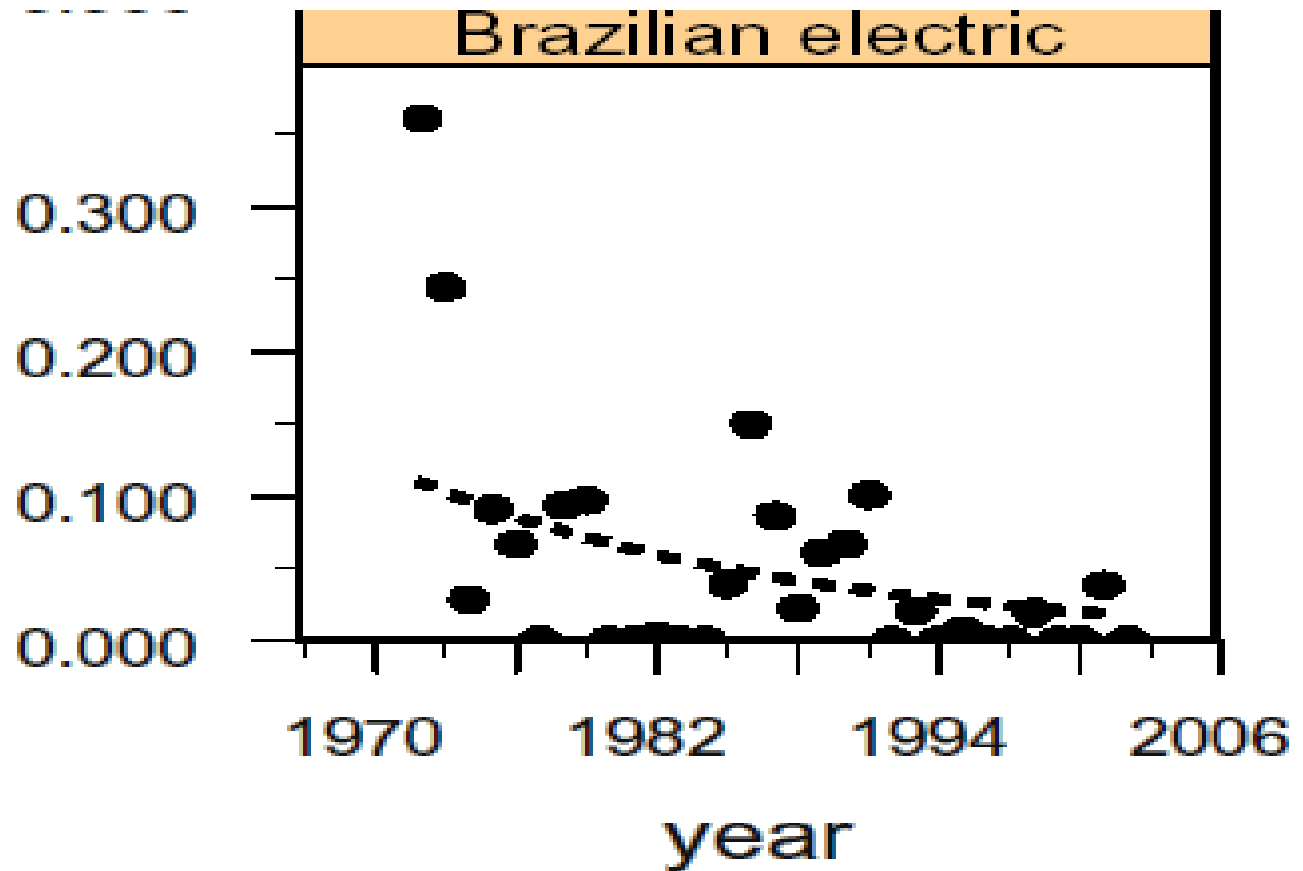
**Stock Assessment and Fishery Evaluation of Skate species
(*Rajidae*) in the Gulf of Alaska**

by
Sarah Gaichas¹, Michael Ruccio², Duane Stevenson¹, and Rob Swanson³

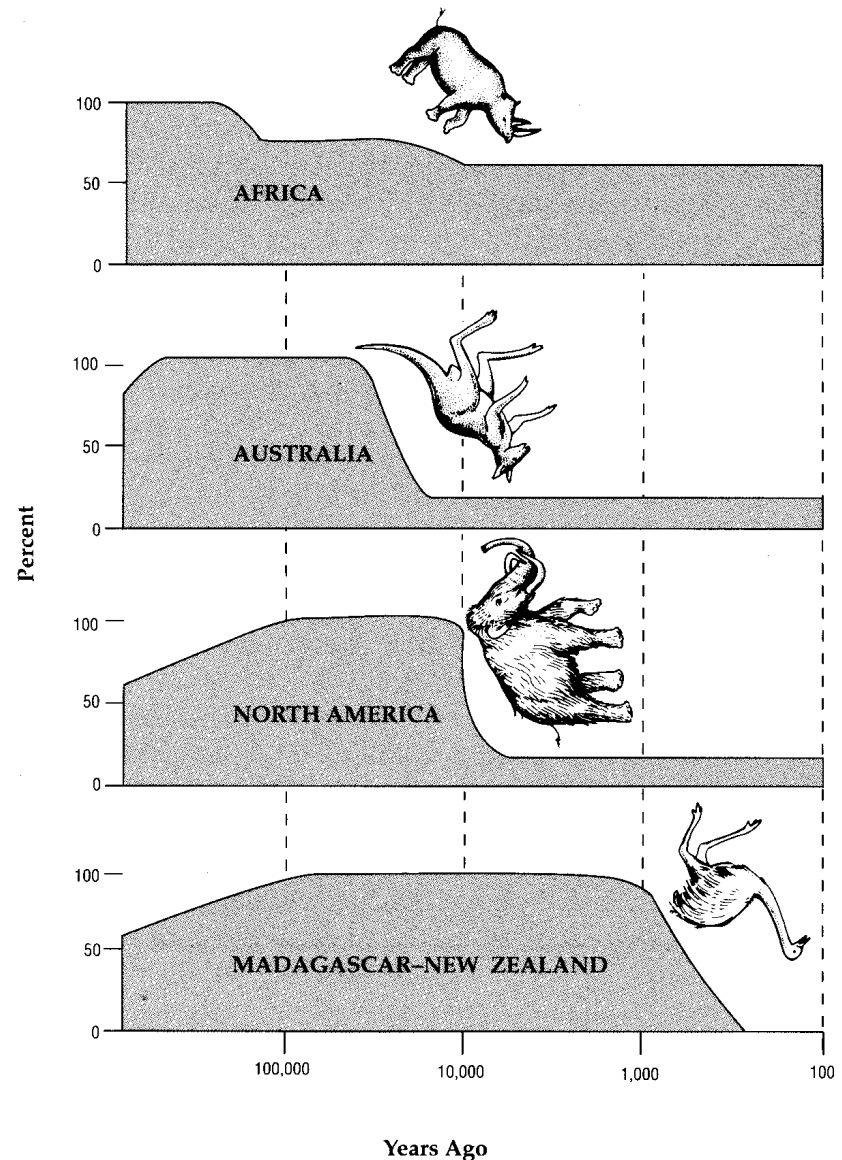
All large sharks declined



Shallow water species that do not survive discarding: large declines:



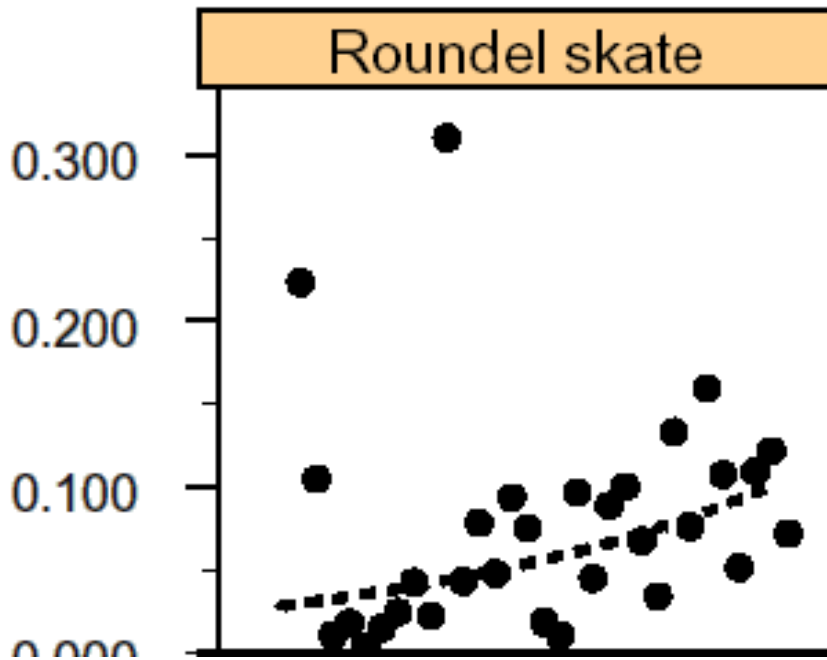
Are the pleistocene extinctions* going to be repeated in the ocean?

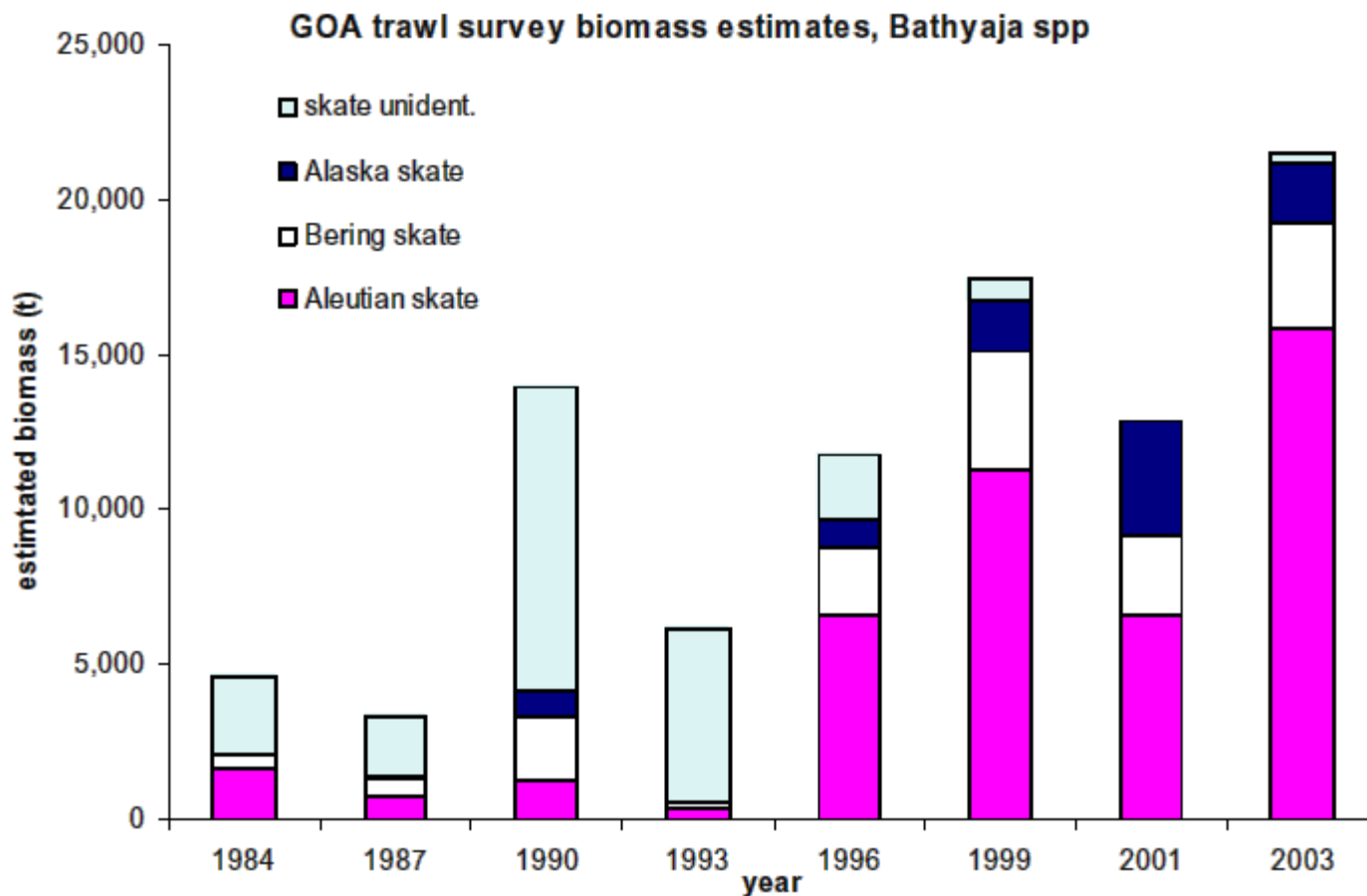


*Present North American biota has lost almost all large species – We have no mammoths, mastodons, giant ground sloths, giant beavers, and 65 other species that weighted more than 100 kilograms.

The extinction of large mammals and flightless birds coincided closely with the arrival of humans in North America, Madagascar, and New Zealand, and less decisively earlier in Australia. In Africa, where humans and animals evolved together for millions of years, the damage was less severe.

Deeper skate species that survive discarding increased

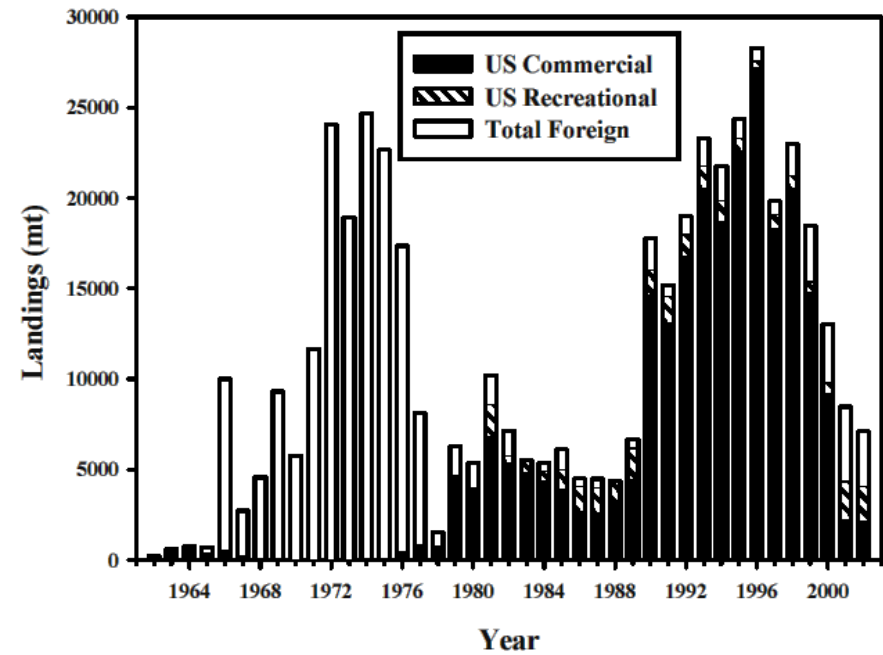
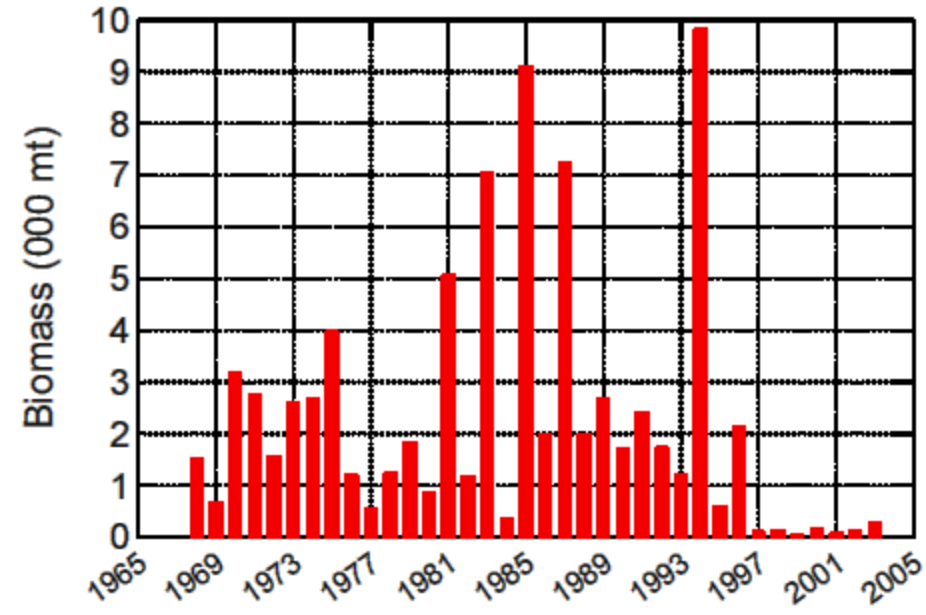




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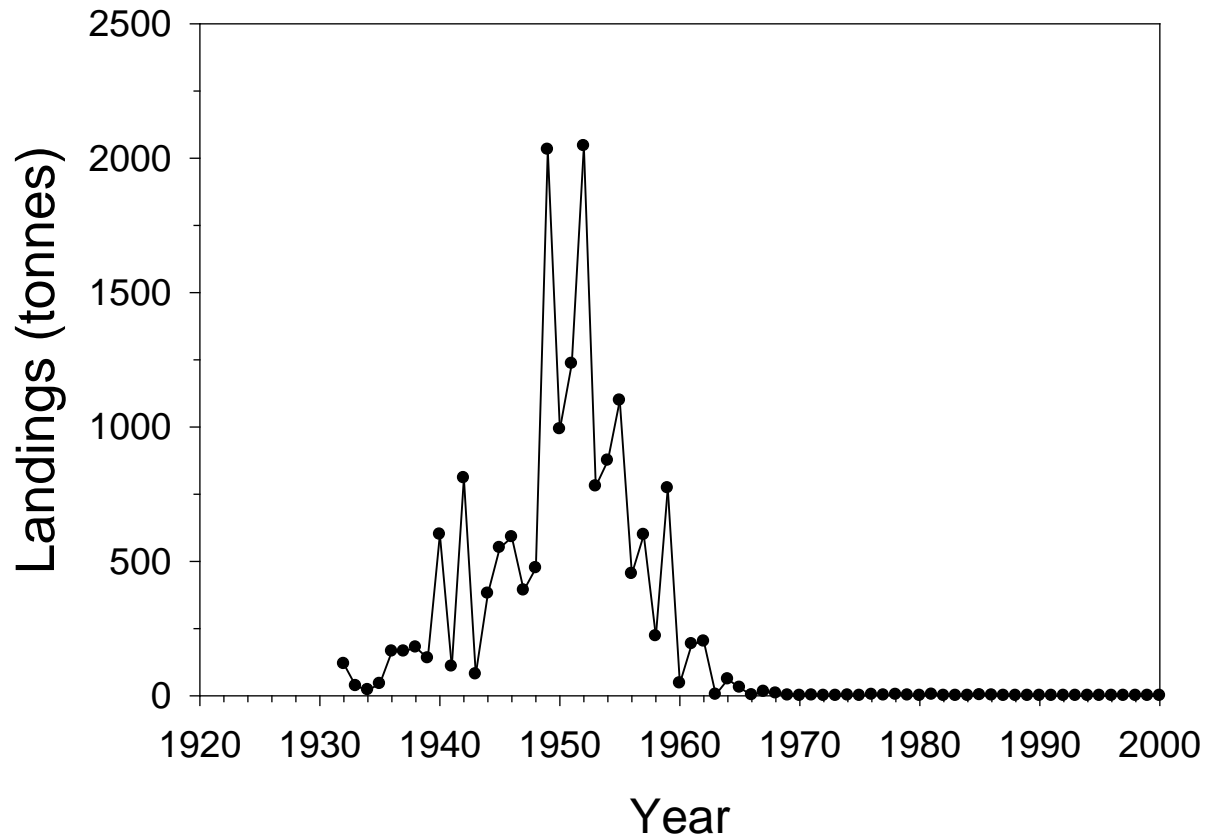
by
Sarah Gaichas¹, Michael Ruccio², Duane Stevenson¹, and Rob Swanson³

Spiny Dogfish, Northwest Atlantic: Good Science – Ugly Decisions



Danish Landings of Bluefin Tuna

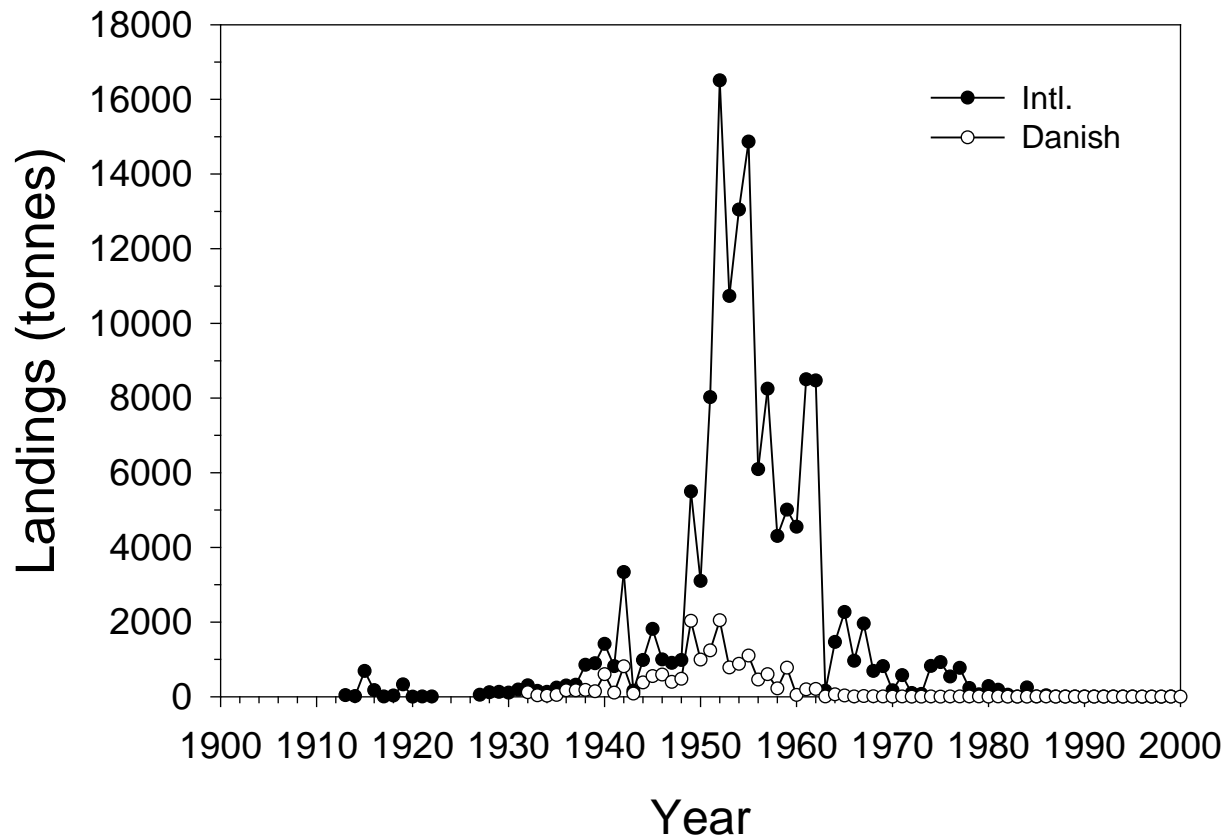
Thunnus thynnus



Data source: DIFRES, ICES, FAO

Landings of Bluefin Tuna

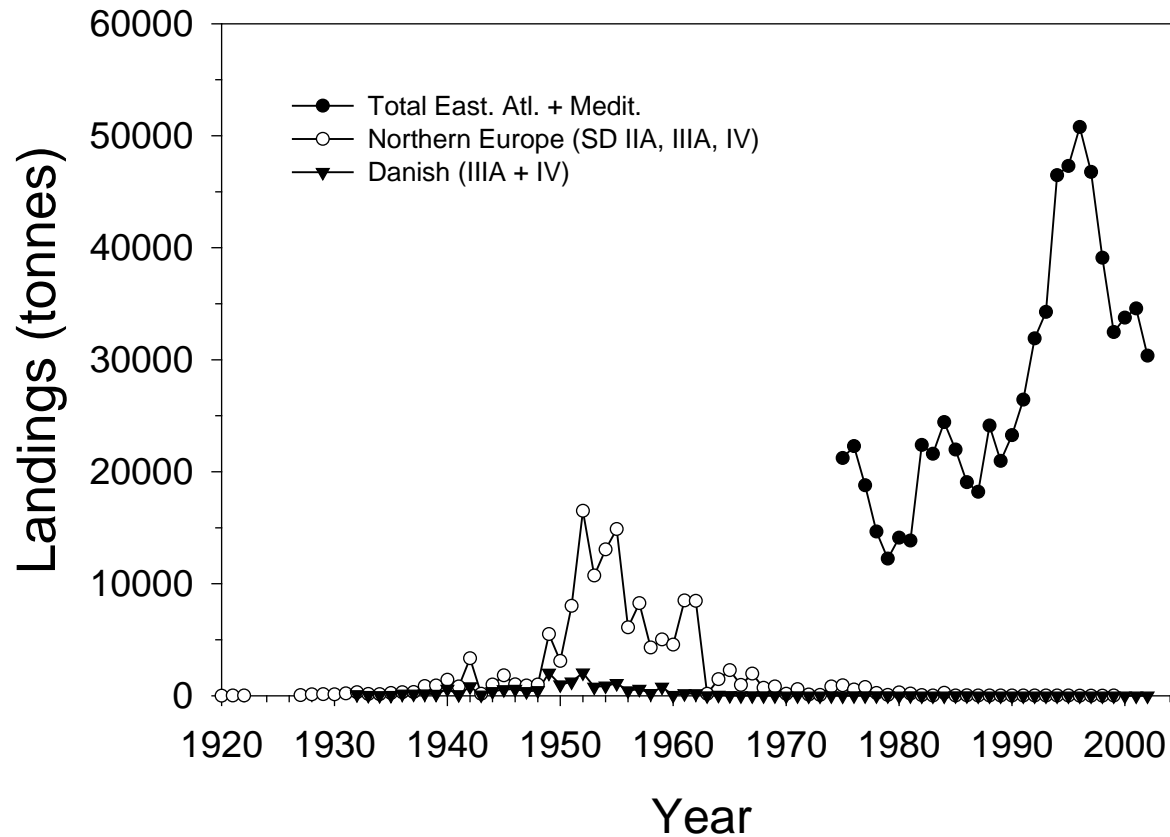
Thunnus thynnus in Northern Europe*

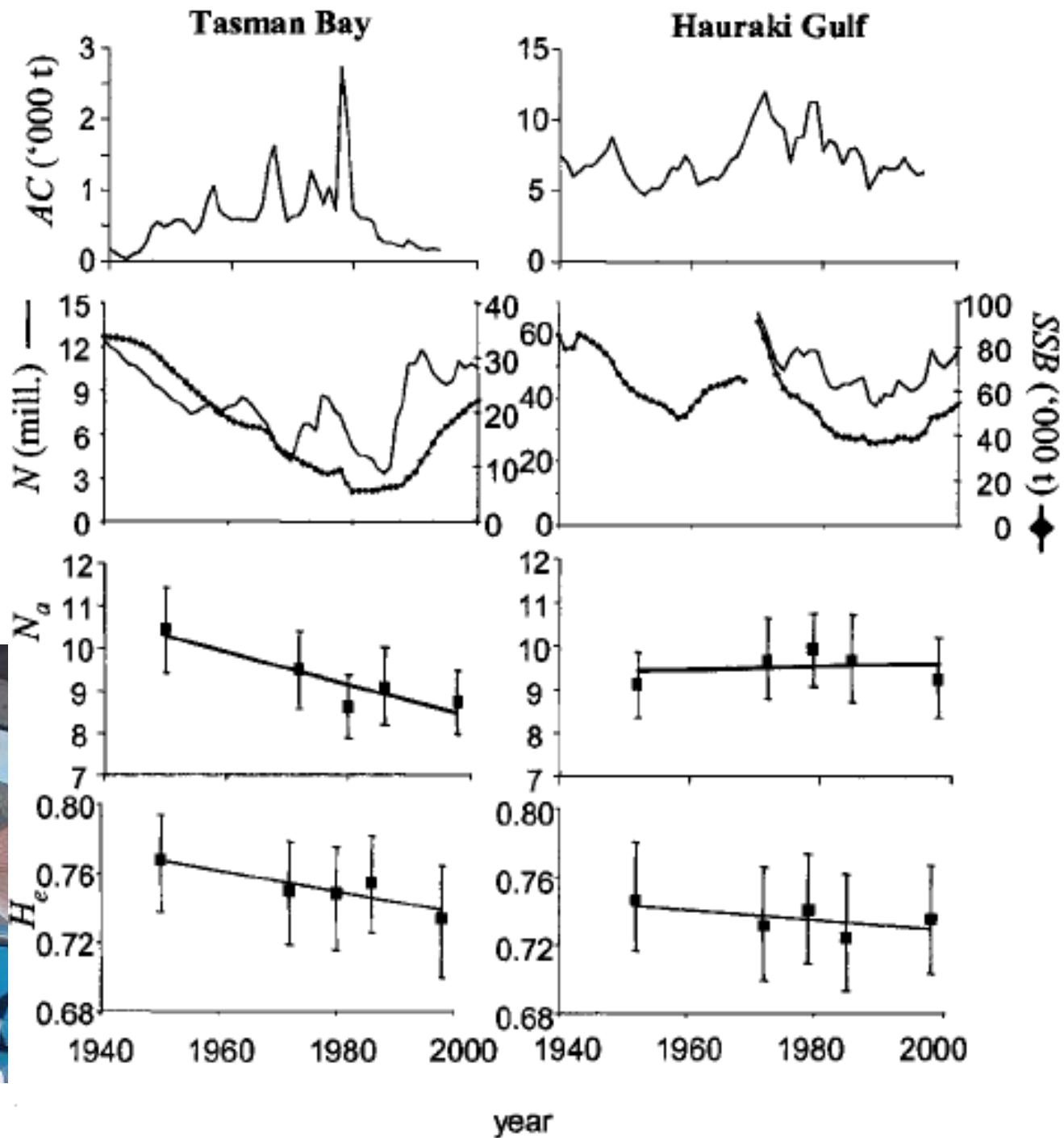


* = Norwegian Sea, North Sea, Skagerrak, Kattegat, Øresund

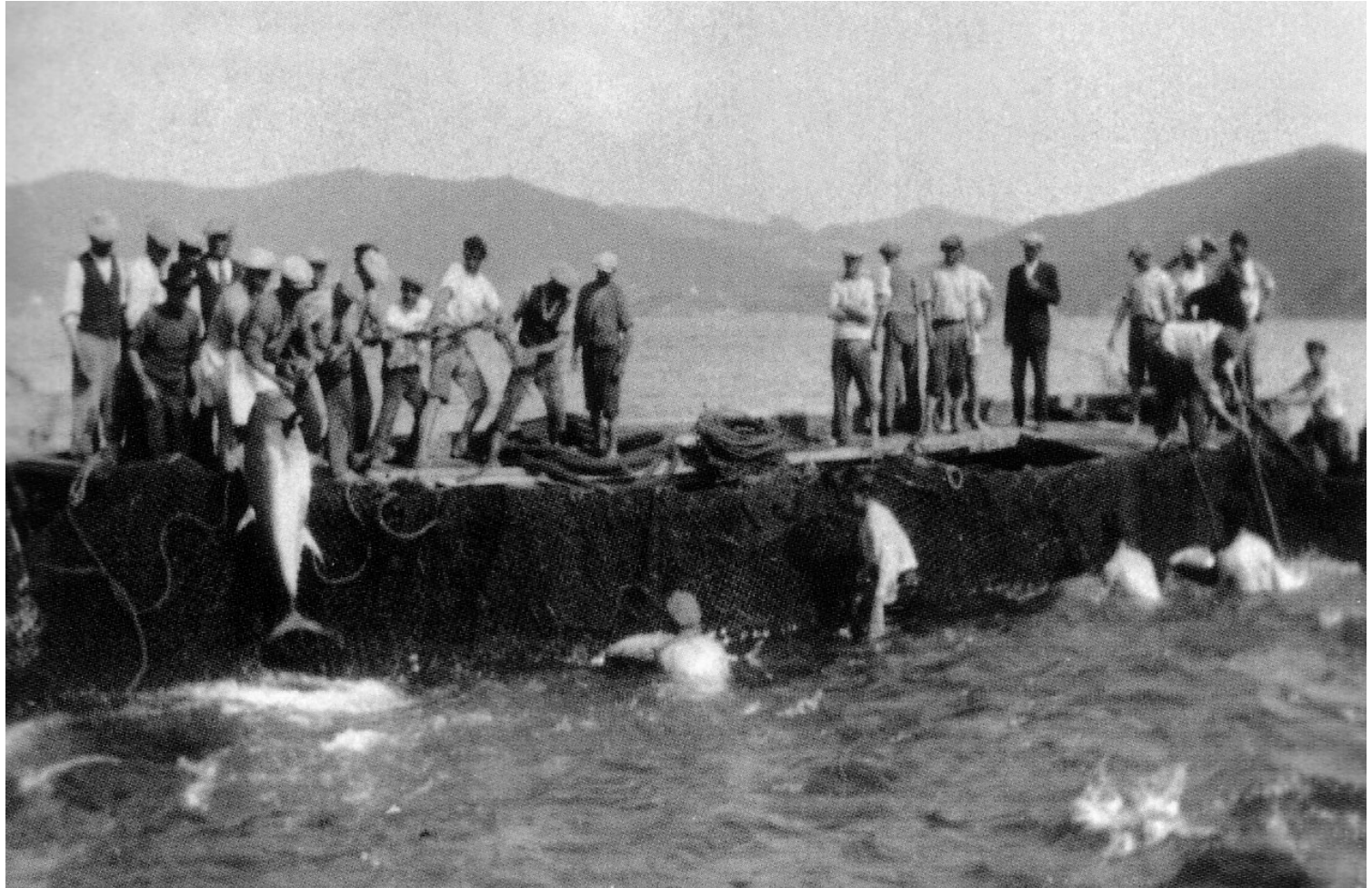
Landings of Bluefin Tuna

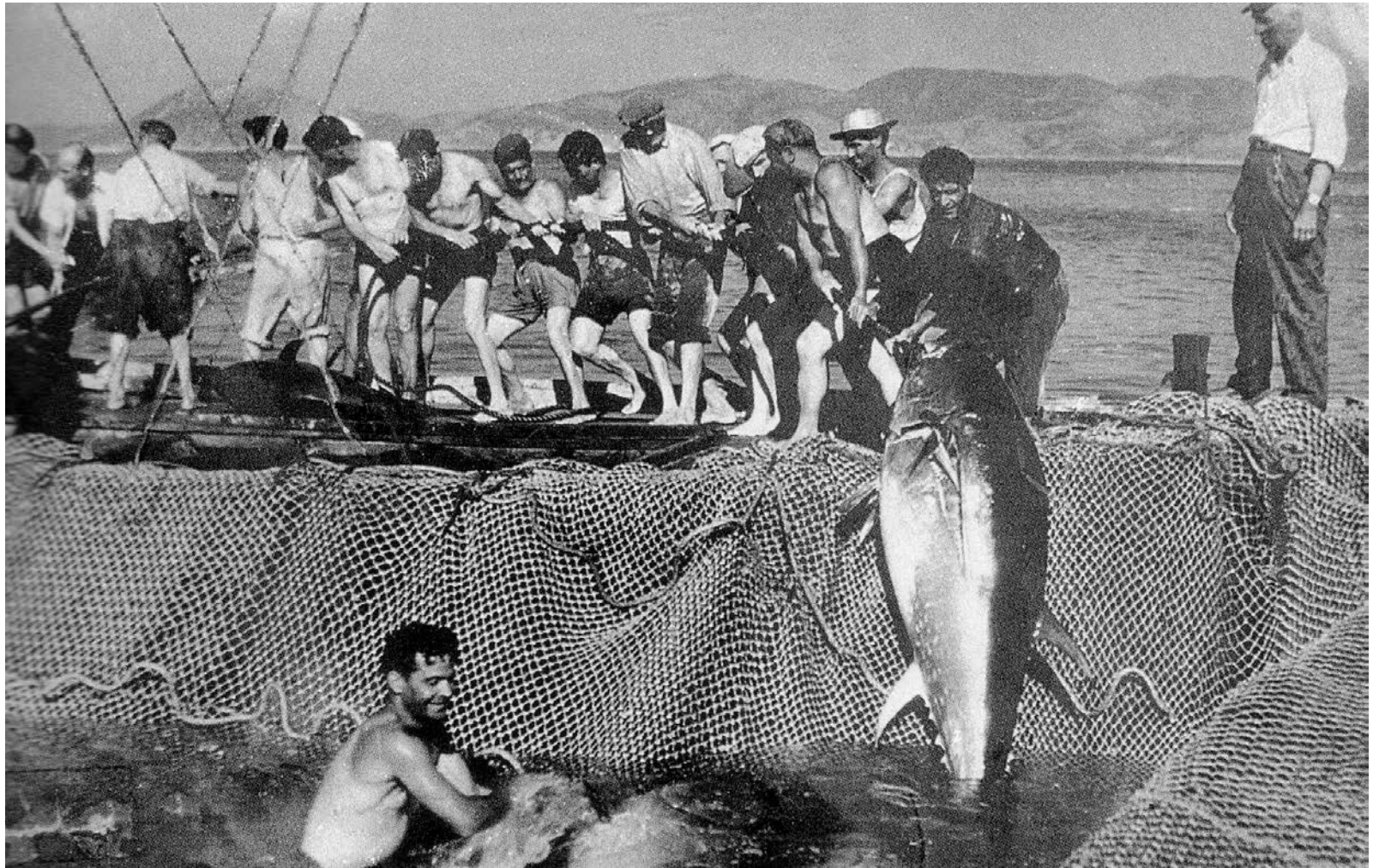
Thunnus thynnus in Northeast Atlantic

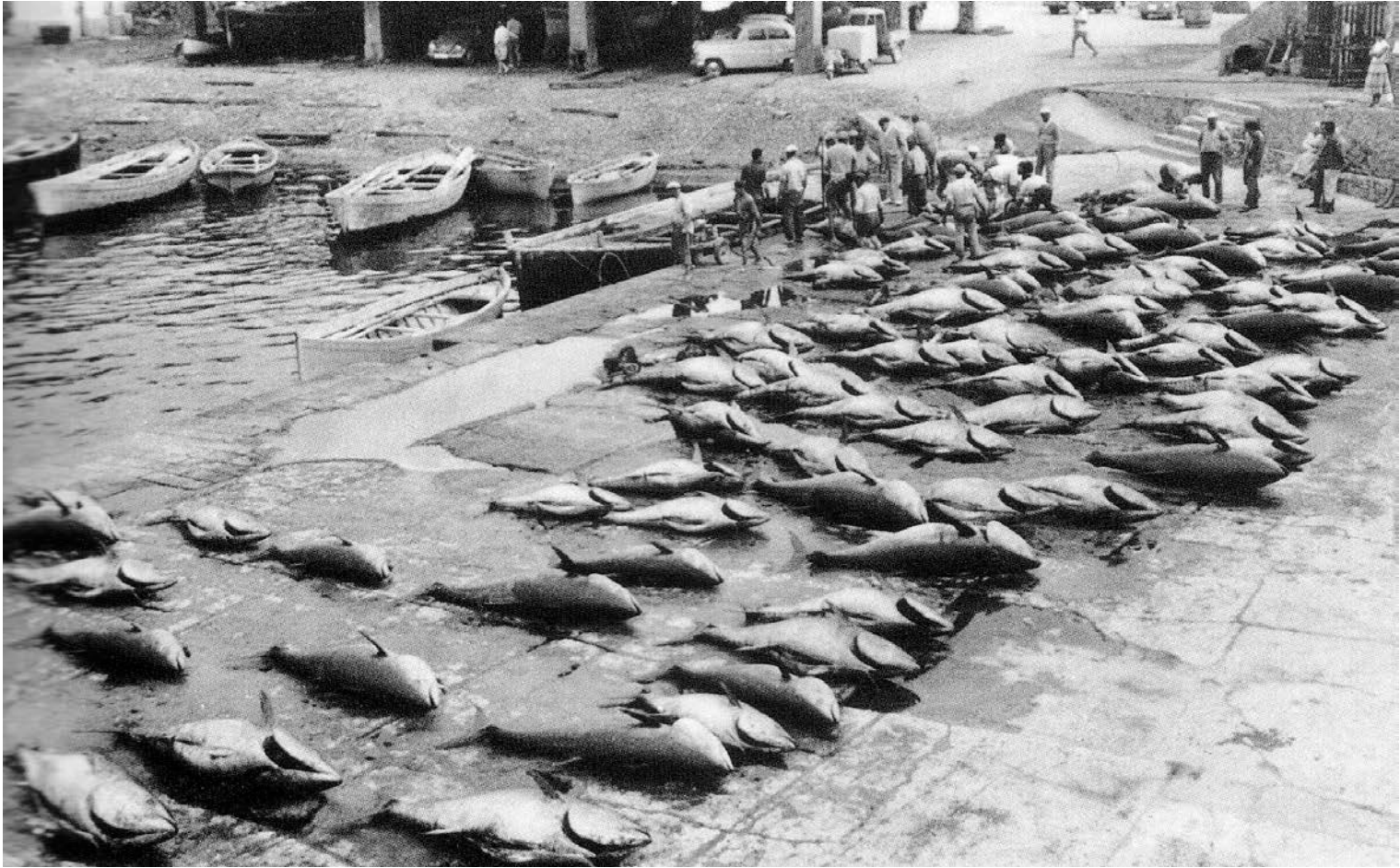




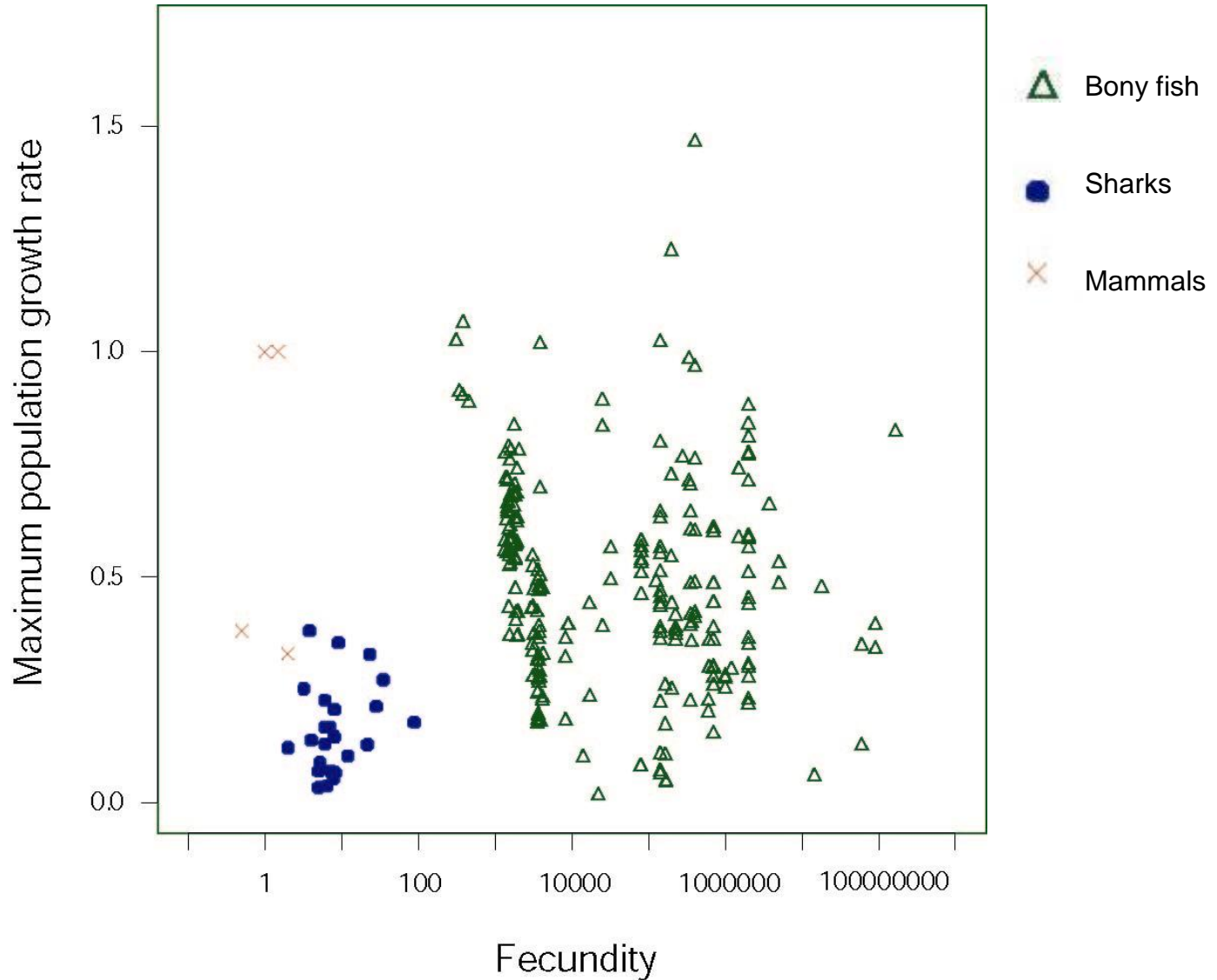
Hauser, et al. PNAS, 2002







Life history of sharks...

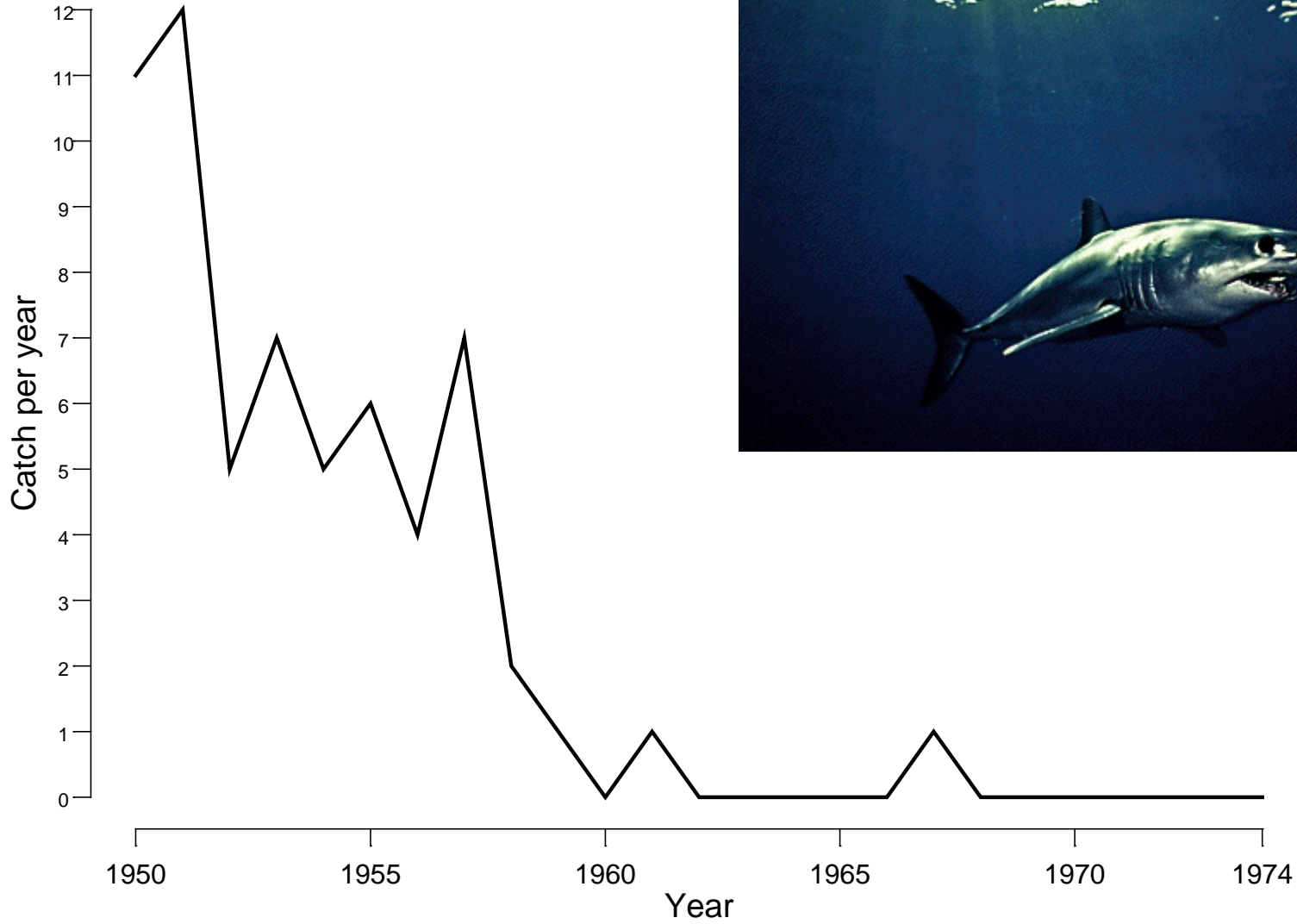


We Cannot Imagine the Loss of Life in the Ocean: We have to look at data.

Ransom A. Myers (RAM)
Dalhousie University, Halifax,
Canada

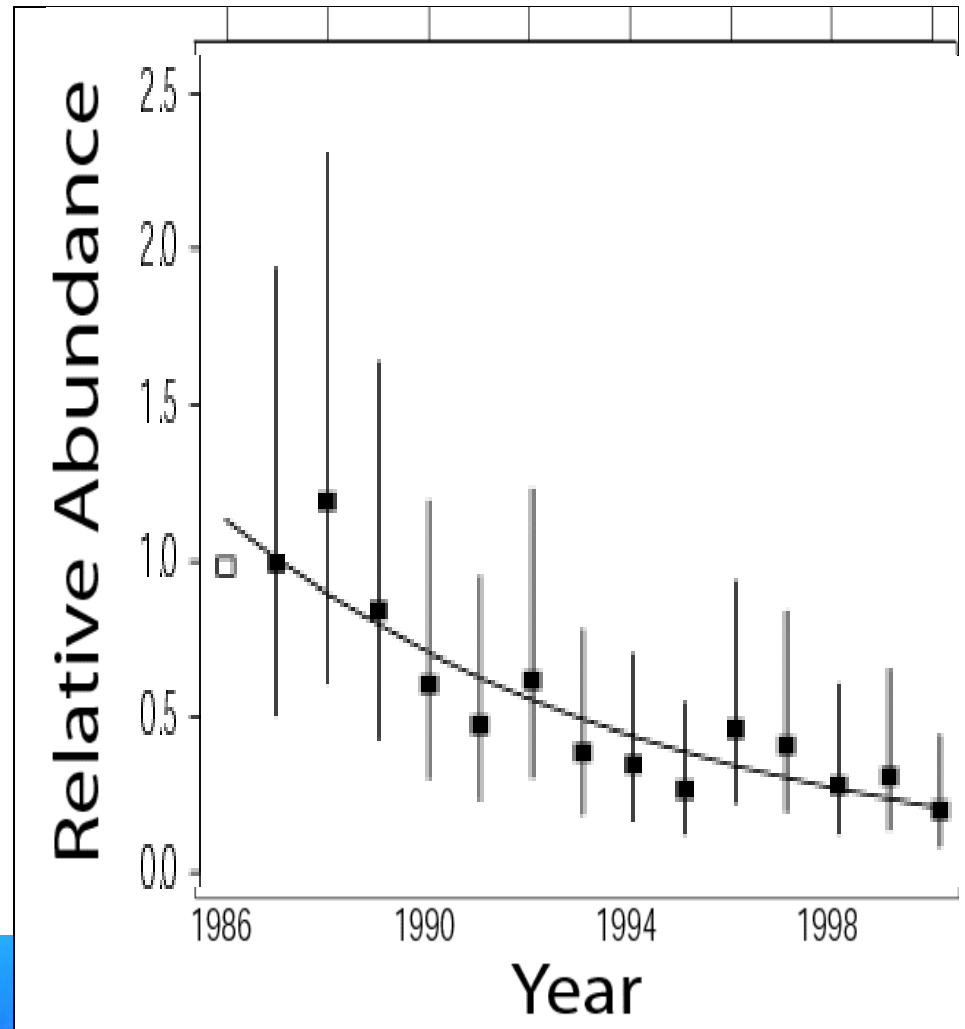


Decline of Mako sharks



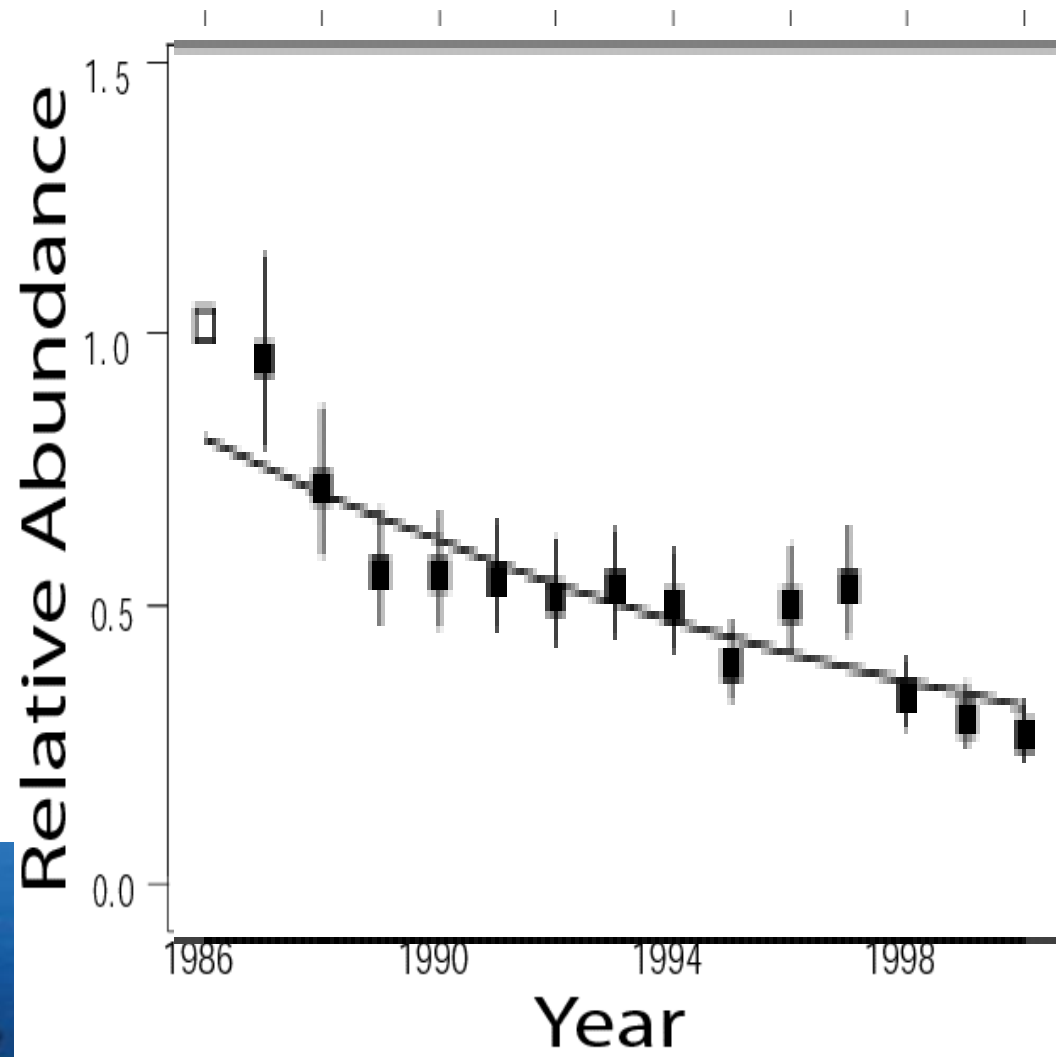
Thresher sharks

Alopias spp.

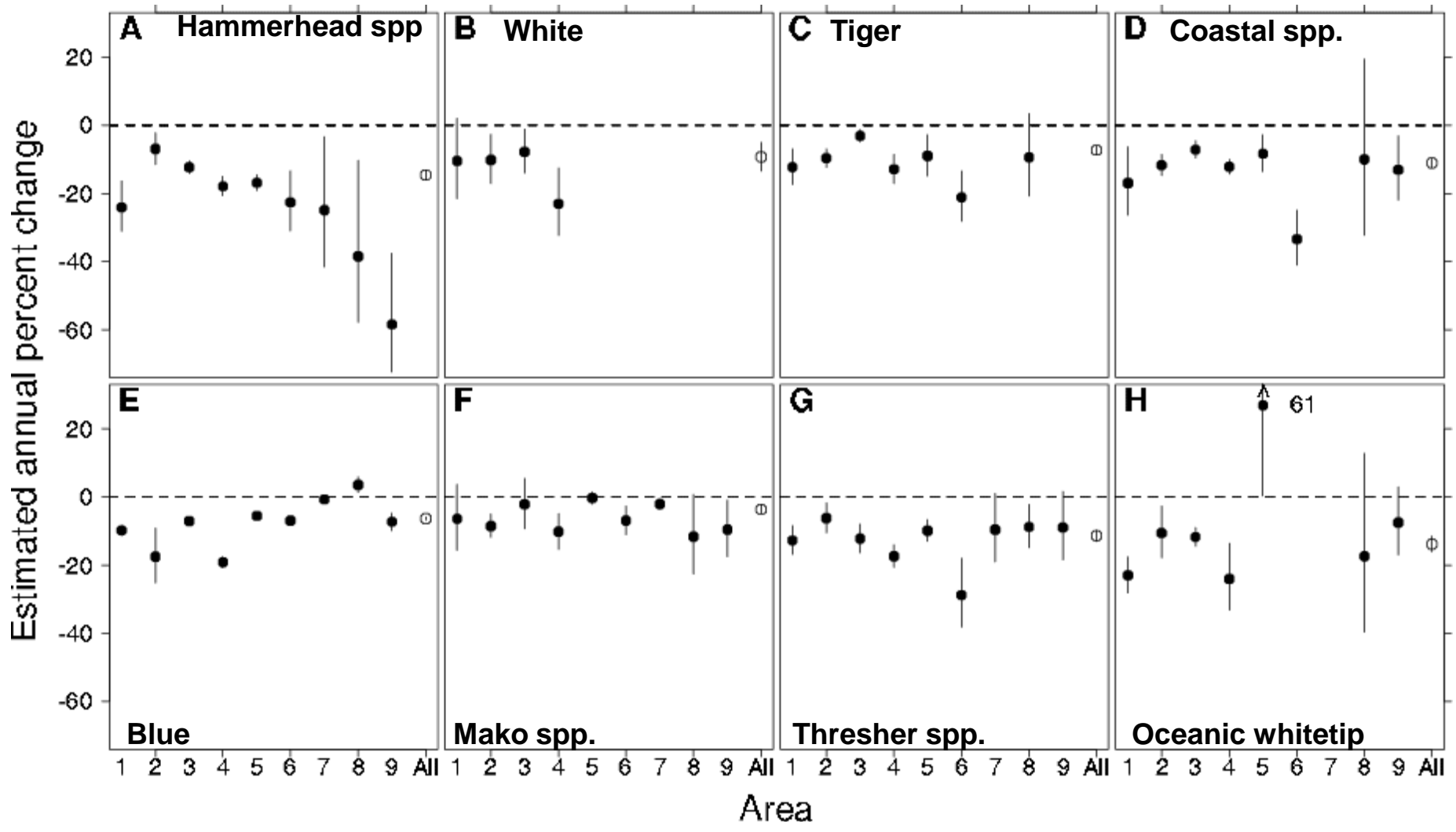


Blue sharks

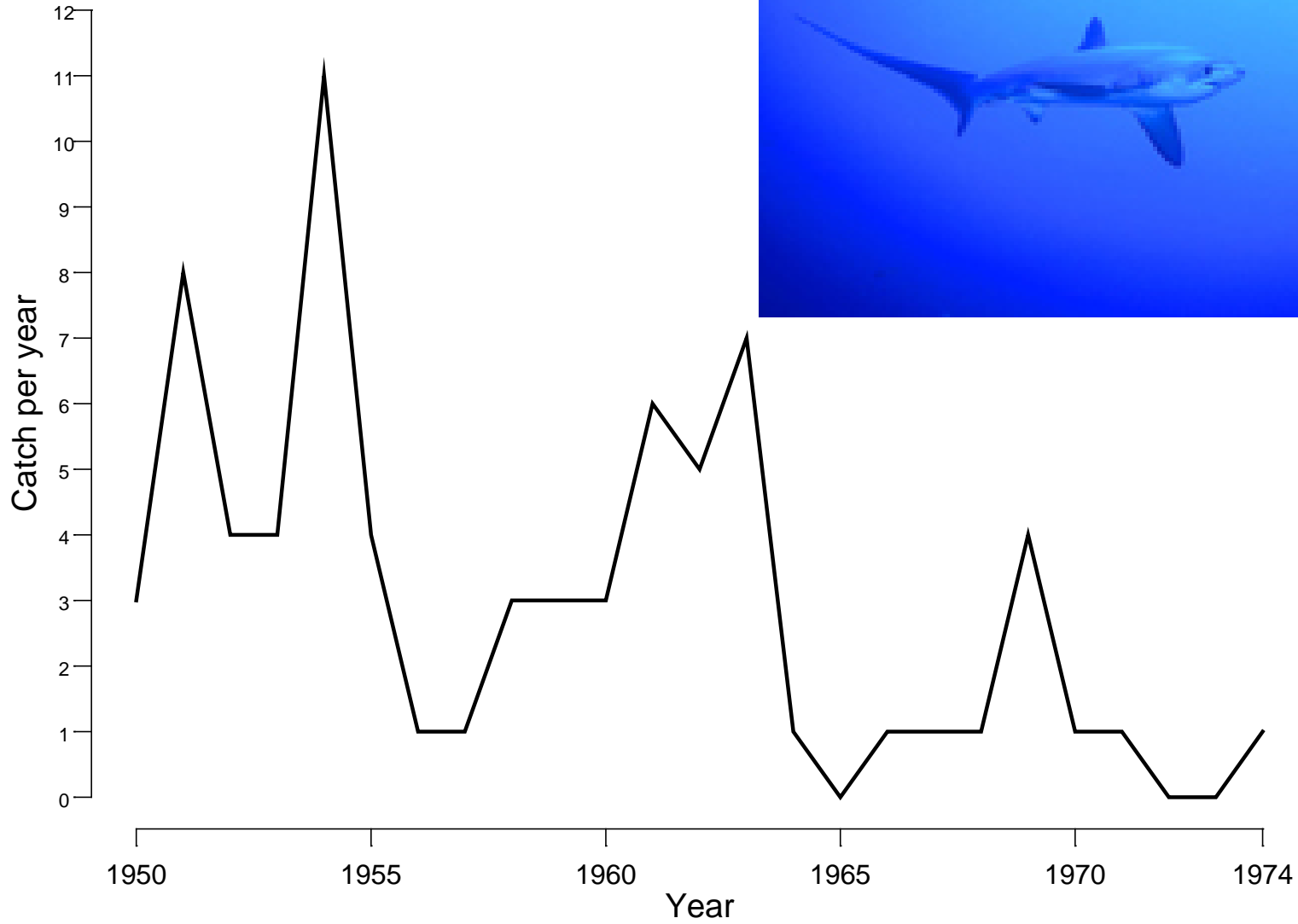
Prionace glauca



- 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

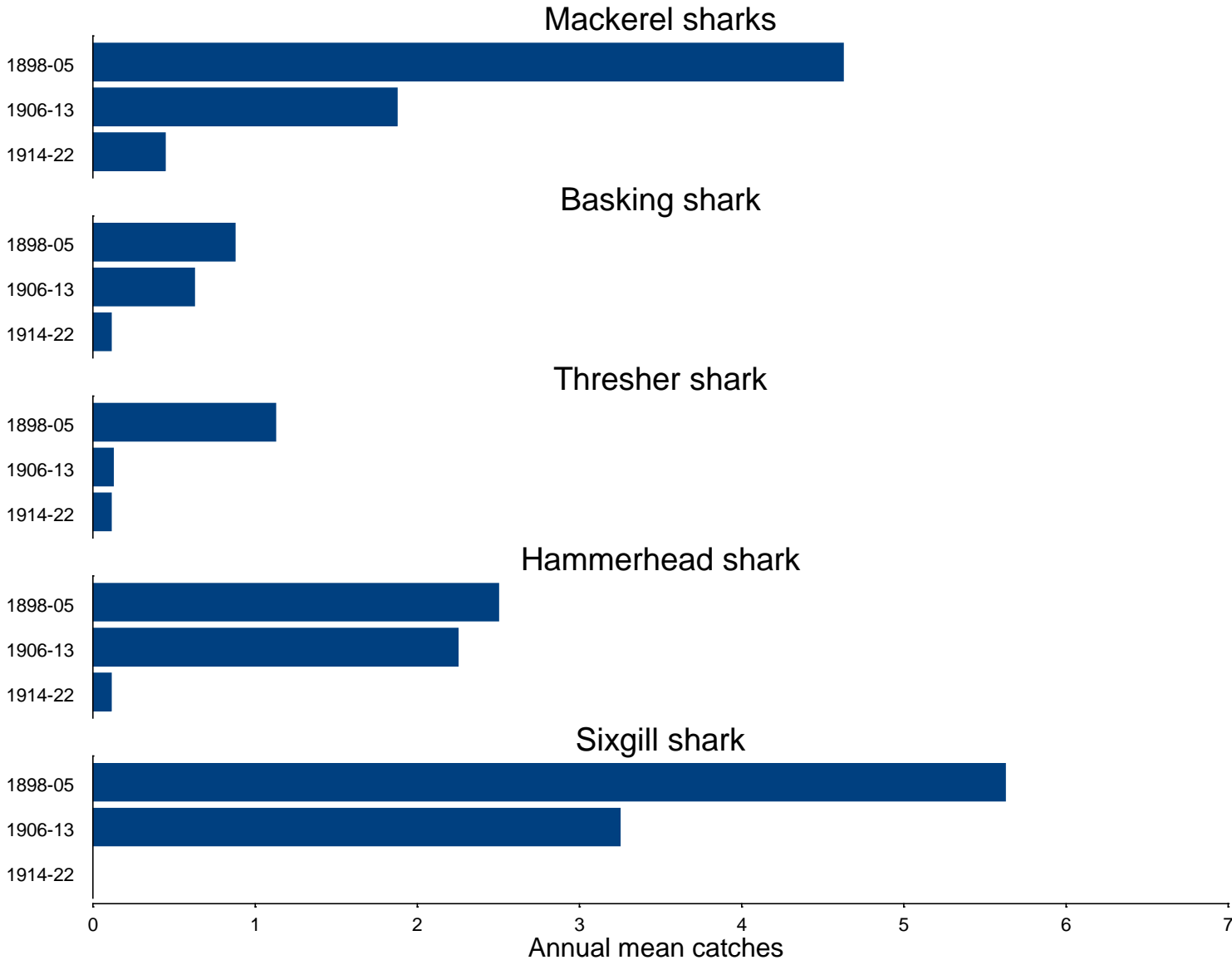


Decline of Thresher sharks



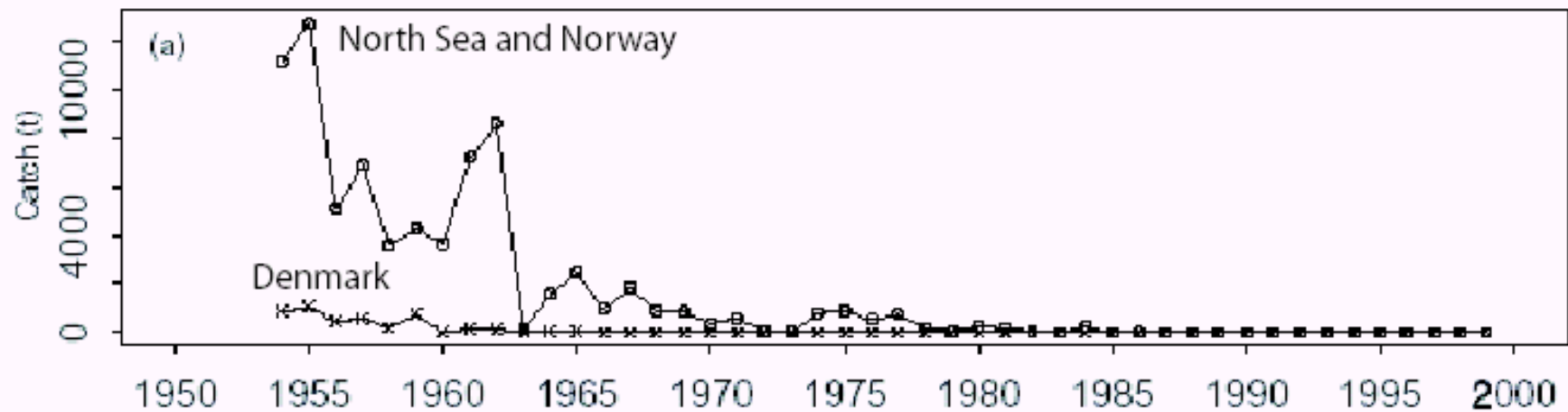
Decline in Large Sharks's Catches by an Italian Tuna Trap

Baratti's "Tonnarella"

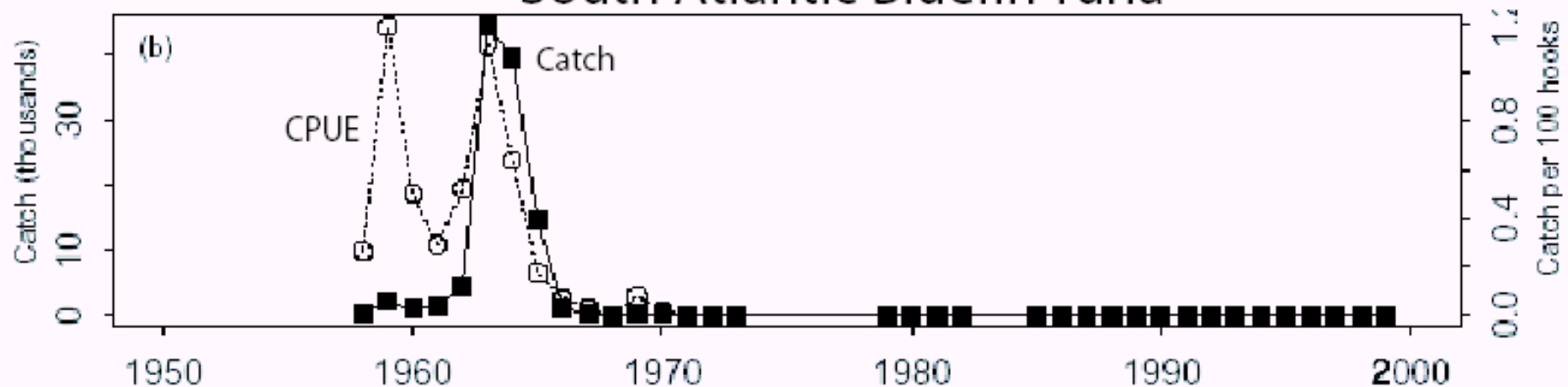


Loss of Bluefin Tuna Populations in the Atlantic

North Sea Bluefin Tuna



South Atlantic Bluefin Tuna

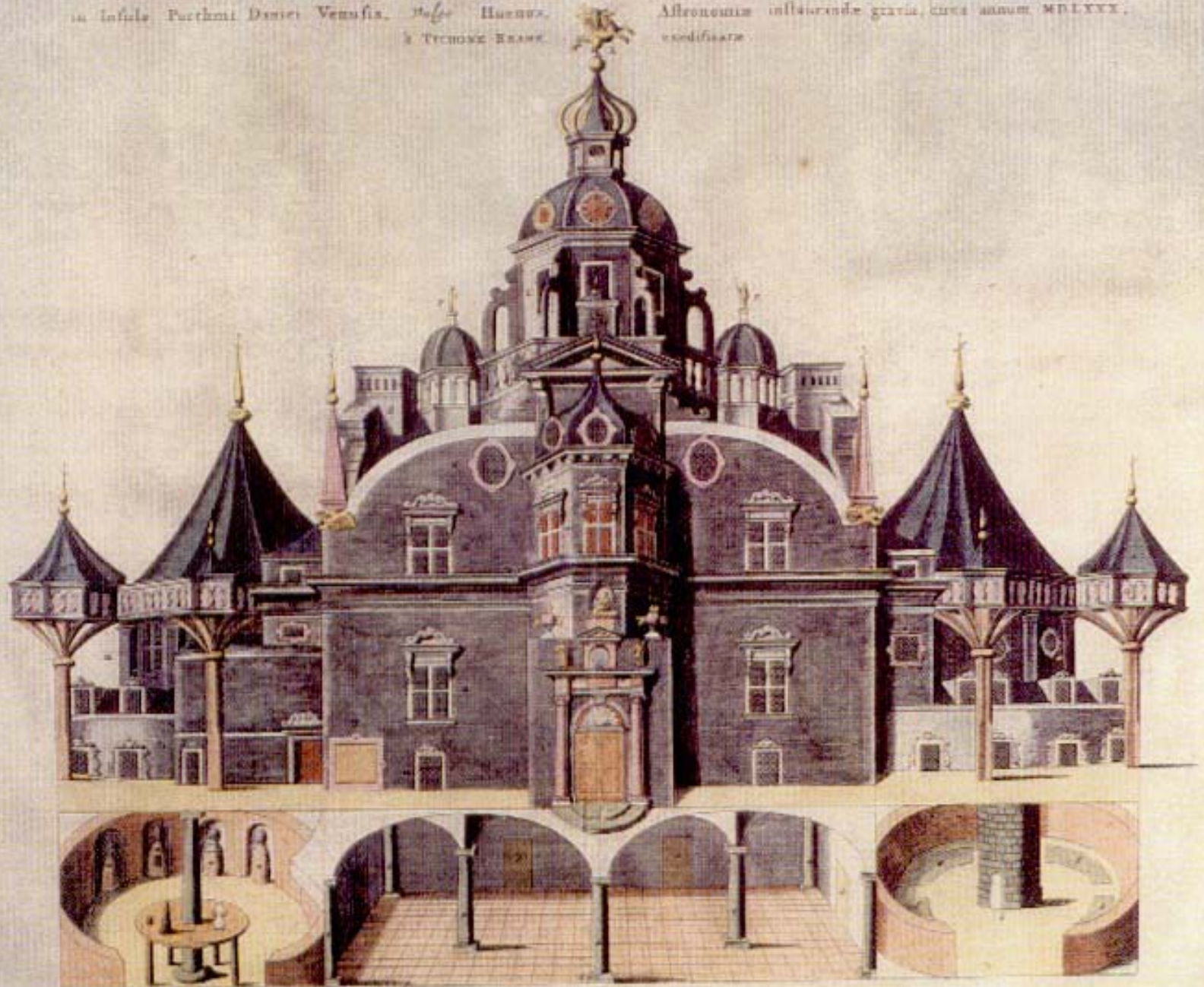




ORTHOGRAPHIA PRÆCIPVÆ DOMVS ARCIS VRANIBV RGI

in Insula Pomerani Dantis Veneris. *Stylus* HUGONIS.
& TICHONIS ERANNI.

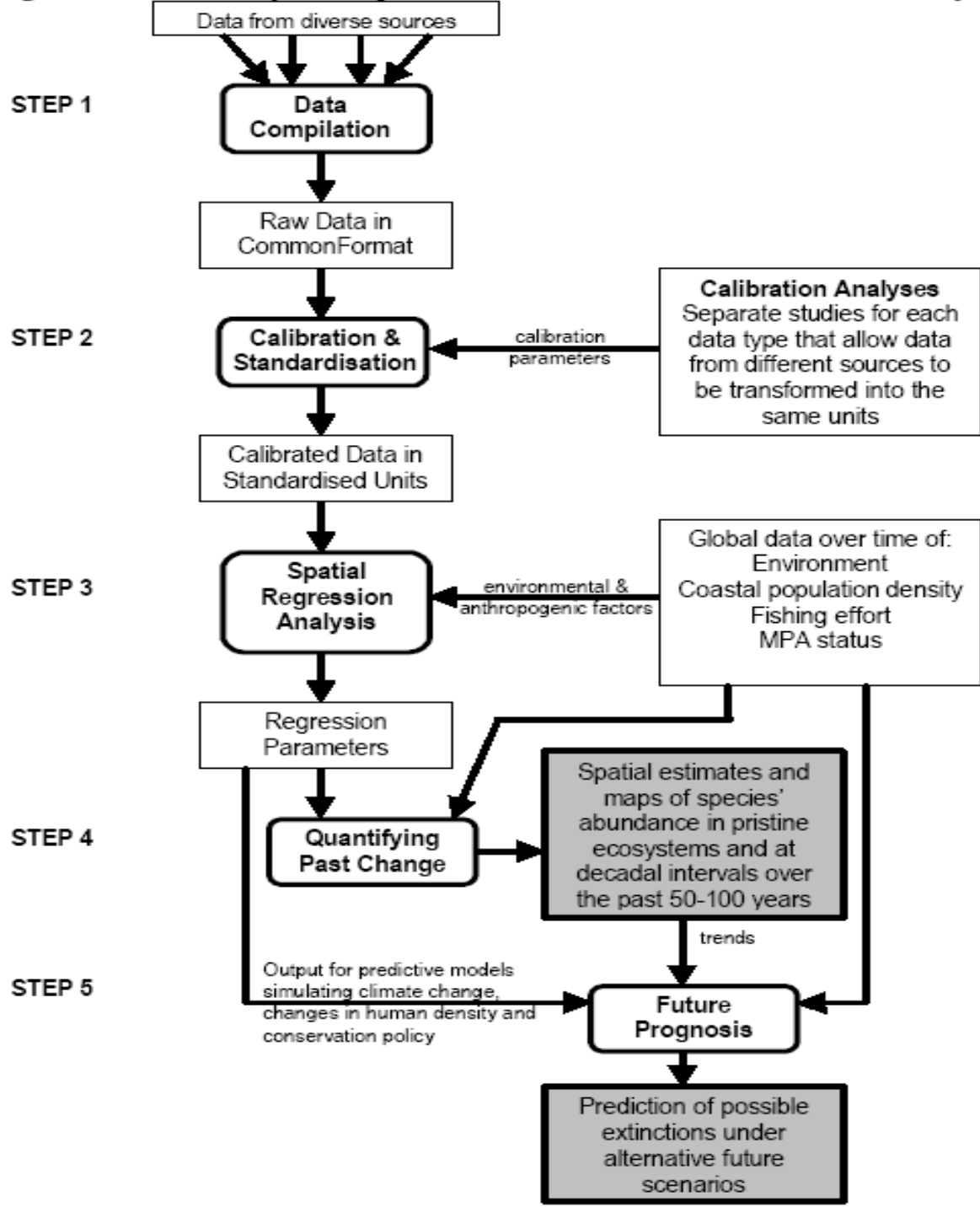
Astronomis illusterrimæ gratiæ, curâ annuæ MDLXXX.
restituitur.





Strategy:

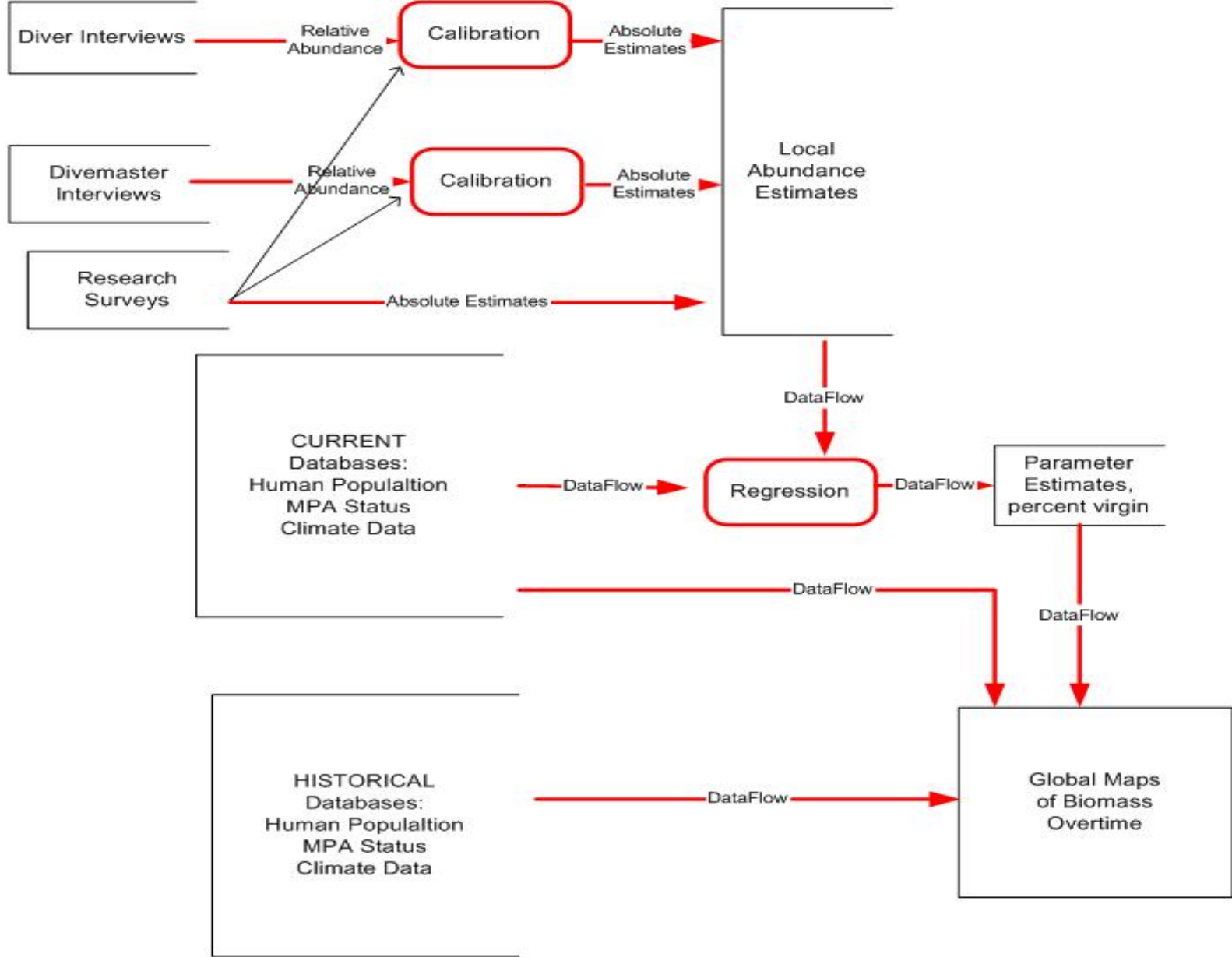
- Formulate the most important problem in terms of a critical model where in terms of a few parameters that can be well estimated.
- Compile all data in the world on the issue
- Analyze it the right way



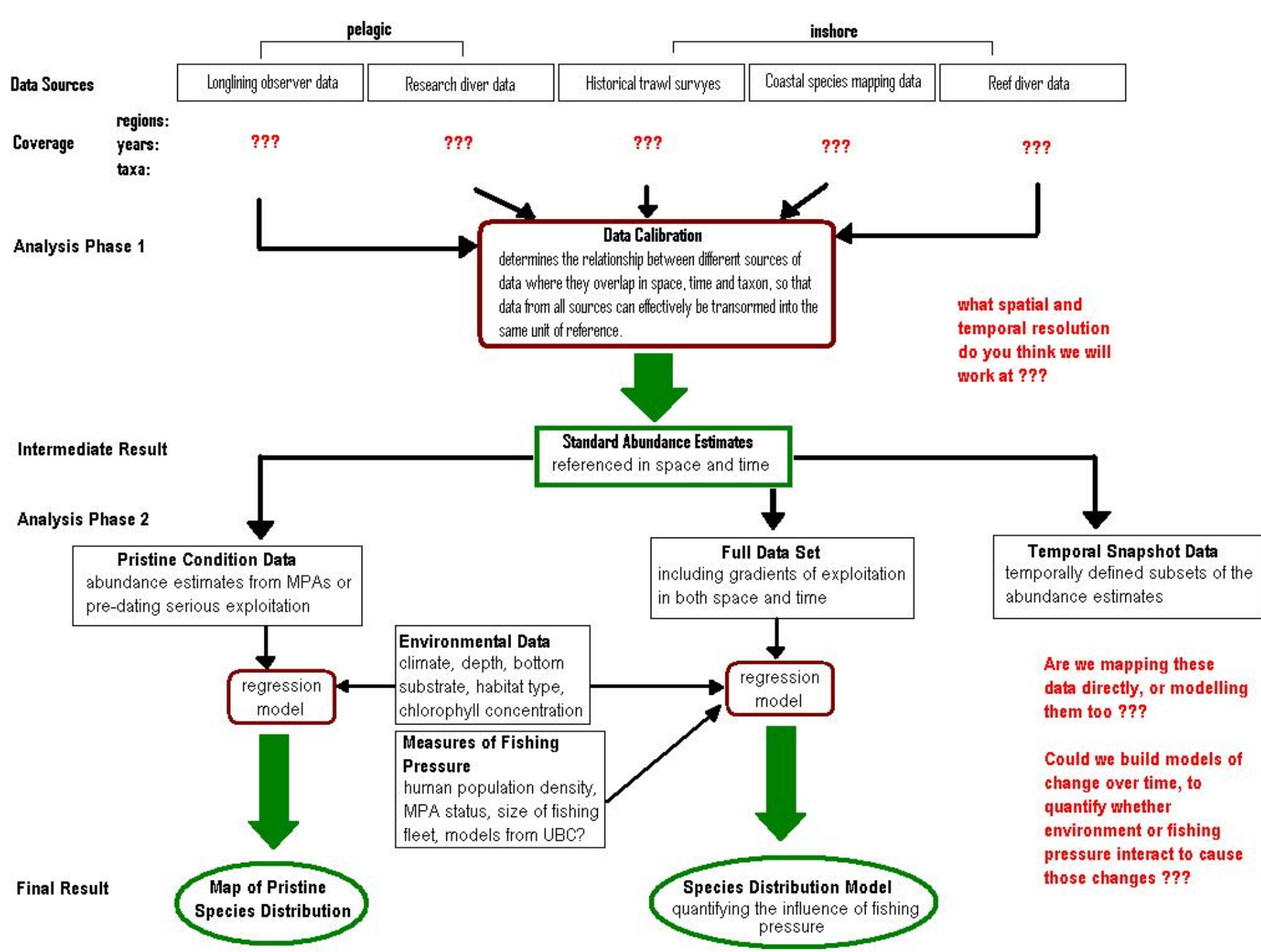




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Outline of data flow to produce global maps of abundance for reef species. The goal is produce maps for species that are of interest to divers over time, and estimate the “pristine” abundances and biomass, and the time trends over time to the present. This will be critical to estimating extinction probability.



Raw data on paper:

- old Japan data from Pacific
- old Japan data from Atlantic (one publication from equatorial Atlantic)
- old California Department of Fish and Game reports
- recent Japan data ICCAT documents (at least 5)
- old Canadian data
- old US east coast reports (we have a few on hand, others may be hidden at NMFS Gloester lab or in Miami)
- US expedition to the Indian Ocean in 1960 (Andy Bakum)
- Uruguay (p. 825 in Swordfish white books)
- Dave Long does longline surveys at NOAA La Jolla

Raw data in digital form:

- updates on Canadian data
- updates on US data
- observer data from the Mediterranean
- South Pacific Commission (we have much of this and could get more)
- Indian Ocean Commission?
- data sources in supplement to Lewison: Ecology Letters (2004) 7: 221-231
- Costa Rica
- cooperative shark tagging in RI
- NE US, Simpendorfer 2002
- Bolten's data from Azores

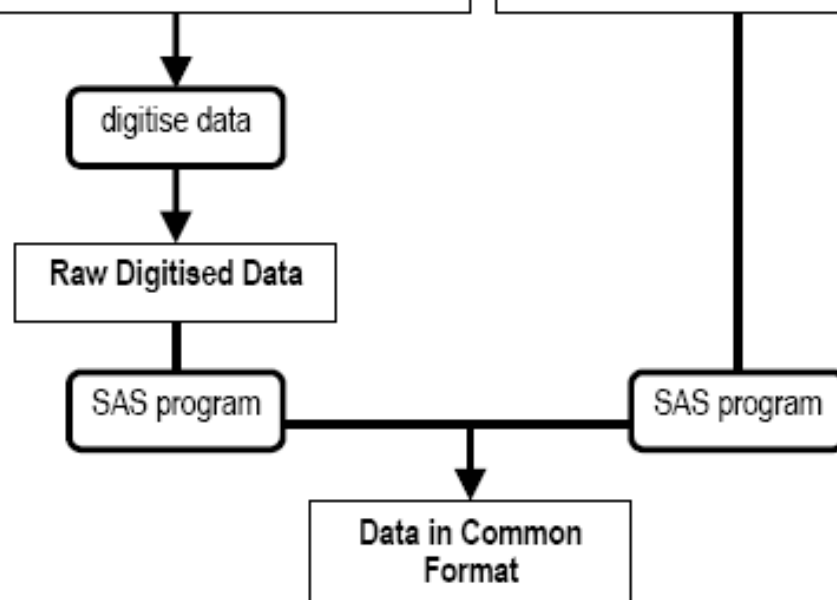


Figure 3. Calibration of data gathered from professional and amateur divers.

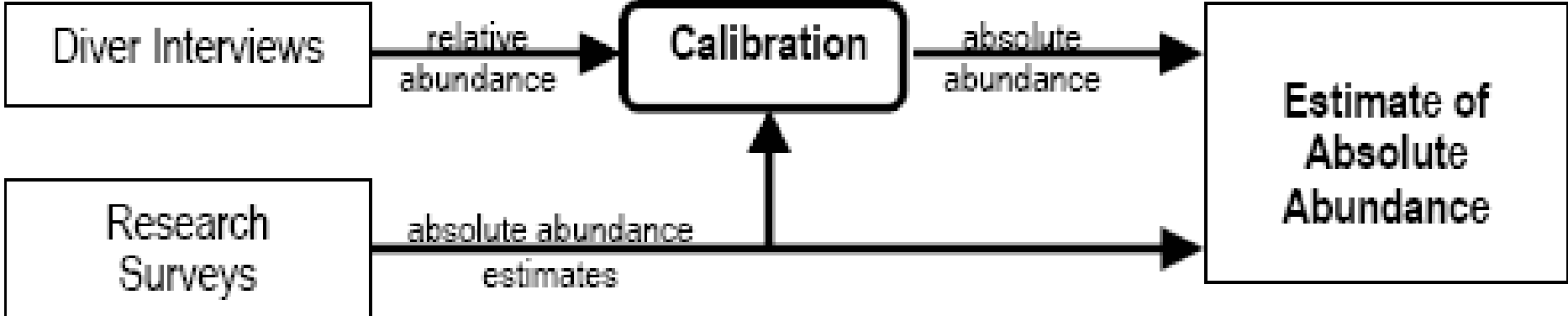
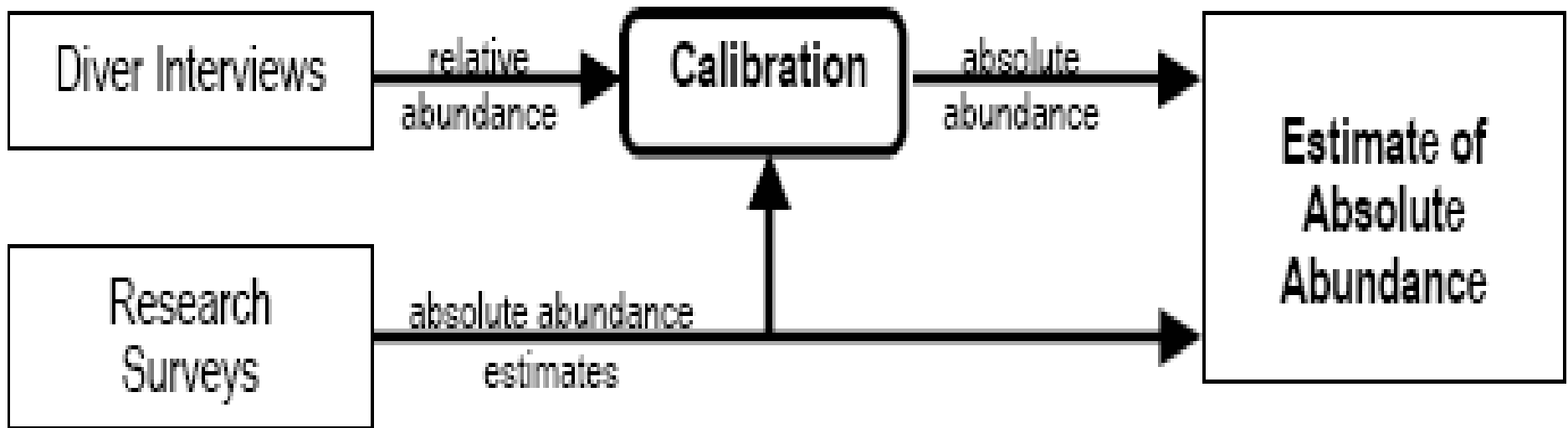


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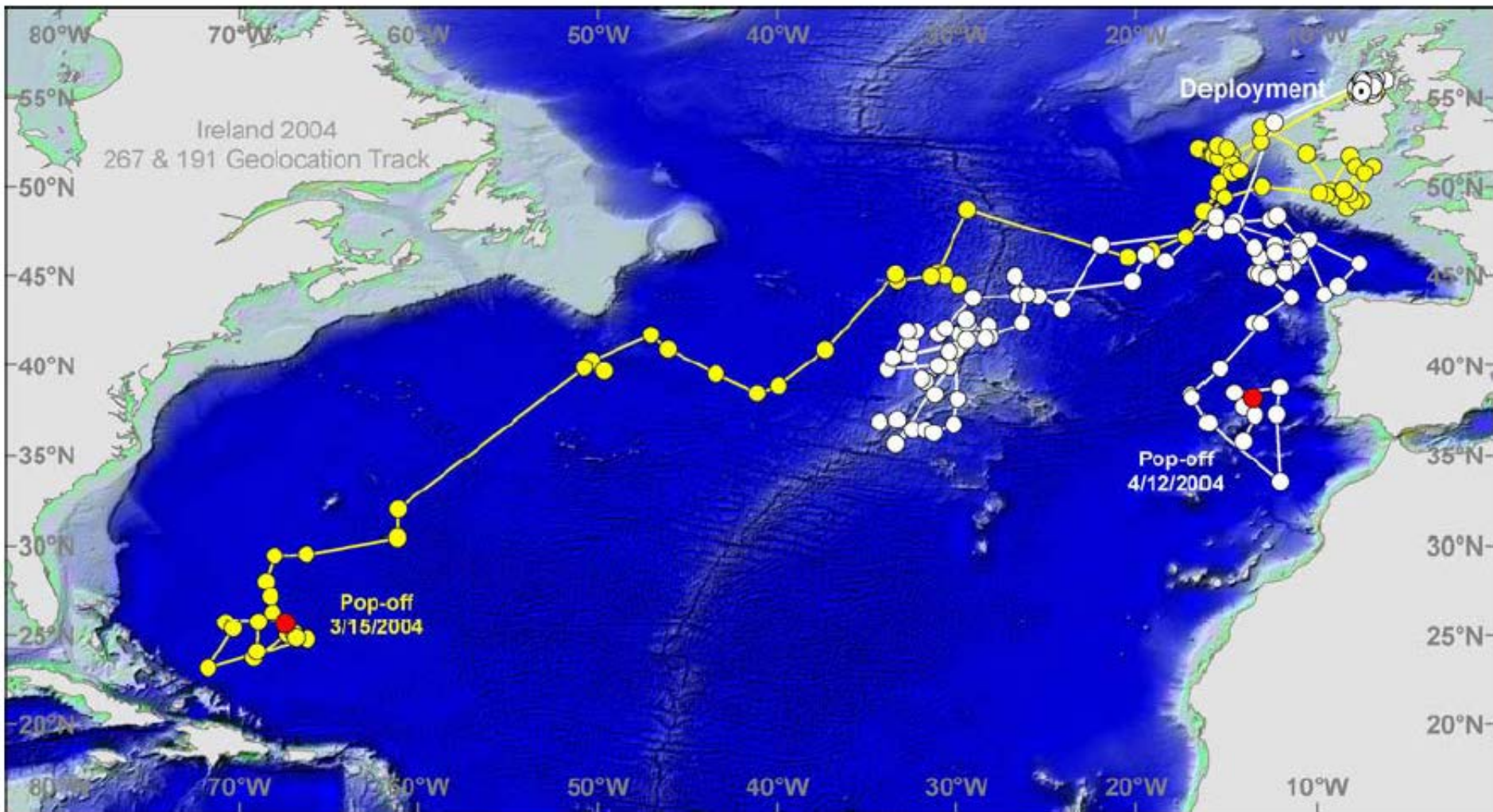




Photo by Matthew Godfrey

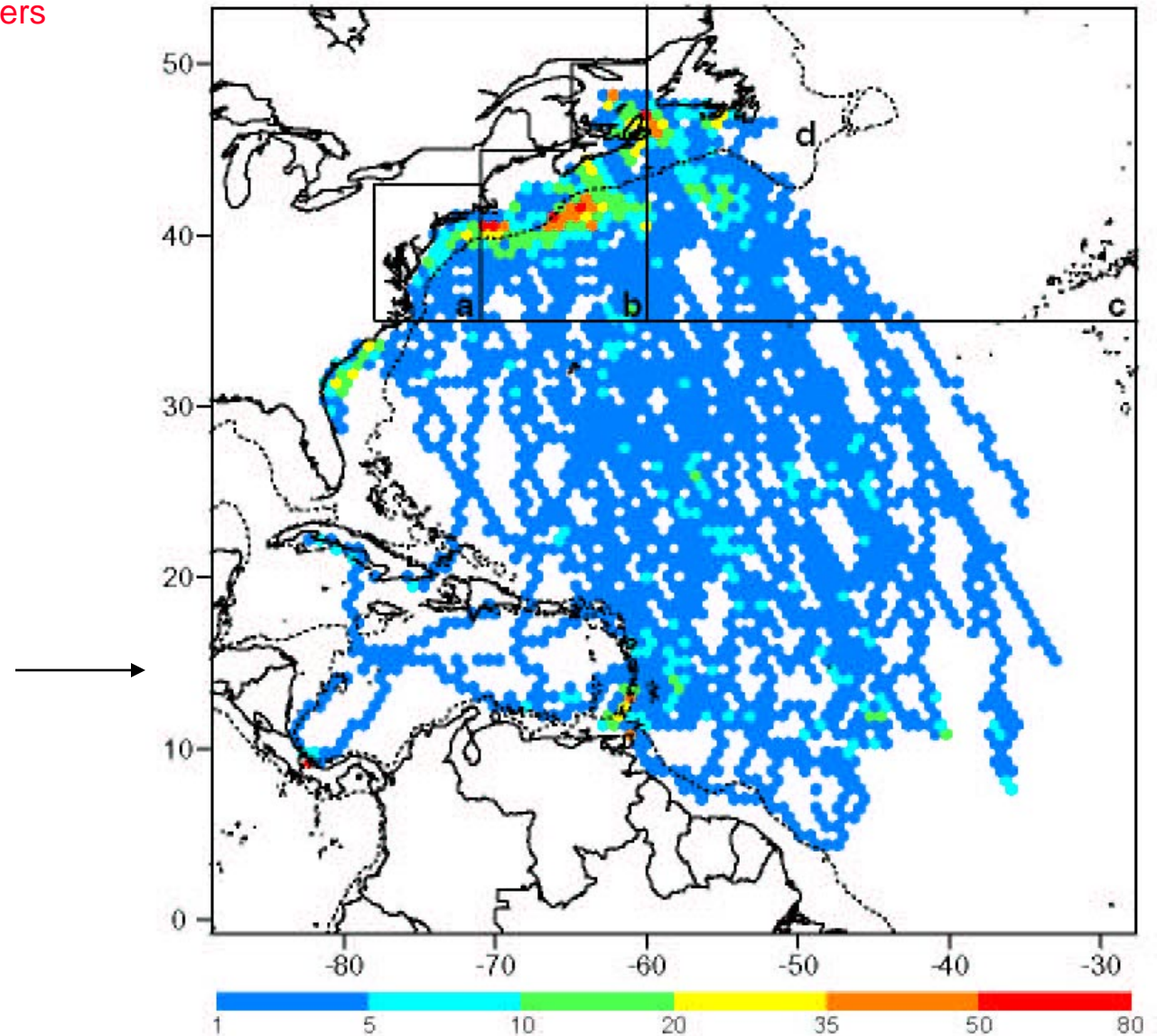


Mike James
Andrea Ottensmeyer

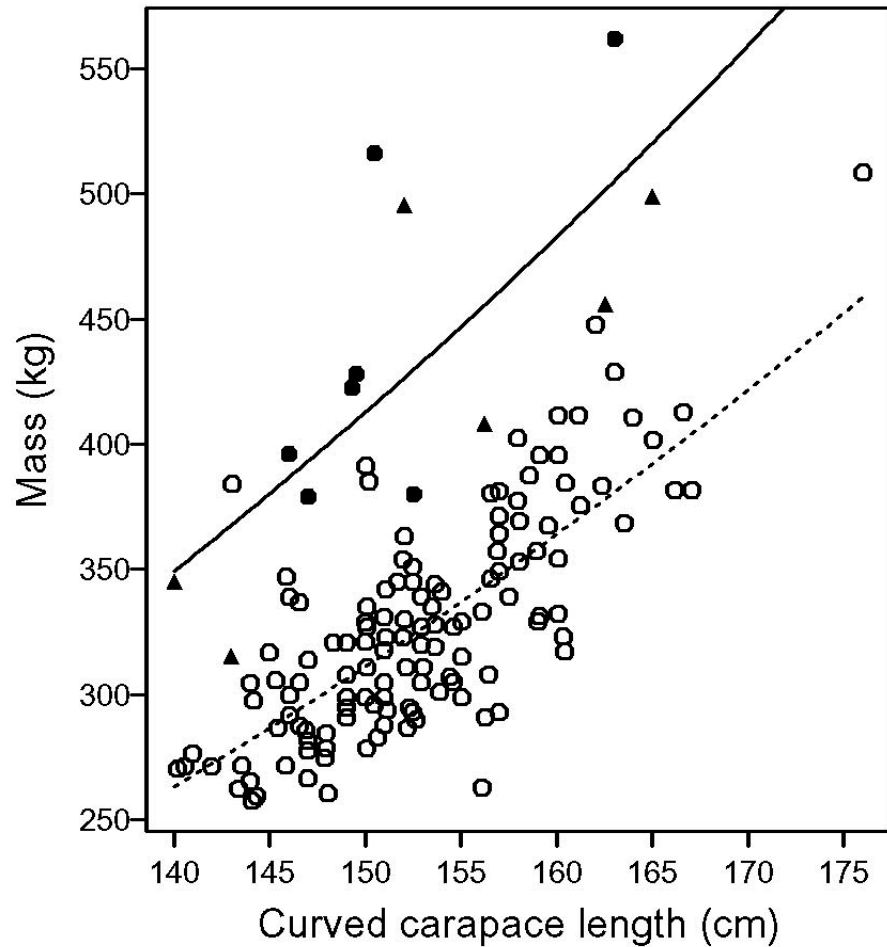


Identification of high-use areas and threats to leatherback sea turtles in northern waters

James, Ottensmeyer and Myers
Ecology Letters (2005)



Weights in Canadian waters



Turtles are
33% heavier in Canadian coastal
areas versus on the nesting
beach

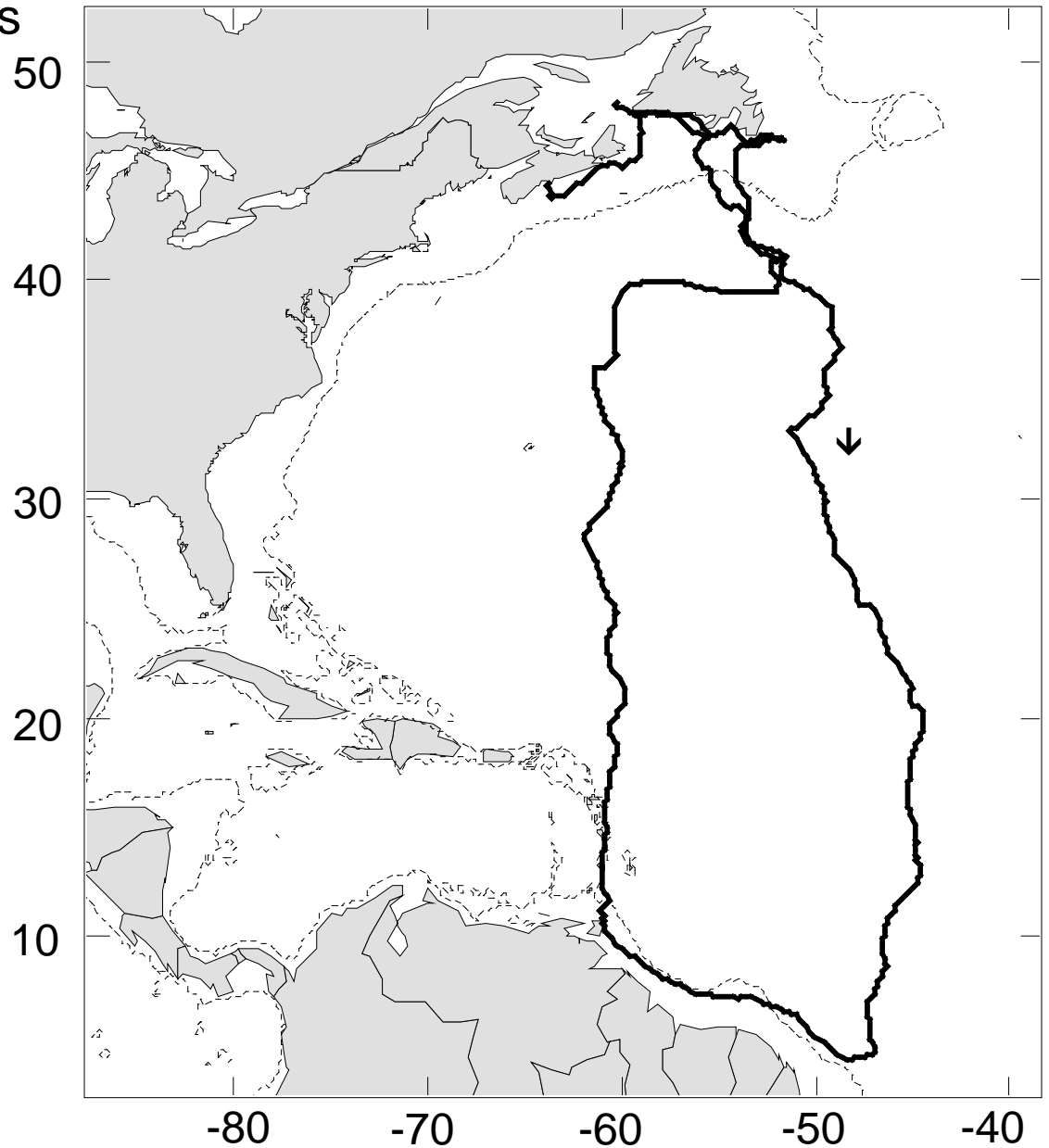


Nesting female morphometrics: St. Croix, U.S.V.I.
Boulon et al. 1996. Chelonian Conserv, Biol. 2:141-147.
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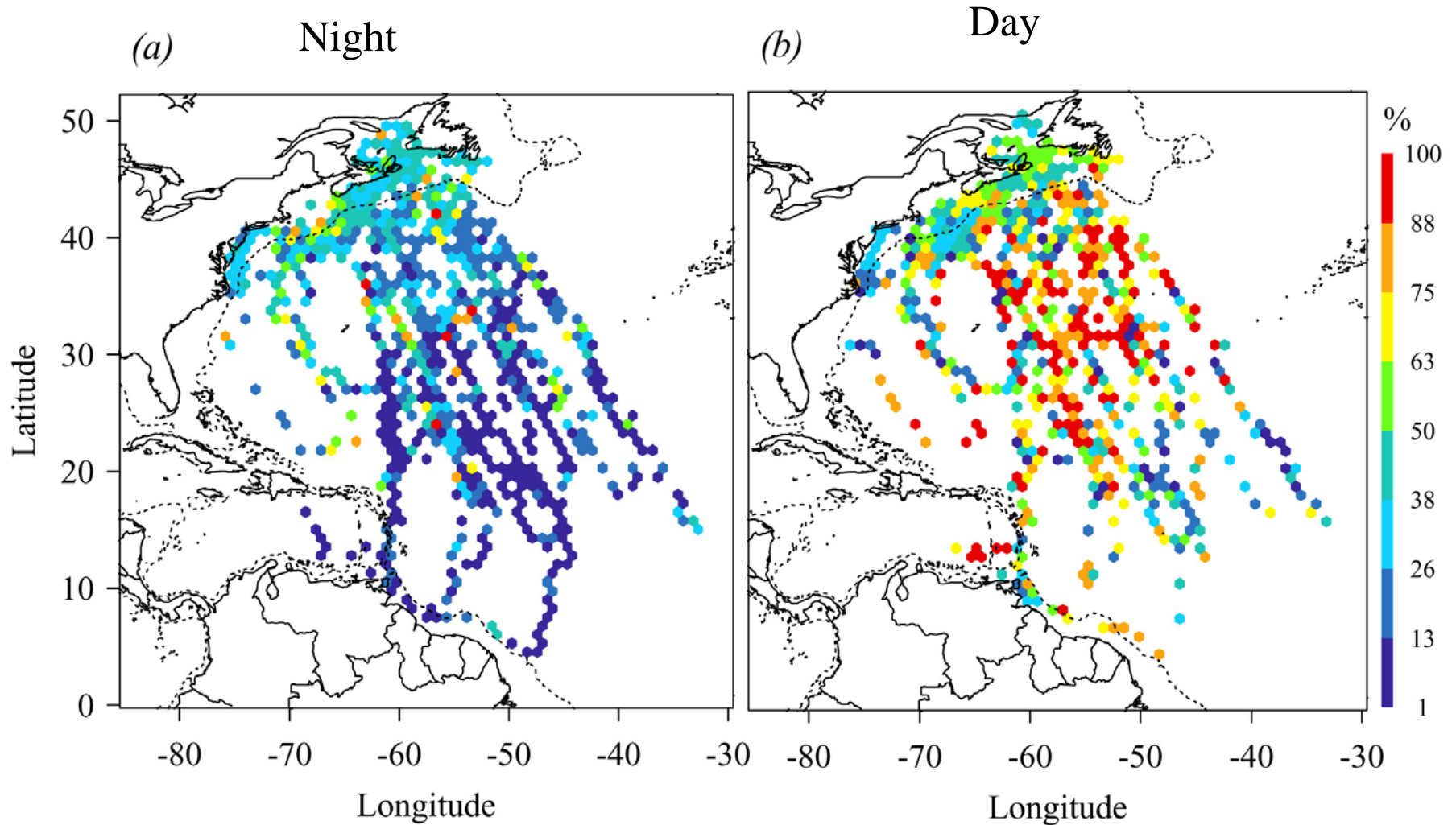
Male leatherback movements

- not previously described
- annual migratory cycle that includes movement between temperate foraging areas and tropical breeding areas

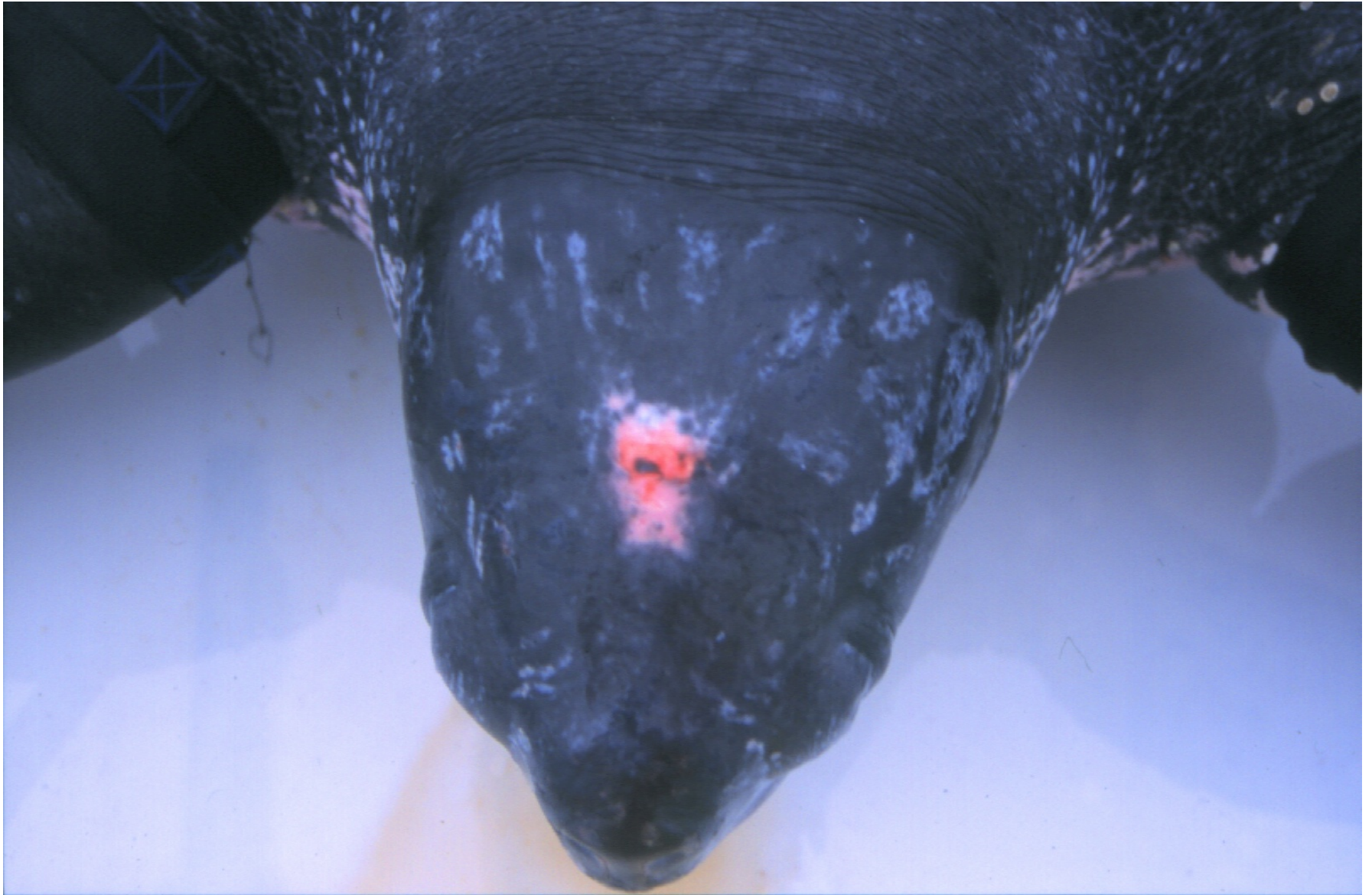
James, Eckert and Myers
Marine Biology (*in press*)



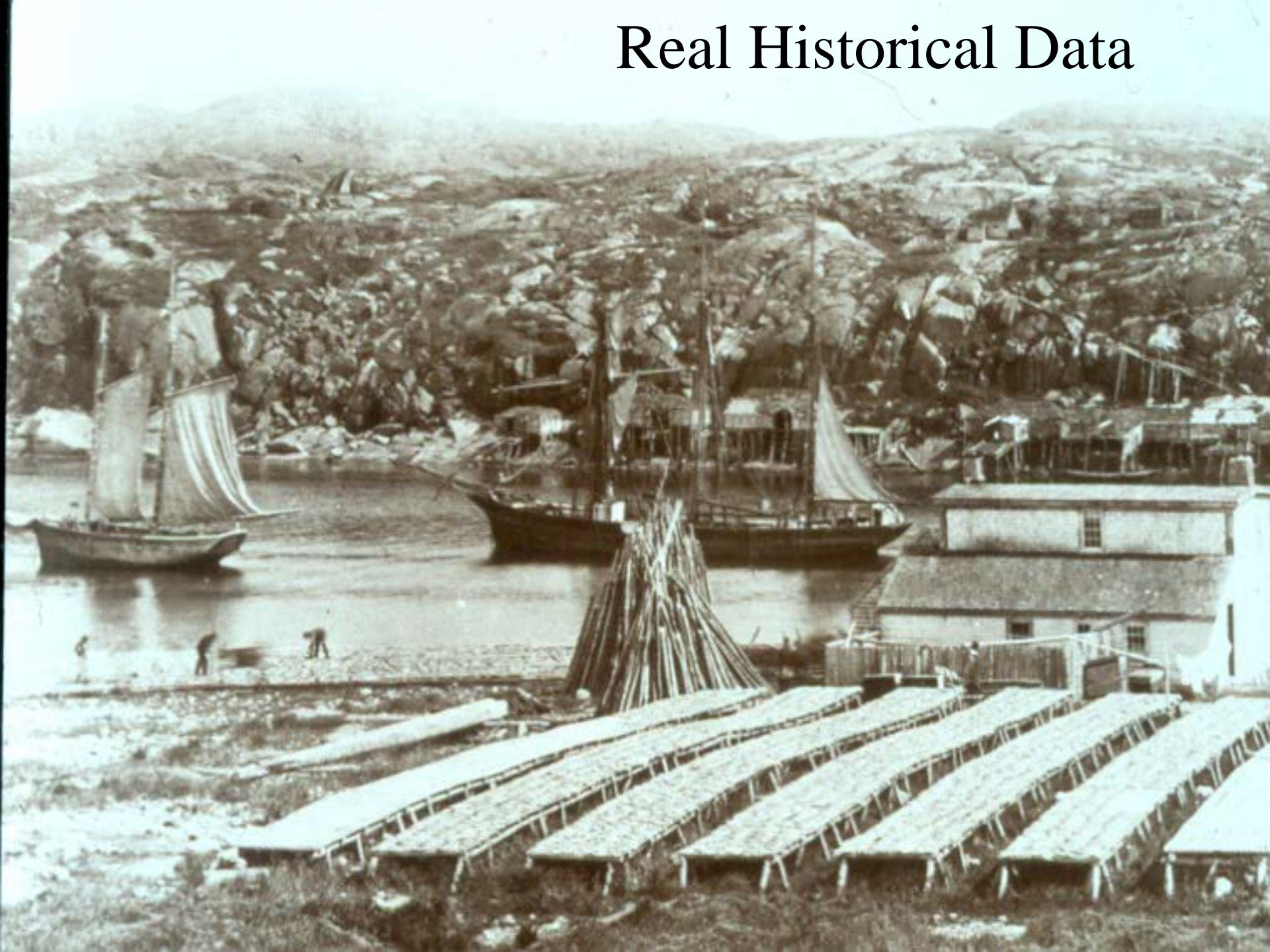
Turtles are close to the surface during the day during migration



Leatherback turtles are unique in that they expose their pineal spot to sunlight.

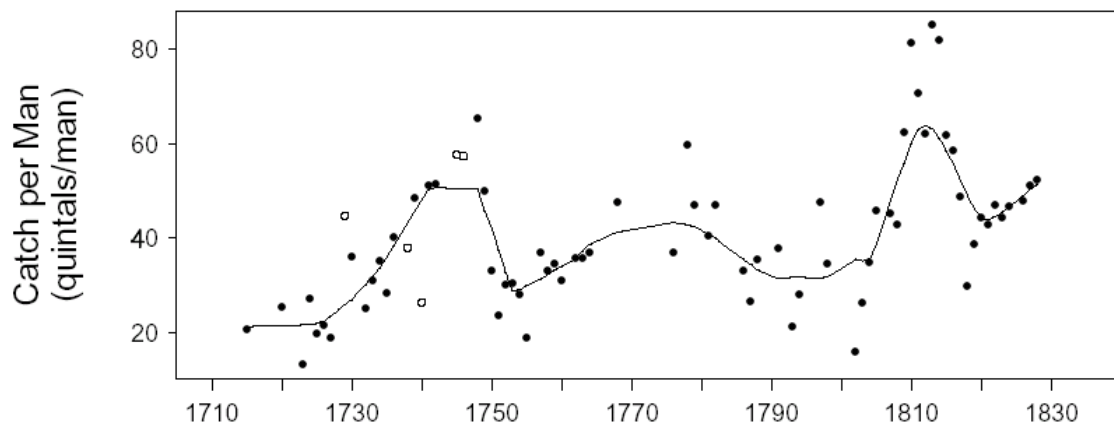
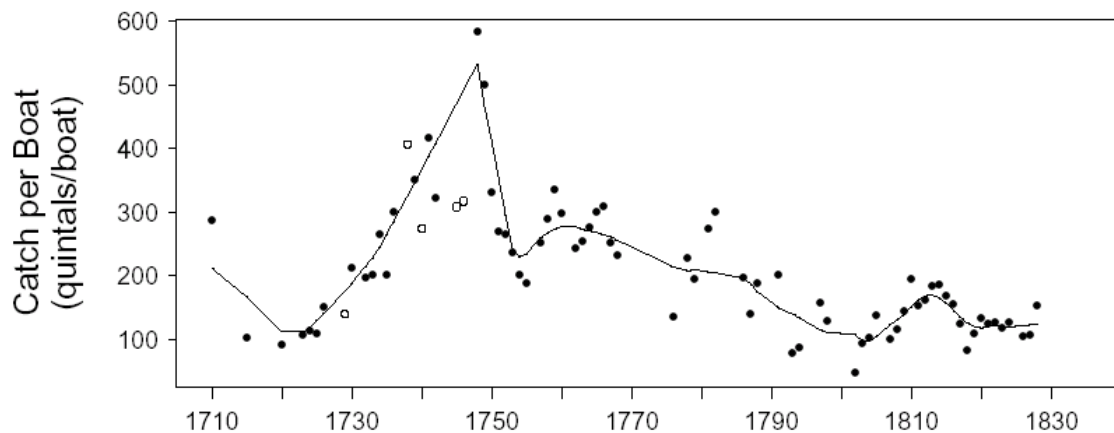
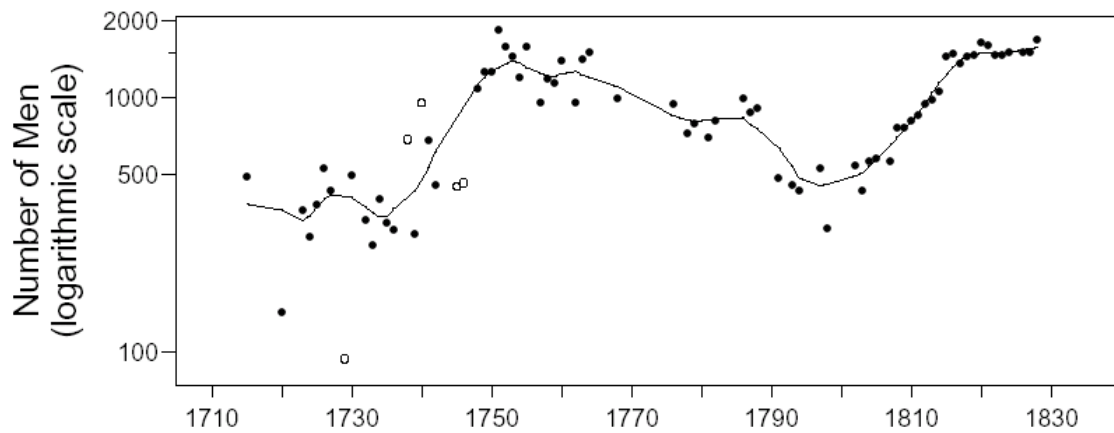


Real Historical Data

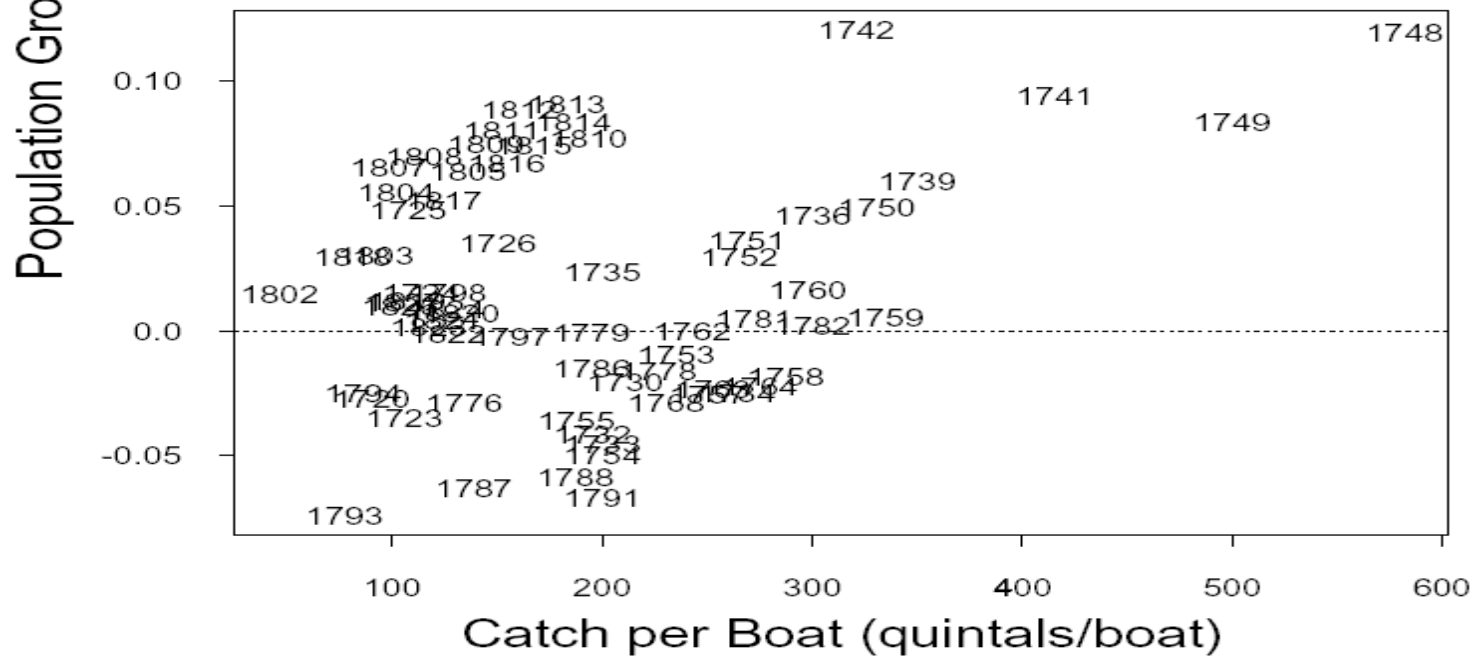
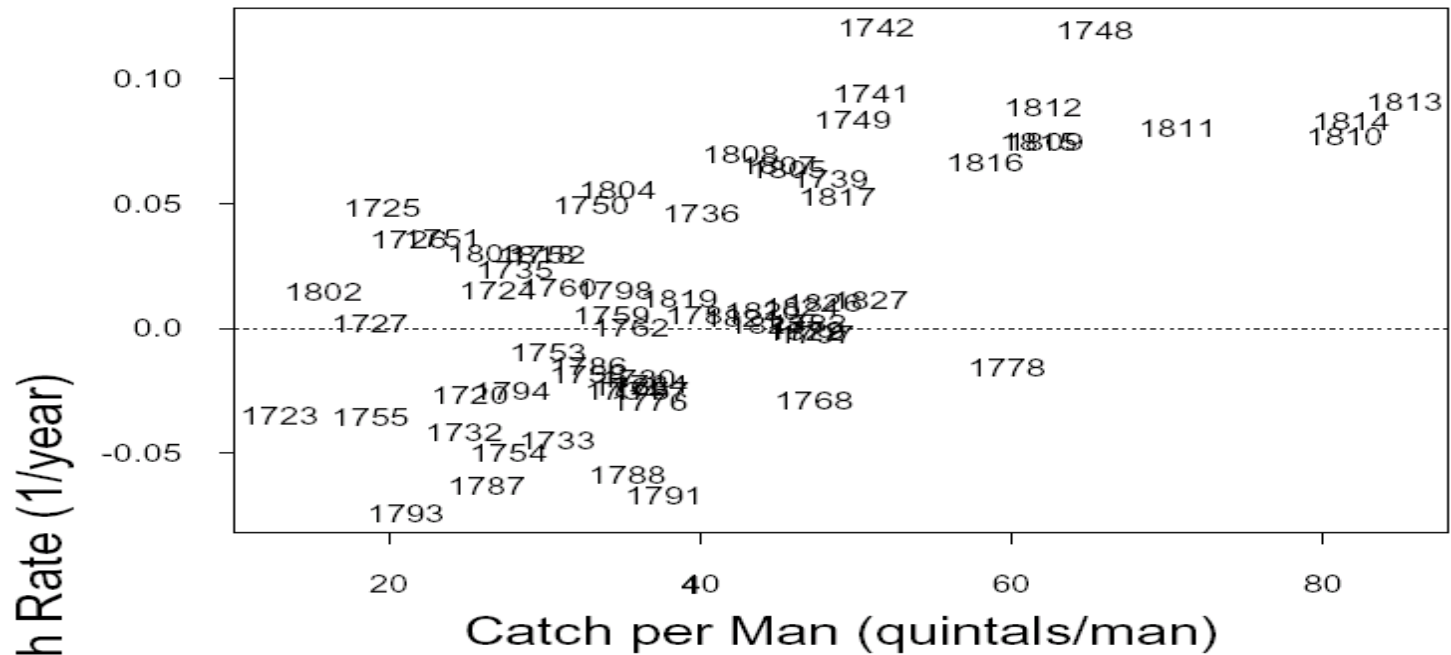




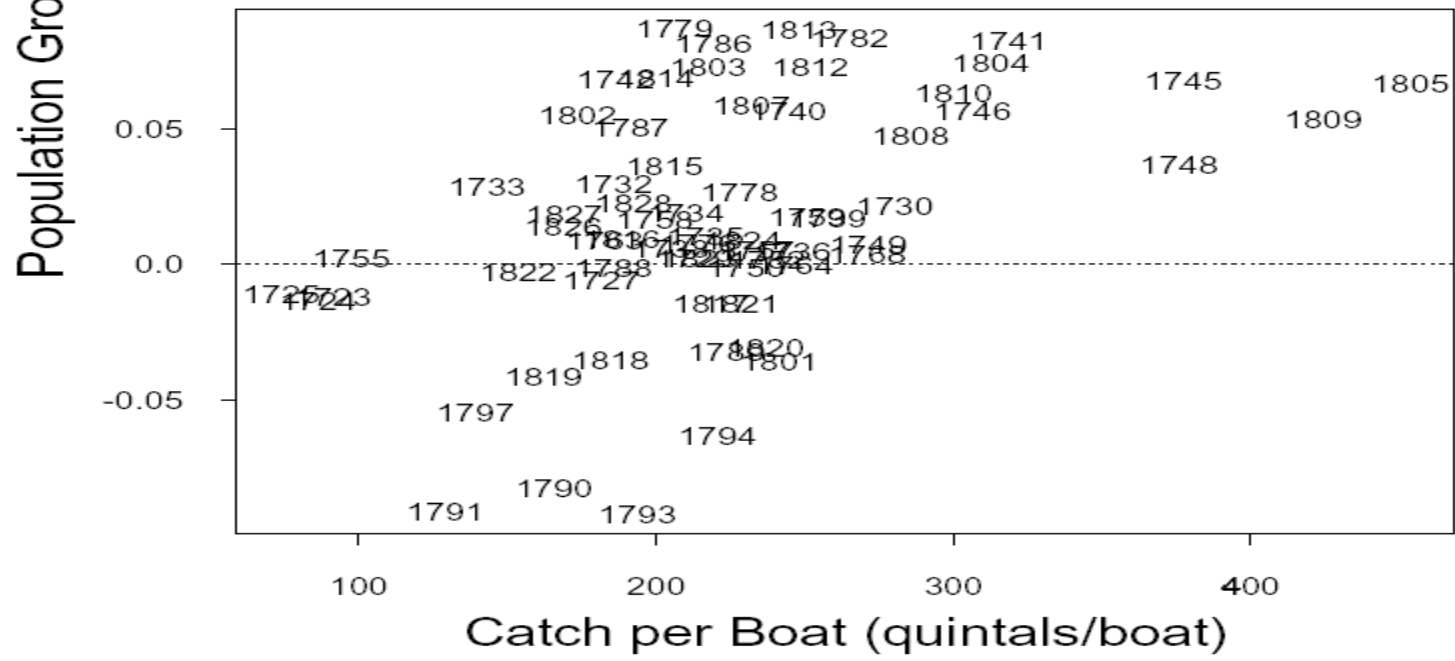
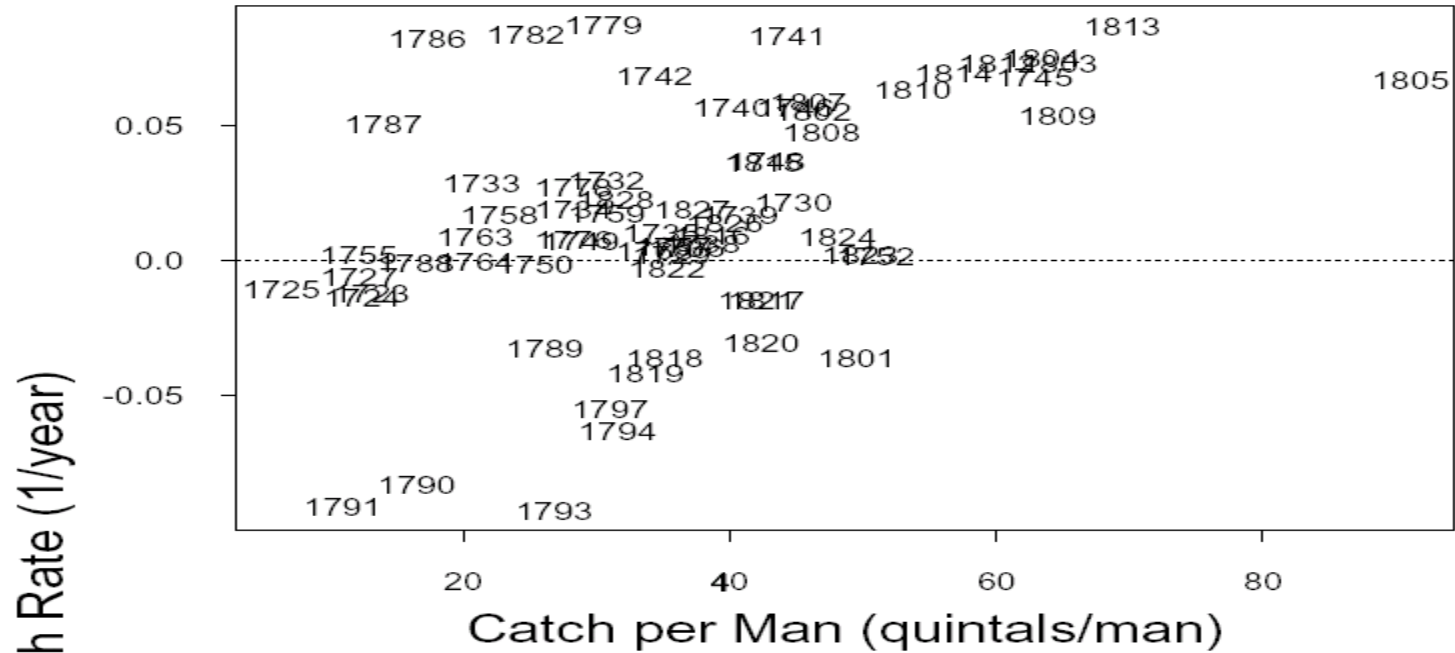
Trinity Bay



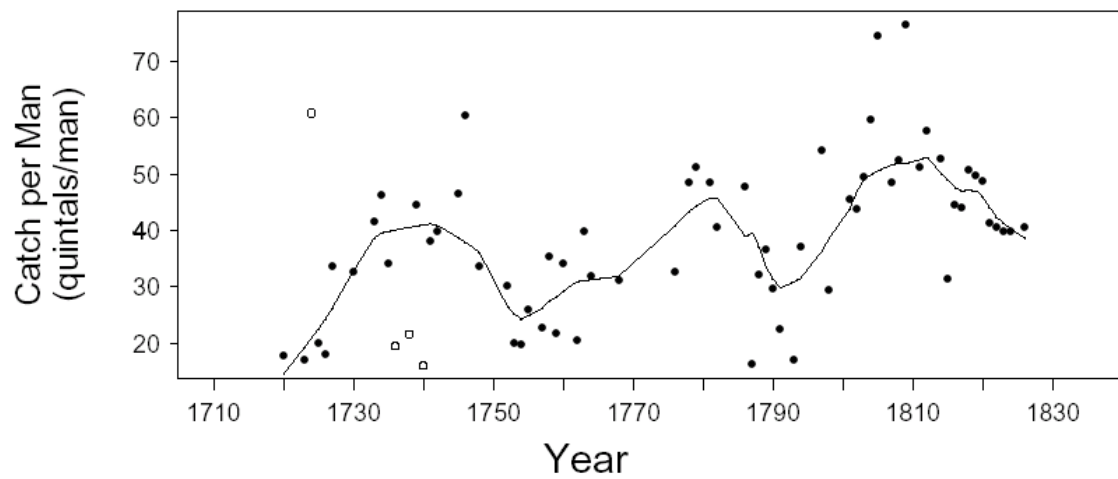
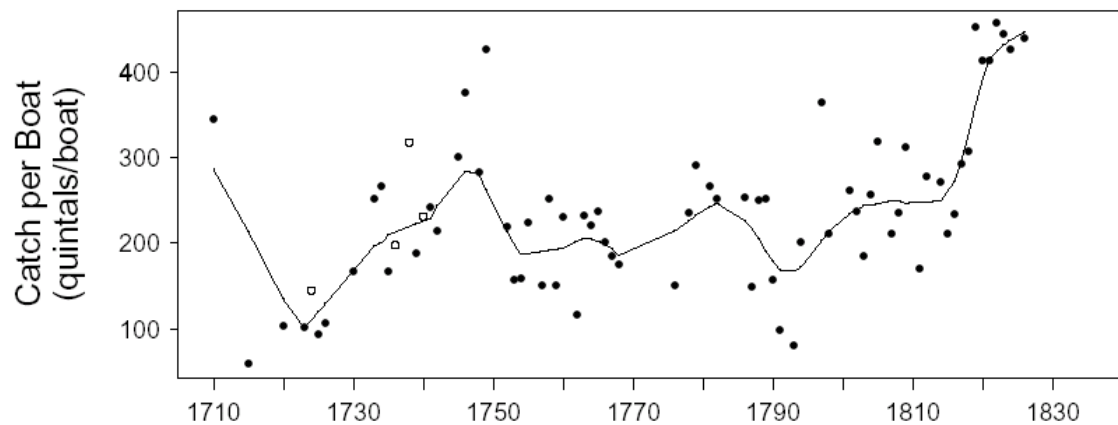
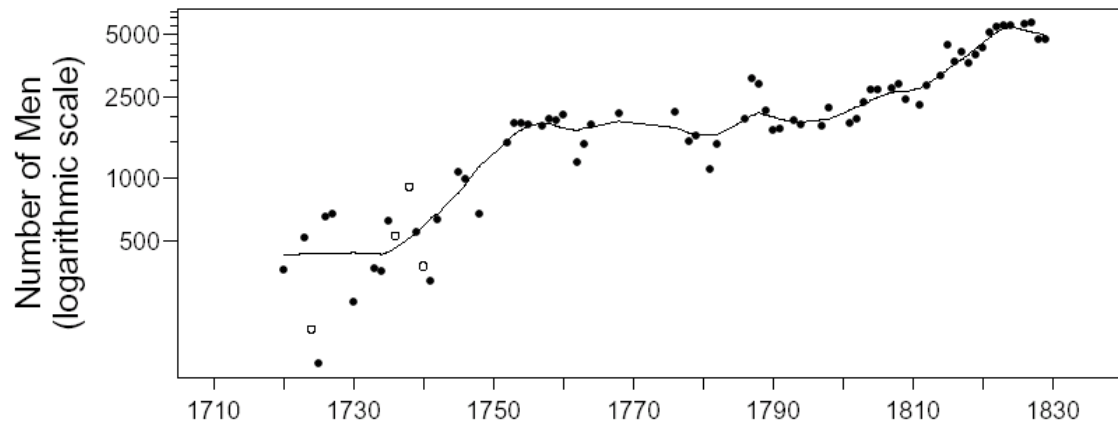
Trinity Bay



St. John's to Cape Race



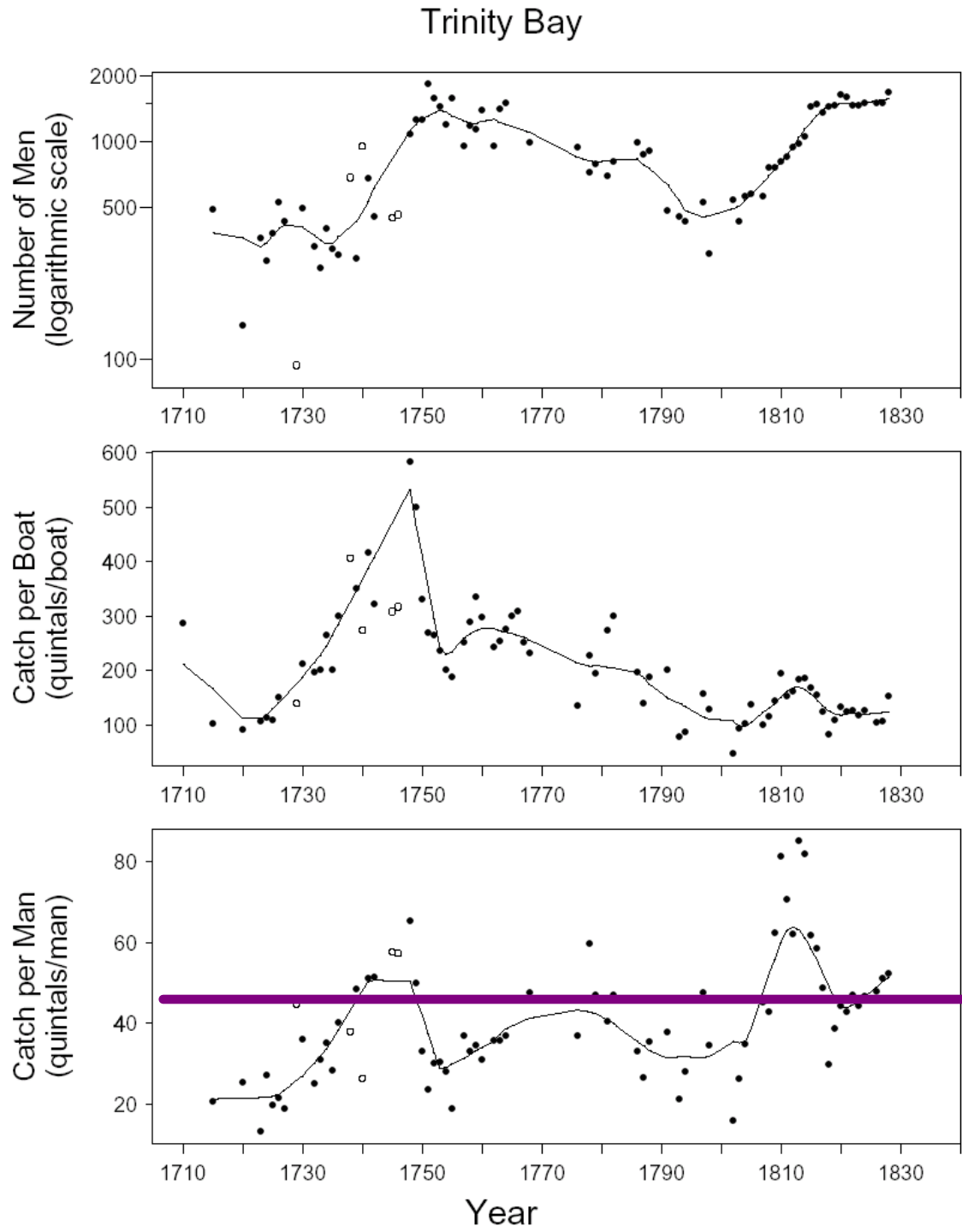
Conception Bay



The efficiency of the Newfoundland cod fishery had not changed in 4 centuries.

The only bioeconomic equilibrium of a highly subsidized fishery is zero fish.

Catch rates in the 1980's per person (20,000 fishers who caught ~200,000 metric tonnes of cod).



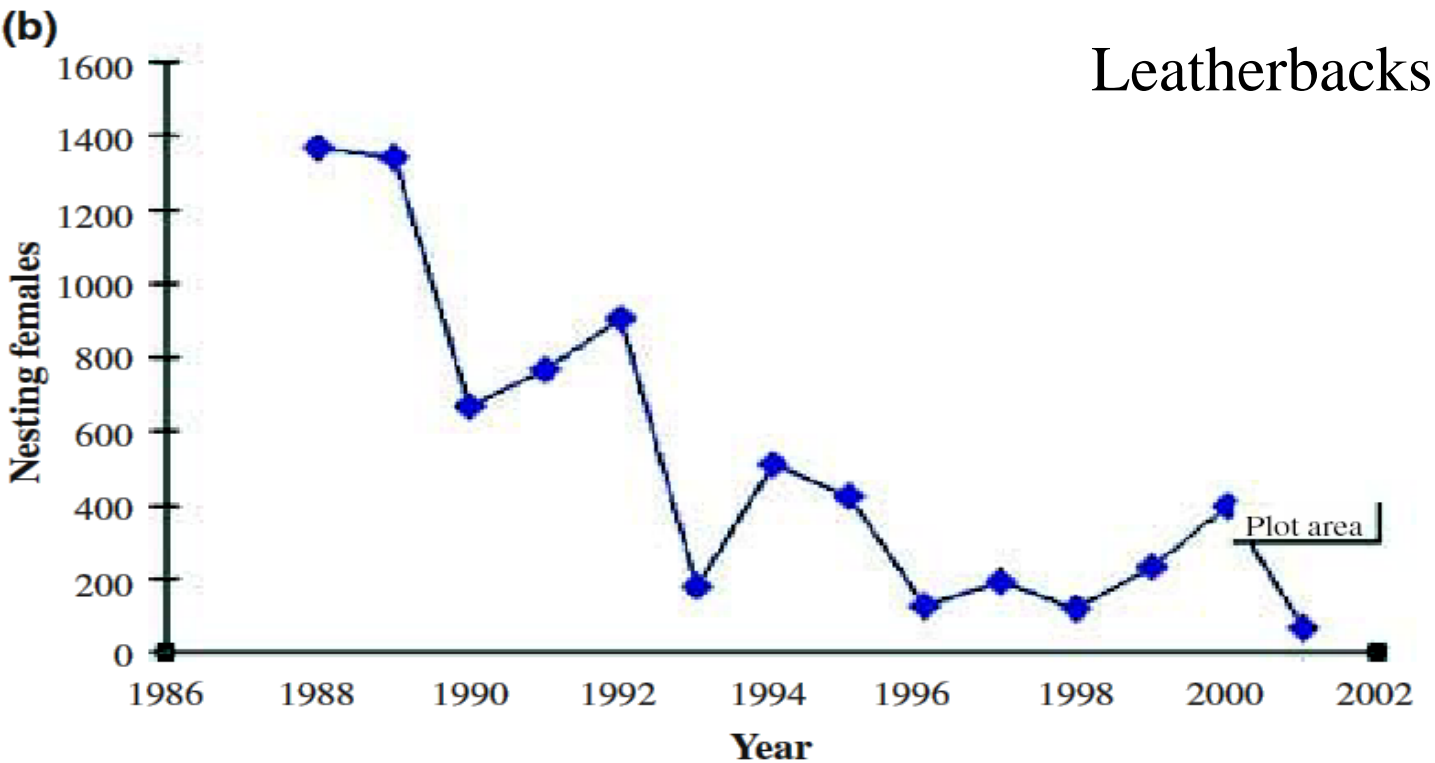
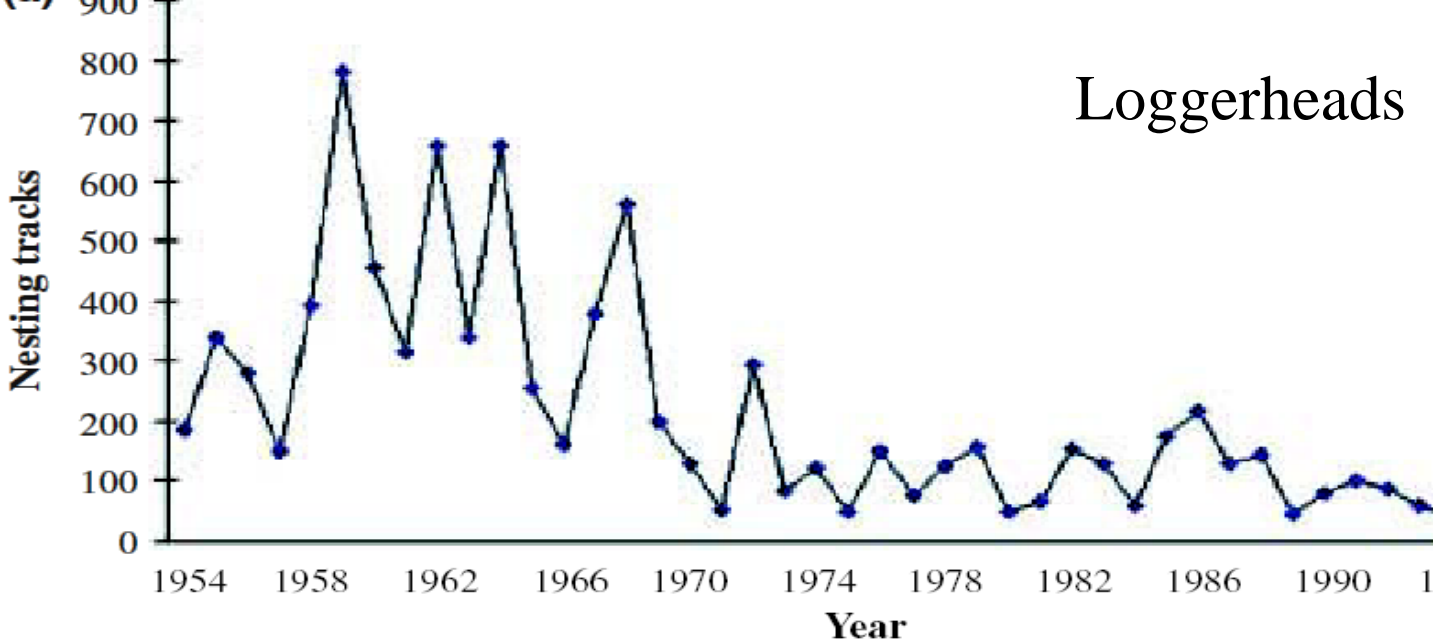




Photo by Matthew Godfrey





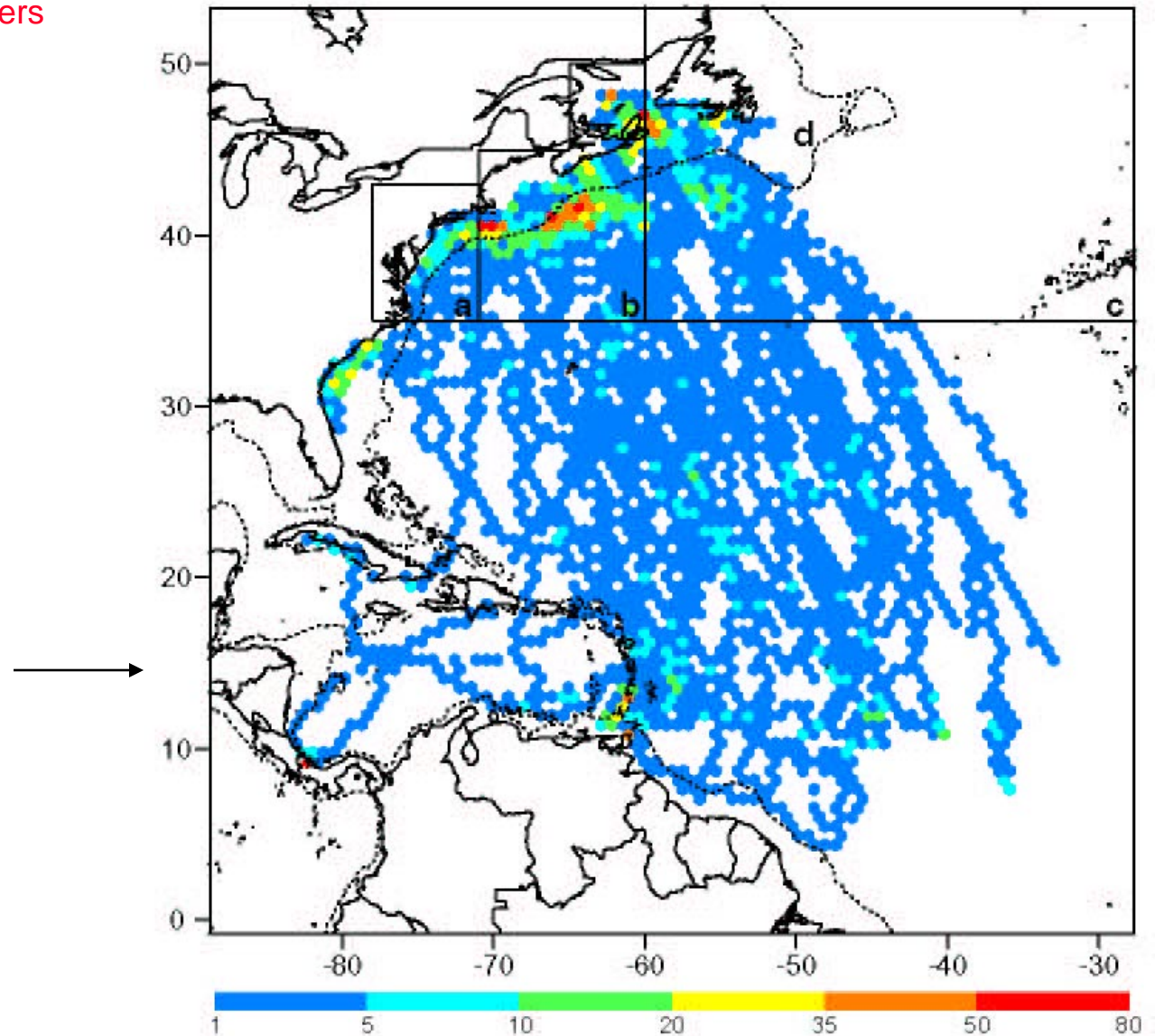
Swordfishing fleet at anchor, Neils Harbour, Cape Breton.—13.

Mike James
Andrea Ottensmeyer

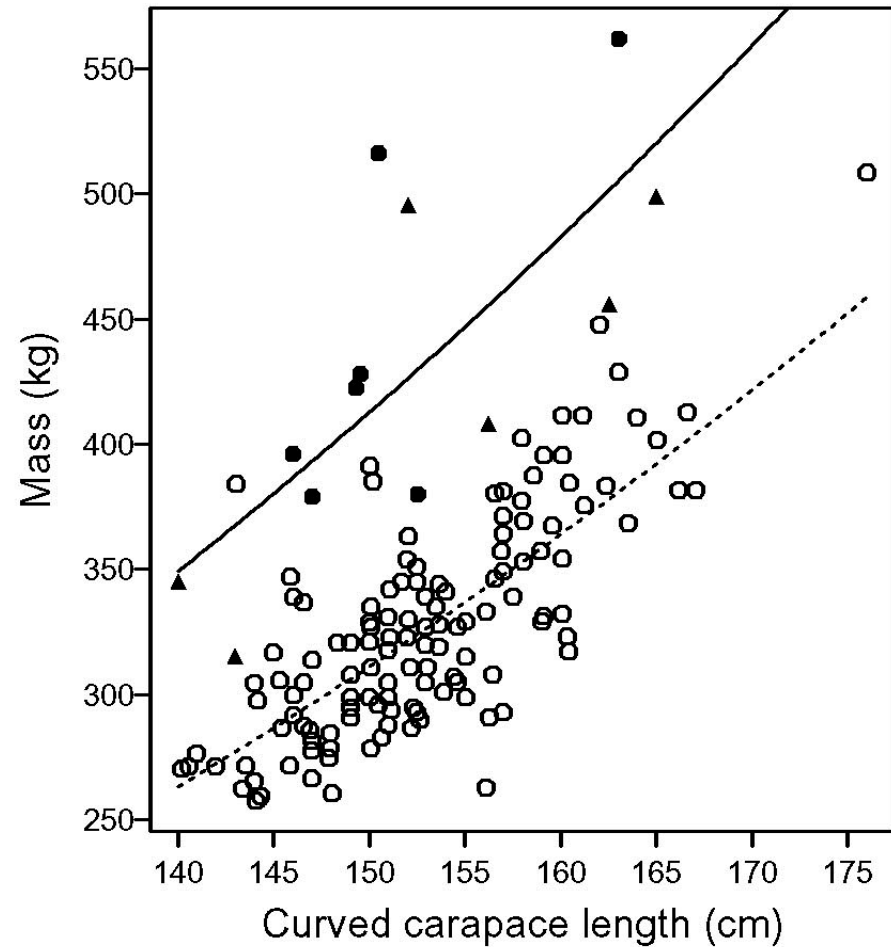


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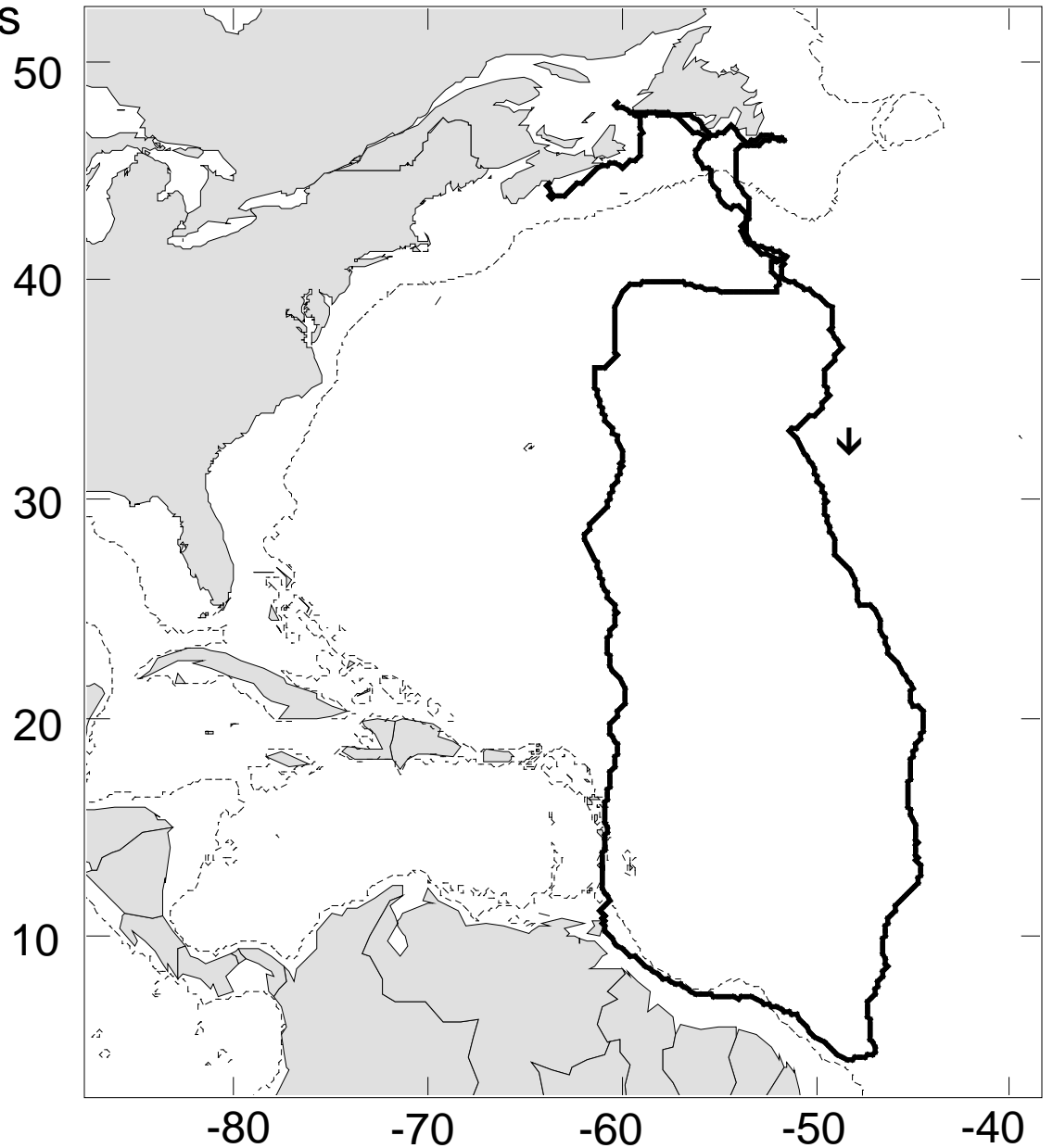


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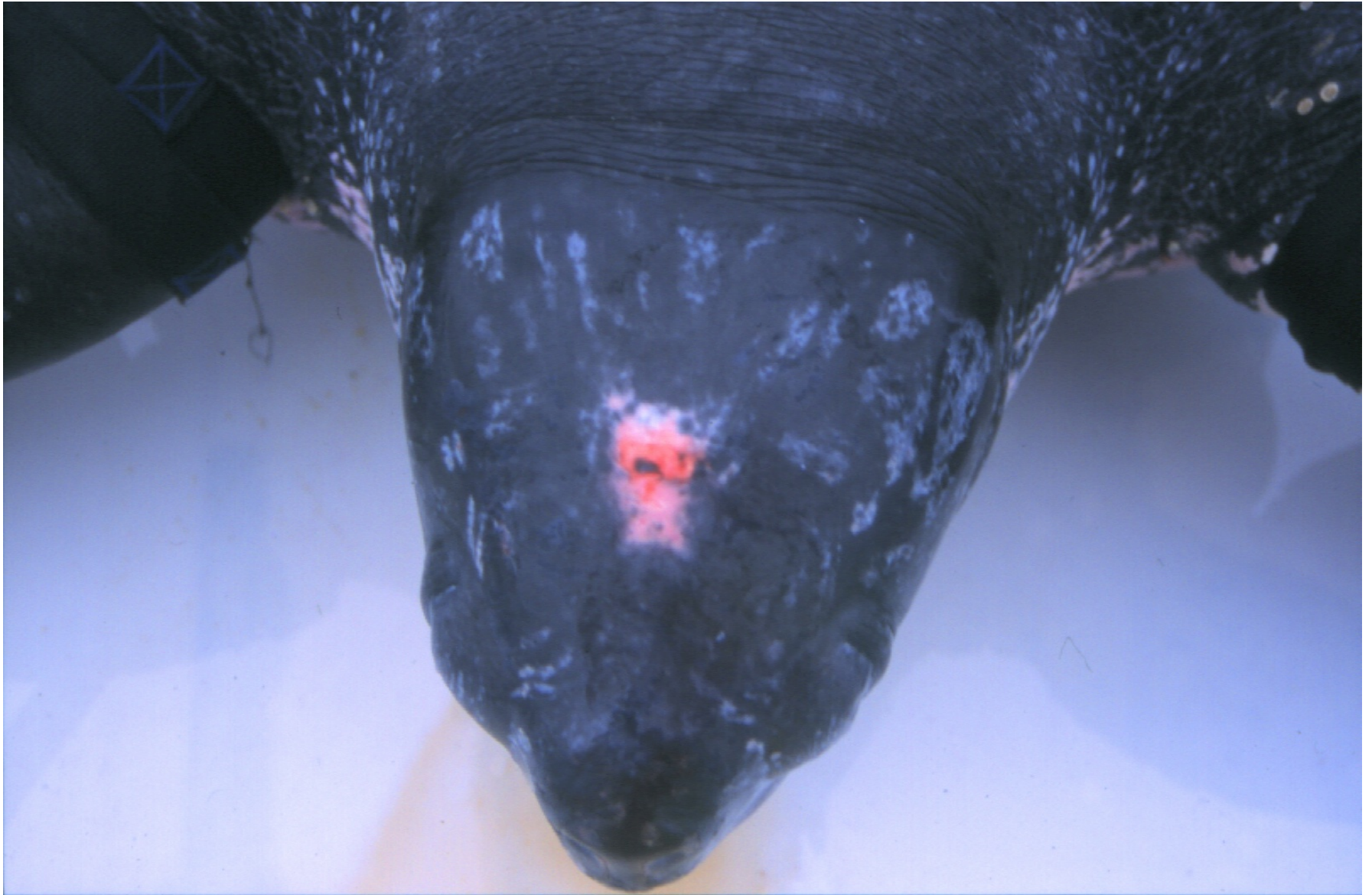
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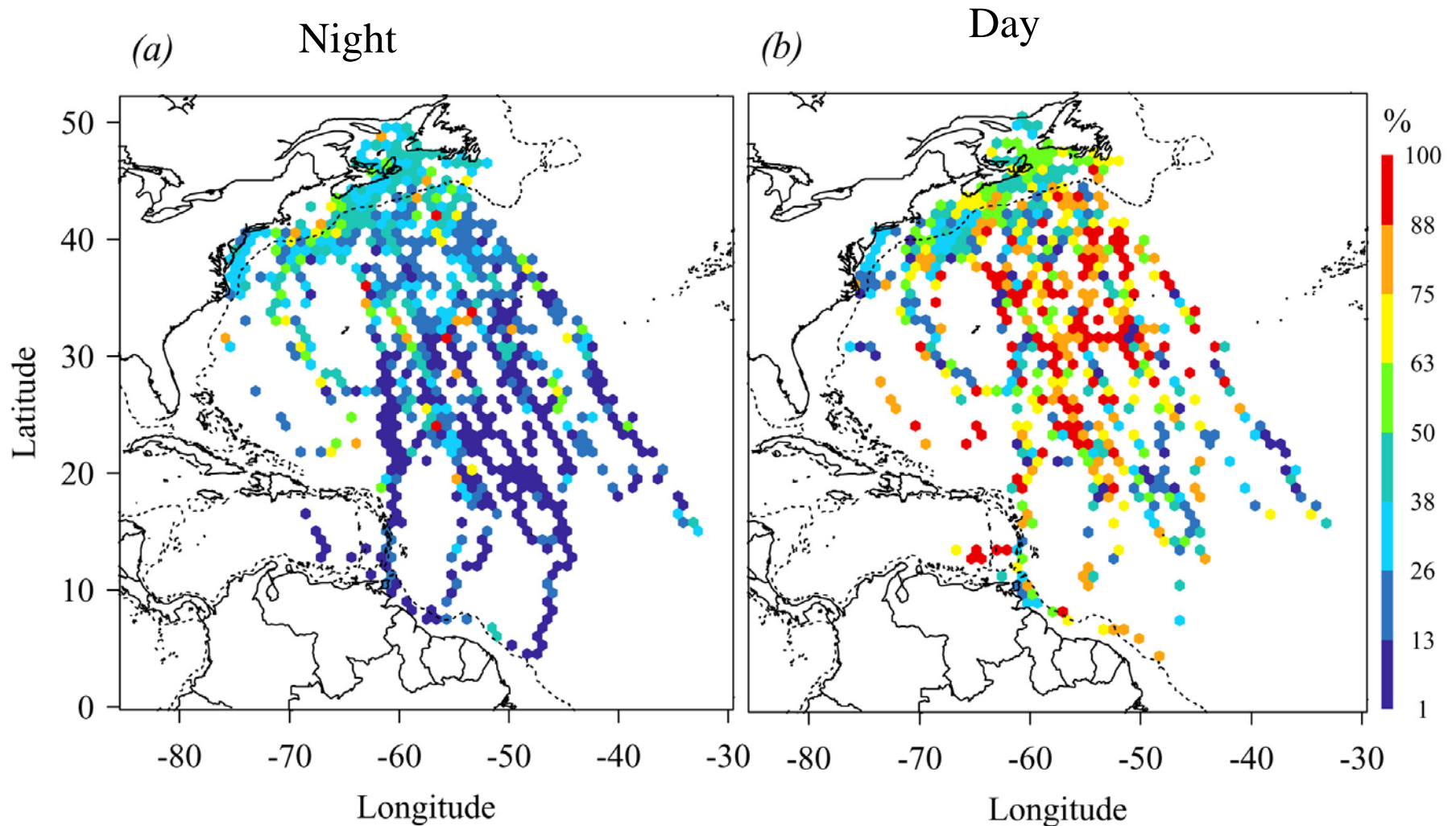
James, Eckert and Myers
Marine Biology (*in press*)



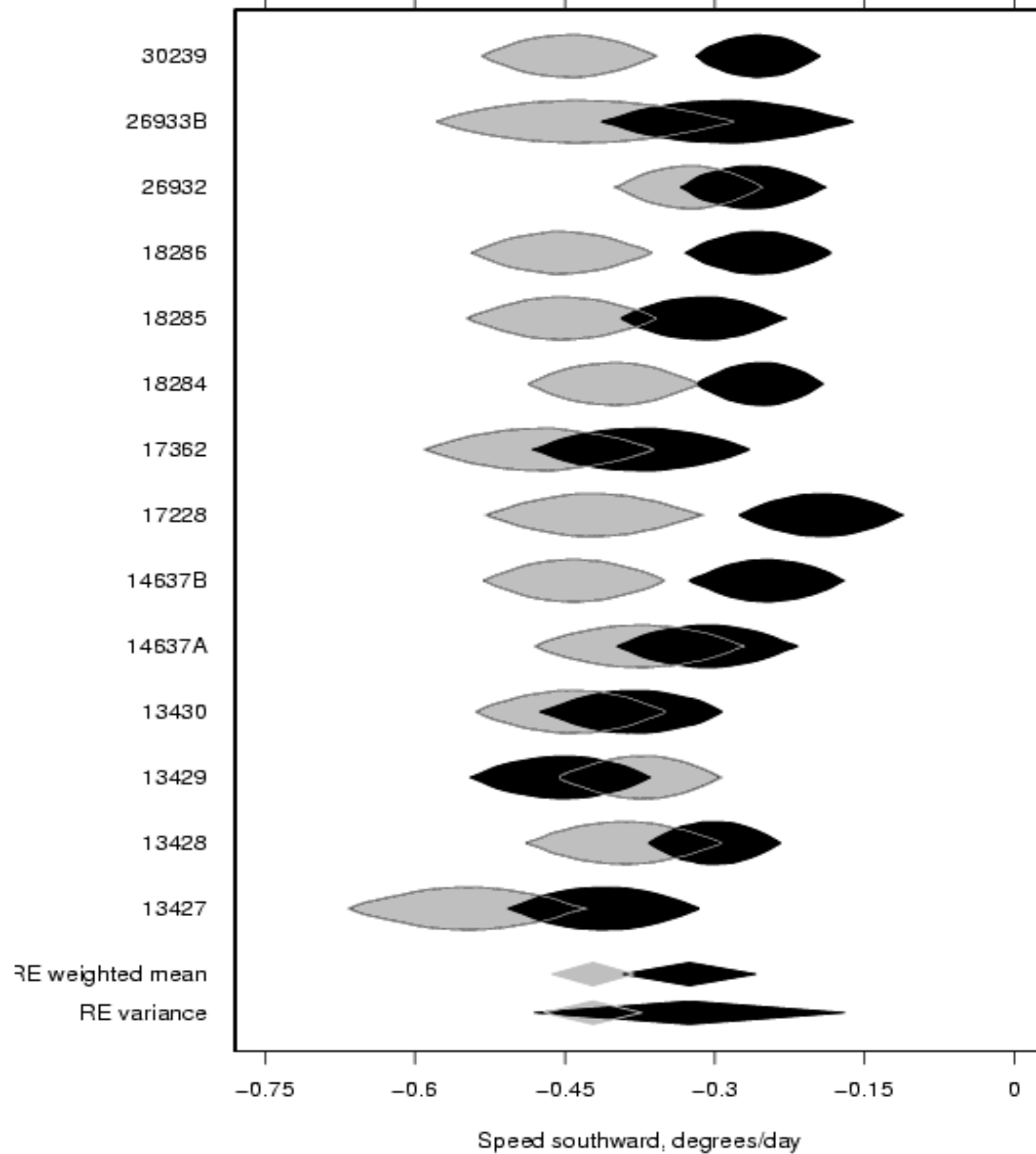
Leatherback turtles are unique in that they expose their pineal spot to sunlight.



Turtles are close to the surface during the day during migration



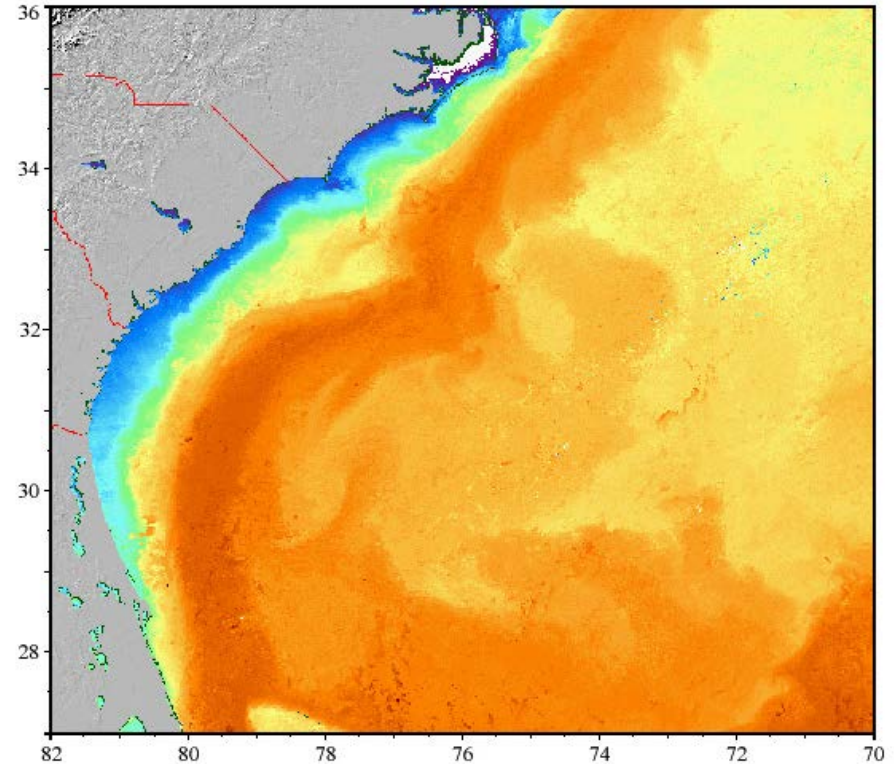
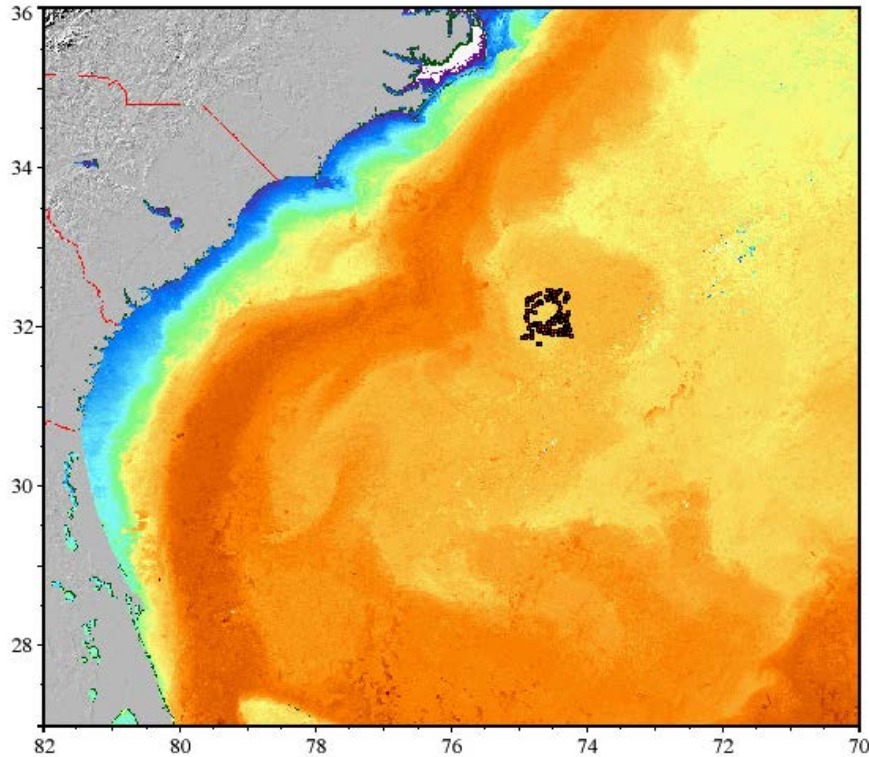
Turtles make more progress south during the day



Totally Stupid Reasons for not Believing the Obvious

- You ignore research surveys.
- Removing Large Predators Couldn't Possibly Affect Survival of Other Fish.
- Fishing Couldn't Possibly Affect the Size of Tuna.
- Fishermen are so stupid they cannot use satellite data to find tuna.
- Fishermen are so stupid that they don't improve their gear.

These estimates are conservative: 6 Fishermen are smarter (gps, satellite information, **ACDP** (Acoustic Current Doppler Profiler)).



Locations of a leatherback turtle over a two week period tagged by my student Mike James that maintains its position within a cold core ring (somehow).

However, fish may be a lot smarter too (the stupid ones were caught).

New Materials for Fishing Gear

Double Efficiency

Results from paired experiment

M – Monofilament

B – Multifilament (old gear)

Design, every other ganglion was monofilament

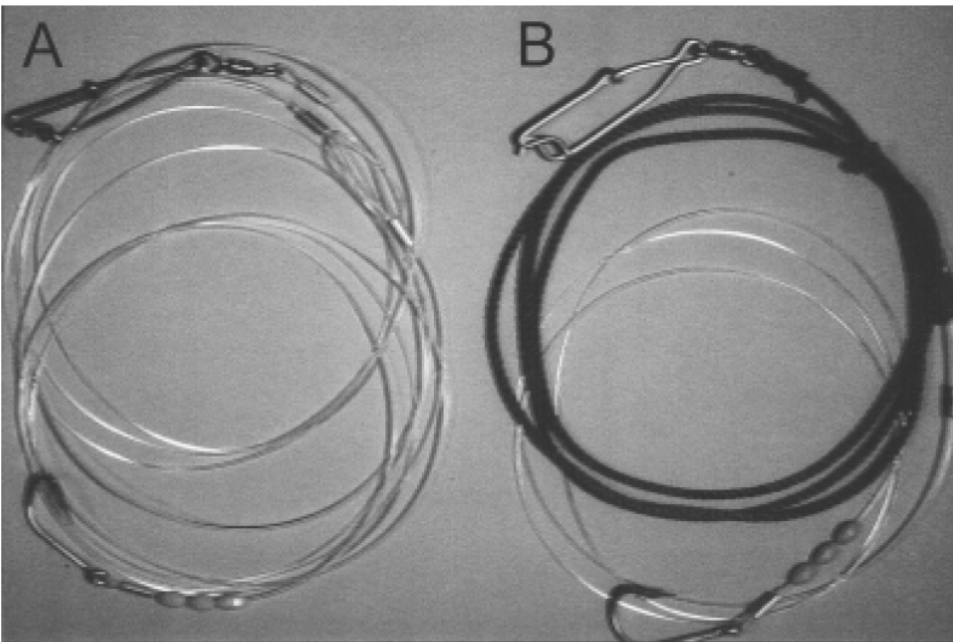
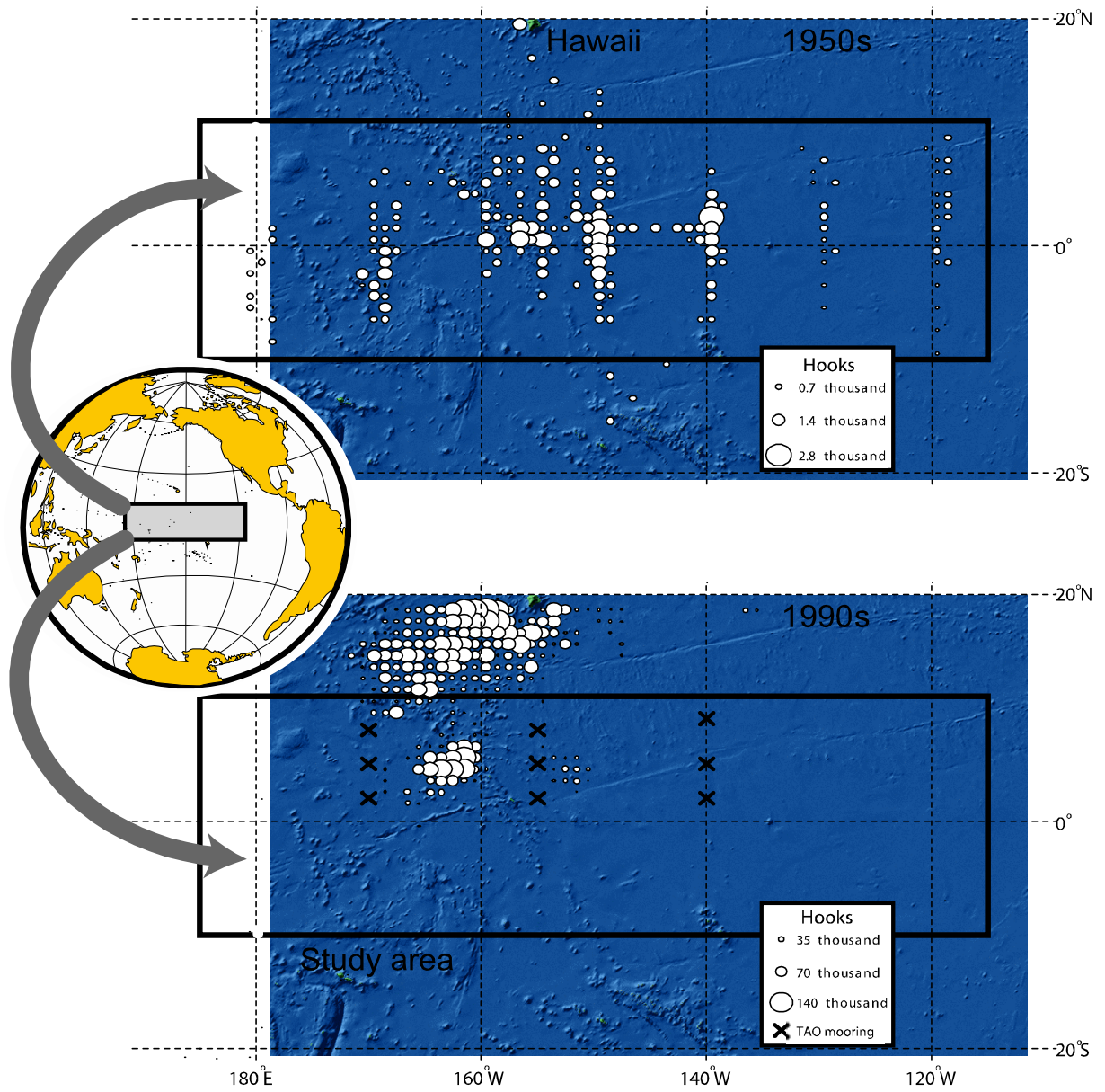
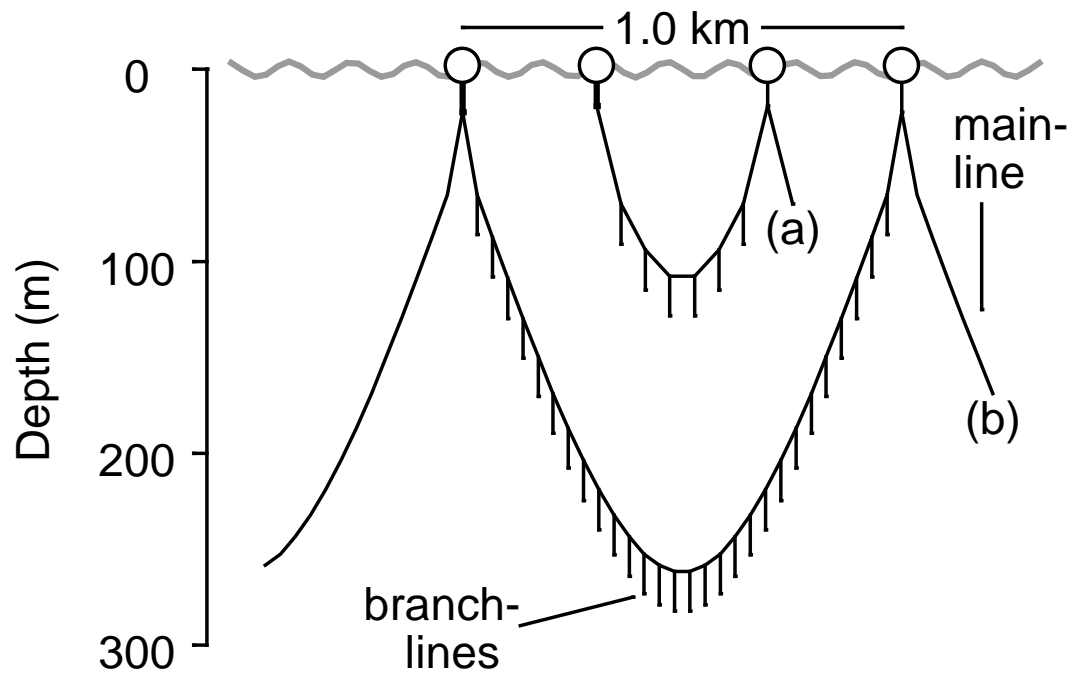


Figure 3

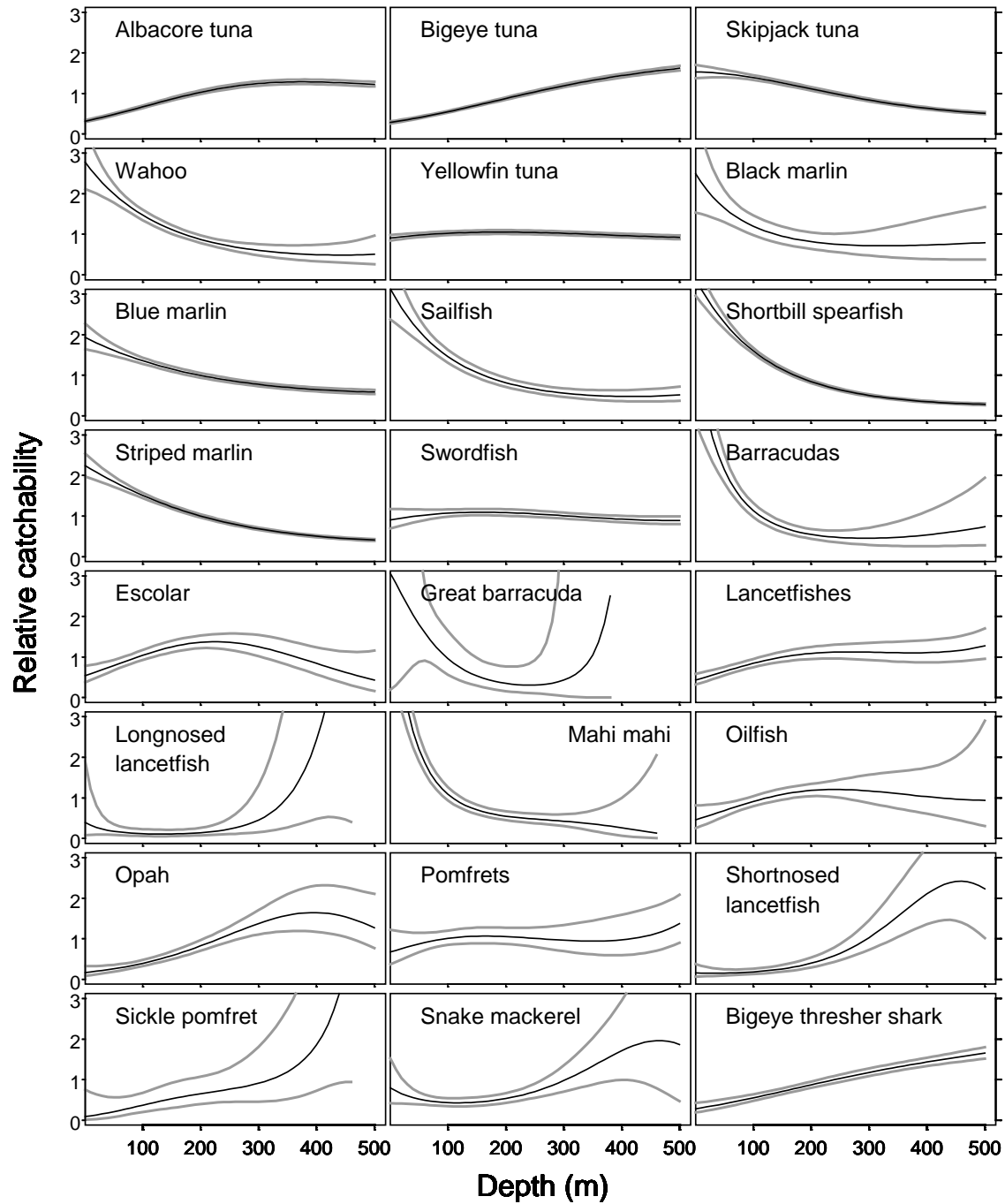
Monofilament nylon (A) and tared multifilament nylon (B) ganglions used for ten pelagic longline sets conducted off Georges Bank from 22 July to 2 August 1999.

Species	Ganglion	<i>n</i>
Swordfish	M	260
	B	128
Yellowfin tuna	M	9
	B	1
Mako shark	M	58
	B	39
Blue shark	M	225
	B	116
White marlin	M	47
	B	13
Dolphinfish	M	27
	B	10
Stingray	M	63
	B	31
Loggerhead turtle	M	40
	B	26
Total	M	729
	B	364





(a) Day Operations



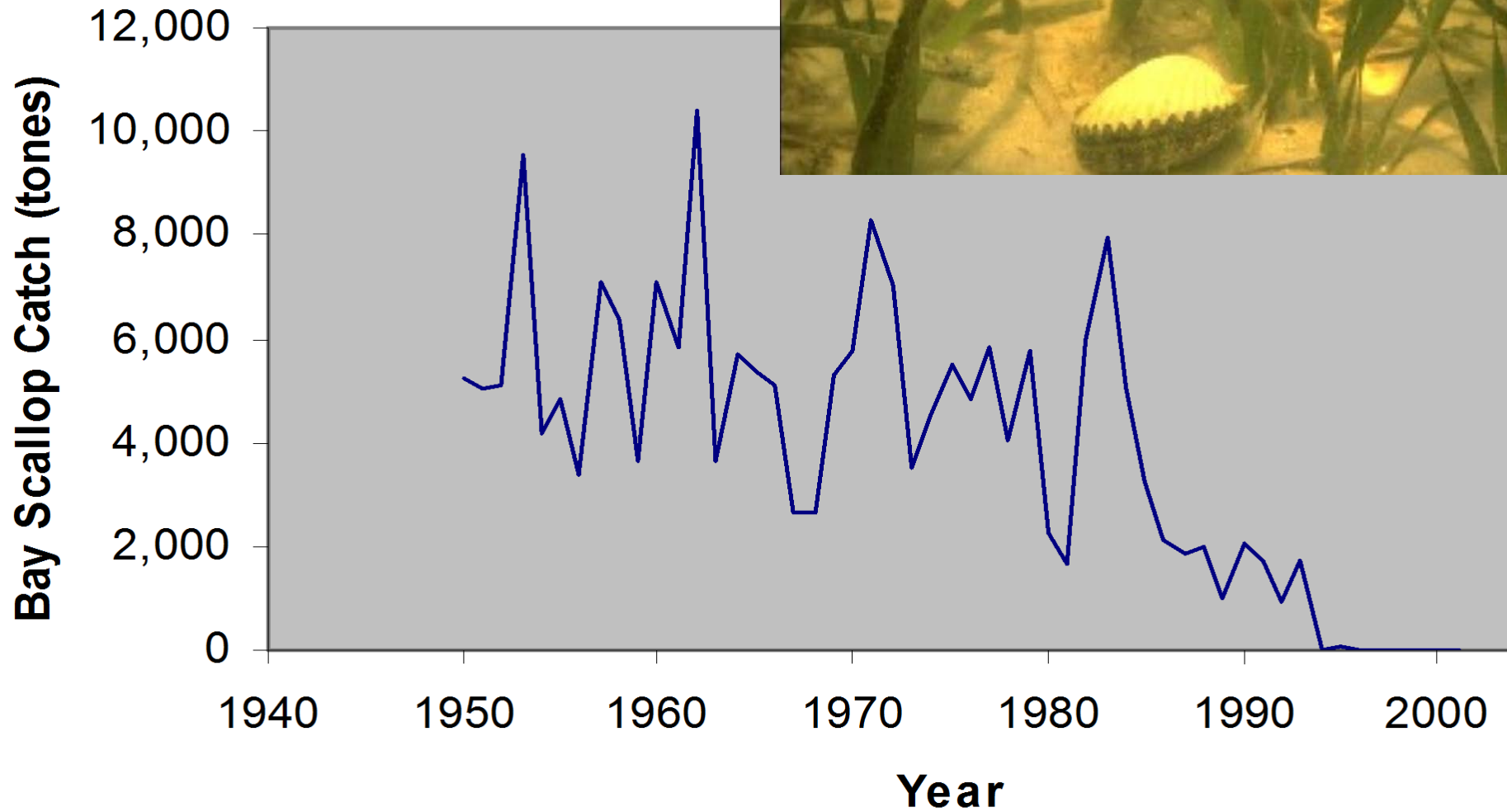
Ecosystem changes are consistent with a 10 fold decline in predation

➤ Key prey species would be predicted to increase by the changes in predation rate

Table 7. The occurrence of bramidae and gempylidae in tuna and billfish stomach contents in other studies.

species	Bramidae	Gempylidae	Literature	Region
Bigeye tuna	High	low	Moteki <i>et al.</i> (2001)	Pacific
	High	no	Mattews <i>et al.</i> (1977)	Atlantic
Yellowfin tuna	High	low	Moteki <i>et al.</i> (2001)	Pacific
	High	low	Mattews <i>et al.</i> (1977)	Atlantic
Albacore	High	High	Mattews <i>et al.</i> (1977)	Atlantic
Sword fish	High	low	Moteki <i>et al.</i> (2001)	Pacific

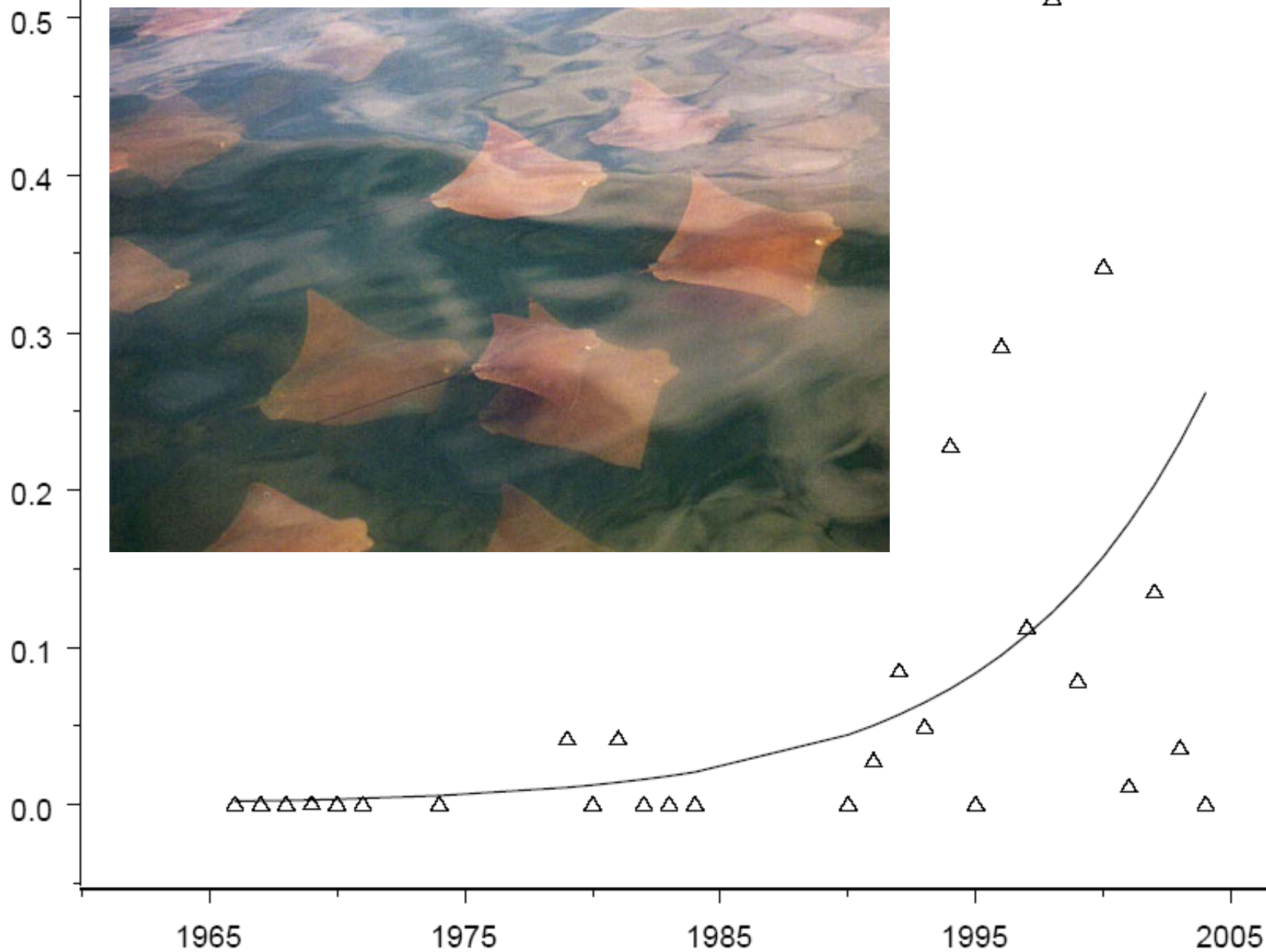
Bay Scallops Northeast US



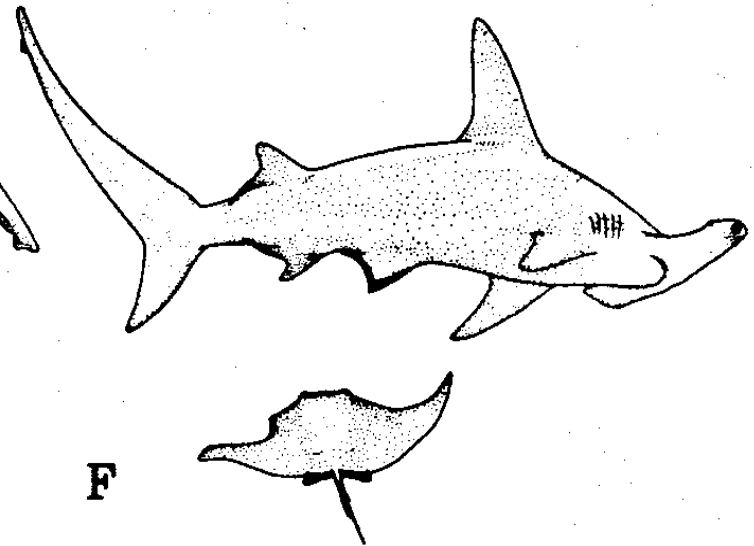
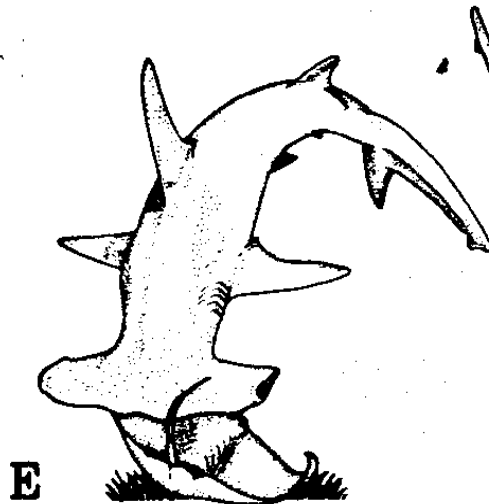
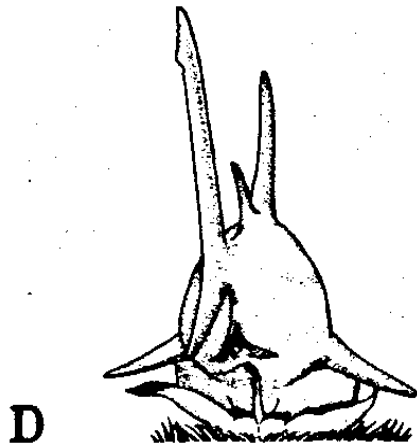
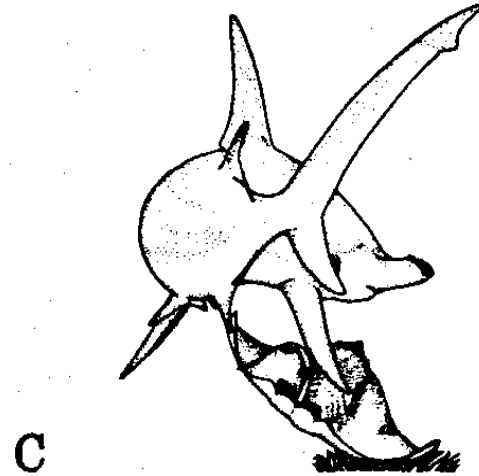
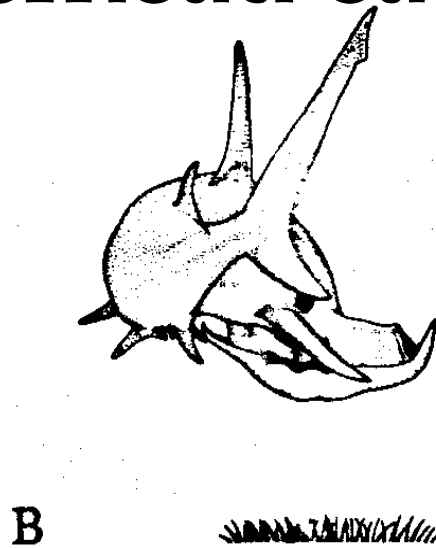
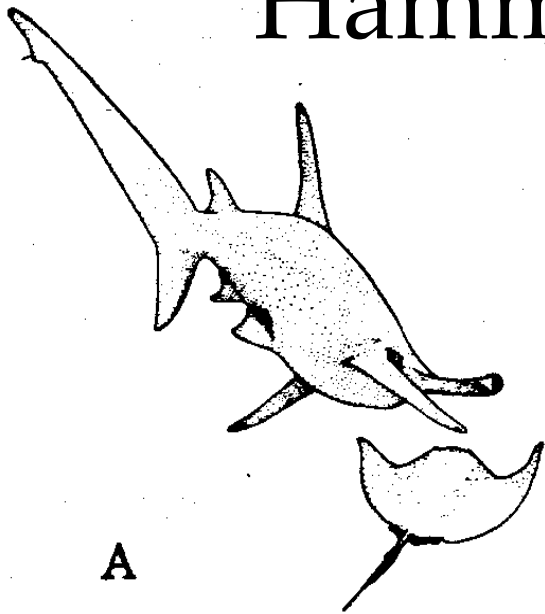
Cownose Ray - Delaware Bay



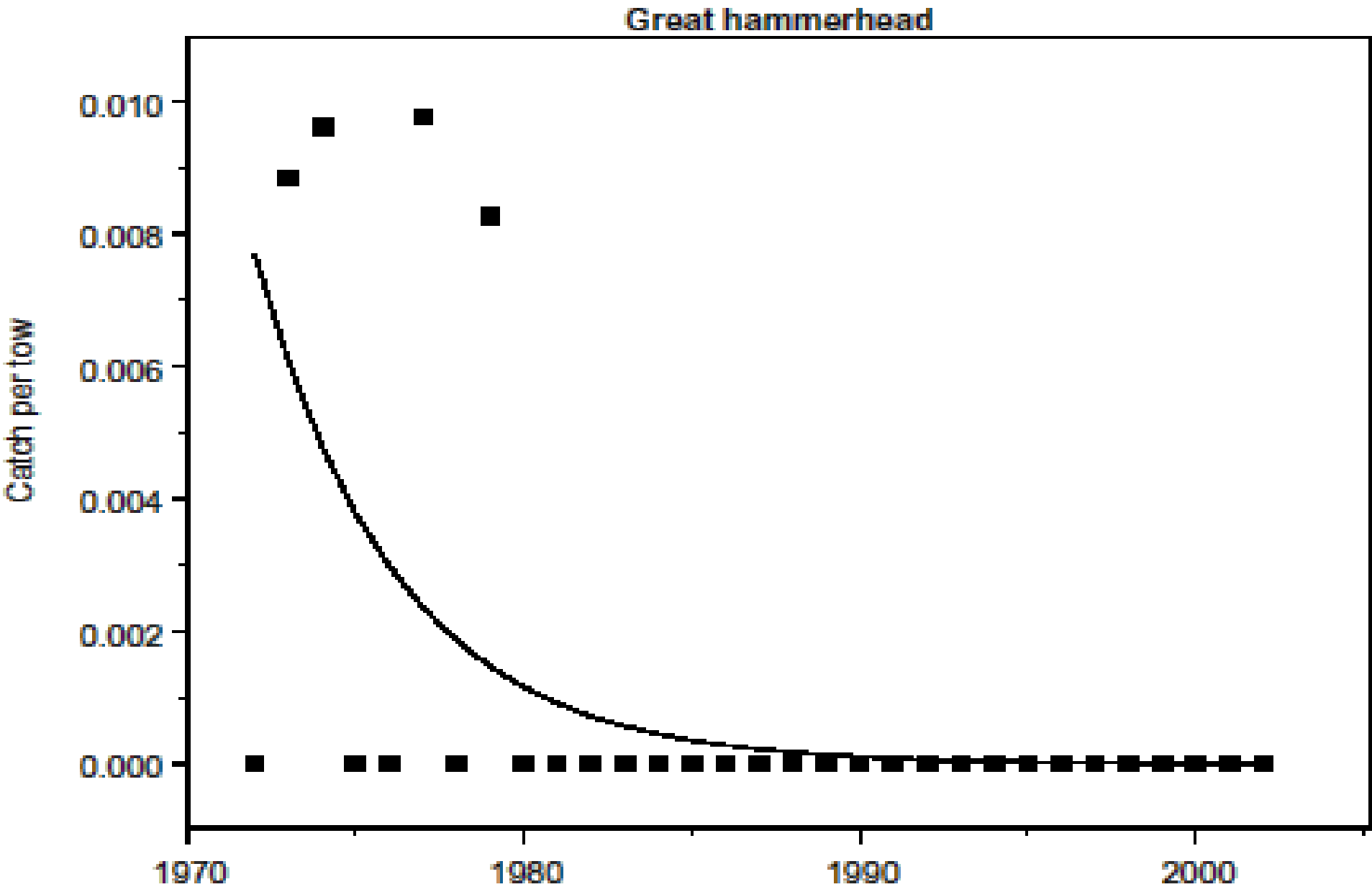
Mean standardized catch per tow

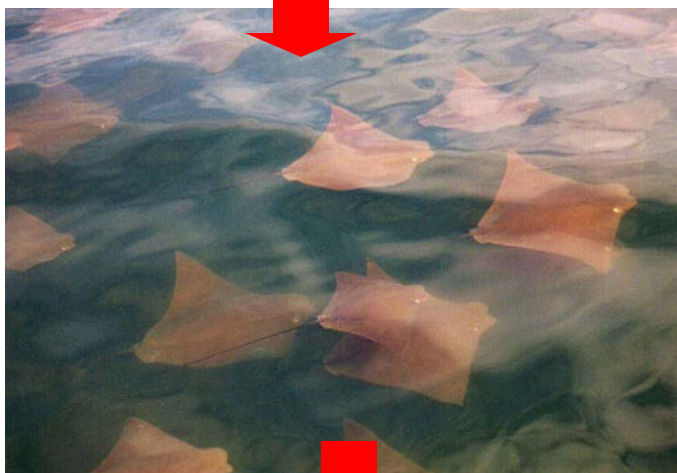
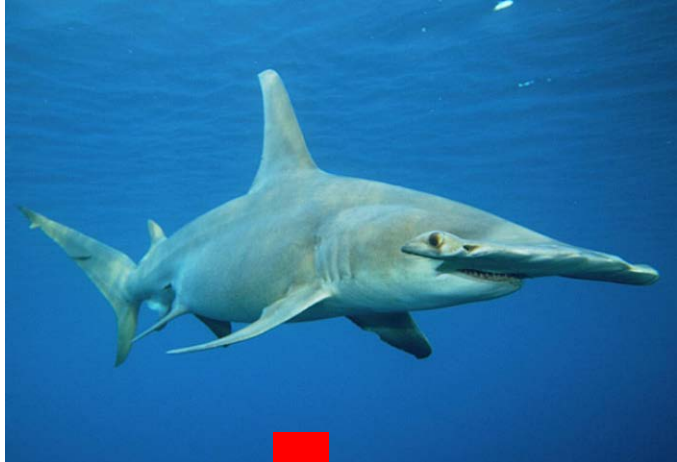


Hammerhead eating stingray

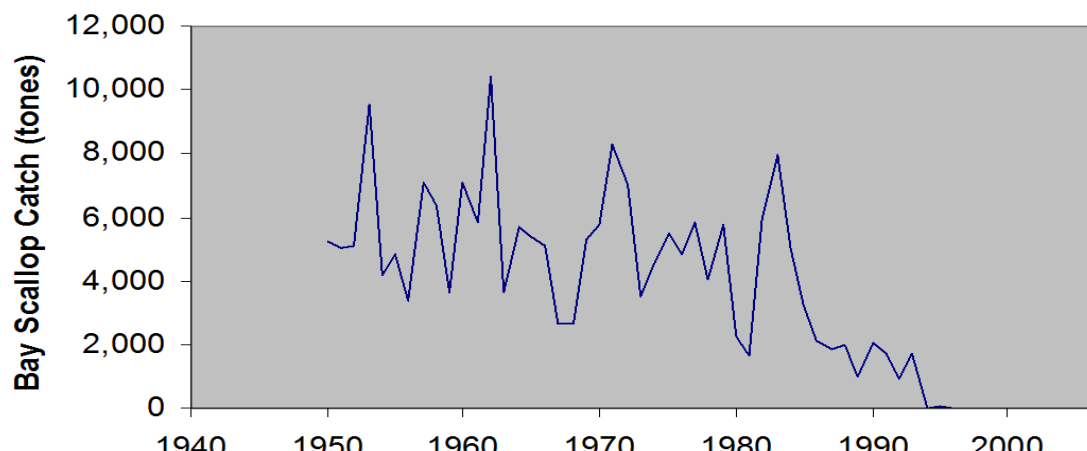
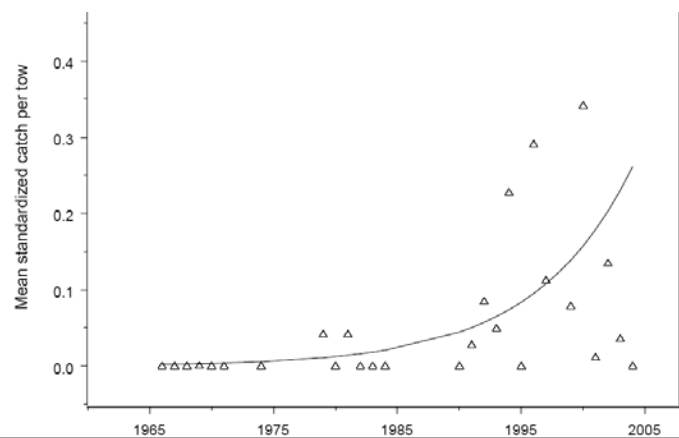
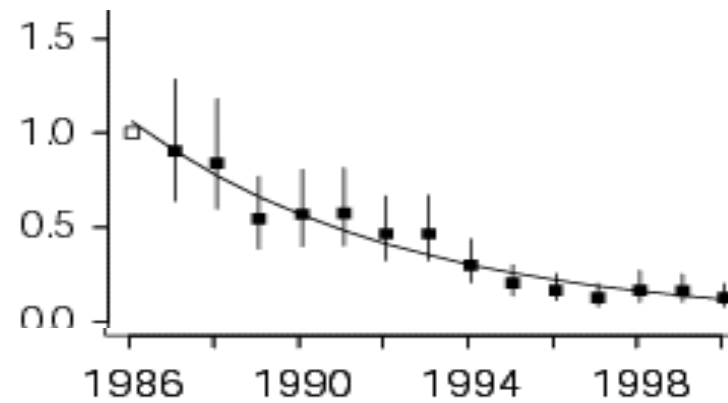


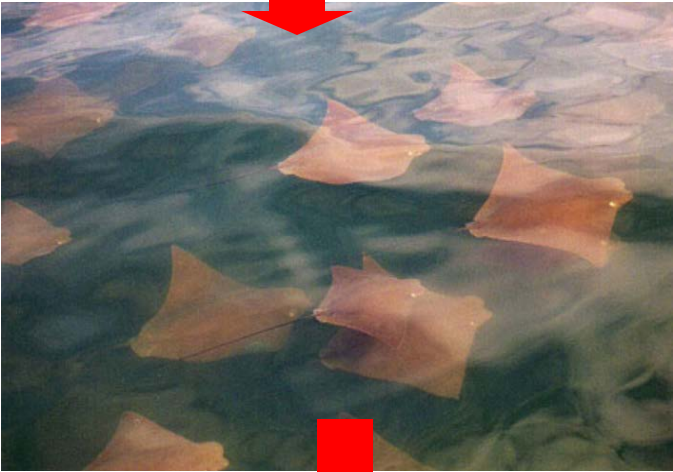
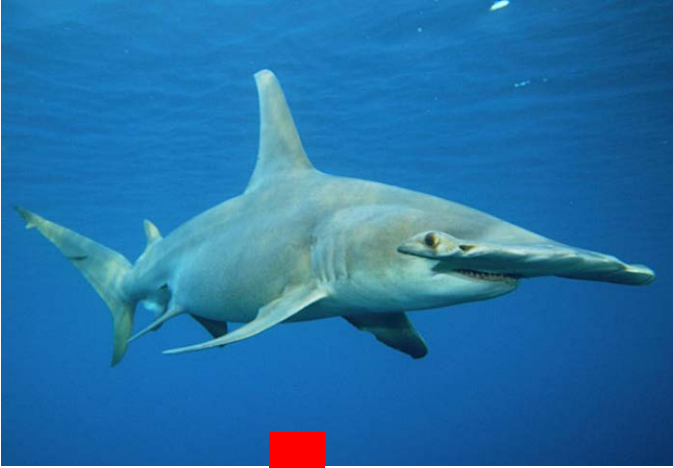
Loss of hammerheads from surveys





Relative abundance





Trophic Cascades:
Consequences of the
loss of top predators
may be greater than
we think