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

Ransom A. Mye
Dalhousie Unive
Canada

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

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

How do you get the right results from models?

- Right question
- As simple models as possible, (and no simpler)
- Parameters are random variables in which everything is heirachically structured.
- Multiple tests for robustness
- Repeat analysis using all other independent data in the world and combine using meta-analysis.
- Plot data and model results to reveal truth.

Asking the right question requires intellectual honesty and independence.

- "Tame" scientist: "Think what they are told to think even before they told to think it".
- We are a tribal species, and anyone who believes that thinking independently is easy, has simply never tried it.


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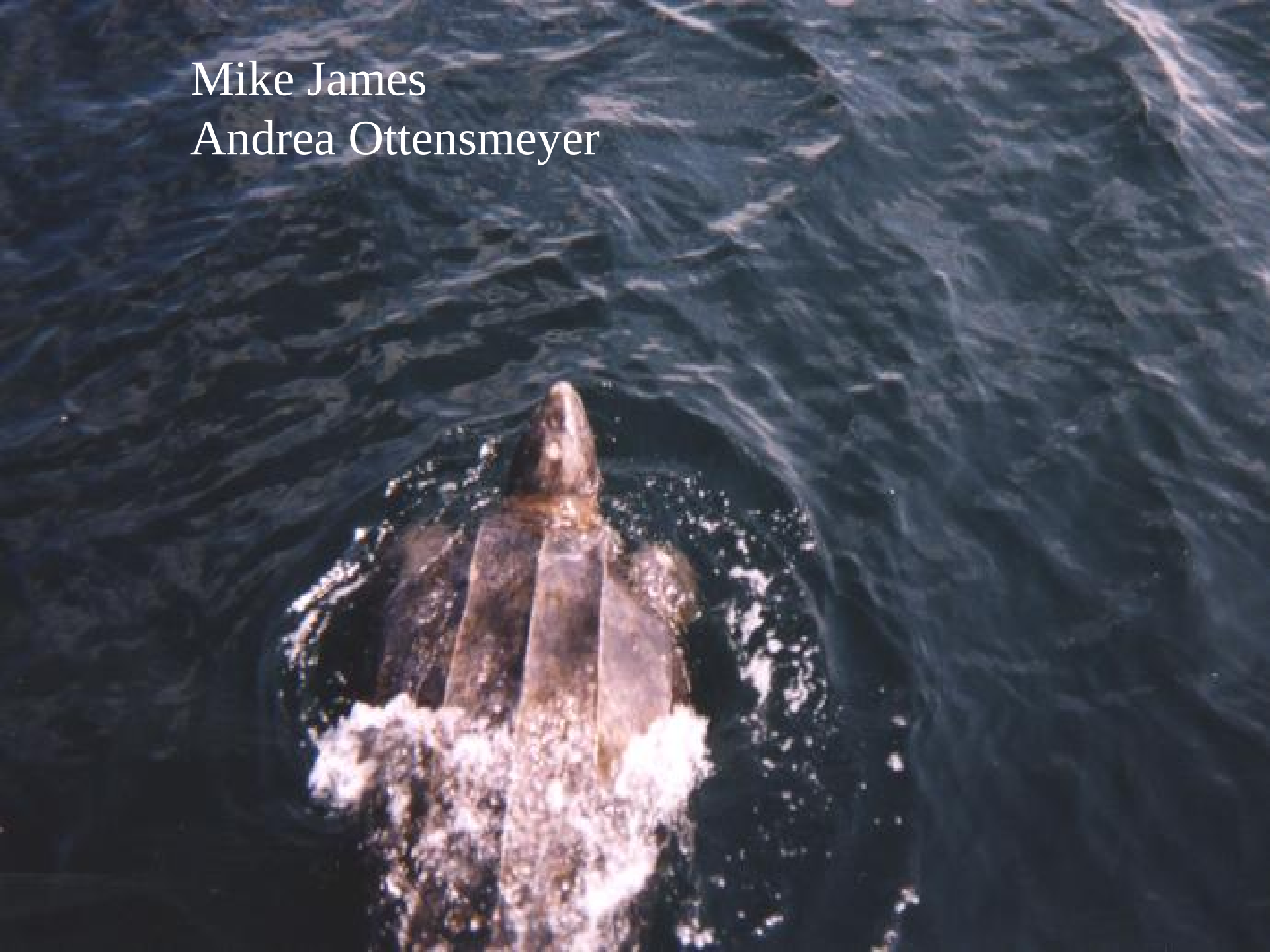
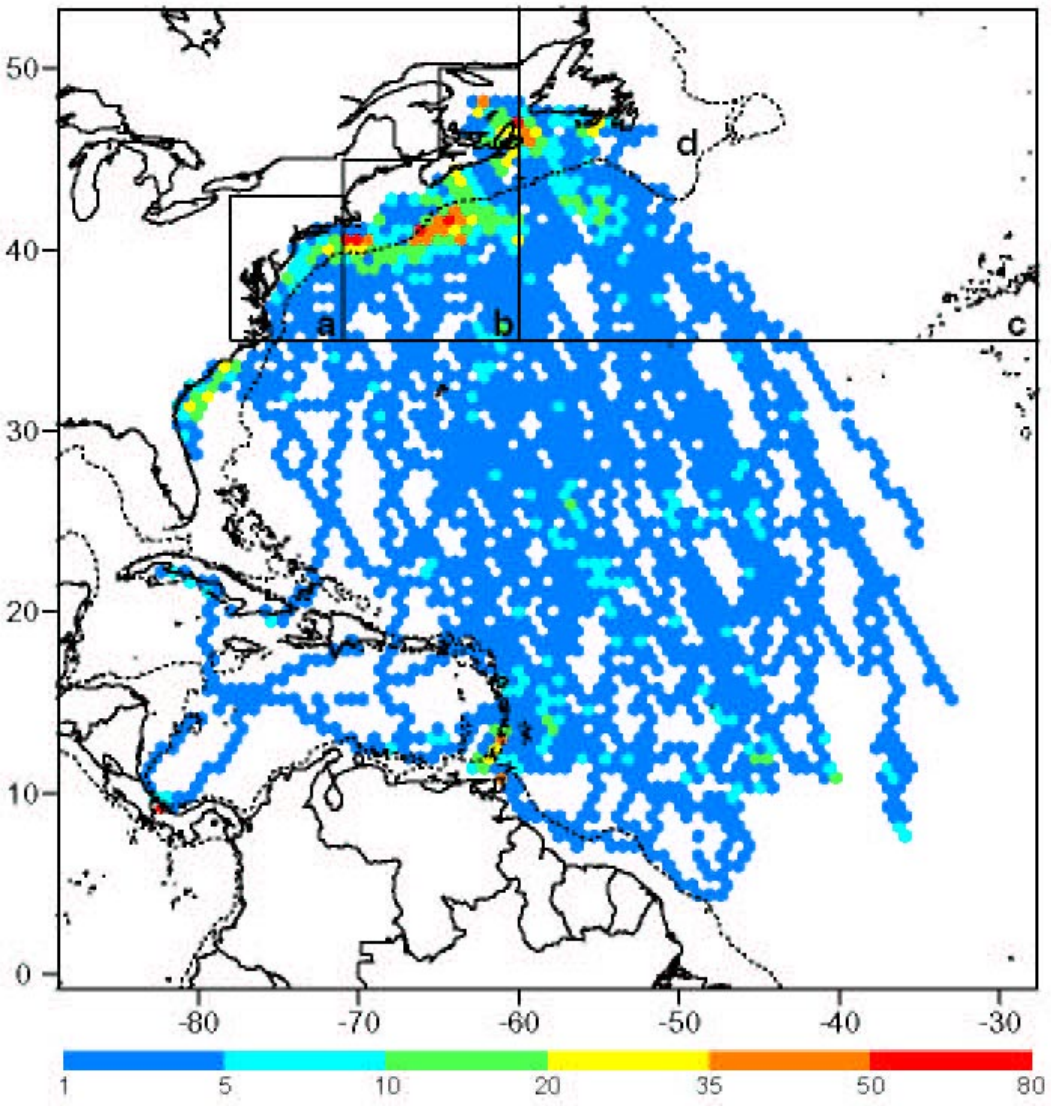
Photo by Matthew Godfrey

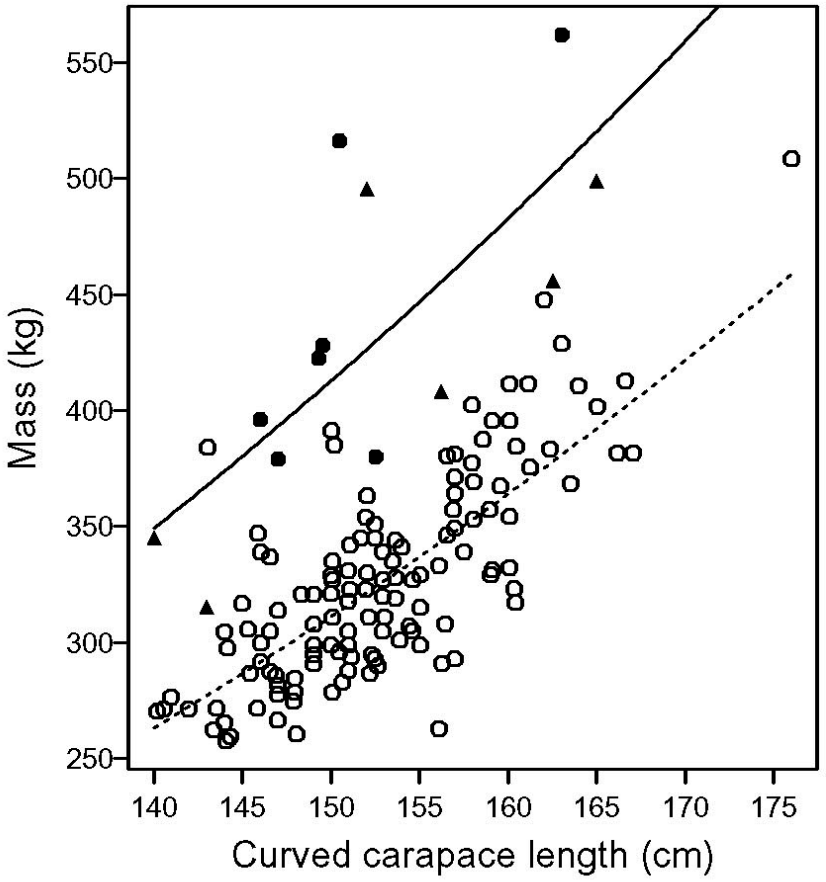

Mike James
Andrea Ottensmeyer

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



recovered dead from fishing gear

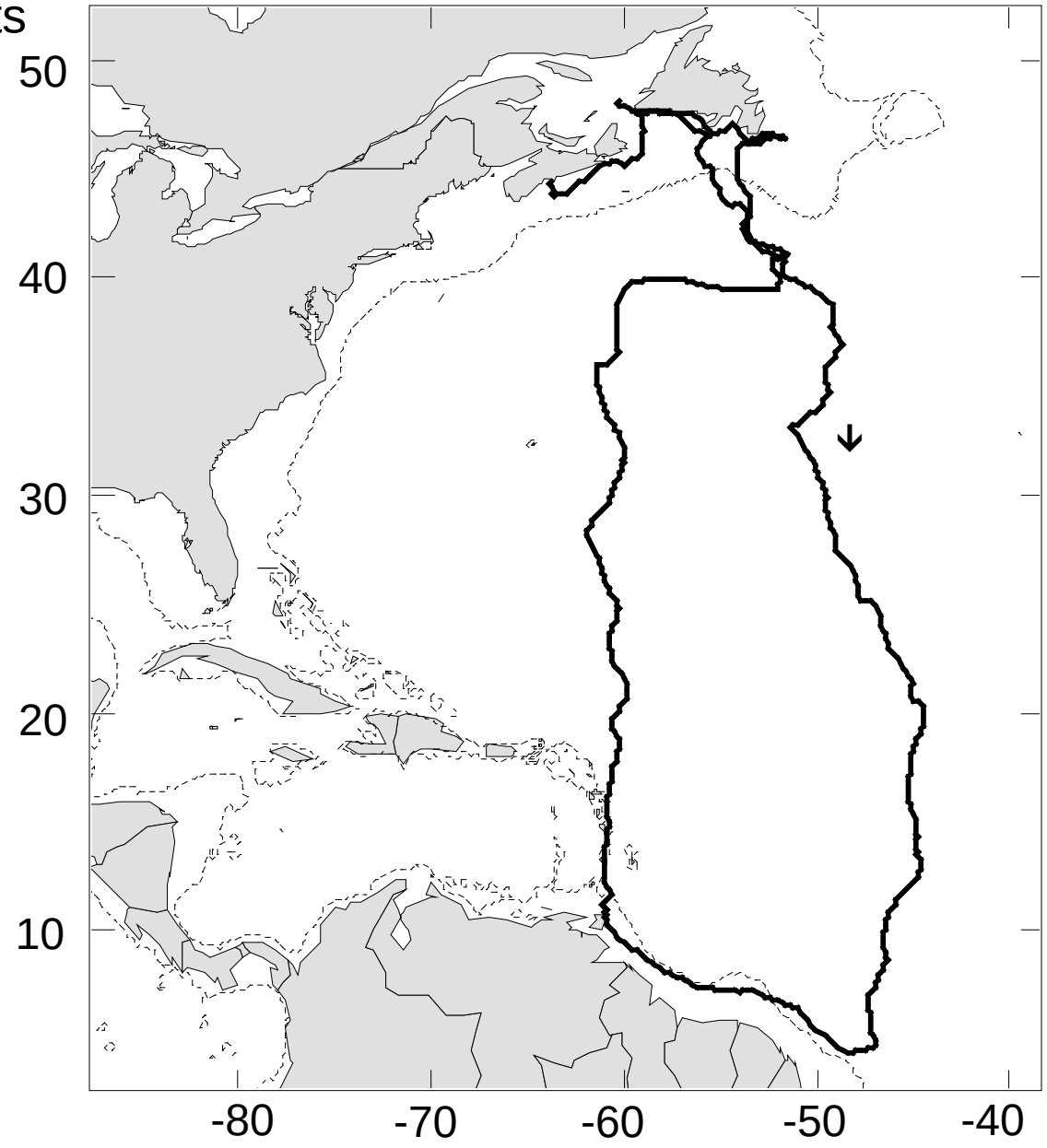
- 33% heavier in Canadian coastal areas versus on the nesting beach

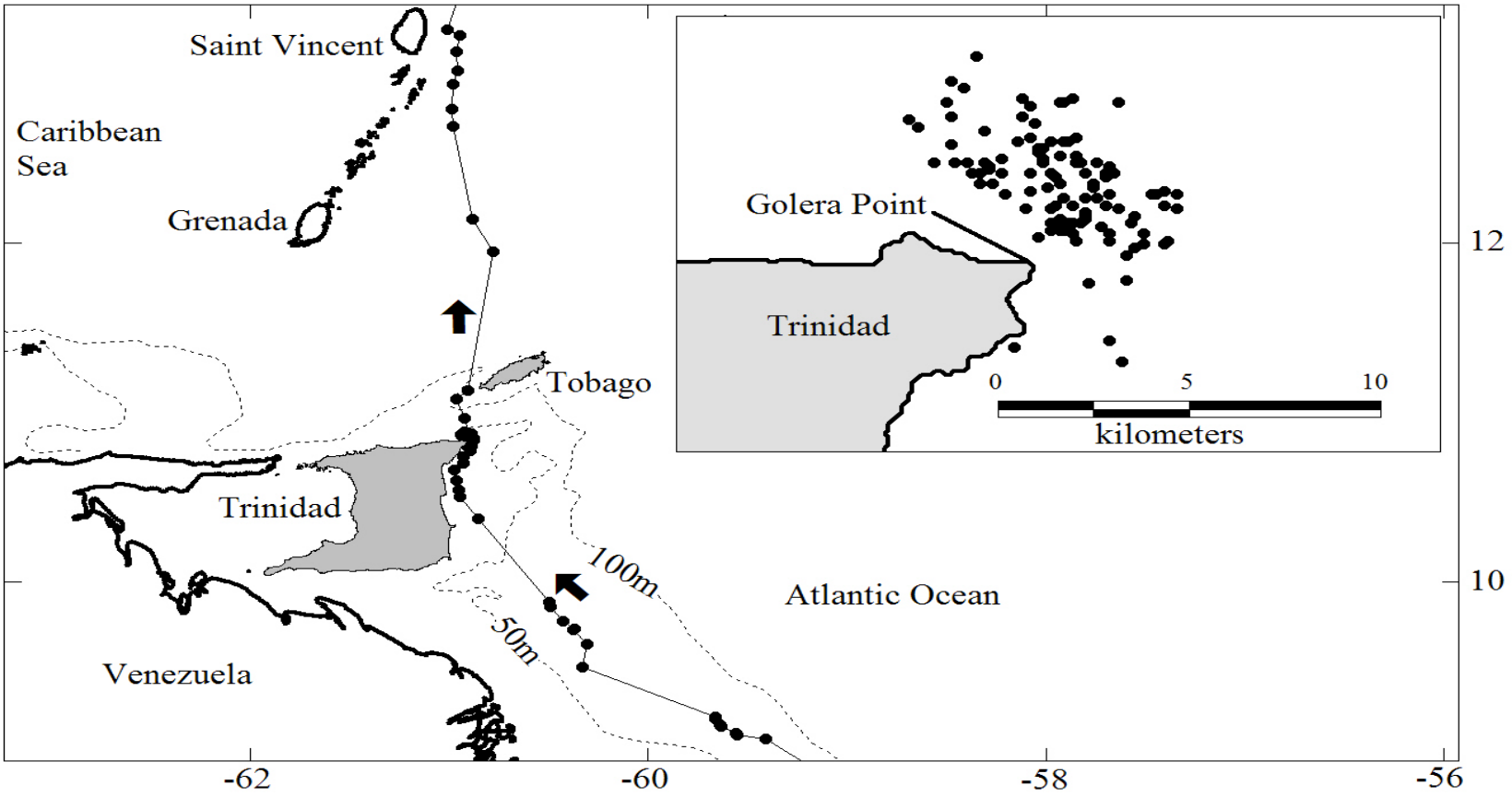
Nesting female morphometrics: St. Croix, U.S.V.I.
Boulon et al. 1996. Chelonian Conserv, Biol. 2:141-147.
Lines fit by constant slope analysis of covariance after log transformation.

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*)





Male residency in nearshore waters off large nesting colonies

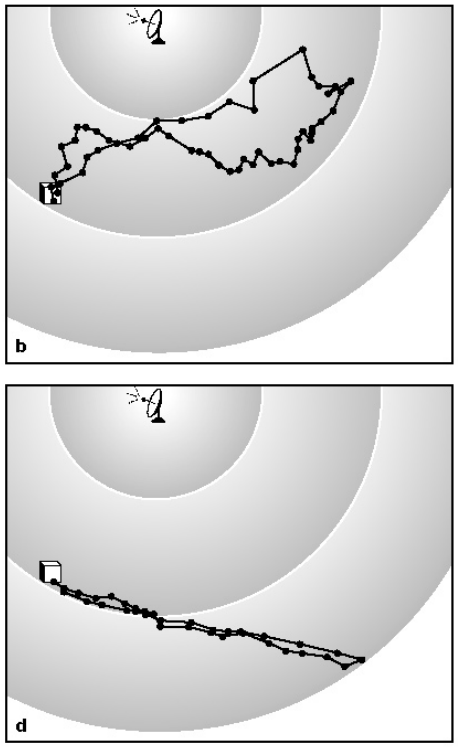
- Location and timing of mating activity not previously known
- long-term tracking (e.g. 20 months +) reveals fidelity for breeding areas

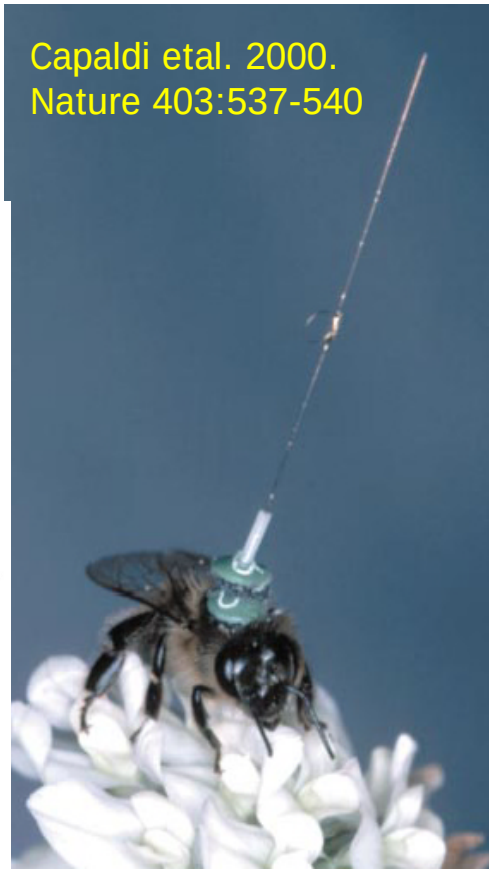
Meta-analytic State Space Movement Models

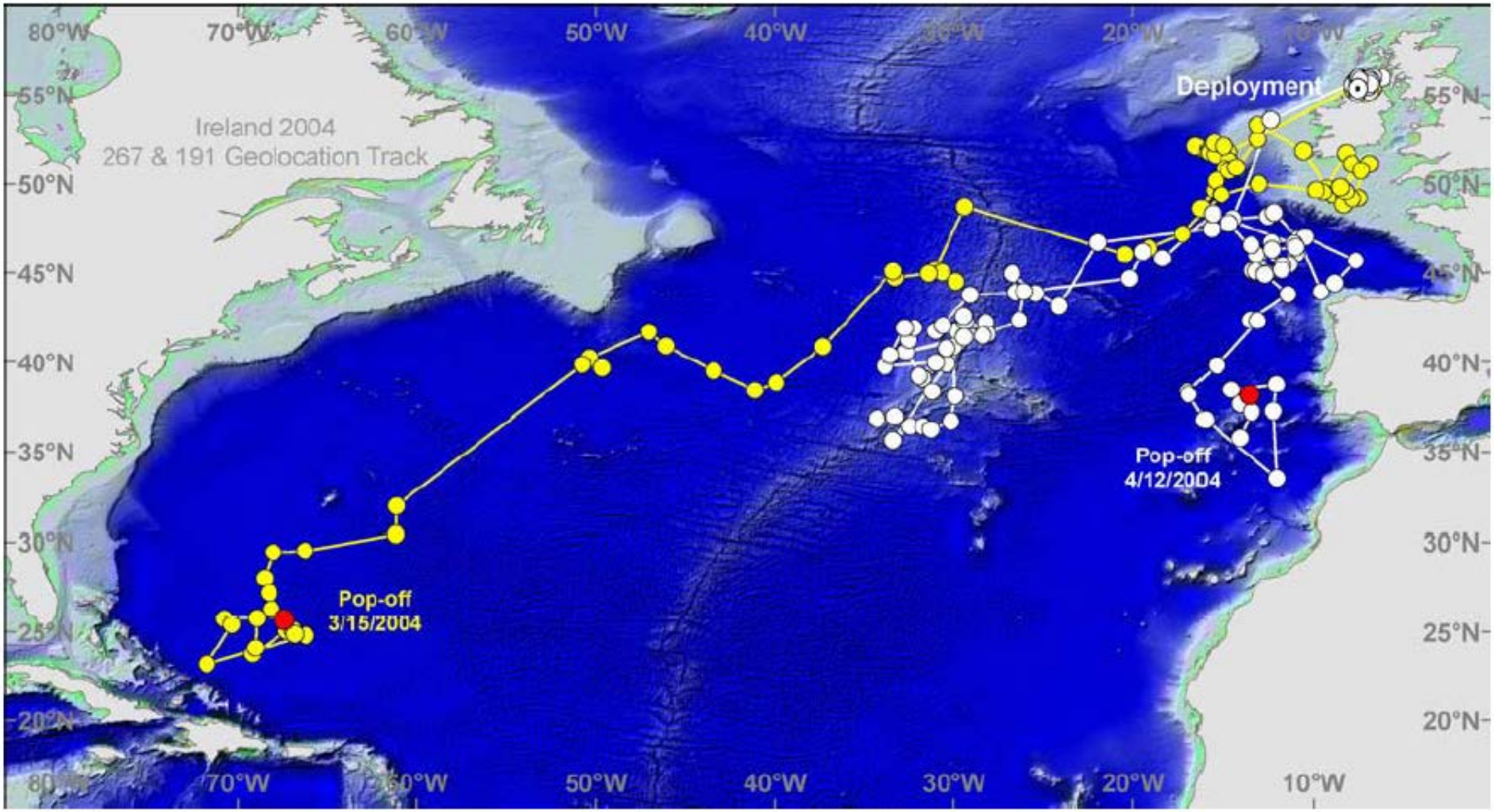
Ian Jonsen

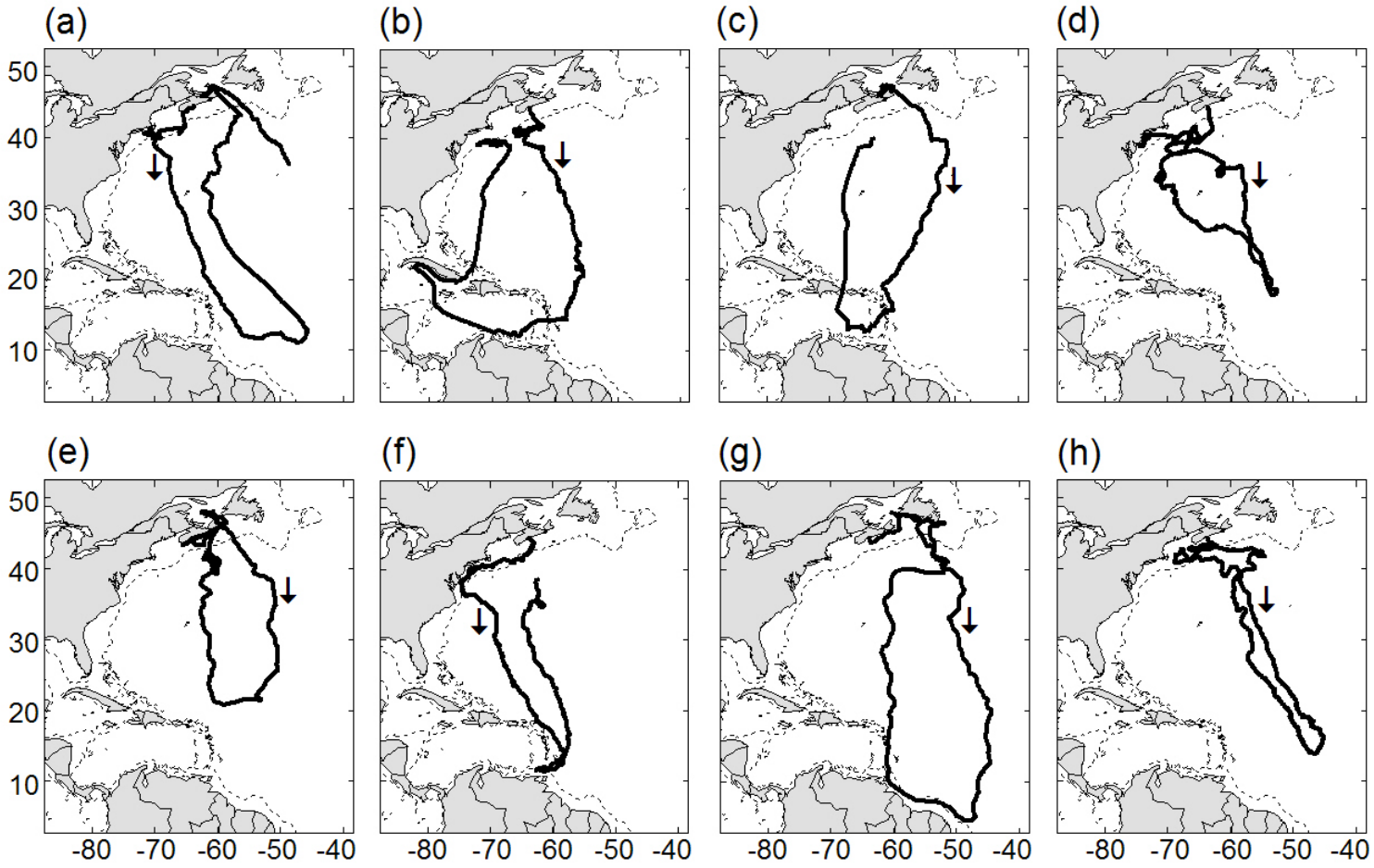
Joanna Mills

Greg Breed



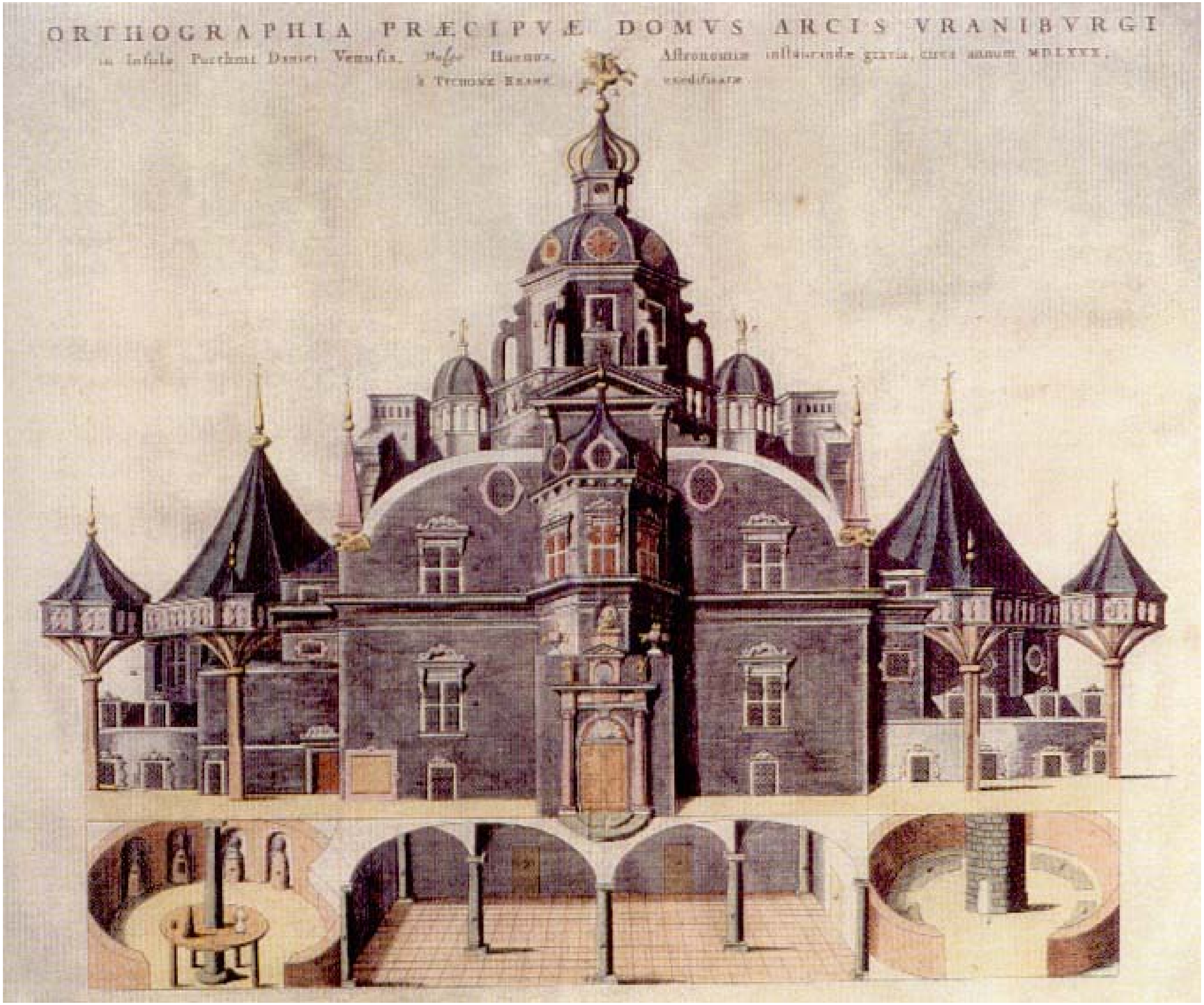


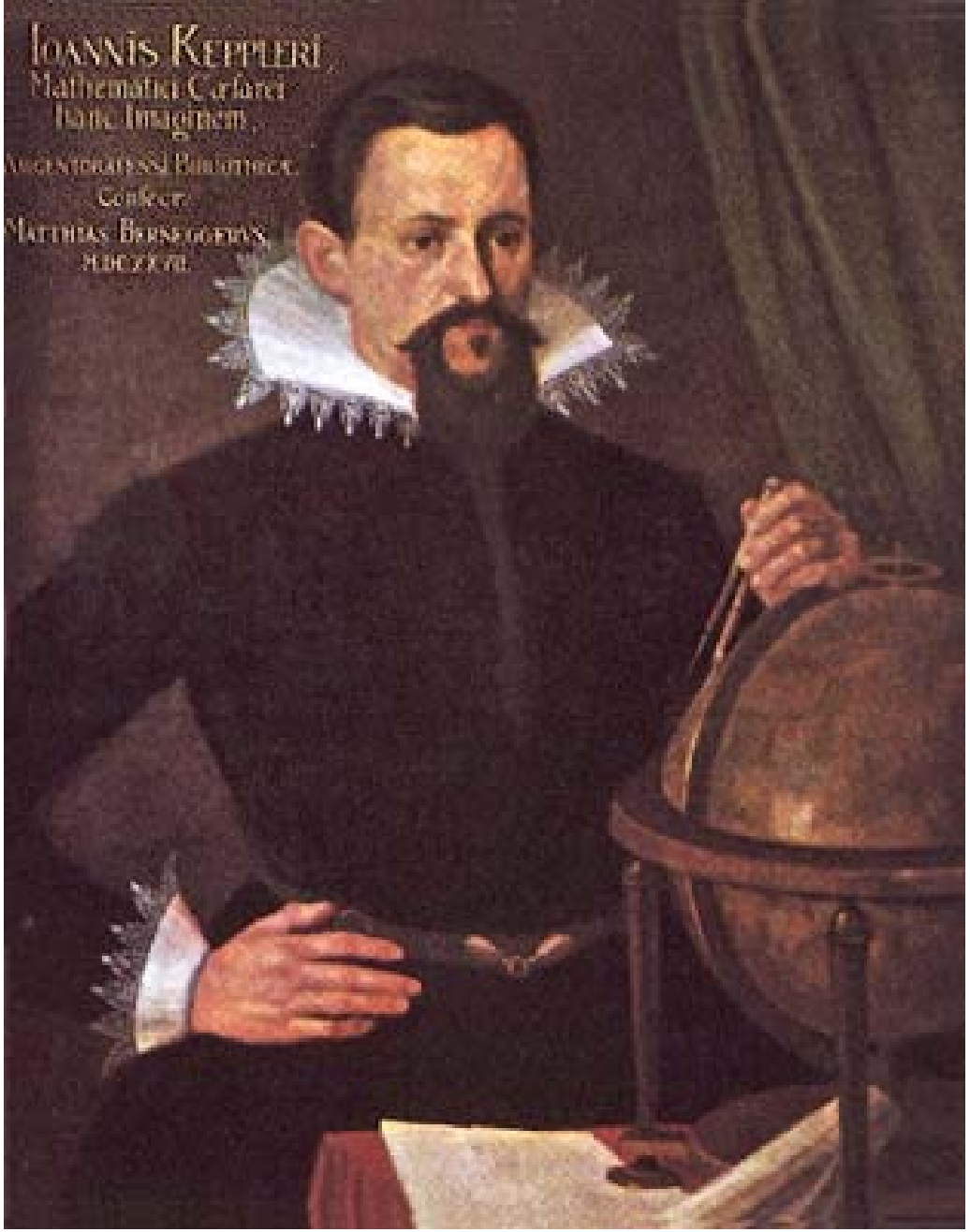

Ireland 2004
267 & 191 Geolocation Track
Deployment
Pop-off
4/12/2004
Pop-off
3/15/2004
80°W
70°W
60°W
50°W
40°W
30°W
20°W
10°W
55°N
50°N
45°N
40°N
35°N
30°N
25°N
20°N



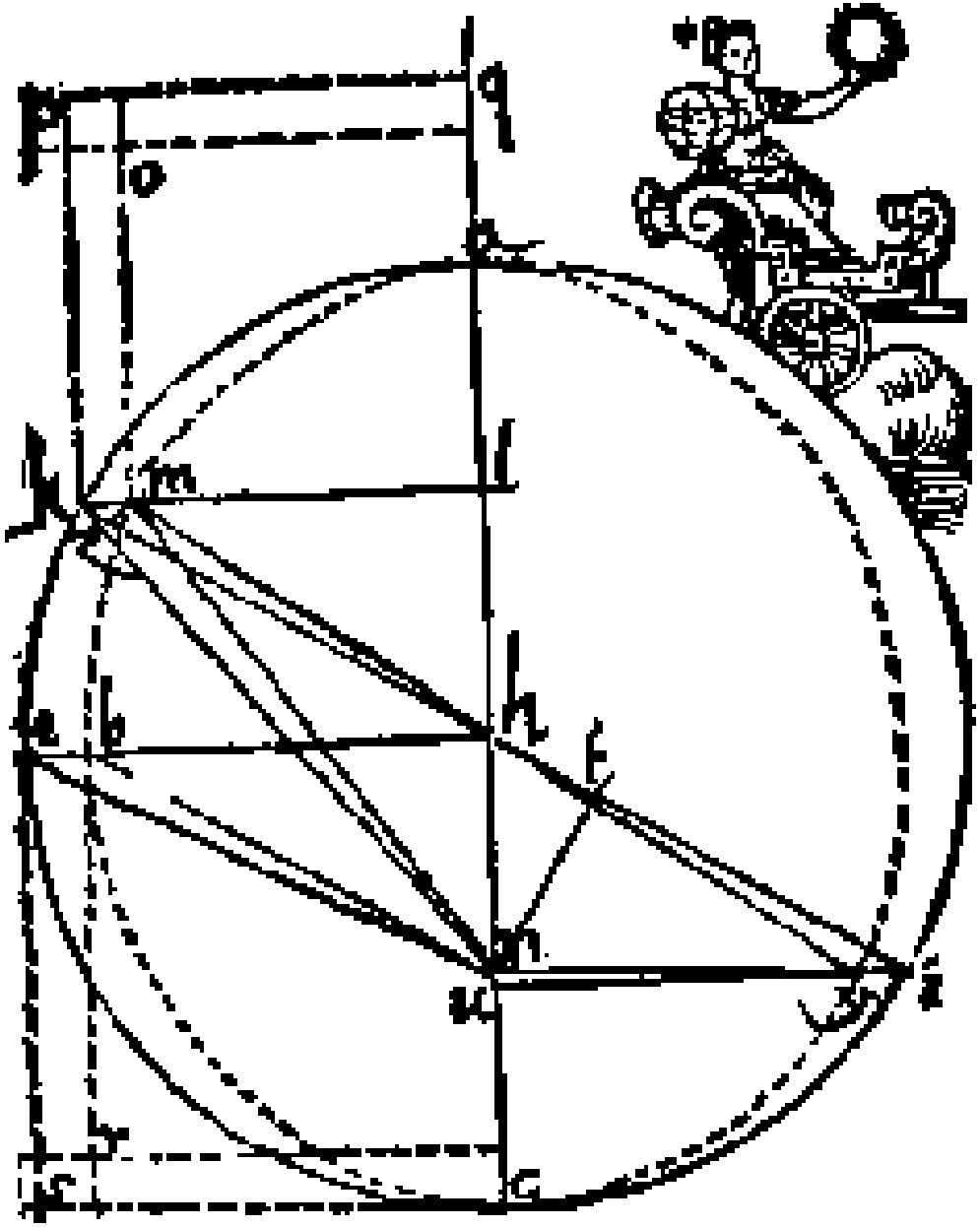
- First documented return migrations to foraging areas
- return migrations to Canada/Northeastern U.S. are annual
- similar migratory cycle for sub-adults and females in their internesting years
- modified cycle for mature males and nesting females (nearshore phase in tropical waters)

Why studying trajectories is an important thing to do.

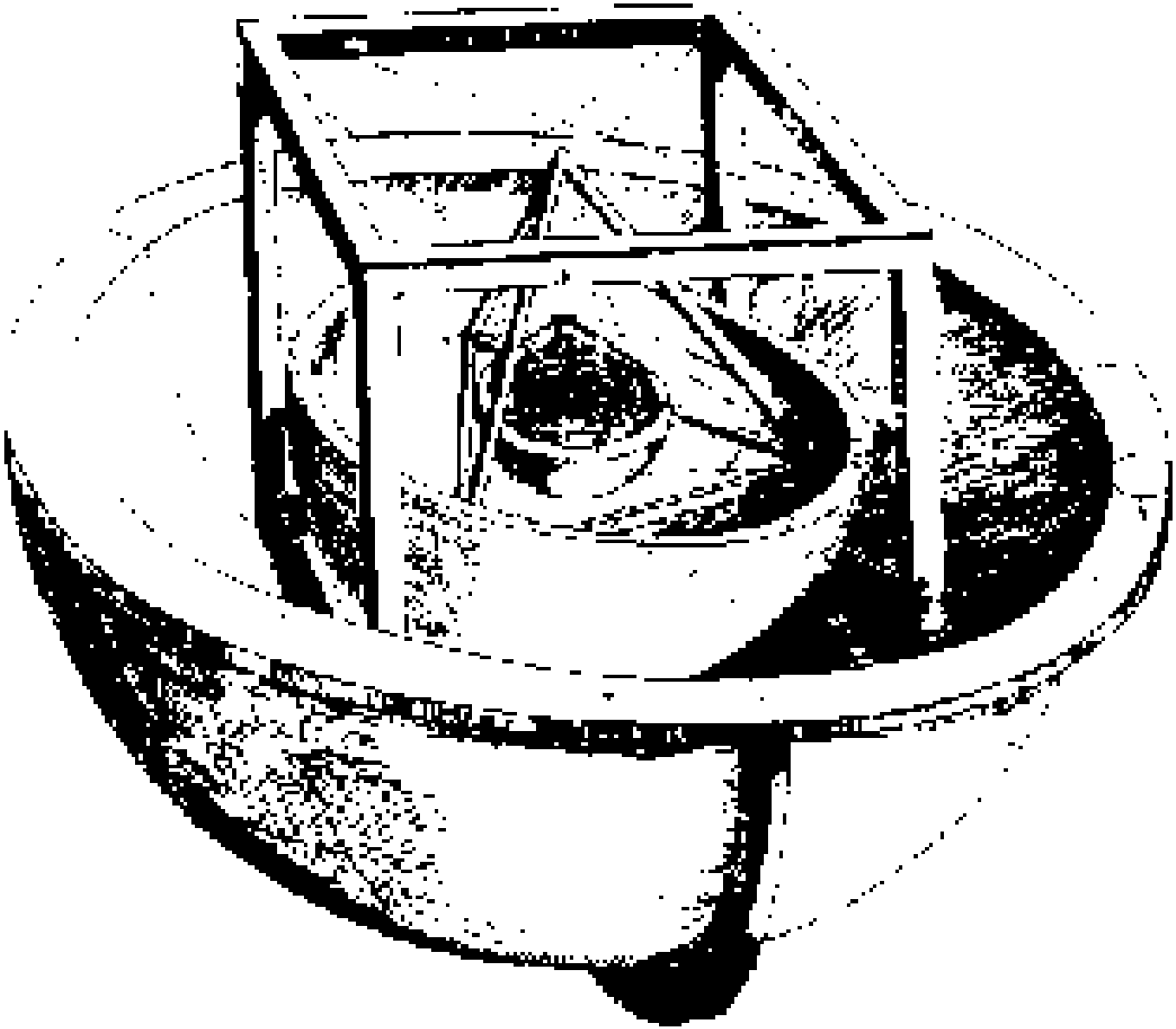

ORTHOGRAPHIA PRÆCIPVÆ DOMVS ARCIS VRANIBVRGI

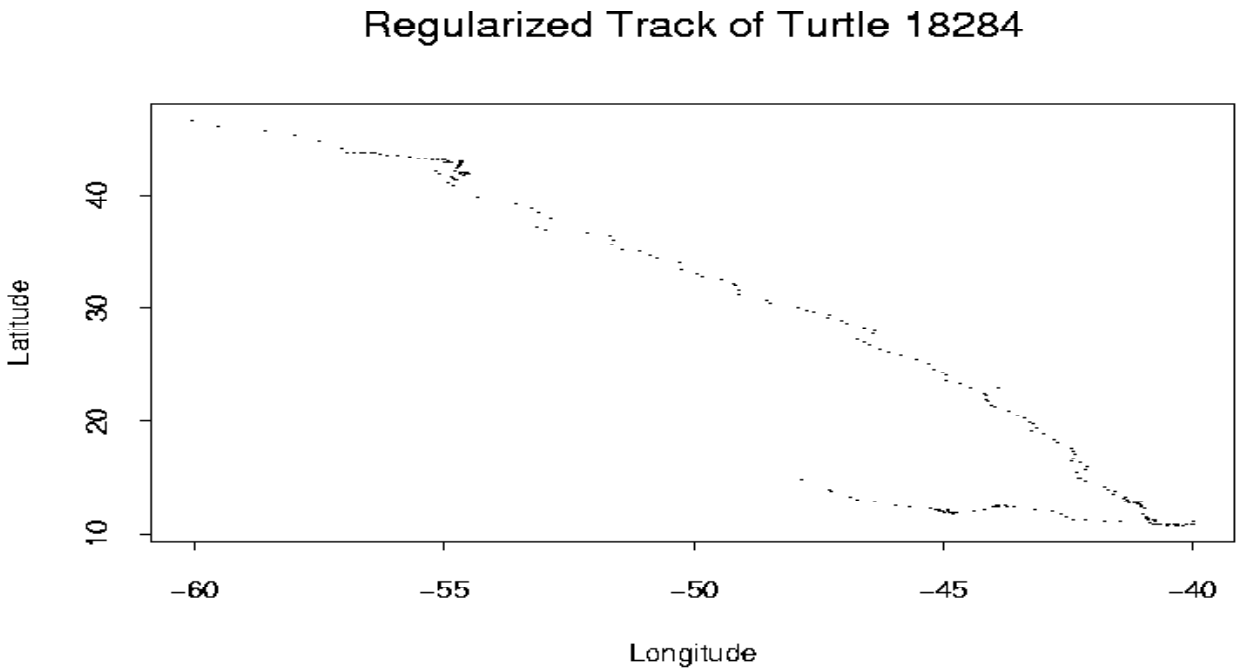


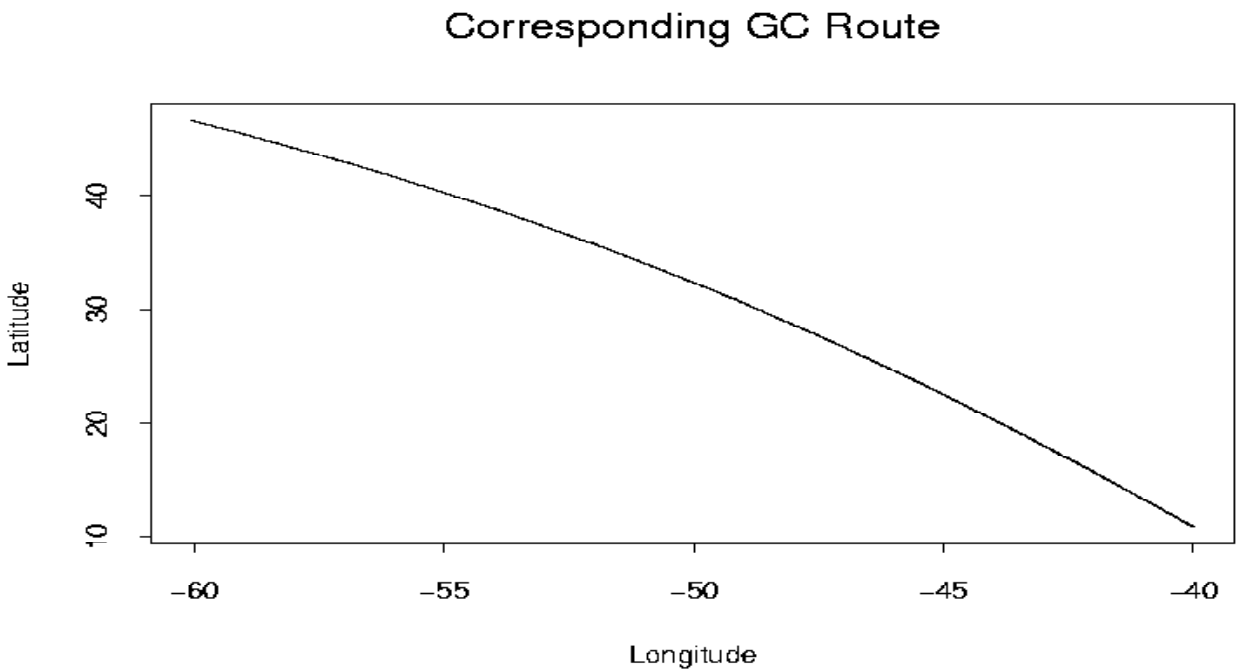
Imperial Mathematician



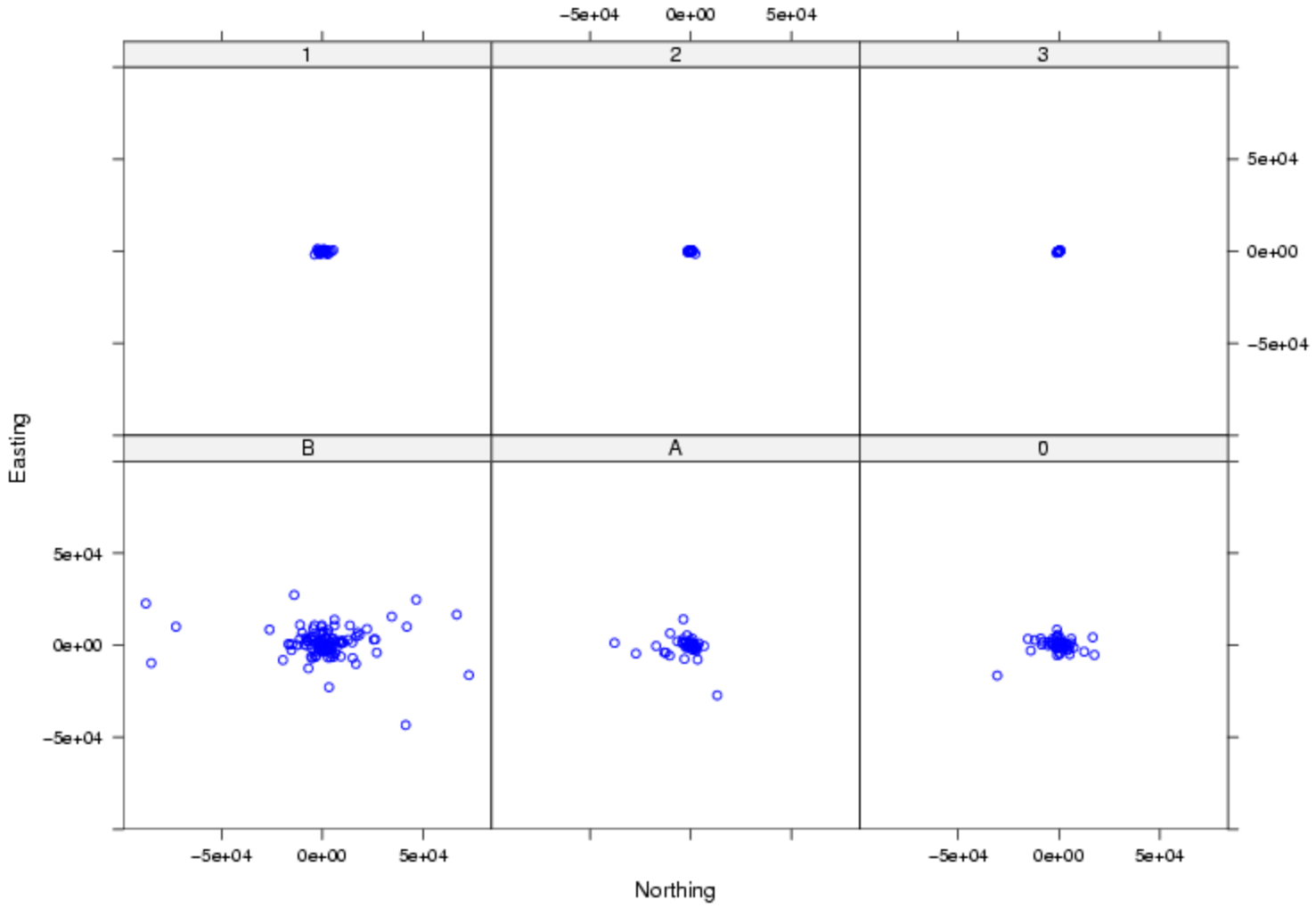
Kepler's elliptical orbit for Mars..



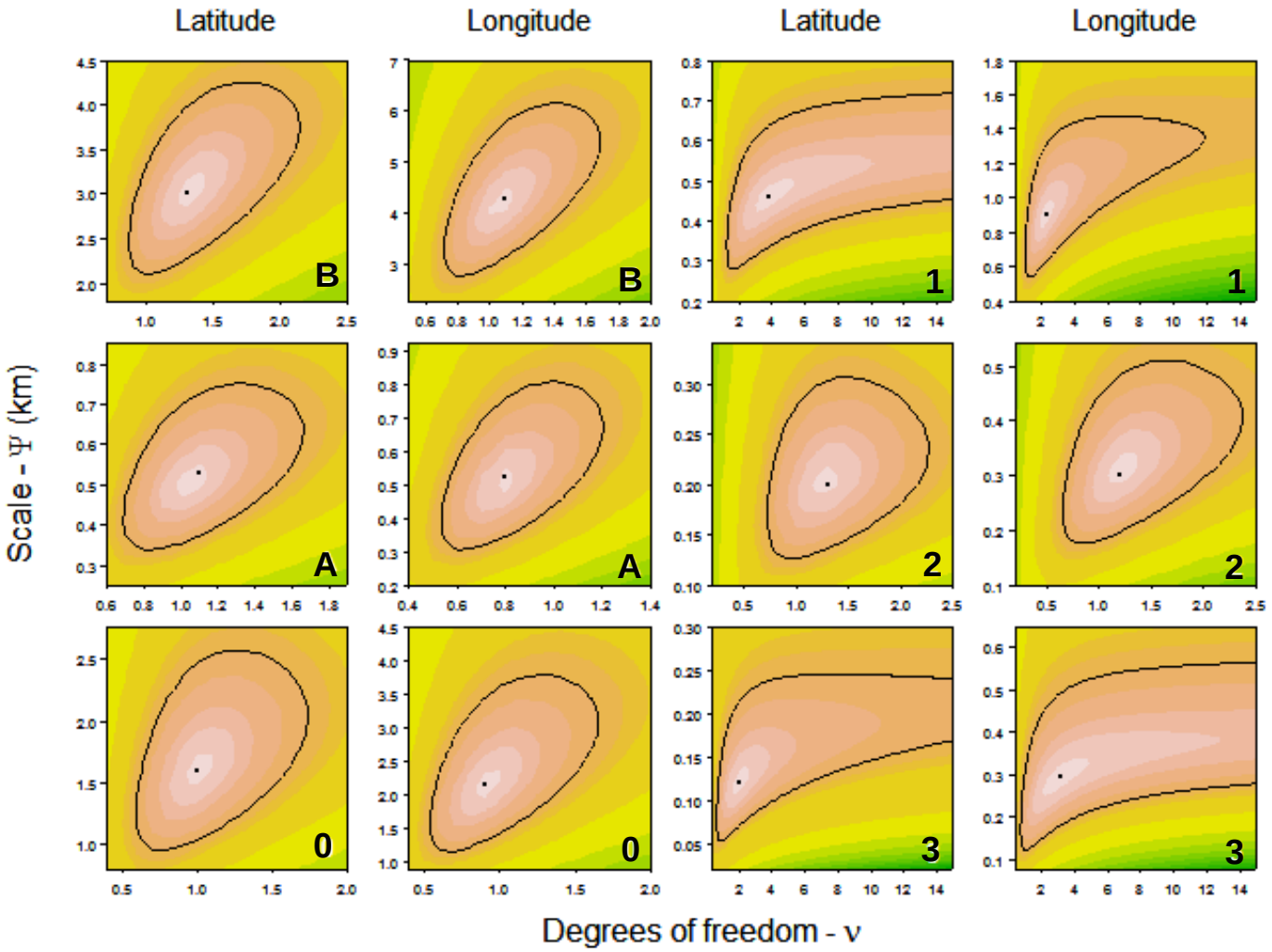

Regularized Track of Turtle 18284
Latitude
10
20
30
40
−60
−55
−50
−45
−40
Longitude

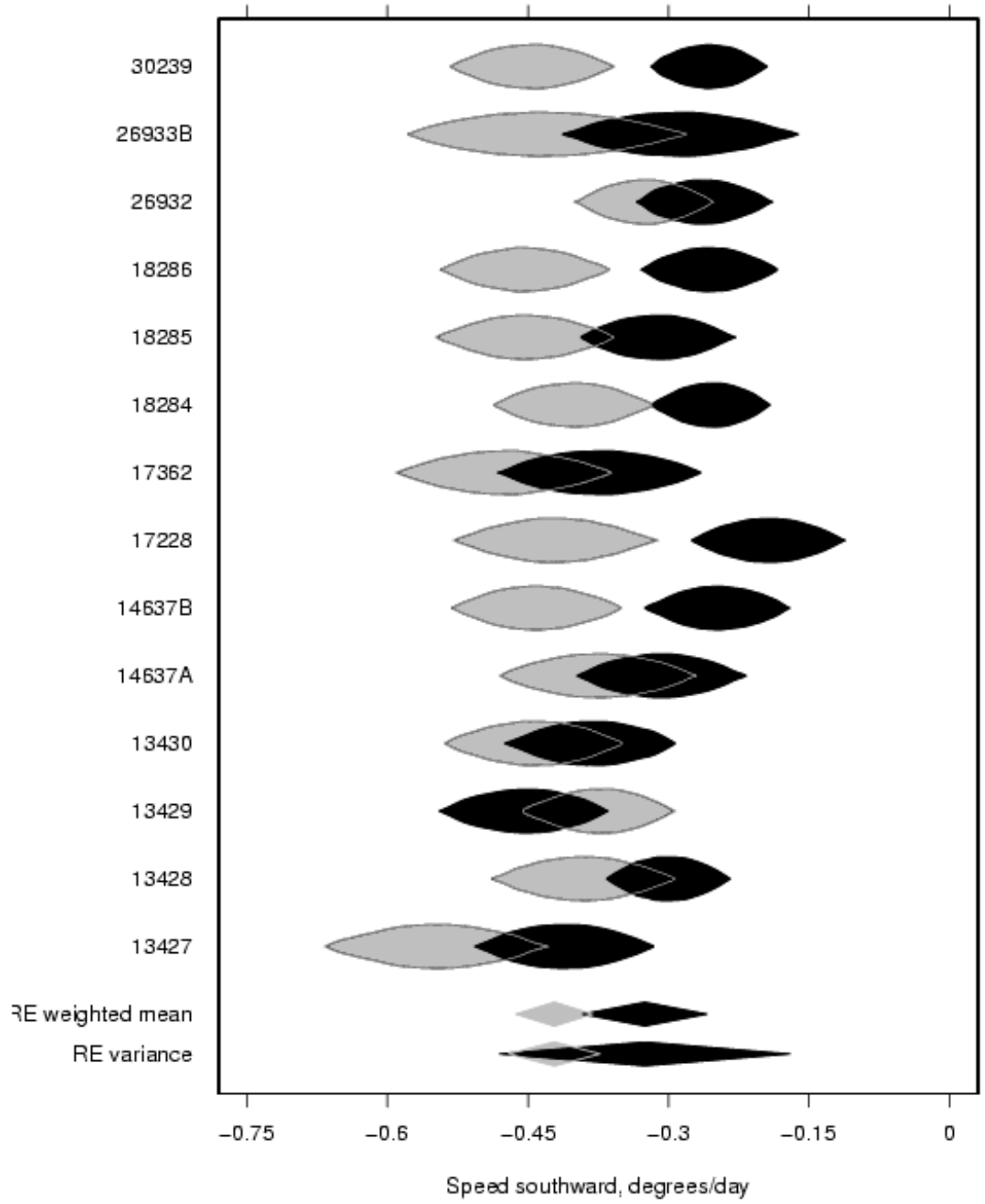

Corresponding GC Route
Latitude
10
20
30
40
−60
−55
−50
−45
−40
Longitude

A



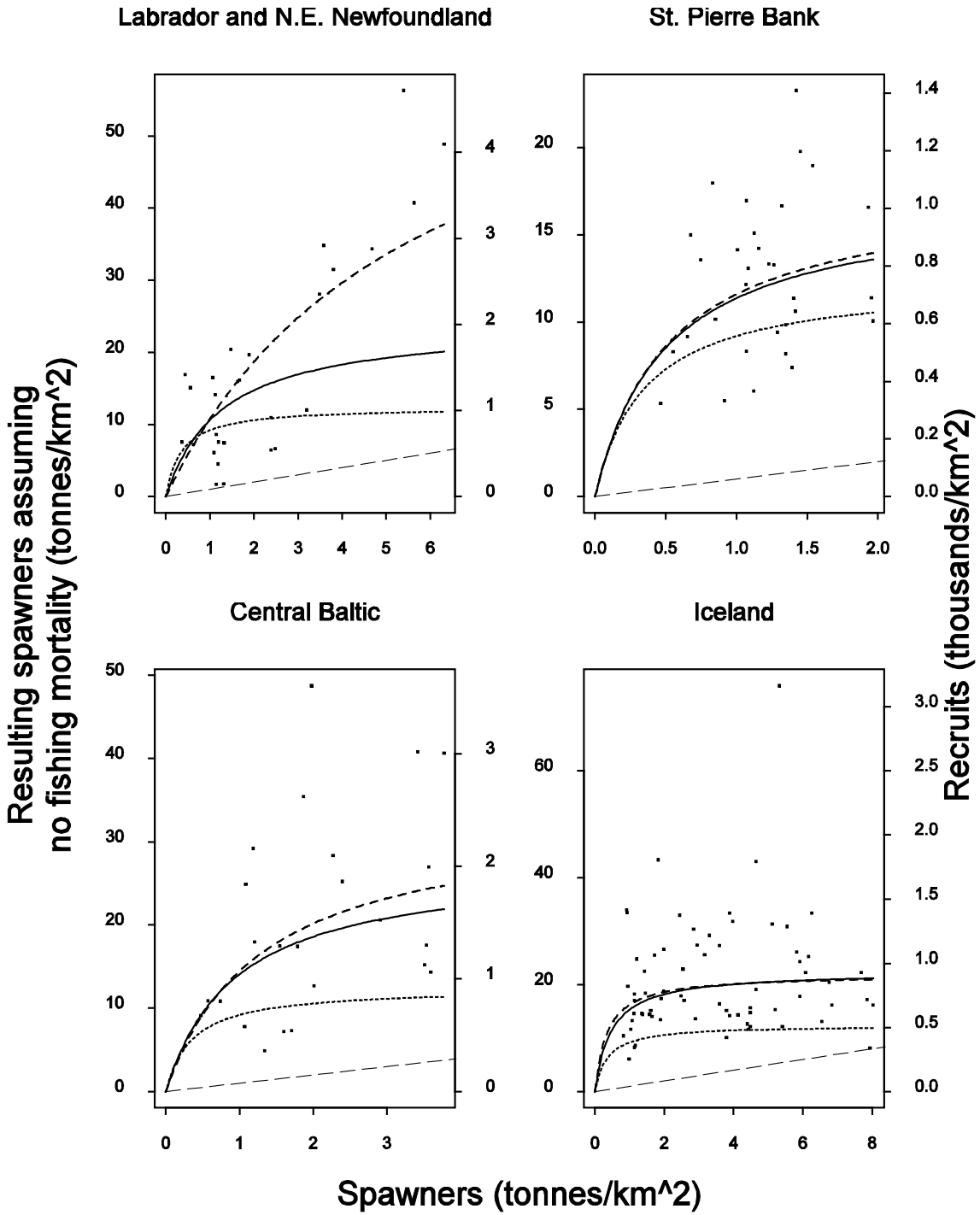
t-distribution parameters

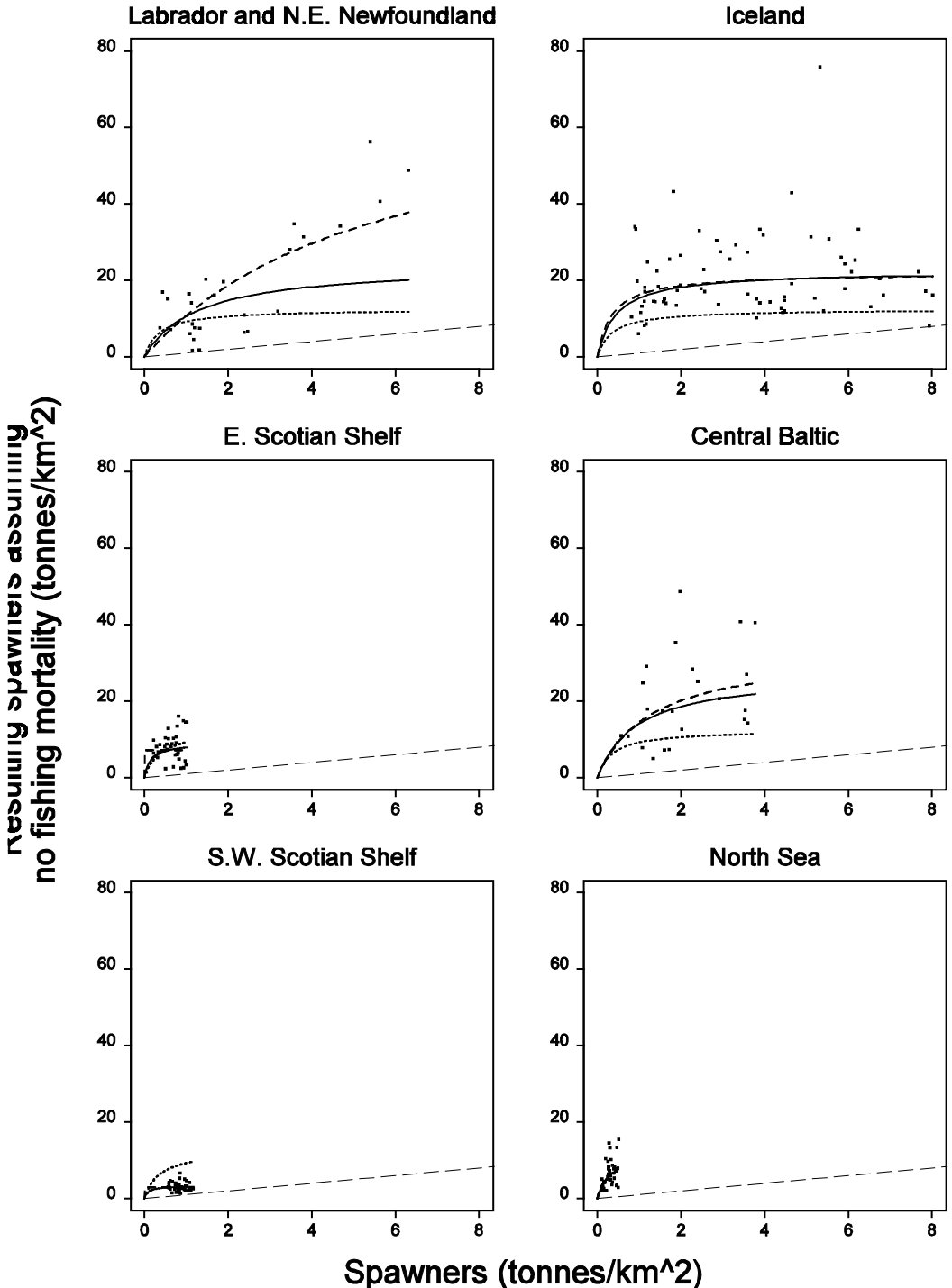



30239
26933B
26932
18286
18285
18284
17362
17228
14637B
14637A
13430
13429
13428
13427
RE weighted mean
RE variance
−0.75
−0.6
−0.45
−0.3
−0.15
0
Speed southward, degrees/day

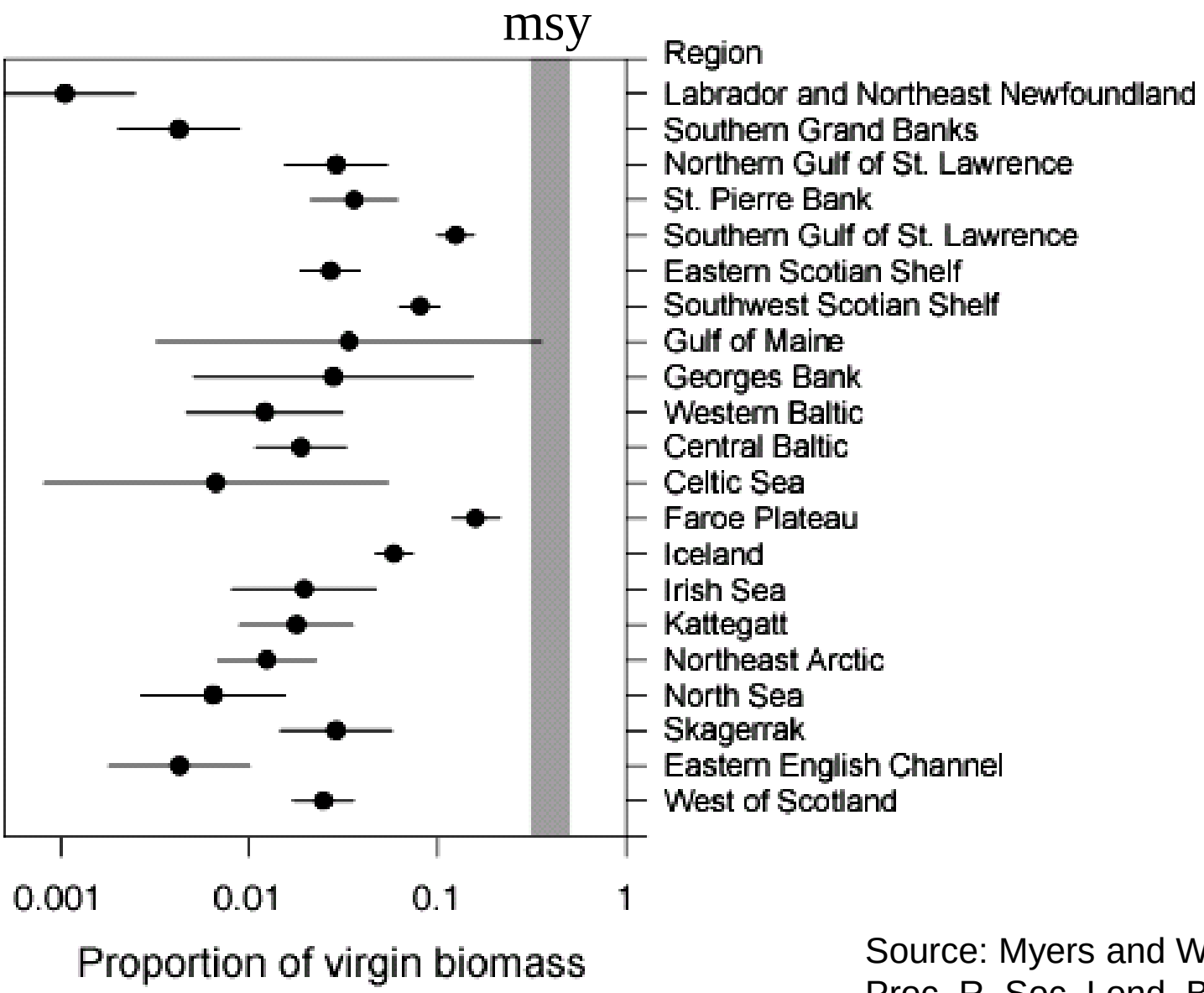
Meta-analysis of everything

- Dan Ricard – Meta-analysis of diffusion from MPA's
- Scott Sherrill-Mix – Meta-analysis of fisher's behaviour when populations change
- Andy Edwards and Coilin Minto – Meta-analysis of species interactions
- Julia Baum – Carrying capacity and recovery

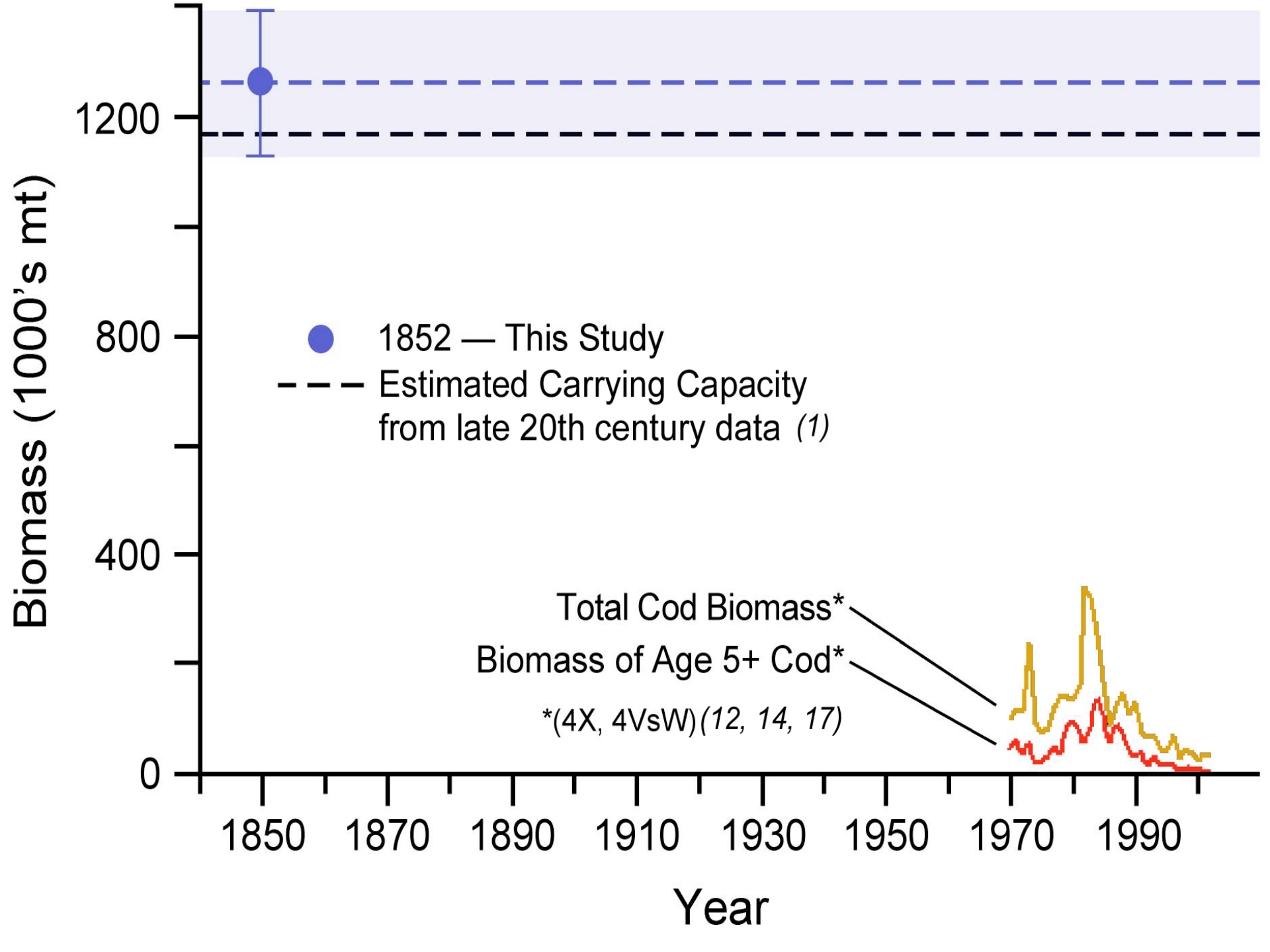

Labrador and N.E. Newfoundland
St. Pierre Bank
Central Baltic
Iceland
Resulting spawners assuming no fishing mortality (tonnes/km^2)
Recruits (thousands/km^2)
Spawners (tonnes/km^2)


Labrador and N.E. Newfoundland
Iceland
E. Scotian Shelf
Central Baltic
S.W. Scotian Shelf
North Sea
Resulting spawners assuming no fishing mortality (tonnes/km^2)
Spawners (tonnes/km^2)
0
20
40
60
80
0
2
4
6
8

There is much less than 10% of cod left -



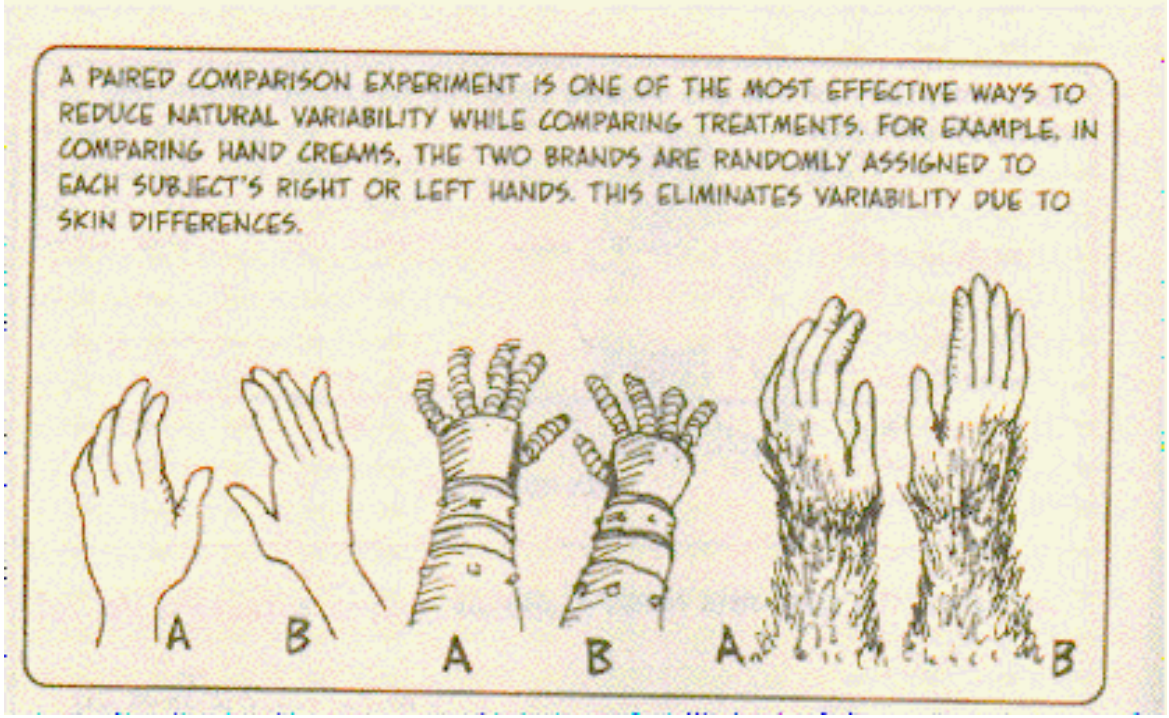
Source: Myers and Worm 2005. Proc. R. Soc. Lond. B


Biomass (1000's mt)
1200
800
400
0
1852 — This Study
Estimated Carrying Capacity
from late 20th century data (1)
Total Cod Biomass*
Biomass of Age 5+ Cod*
*(4X, 4VsW)(12, 14, 17)
1850
1870
1890
1910
1930
1950
1970
1990
Year

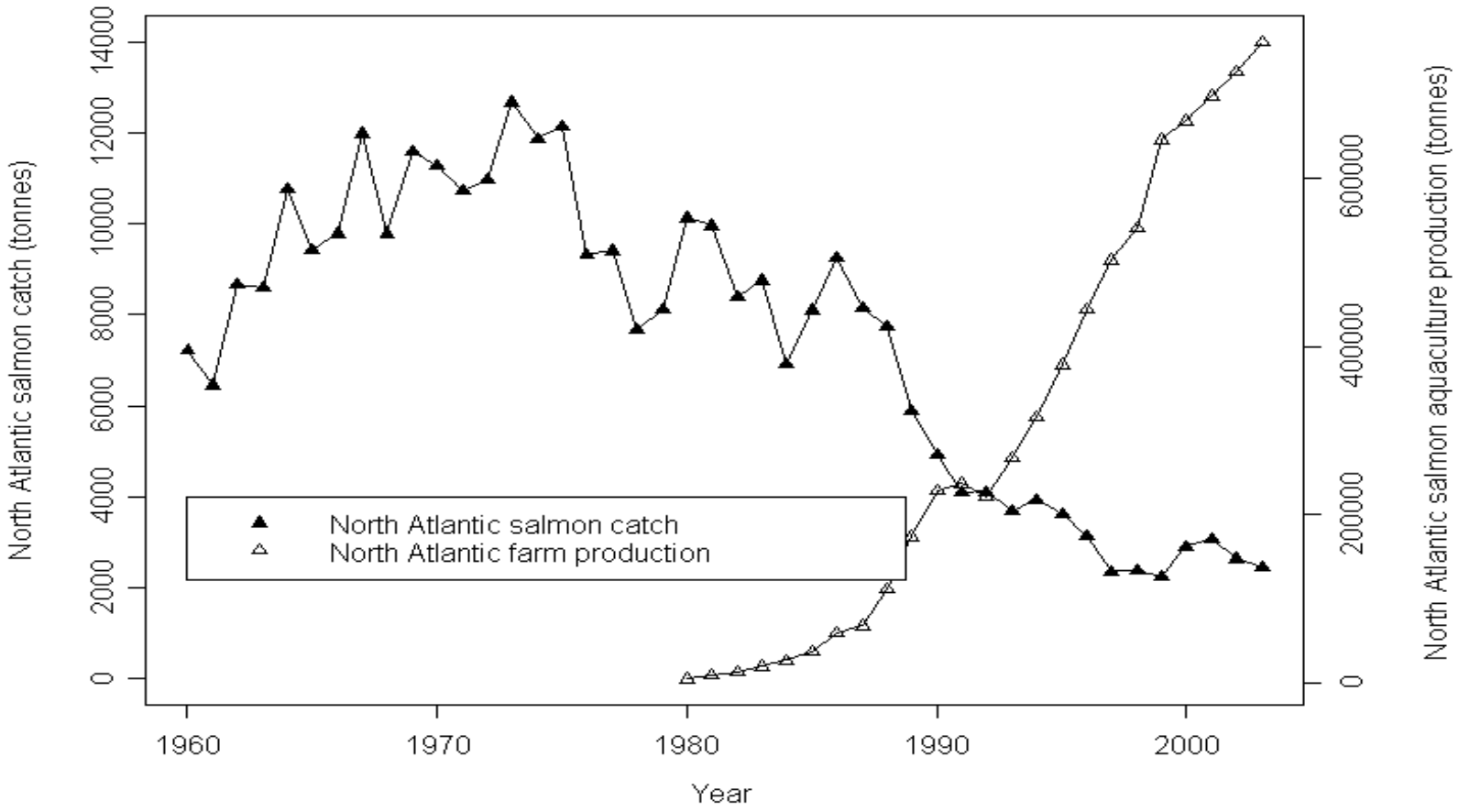
Can wild salmonid populations survive salmon aquaculture?

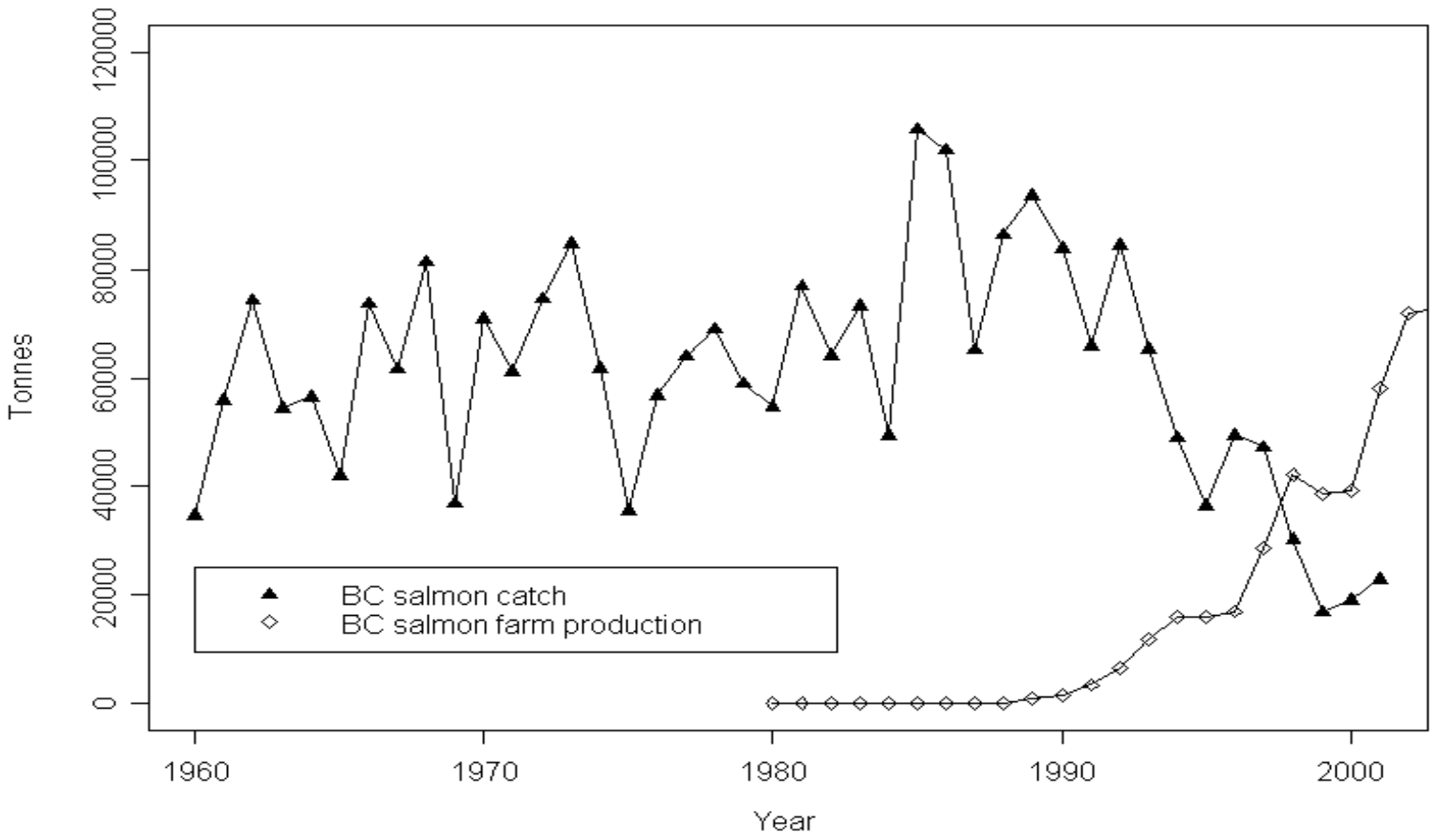
Jennifer Ford

Use paired comparisons.



Source: Cartoon Guide to Statistics, Larry Gonick & Woolcott Smith


North Atlantic salmon catch (tonnes)
0
2000
4000
6000
8000
10000
12000
14000
North Atlantic salmon aquaculture production (tonnes)
0
200000
400000
600000
1960
1970
1980
1990
2000
Year
North Atlantic salmon catch
North Atlantic farm production


Tonnes
0
20000
40000
60000
80000
100000
120000
1960
1970
1980
1990
2000
Year
BC salmon catch
BC salmon farm production

POLICY FORUM

ECOLOGY

Hatcheries and Endangered Salmon

Ransom A. Myers,[1] Simon A. Levin,[2] Russell Lande,[3] Frances C. James,[4] William W. Murdoch,[5] Robert T. Paine[6]

The role of hatcheries in restoring threatened and endangered populations of salmon to sustainable levels is one of the most controversial issues in applied ecology (*1*). The central issue has been whether such hatcheries can work, or whether, instead, they may actually harm wild populations (*2*, *3*). A new and overriding issue, however, has arisen because of a recent judicial decision.

On 10 September 2001, U.S. District Court Judge Michael Hogan revoked the listing, by the National Marine Fisheries Service (NMFS), of all Oregon coast coho salmon under the Endangered Species Act (*4*). He ruled that, if hatchery fish were included in the same distinct population segment as the wild fish with which they are genetically associated, then they must be listed together. This approach could have devastating consequences: Wild salmon could decline or go extinct while only hatchery fish persist. Petitions are now pending to delist 15 other evolutionarily significant units (ESUs) (*5*).

An ESU is defined as a genetically distinct segment of a species, with an evolutionary history and future largely separate from other ESUs (*6*). For taxonomic purposes, one could use genetic similarity to classify hatchery fish as part of the ESU from which they were derived. However, for assessing ESU extinction risk and/or potential listing under the Endangered Species Act, including hatchery fish in an ESU confounds risk of extinction in the wild with ease of captive propagation and ignores important biological differences between wild and hatchery fish.

We define "hatchery fish" as fish fertilized and/or grown artificially in a production or conservation hatchery. Inevitably, hatchery brood stock show domestication effects, genetic adaptations to hatchery environments that are generally maladaptive in the wild. Hatchery fish usually have poor survival in the wild and altered morphology, migration, and feeding behavior (*7*). On release, hatchery fish, which are typically larger, compete with wild fish (*1*). Their high local abundance may mask habitat degradation, enhance predator populations, and allow fishery exploitation to increase, with concomitant mortality of wild fish (*1*, *8*). The absence of imprinting to the natal stream leads to greater straying rates, and that spreads genes not adapted locally (*1*). Also, hybrids have poor viability, which may take two generations to be detected (*9*).

Interagency draft criteria (*10*) describe hatchery fish most appropriate for inclusion in an ESU as those founded within two generations or those that had regular infusions of fish from the wild population. However, fish grown in hatcheries for even two generations may not assist population recovery; their rate of survival in the wild is much lower than that of wild fish (*11*). Regularly infusing hatchery stocks with natural fish may also be a drain on the natural system. Hence, even these hatchery fish should not be included in an ESU, even if they are indistinguishable at the quasi-neutral molecular genetic loci typically used to identify an ESU.

Much evidence exists that hatcheries cannot maintain wild salmon populations indefinitely (*7*). In the inner Bay of Fundy in Eastern Canada, hatchery supplementation of Atlantic salmon occurred for more than a century (*12*). Despite the longevity of this program, it failed to maintain viable natural populations. Hatcheries effectively disguised long-term problems, which probably contributed to the near extirpation of native Atlantic salmon. Moreover, as recommended by the World Conservation Union (IUCN), long-term reliance on artificial propagation is imprudent, because of the impossibility of its maintenance in perpetuity (*13*).

Although their effectiveness has not been shown (*14*), conservation hatcheries may play a role in future salmon recovery. However, to avoid the dysgenic effects of domestication, even conservation hatcheries should be strictly temporary and should not prevent protection of wild populations under the Endangered Species Act.

To address one of the subsidiary lawsuits, NMFS has pledged to complete a review of eight ESUs by 31 March 2004. NMFS should continue to pursue its current recovery goal of establishing self-sustaining, naturally spawning populations. The danger of including hatchery fish as part of any ESU is that it opens the legal door to the possibility of maintaining a stock solely through hatcheries. However, hatcheries generally reduce current fitness and inhibit future adaptation of natural populations. Hence, the legal definition of an ESU must be unambiguous and must reinforce what is known biologically. Hatchery fish should not be included as part of an ESU.

[1]Department of Biology, Dalhousie University, Halifax, Nova Scotia, Canada B3H 4J1; ransom.myers@dal.ca. [2]Department of Ecology and Evolutionary Biology, Princeton University, Princeton, NJ 08544, USA; slevin@princeton.edu. [3]Department of Biology, University of California–San Diego, La Jolla, CA 92093, USA; rlande@ucsd.edu. [4]Department of Biological Science, Florida State University, Tallahassee, FL 32306, USA; james@bio.fsu.edu. [5]Department of Ecology, Evolution, and Marine Biology, University of California, Santa Barbara, CA 93106, USA; murdoch@lifesci.ucsb.edu. [6]Department of Biology, University of Washington, Seattle, WA 98195, USA; painert@u.washington.edu

References and Notes

1. National Research Council, *Upstream: Salmon and Society in the Pacific Northwest* (National Academy Press, Washington, DC, 1996).
2. R. Hilborn, J. Winton, *Can. J. Fish. Aquat. Sci.* **50**, 2043 (1993).
3. R. S. Waples, *Fisheries* **24**, 12 (February 1999).
4. *Alsea Valley Alliance v. Evans*, 161 F. Supp. 2d 1154 (D. Or. 2001).
5. R. Lent, *Fed. Regist.* **67**, 6215 (2002)
6. R. S. Waples, *Mar. Fish. Rev.* **53**, 11 (3: 1991).
7. S. Einum, I. A. Fleming, *Nordic J. Freshw. Res.* **75**, 56 (2001).
8. J. Lichatowich, *Salmon Without Rivers* (Island Press, Washington, DC, 1999).
9. P. McGinnity *et al.*, *Proc. R. Soc. London Ser. B* **270**, 2443 (2003).
10. NMFS, 2003, www.nwfsc.noaa.gov/trt/brt/backintro.pdf
11. R. Reisenbichler, G. Brown, in "Assessing Extinctions Risk for West Coast Salmon," A. D. MacCall, T. C. Wainwright, Eds. (NOAA Tech. Memo, NMFS-NWFSC-556, U.S. Department of Commerce, Washington, DC, 2003), pp. 147–154.
12. A. J. F. Gibson, J. Bryan, P. G. Amiro, *Can. Data Rep. Fish. Aquat. Sci.* (no. 1123), 2003.
13. IUCN, 2002, www.iucn.org/themes/ssc/pubs/policy/exsituen.htm.
14. F. Allendorf, R. S. Waples, in *Conservation Genetics: Case Histories from Nature*, J. C. Avise, J. L. Hamrick, Eds. (Chapman & Hall, New York, 1996), pp. 238–280.

15. We thank R. S. Waples for explaining aspects of the problem and C. A. Ottensmeyer for assistance.

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26 MARCH 2004 VOL 303 SCIENCE

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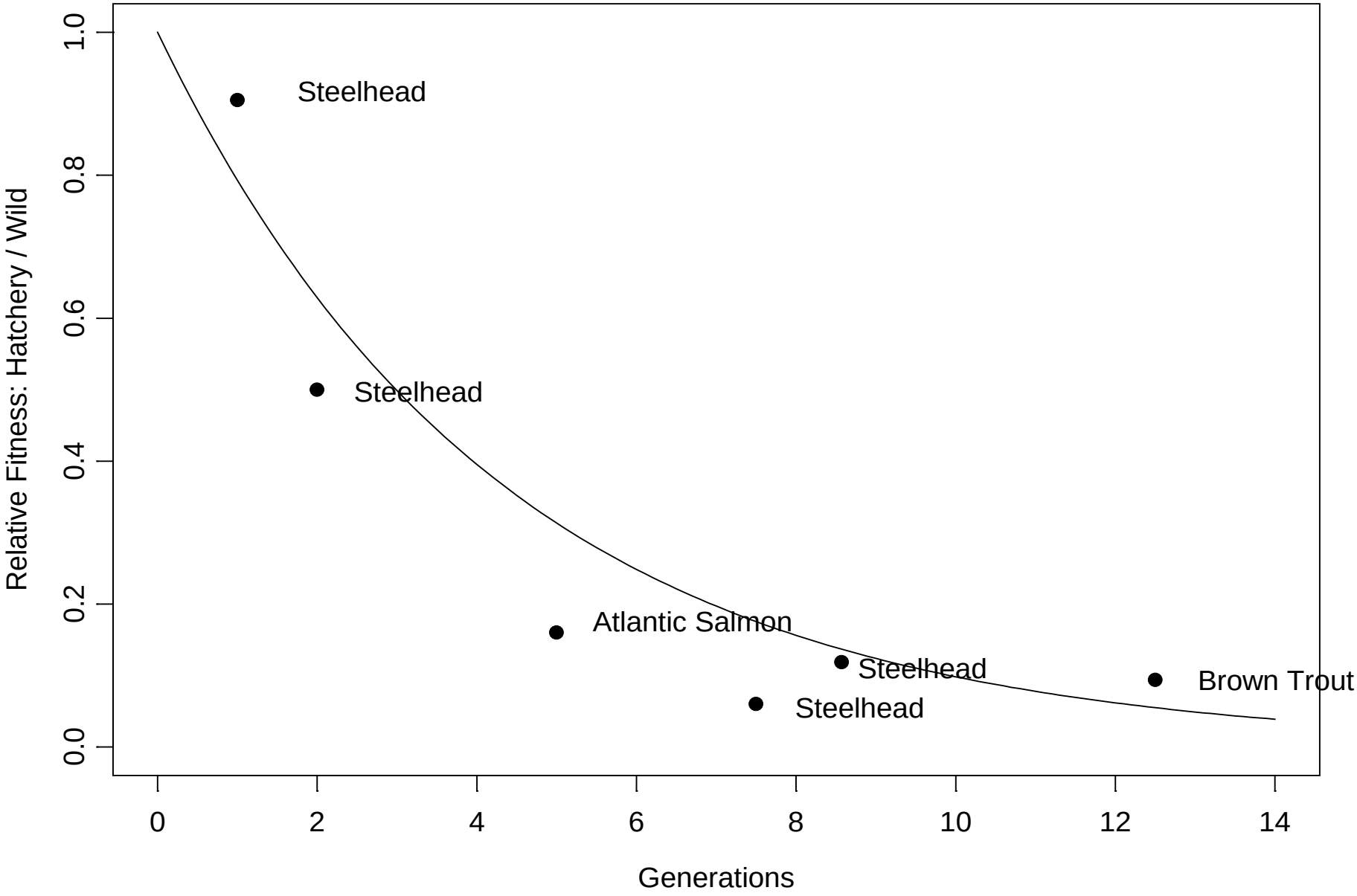
There is always a rapid loss of fitness in the wild with hatcheries; after a few generations hatchery salmon may be useless for recovery.



Sharks

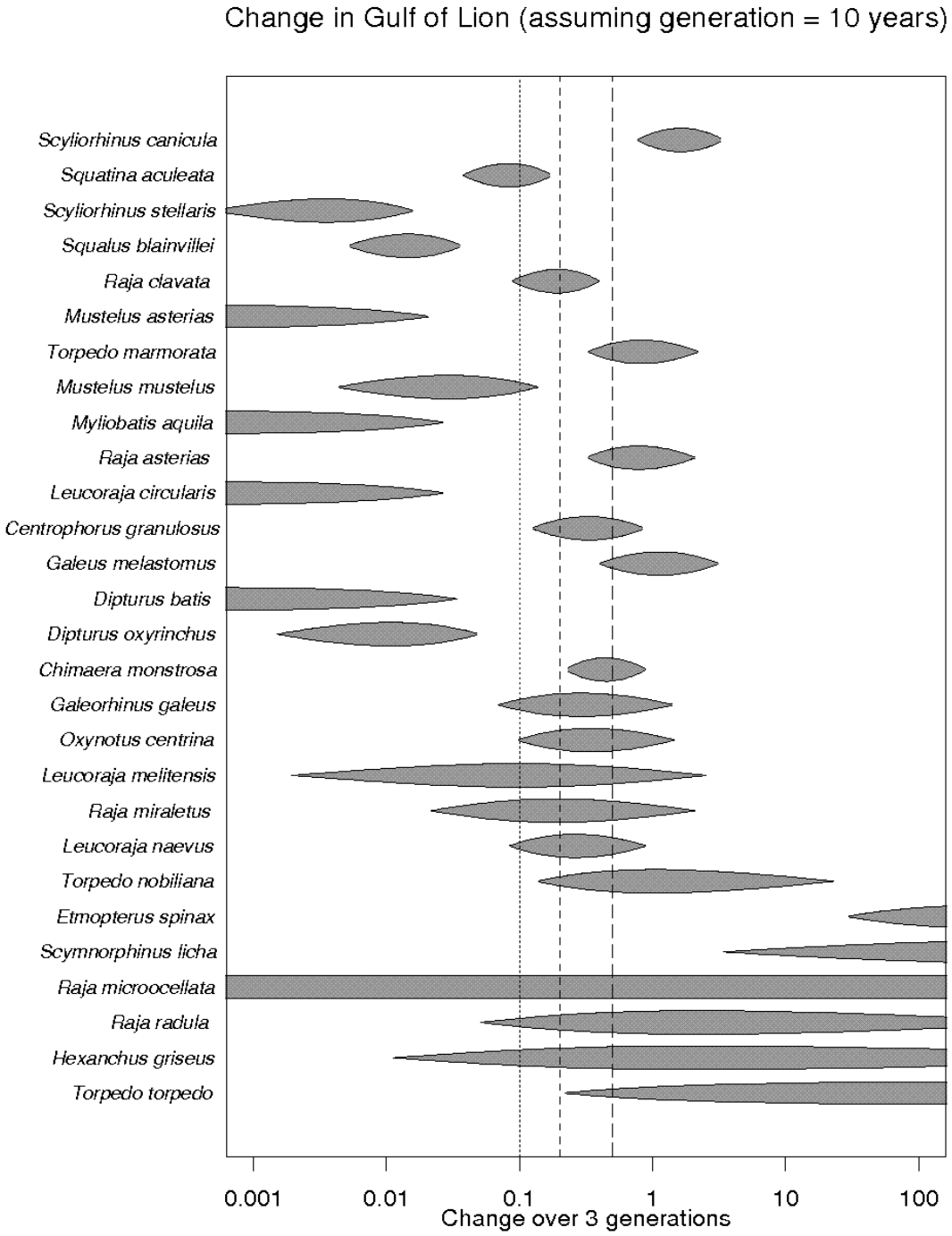
- Christine Ward-Page – Reef sharks
- Luis Lucifora and Travis Shepherd – world
- Anna Massa –Argentina
- Mike Stokesbury – Greenland shark
- Peter Ward – Central Pacific
- Julia Baum – Gulf of Mexico
- Gretchen Fitzgerald – Pelagic species
- Veronica Garcia – deepwater species

How do we Estimate of Trends Using Crazy Data:

There are few guidelines for students dealing with real data

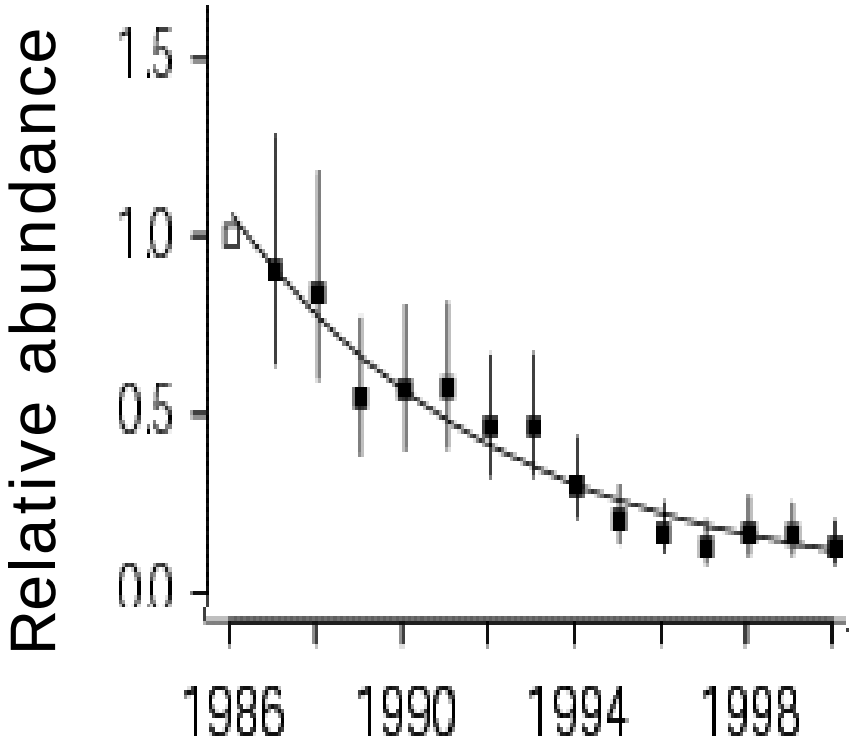
- Joanna Flemming
- Dan Kehler
- Eva Cantonni
- Leah Gerber
- Wade Blanchard

Analysis of old survey data from the Gulf of Lion (where we only have partial data, i.e. the number of positive counts) show that 12 species of sharks and rays meet the IUCN criterion for endangered.



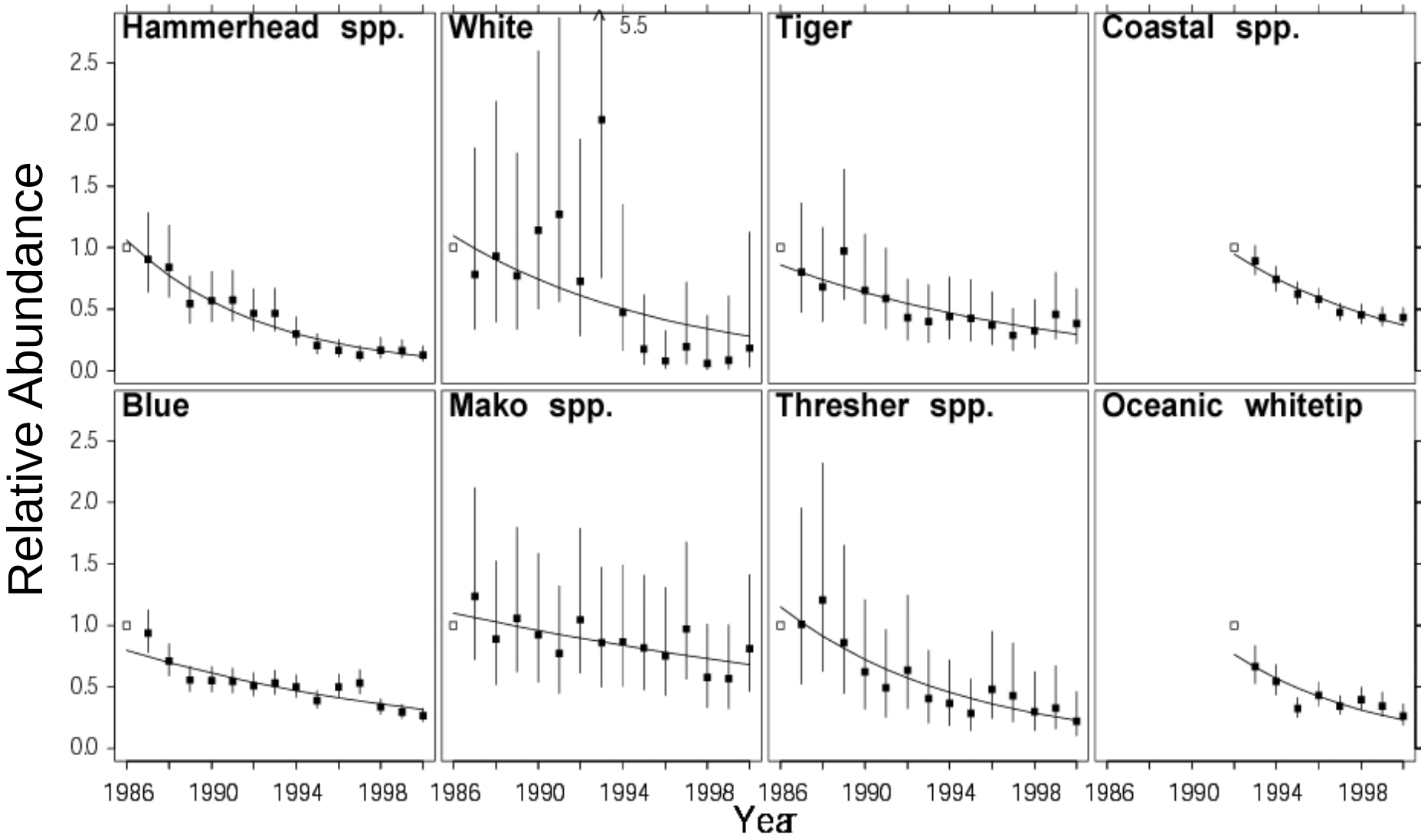
Hammerhead sharks

Sphyrna lewini

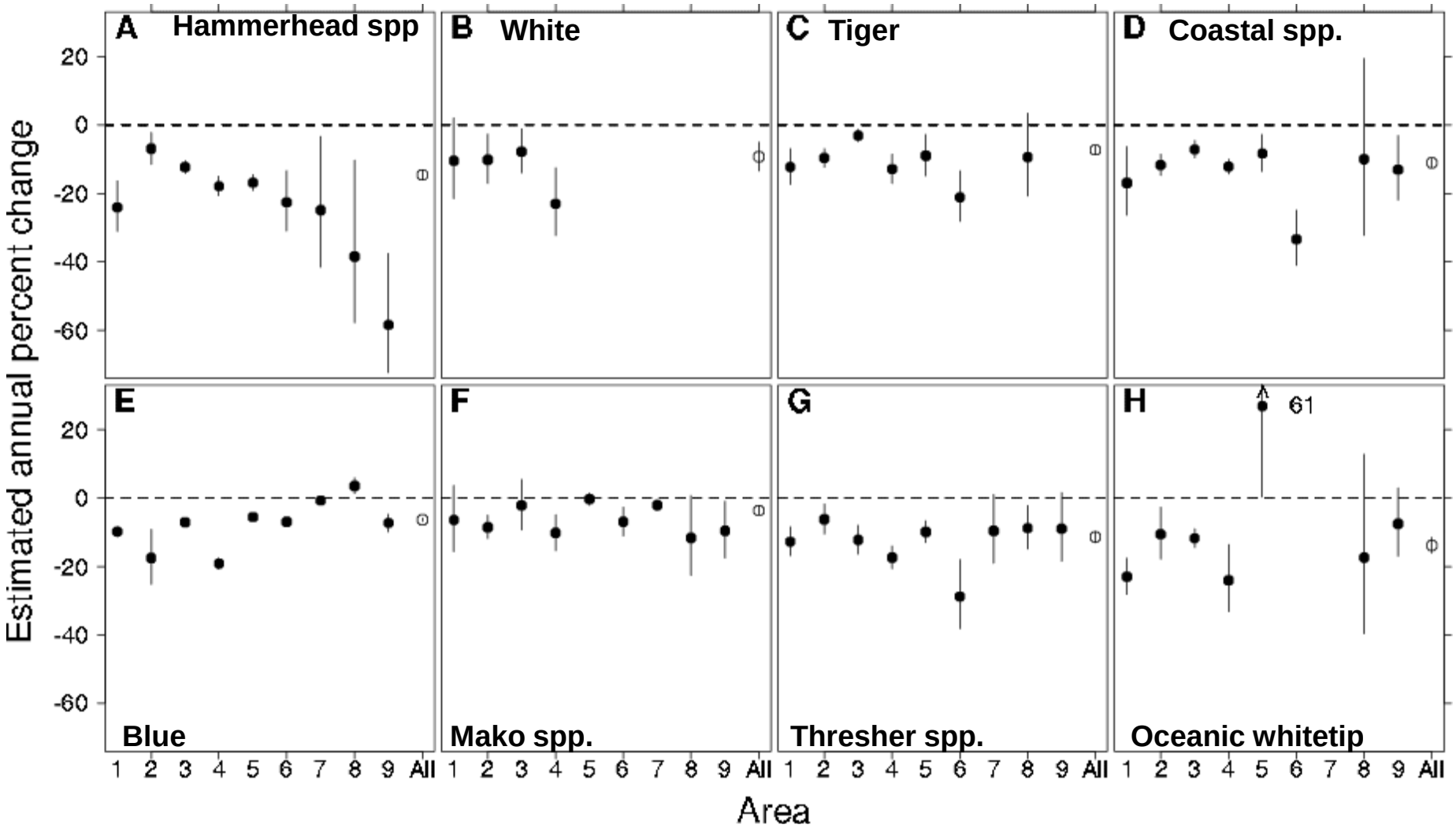


Science. Jan. 2003. J.K. Baum, R.A. Myers, D.G. Kehler, B. Worm, S.J. Harley, P.A. Doherty

Results


Hammerhead spp.
White
5.5
Tiger
Coastal spp.
Blue
Mako spp.
Thresher spp.
Oceanic whitetip
Relative Abundance
2.5
2.0
1.5
1.0
0.5
0.0
1986
1990
1994
1998
Year

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



Data Analysis

- Assume catch follows negative binomial distribution
- Analyse positives only $\rightarrow$ zero-truncated distribution

$$f(y_T) = \frac{\Gamma(y+\theta)}{\Gamma(y)}^{y_T} \left(\frac{\mu}{\theta+\mu}\right)^{y_T} \left(\frac{\theta}{\theta+\mu}\right)^{\theta} \Bigg/ 1-\left(\frac{\theta}{\theta+\mu}\right)^{\theta}$$

Robustness Analyses

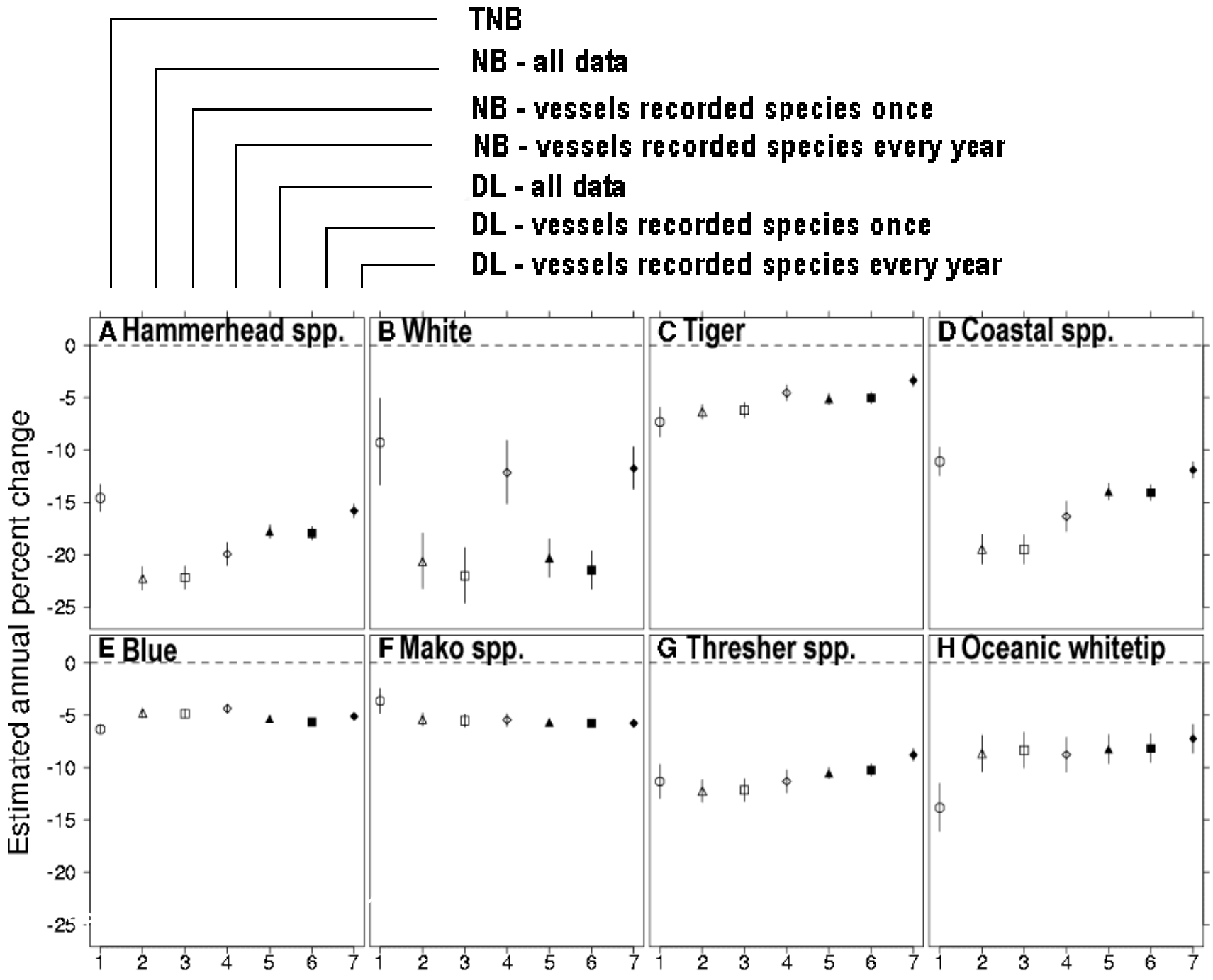
Assume reporting rate has stayed constant for:

- full dataset
- for a subset of vessels: recorded species at least once
  recorded species at least once in a given year

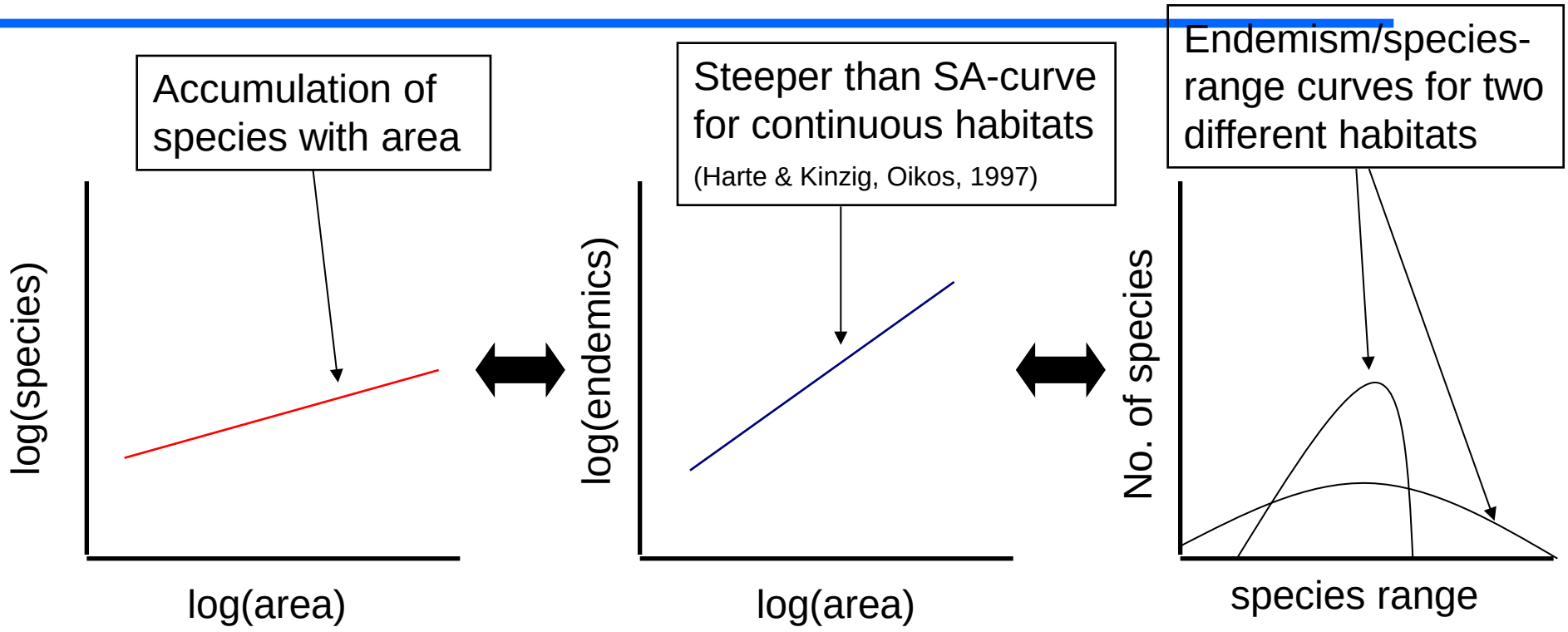
Negative binomial models

Delta-lognormal models

- proportion of positives modelled separately from positives
- standardized CPUE is the product of the two


TNB
NB - all data
NB - vessels recorded species once
NB - vessels recorded species every year
DL - all data
DL - vessels recorded species once
DL - vessels recorded species every year
A Hammerhead spp.
B White
C Tiger
D Coastal spp.
E Blue
F Mako spp.
G Thresher spp.
H Oceanic whitetip
Estimated annual percent change
0
-5
-10
-15
-20
-25
1
2
3
4
5
6
7

Area, species range, and endemism

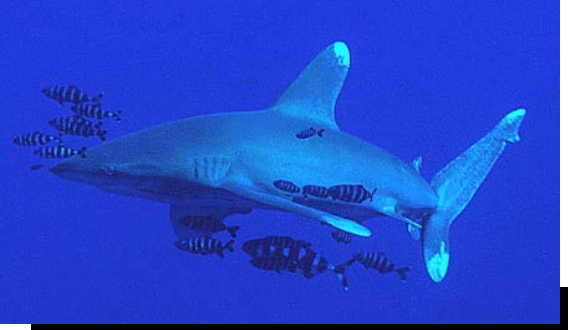


Endemism is explicitly defined by spatial scale. Is there a way to link all these diagrams, and can we create a unifying theoretical model?

Can we compare the patterns of endemism between habitats and assess their differential vulnerability?

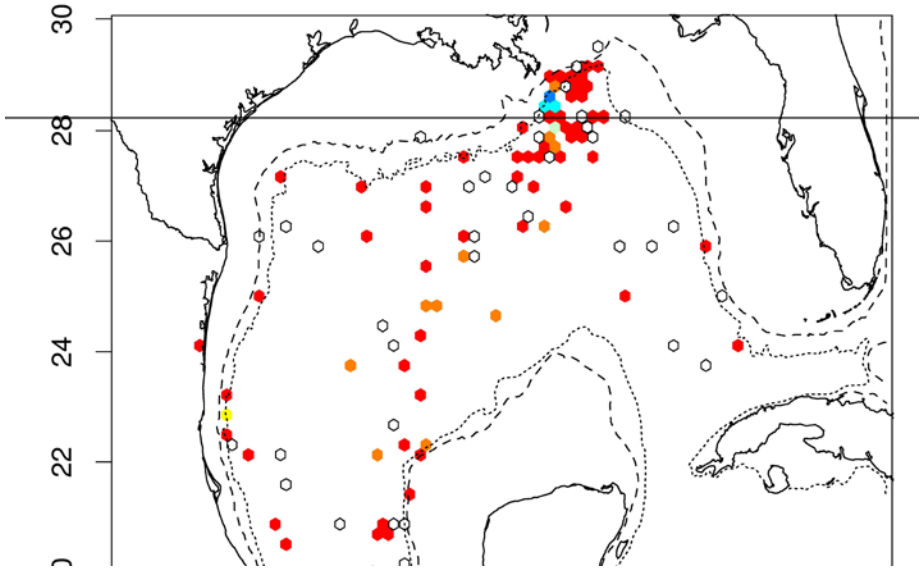
Susanna Fuller - Deep water sponge conservation

What was the most common large animal (>50 Kg) in the world? (perhaps this one was)

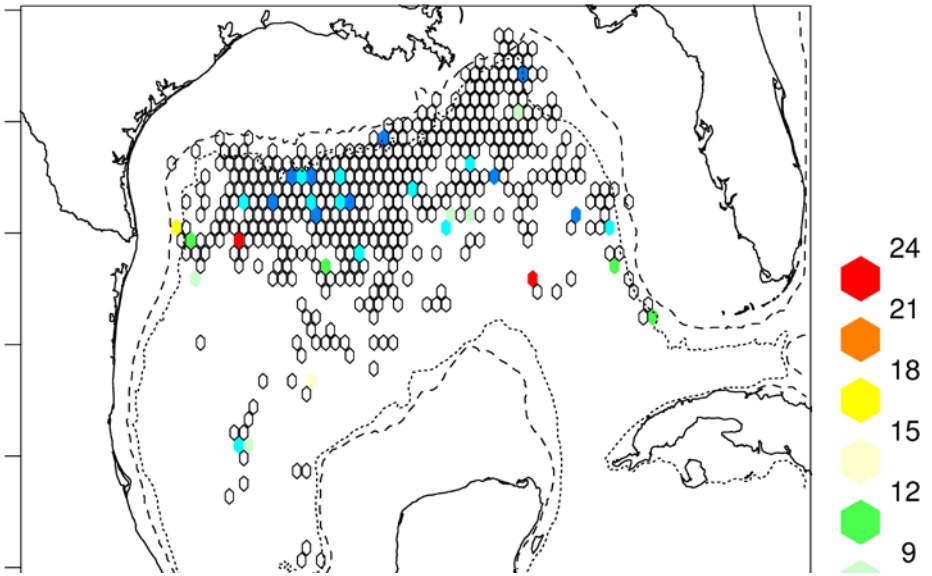


Loss of sharks in the Gulf of Mexico

300 fold decline – no one noticed



1950's



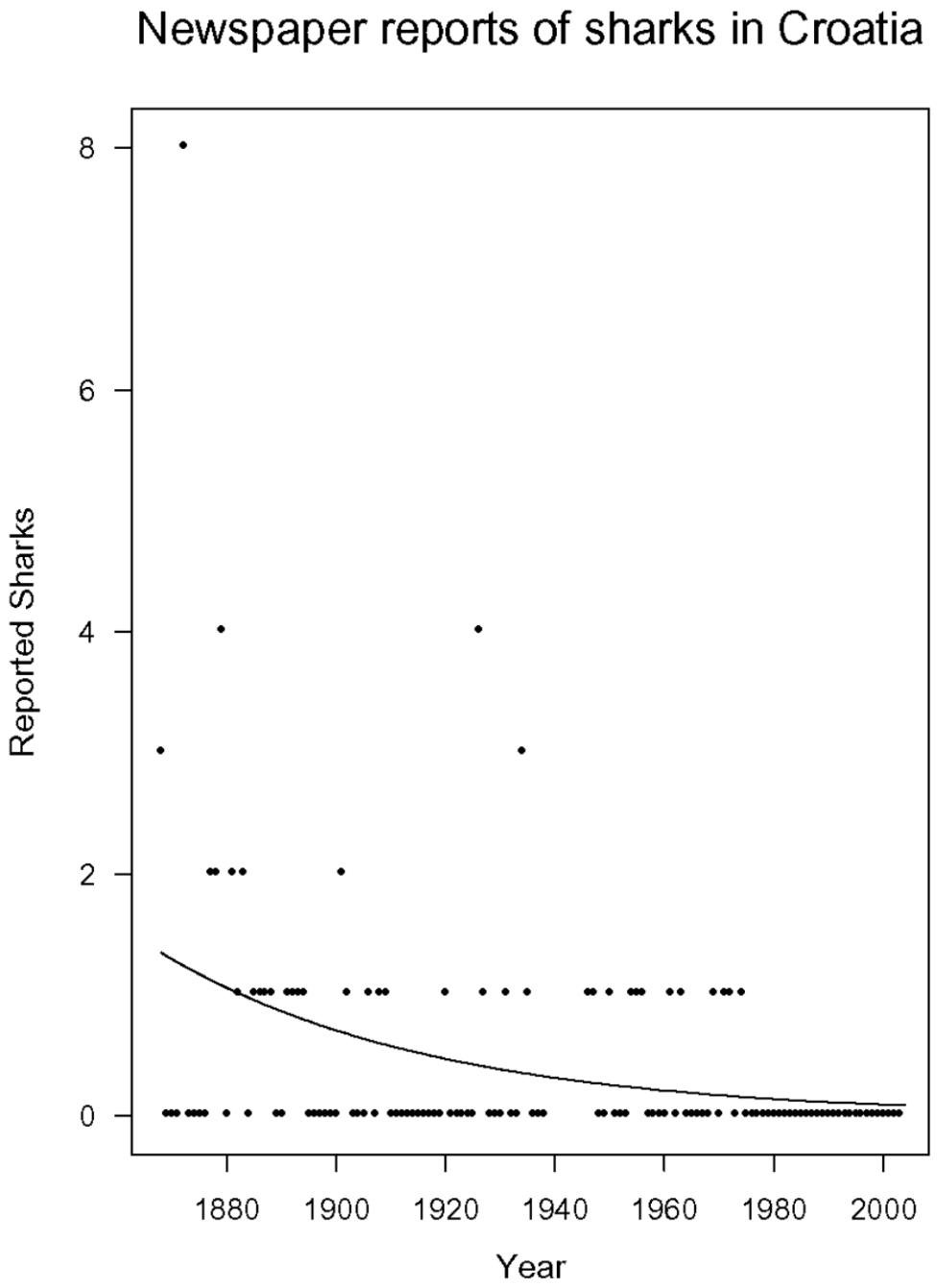
1990's

Oceanic Whitetip captures per 10,000 hooks

Baum and Myers, 2004 Ecology Letters

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



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

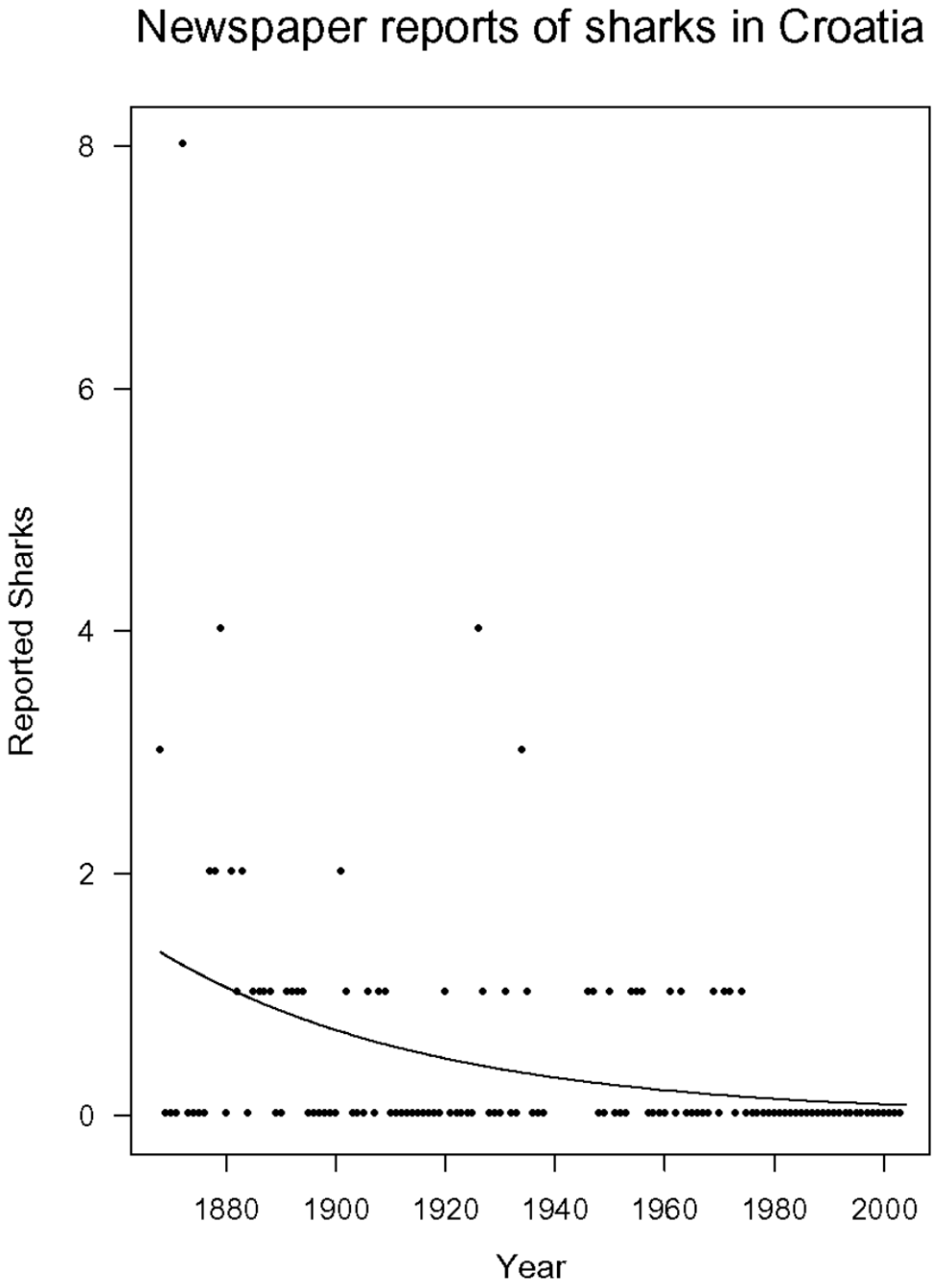
1946 - Pig of 10 kg in stomach

1950 - Encounter during eating a dead calf

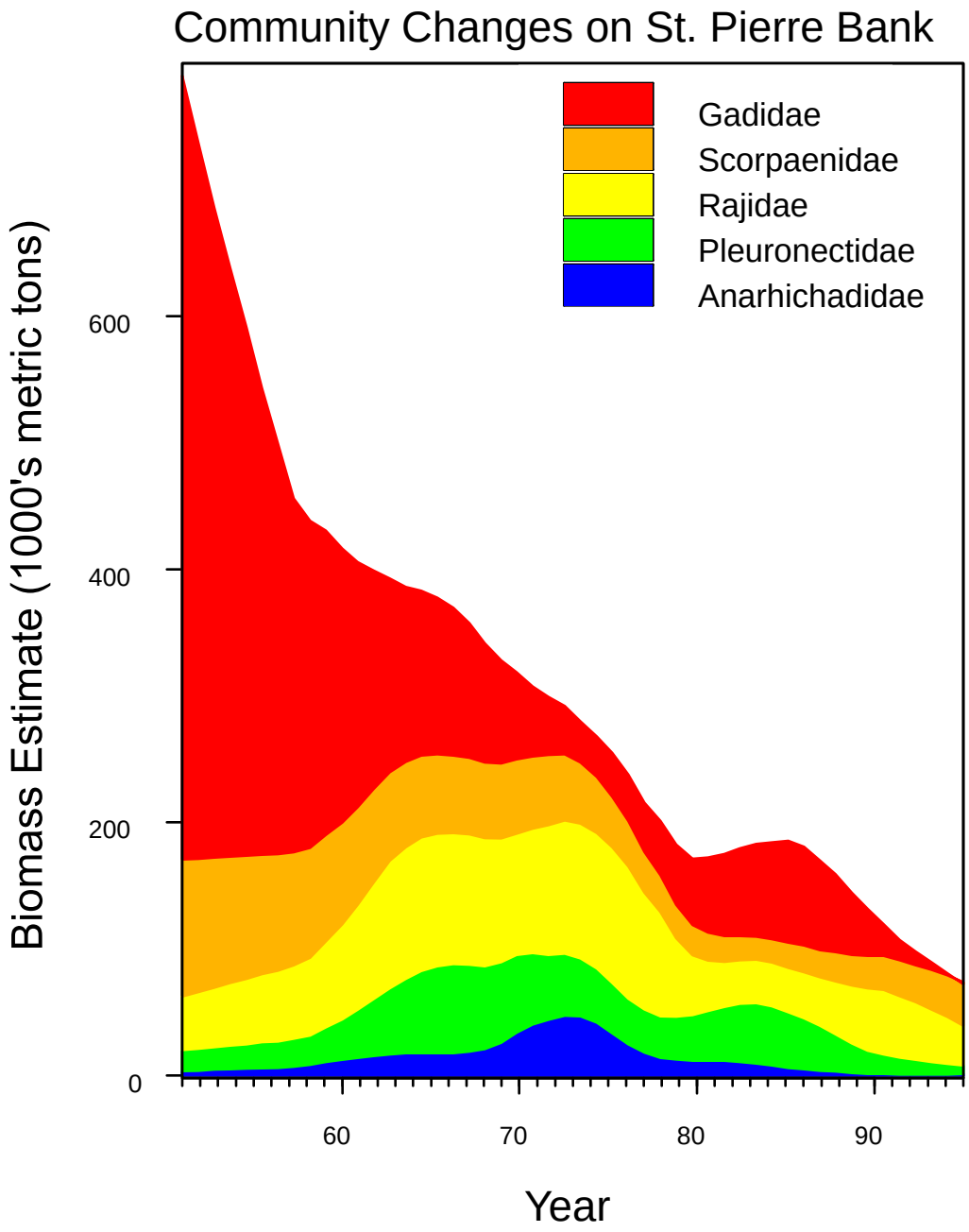
1954 - Attack on boat

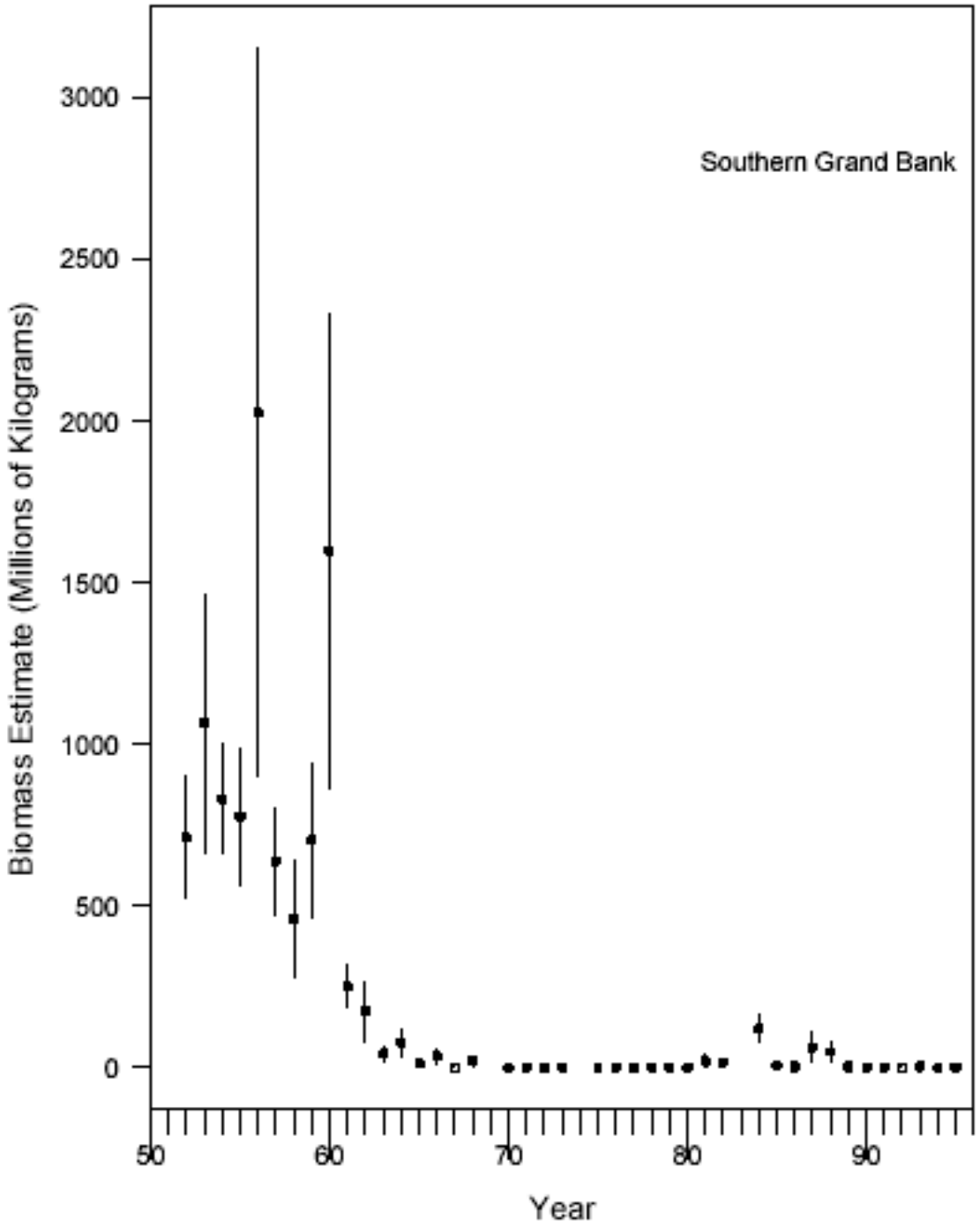
1975+ -No sightings.

Soldo and Jardas, Periodicum Bologorum, 2002


Newspaper reports of sharks in Croatia
Reported Sharks
0
2
4
6
8
1880
1900
1920
1940
1960
1980
2000
Year


788
757
525
650
620
770


Community Changes on St. Pierre Bank
Gadidae
Scorpaenidae
Rajidae
Pleuronectidae
Anarhichadidae
Biomass Estimate (1000's metric tons)
0
200
400
600
60
70
80
90
Year



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

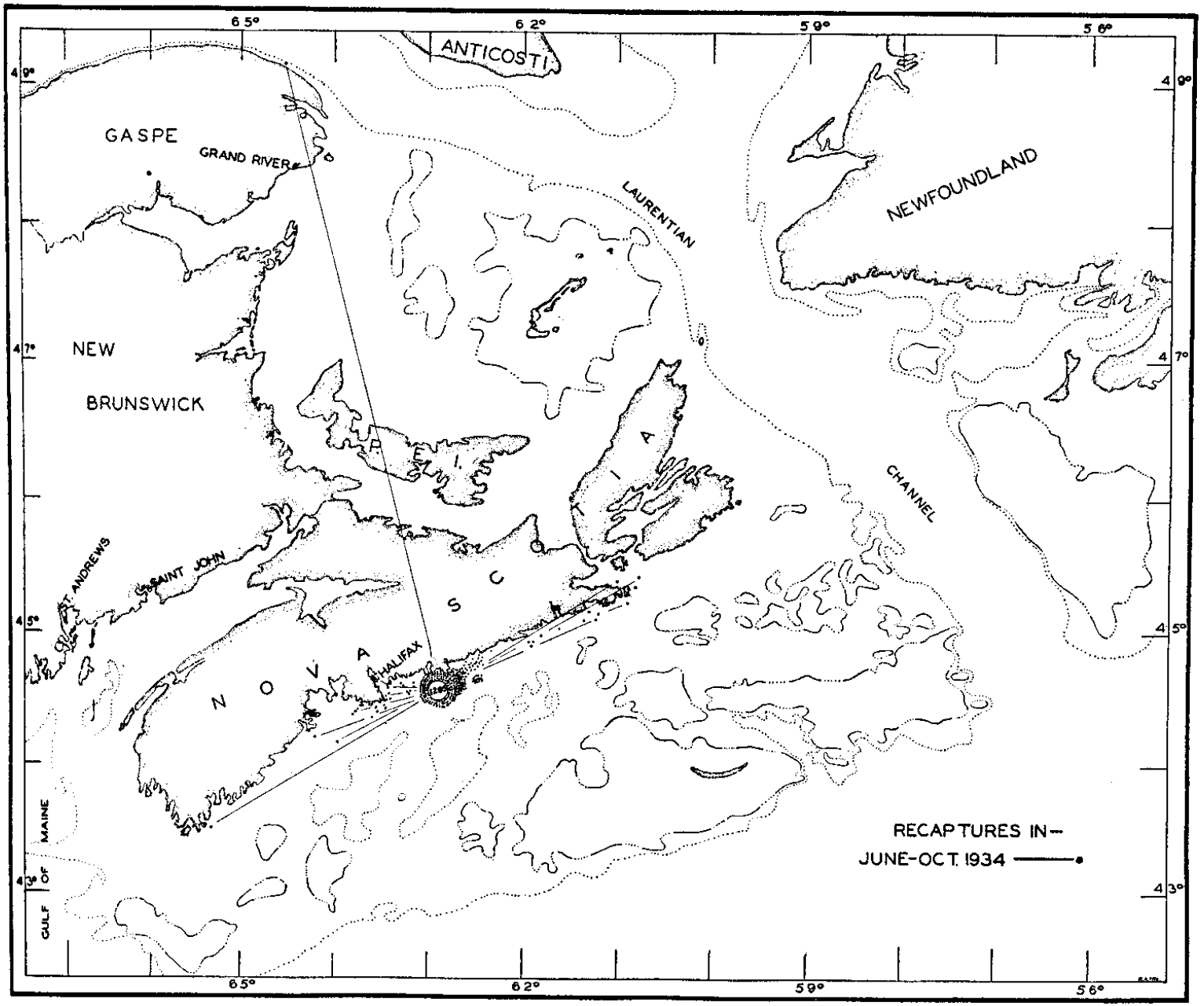


FIG. 21.—Recaptures to October, 1934, of cod tagged in the Jeddore Rock to Egg Island area, N.S., in May, 1934.

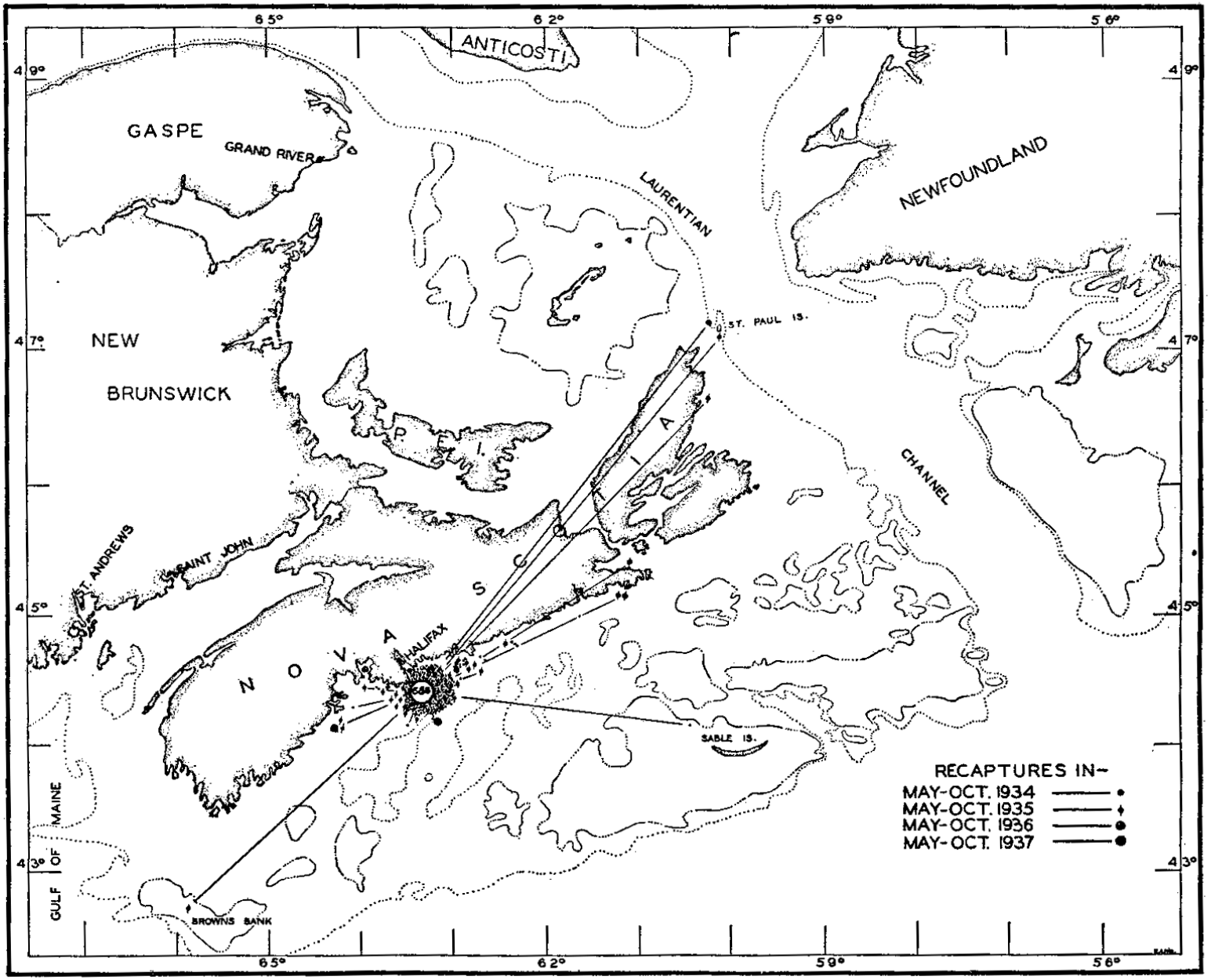


FIG. 18.—Recaptures in May to October, 1934, 1935, 1936 and 1937, of cod tagged near Halifax in June, 1934.

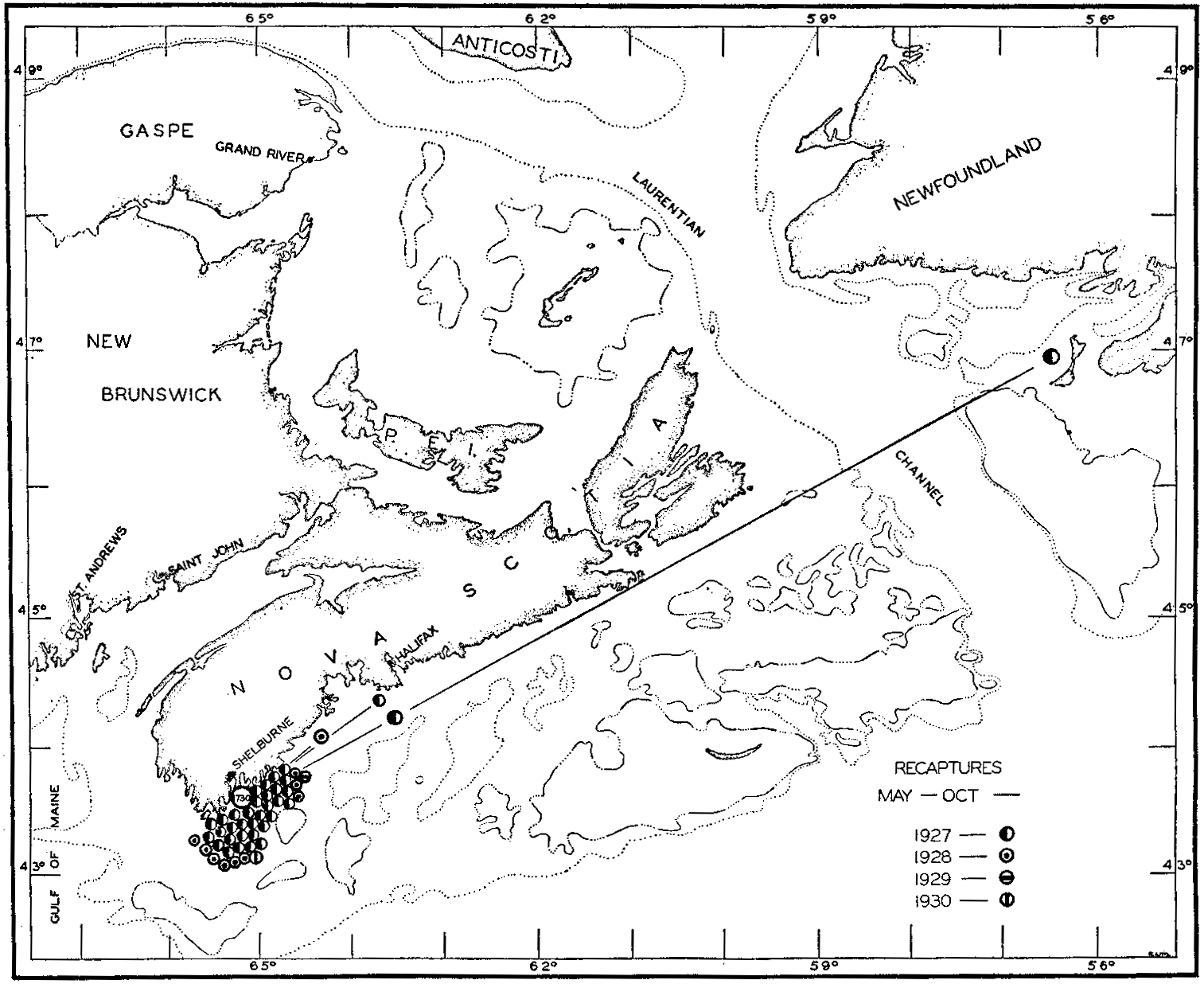
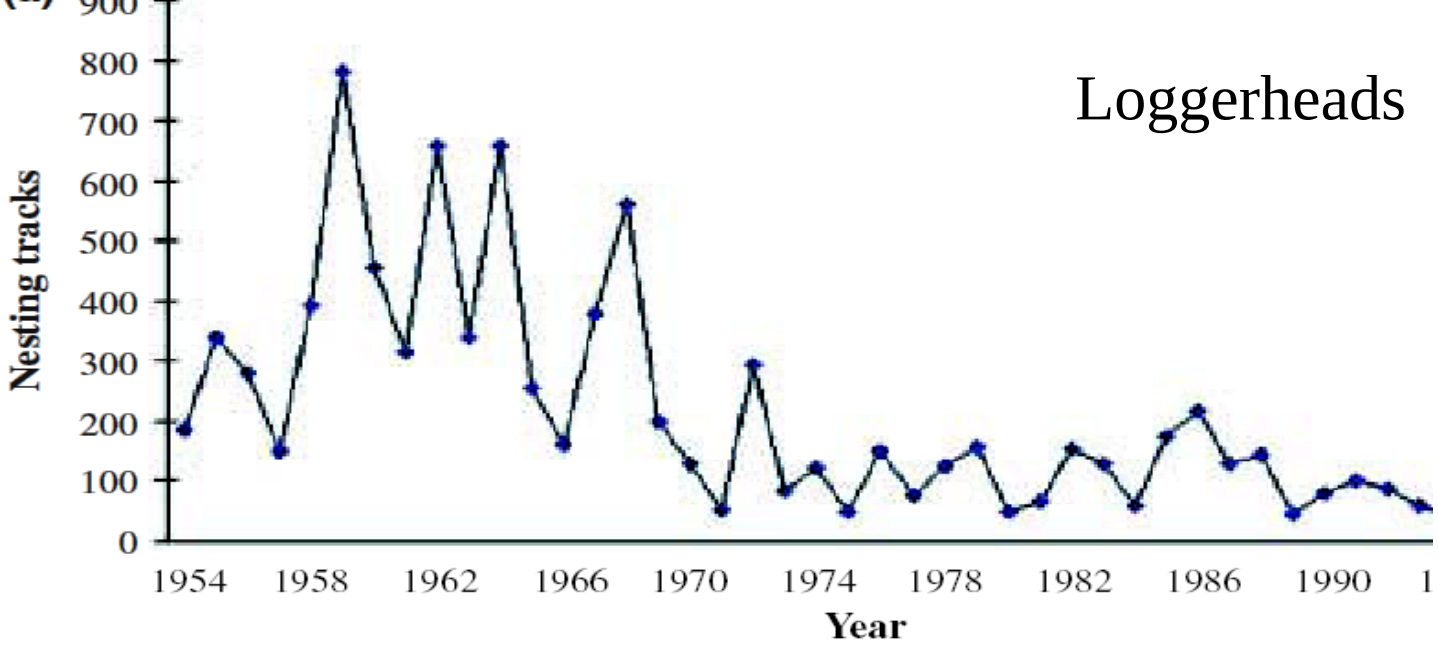
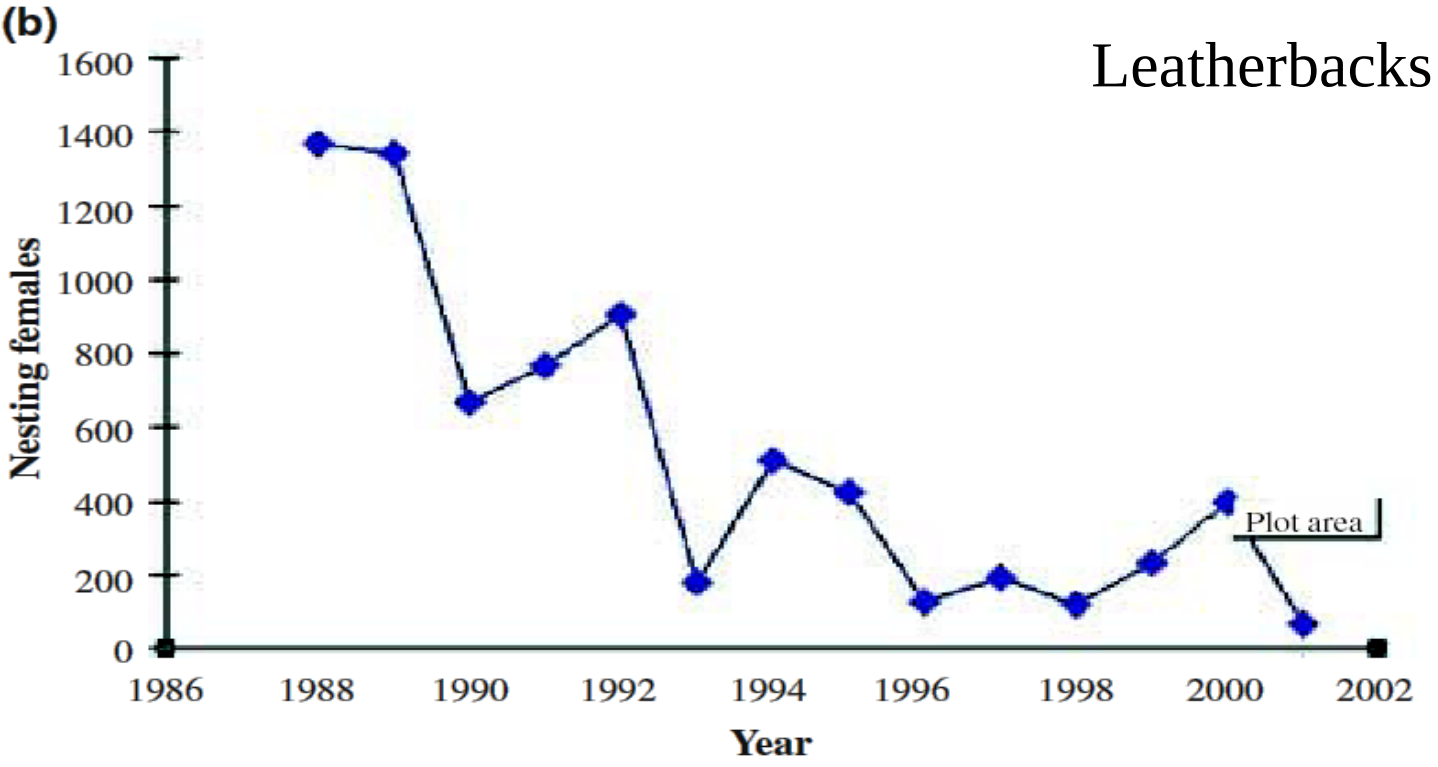


FIG. 15.—Recaptures during "summers" of 1927, 1928, 1929 and 1930 of cod tagged off Shelburne, N.S., during September and the first day of October, 1926.

Hippocratic Oath:
Modified for Fisheries Biologist by RAM:

- **"First, don't drive any population or species extinct".**

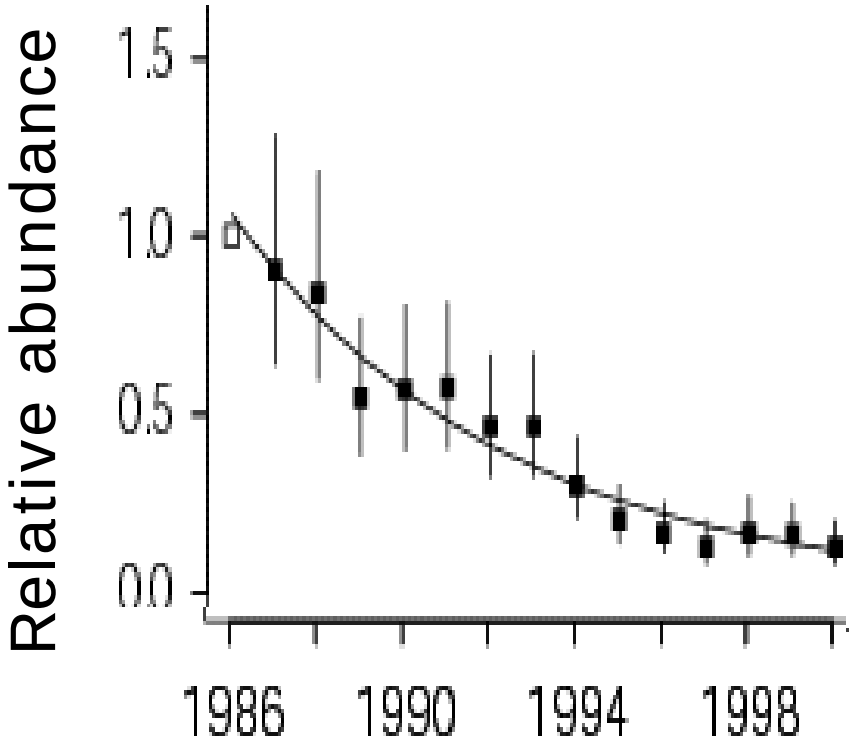




Lewison et al. 2004
Ecology Letters

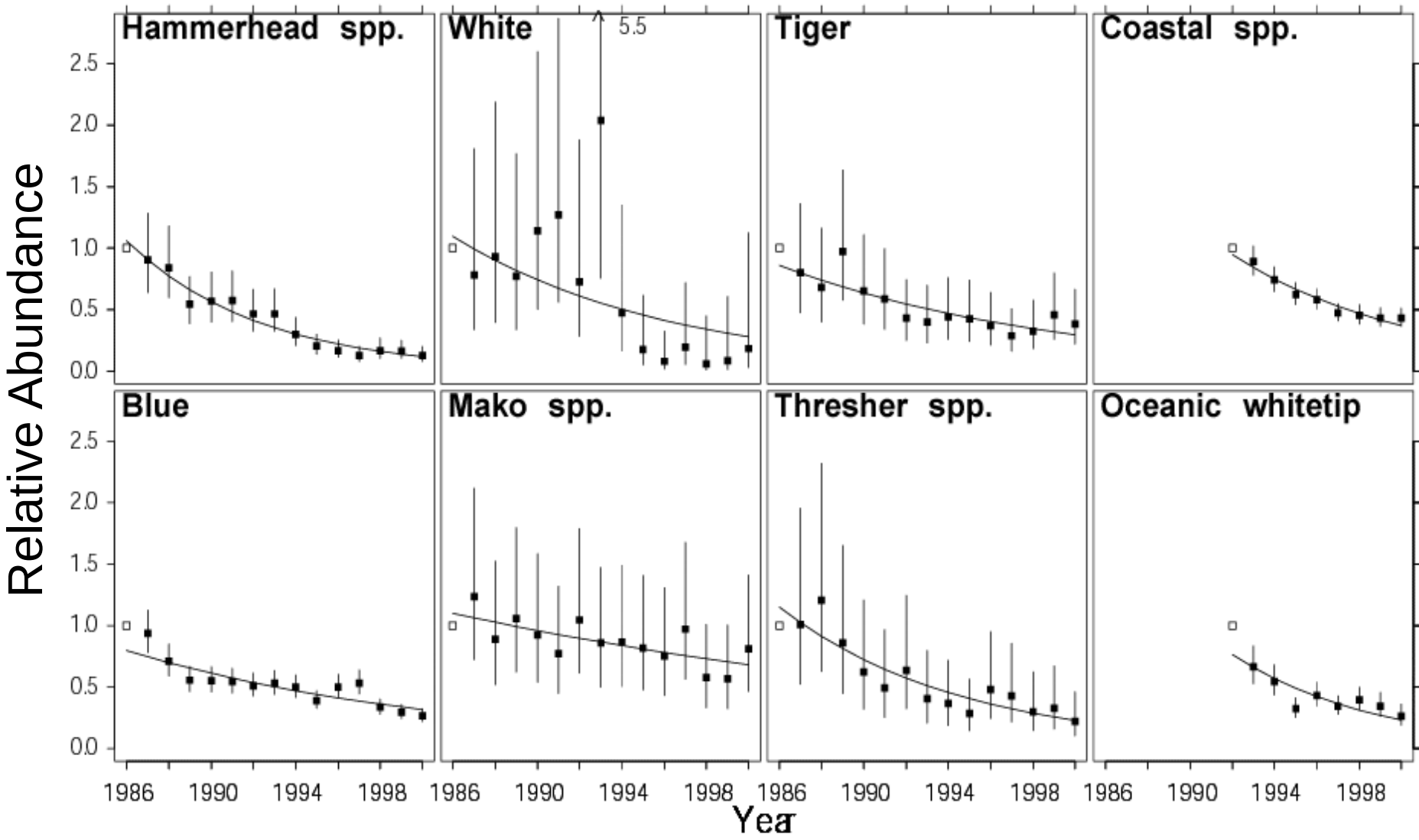
Hammerhead sharks

Sphyrna lewini

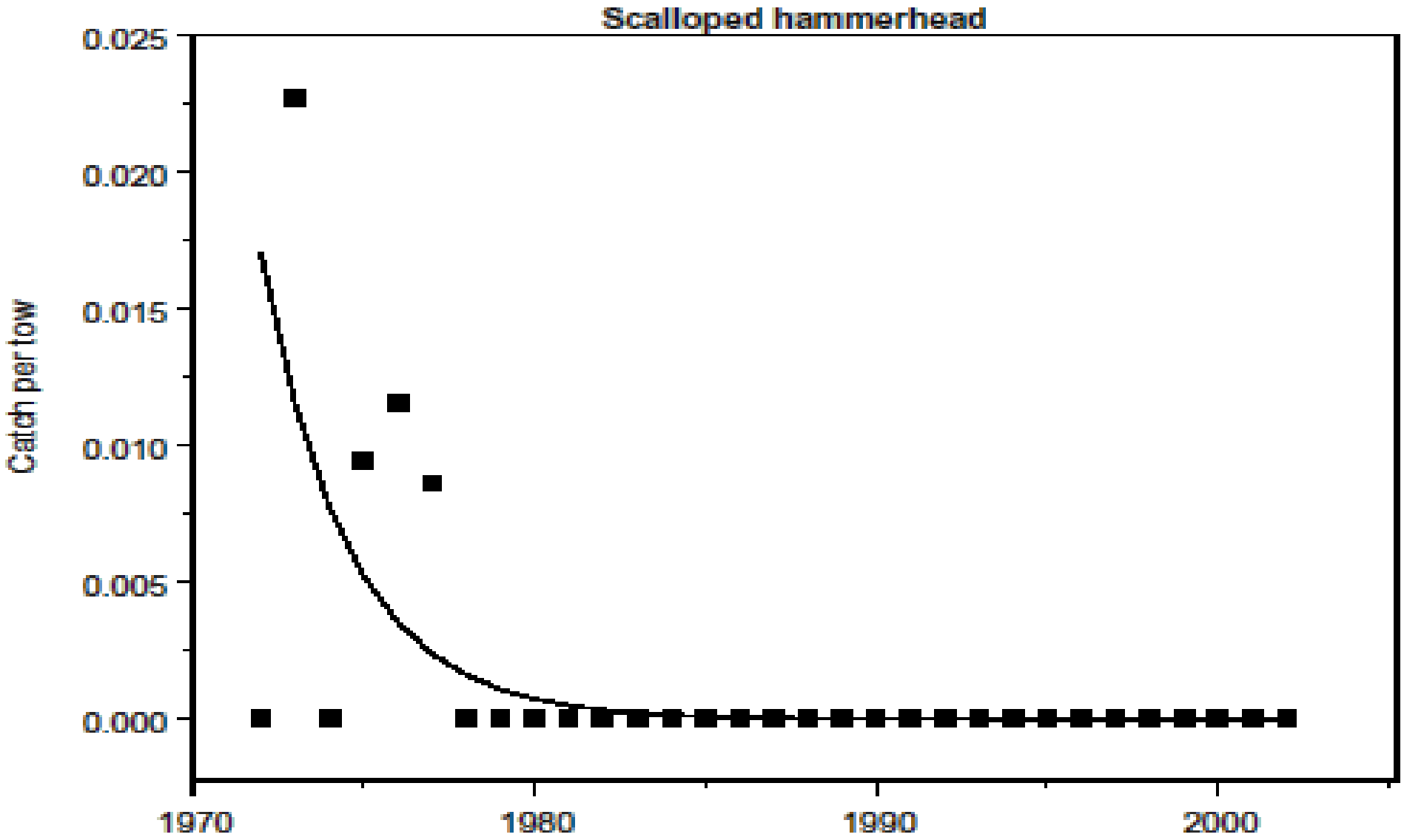


Science. Jan. 2003. J.K. Baum, R.A. Myers, D.G. Kehler, B. Worm, S.J. Harley, P.A. Doherty

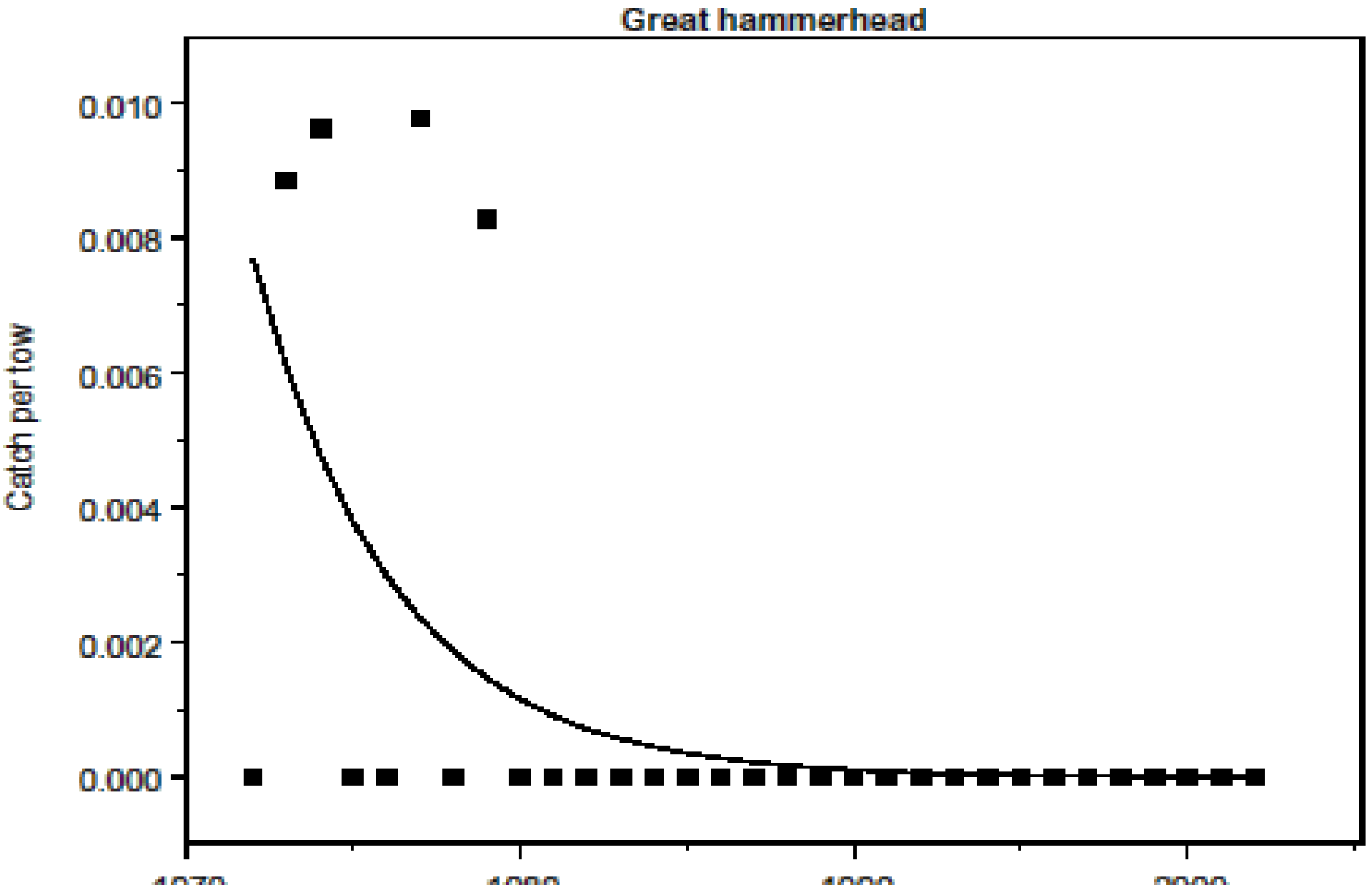
Results


Hammerhead spp.
White
5.5
Tiger
Coastal spp.
Blue
Mako spp.
Thresher spp.
Oceanic whitetip
Relative Abundance
2.5
2.0
1.5
1.0
0.5
0.0
1986
1990
1994
1998
Year

Same results for trawl surveys in Gulf of Mexico



Same results for trawl surveys in Gulf of Mexico

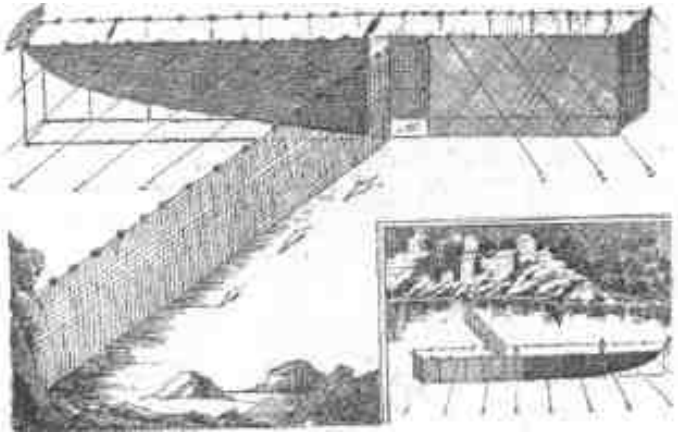


Decline of Mediterranean Sharks

By catch associated with a Tuna Trap

In Ligurian Sea

“Tonnara di Camogli”



Decline of Hammarhead sharks

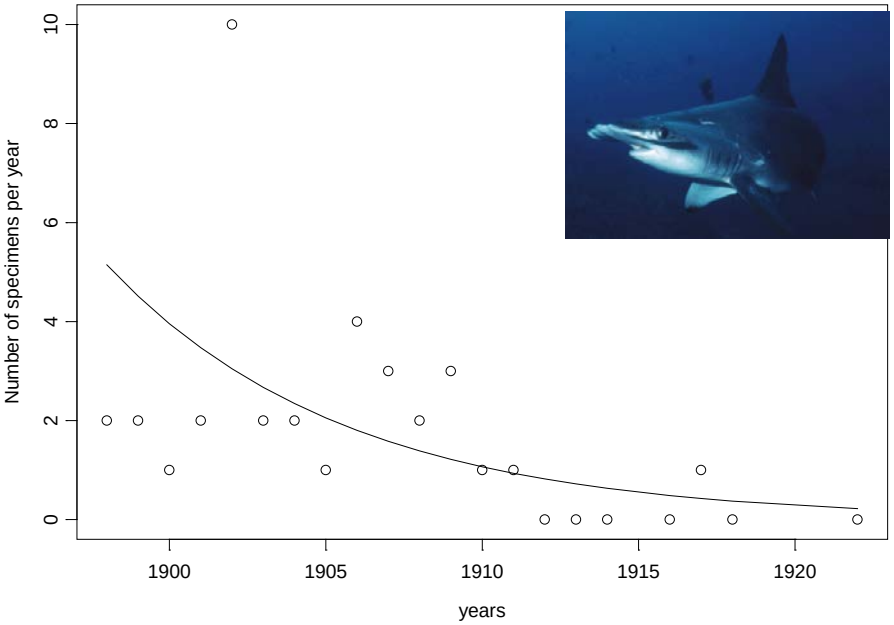
Boero F. & A. Carli 1979 – Boll. Mus. Ist. Biol. Univ. Genoa (47)

Decline of Mediterranean Sharks

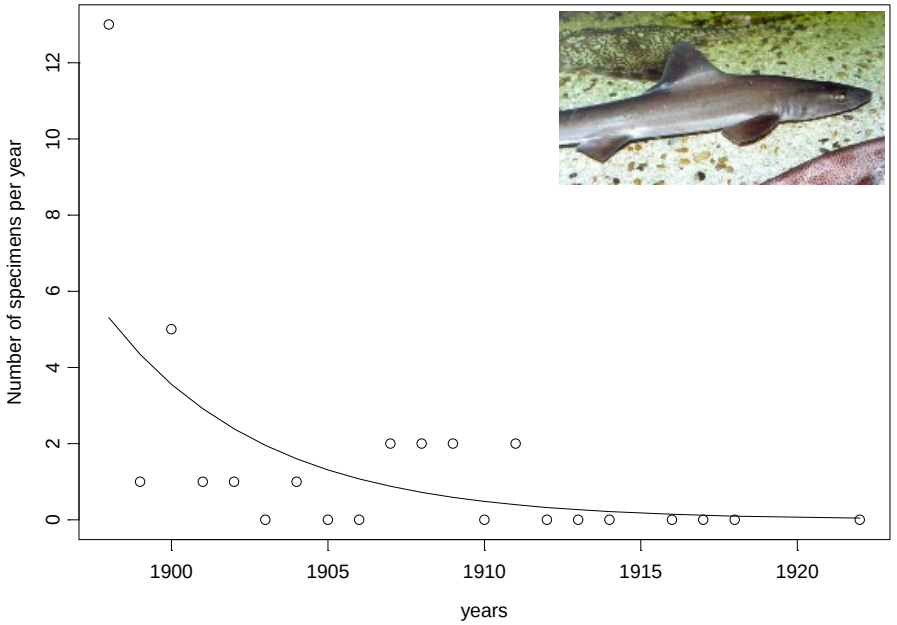
By catch associated with a Tuna Trap
In Tirrenian Sea

“Tonnarella di Baratti”

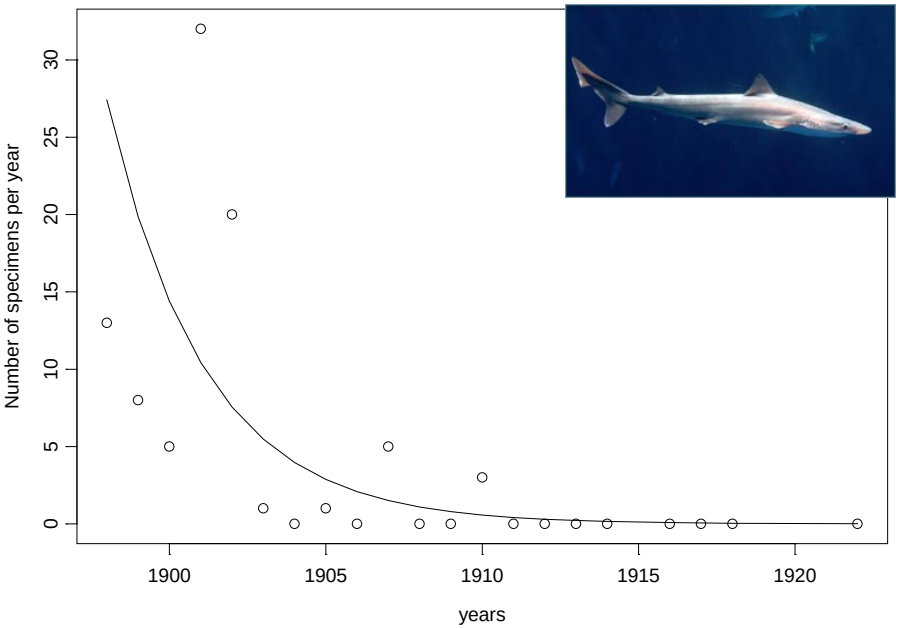
Hammerhead shark



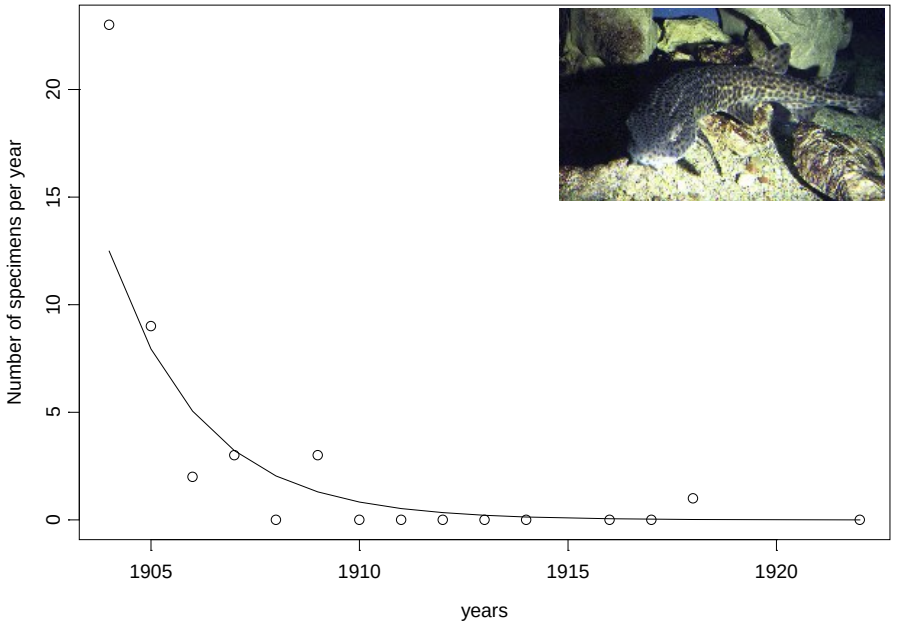
Smooth-hound



School shark



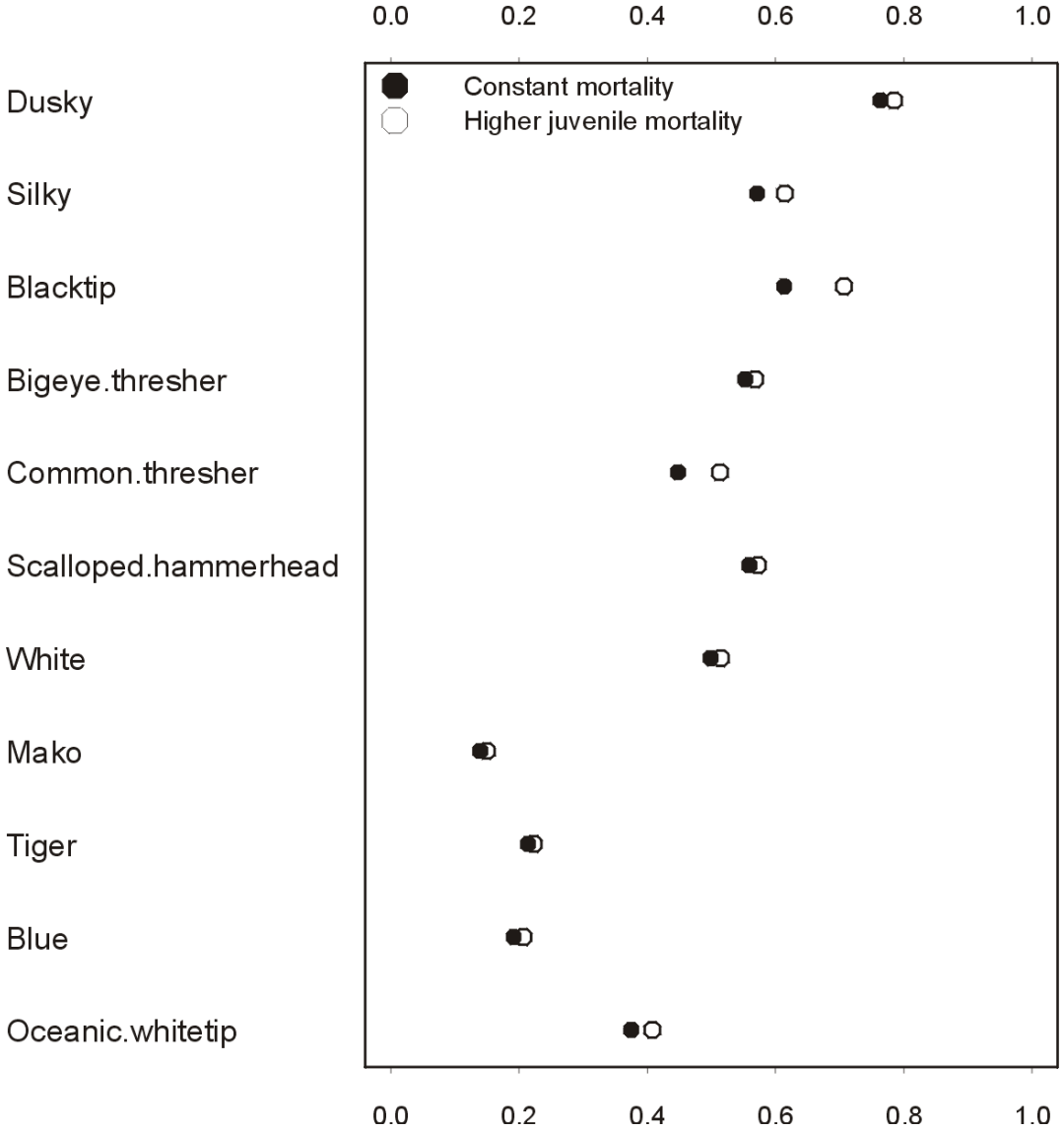
Nursehound



There are at least 2 scalloped hammerhead sharks in the Northwest Atlantic

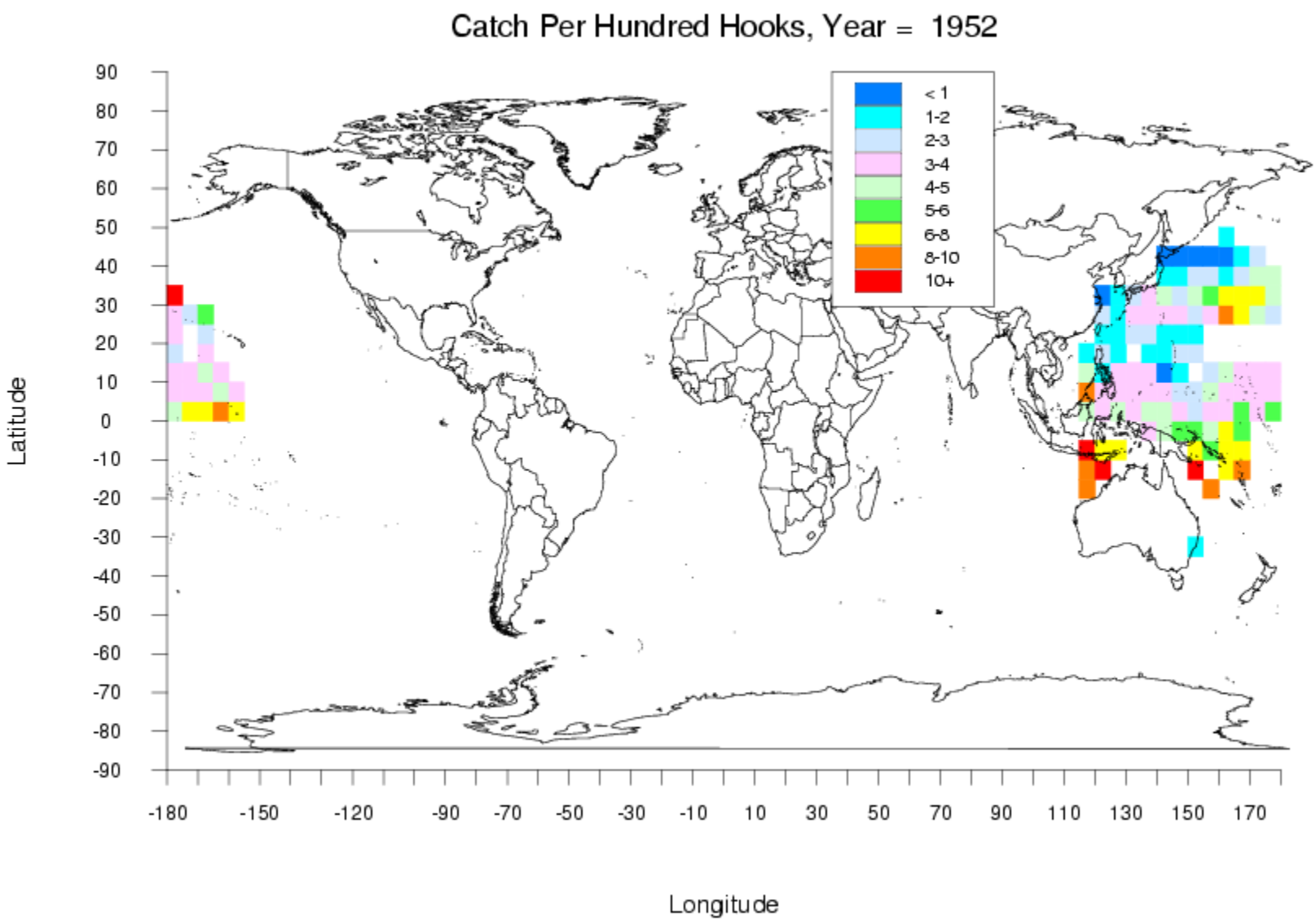
Stoner, D. S., J. M. Grady, W. B. Driggers, K. A. Priede and J. M. Quattro. Molecular Evidence for a Cryptic Species of Hammerhead Shark (Genus *Sphyrna*). *Marine Biology* (submitted).

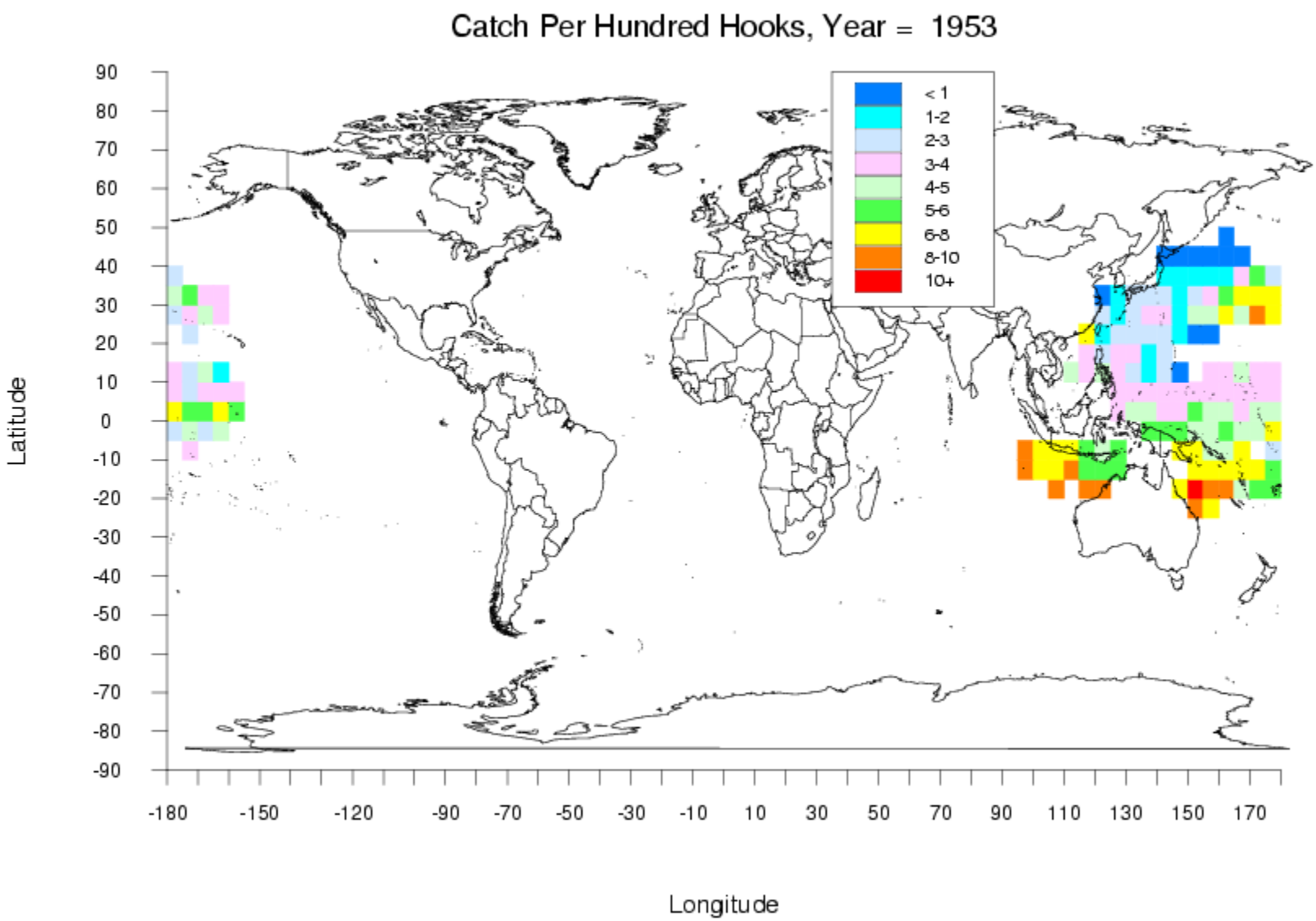
Proportional reduction in current fishing mortality needed to ensure survival of shark populations

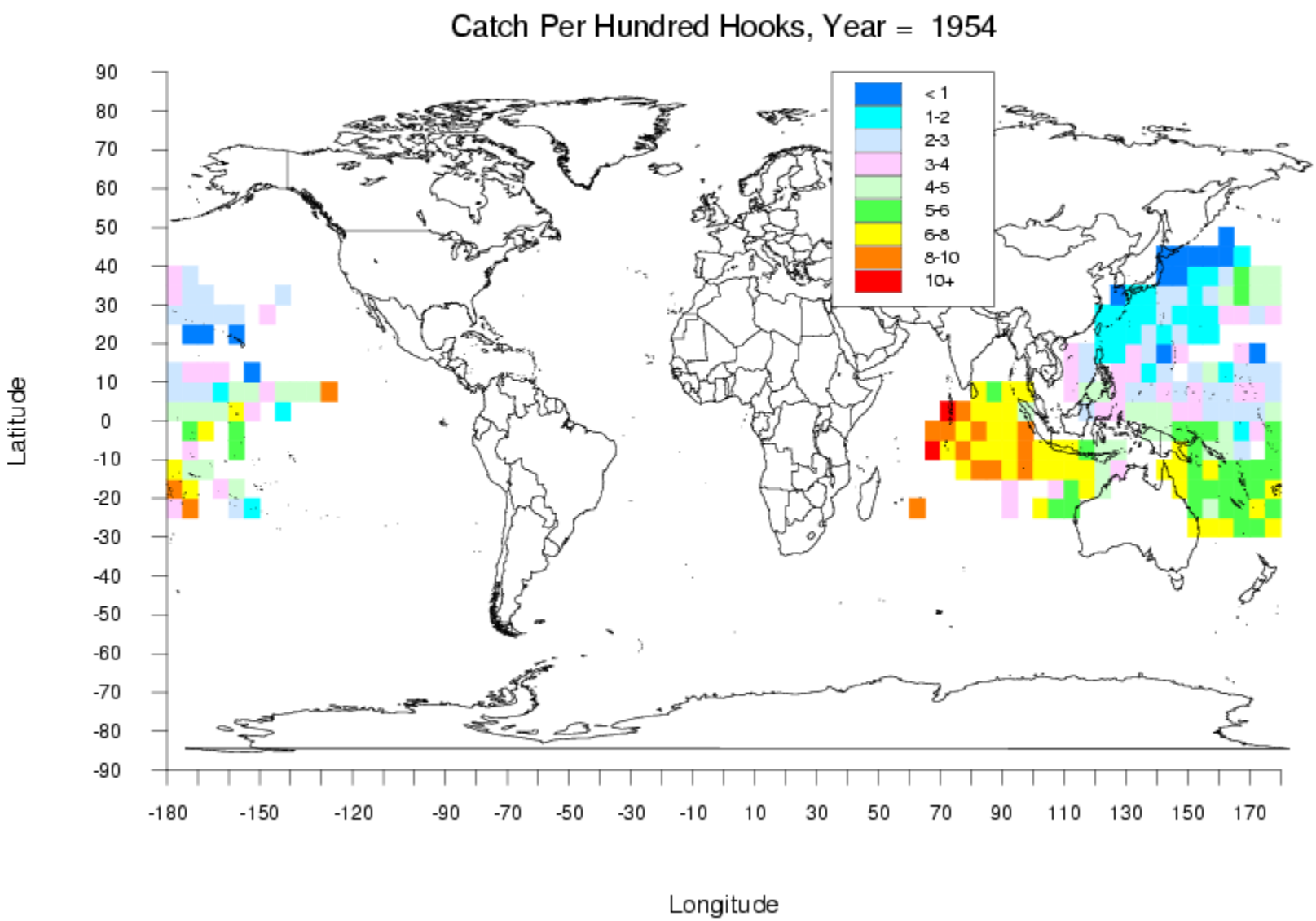


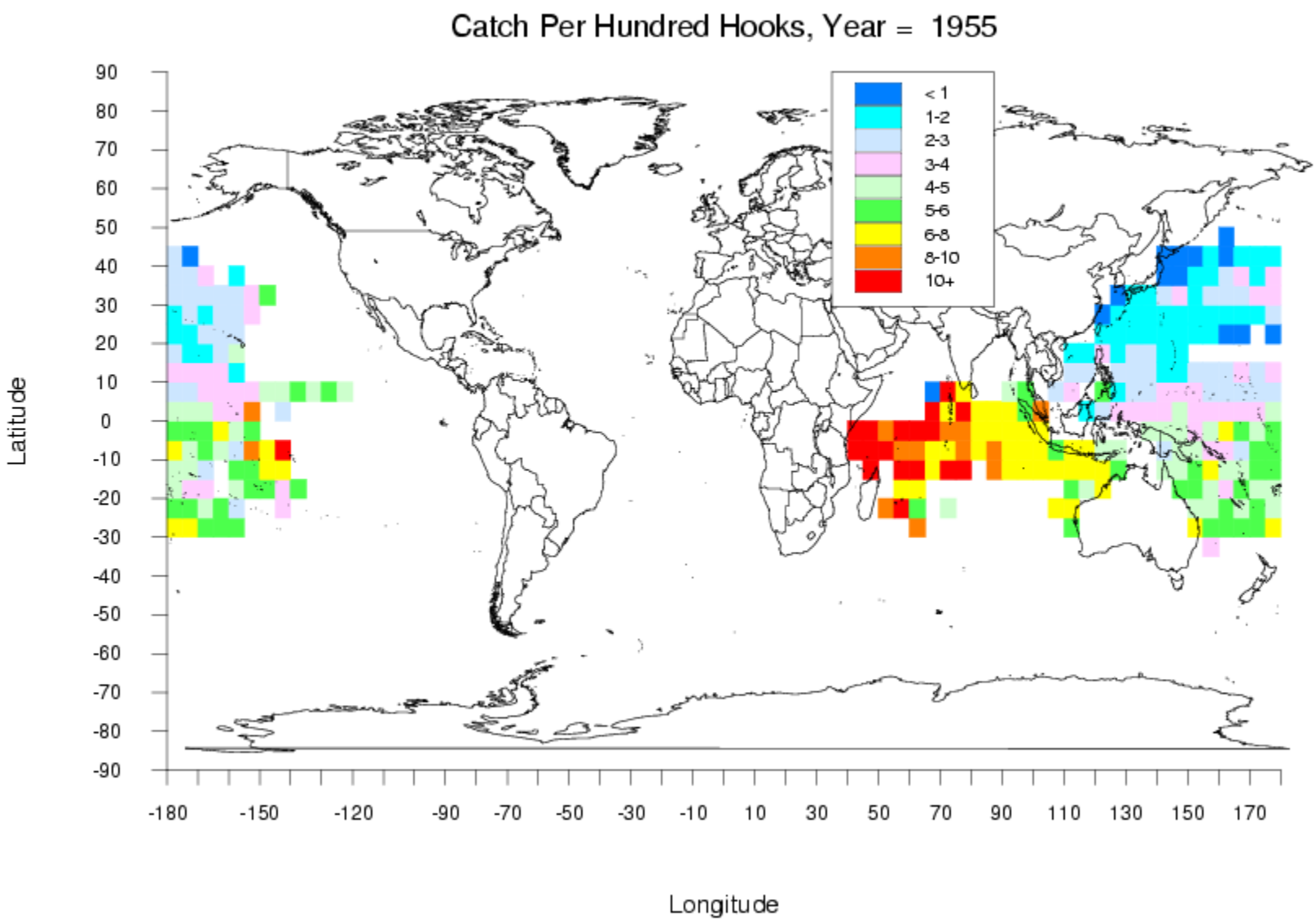
Myers & Worm. PRSB 2005

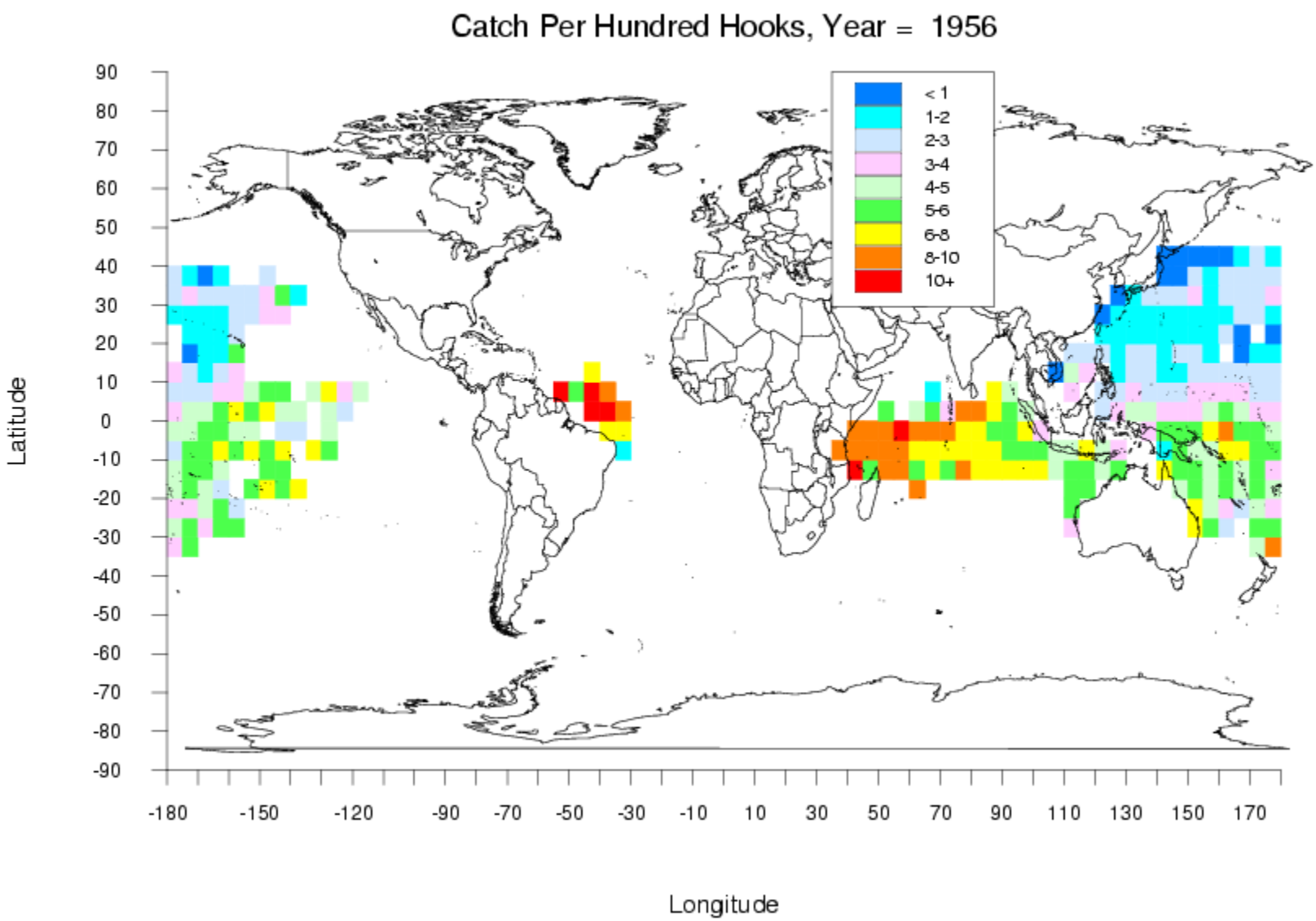

555
lbs.
LBS.
1135
CABO
BLANCO

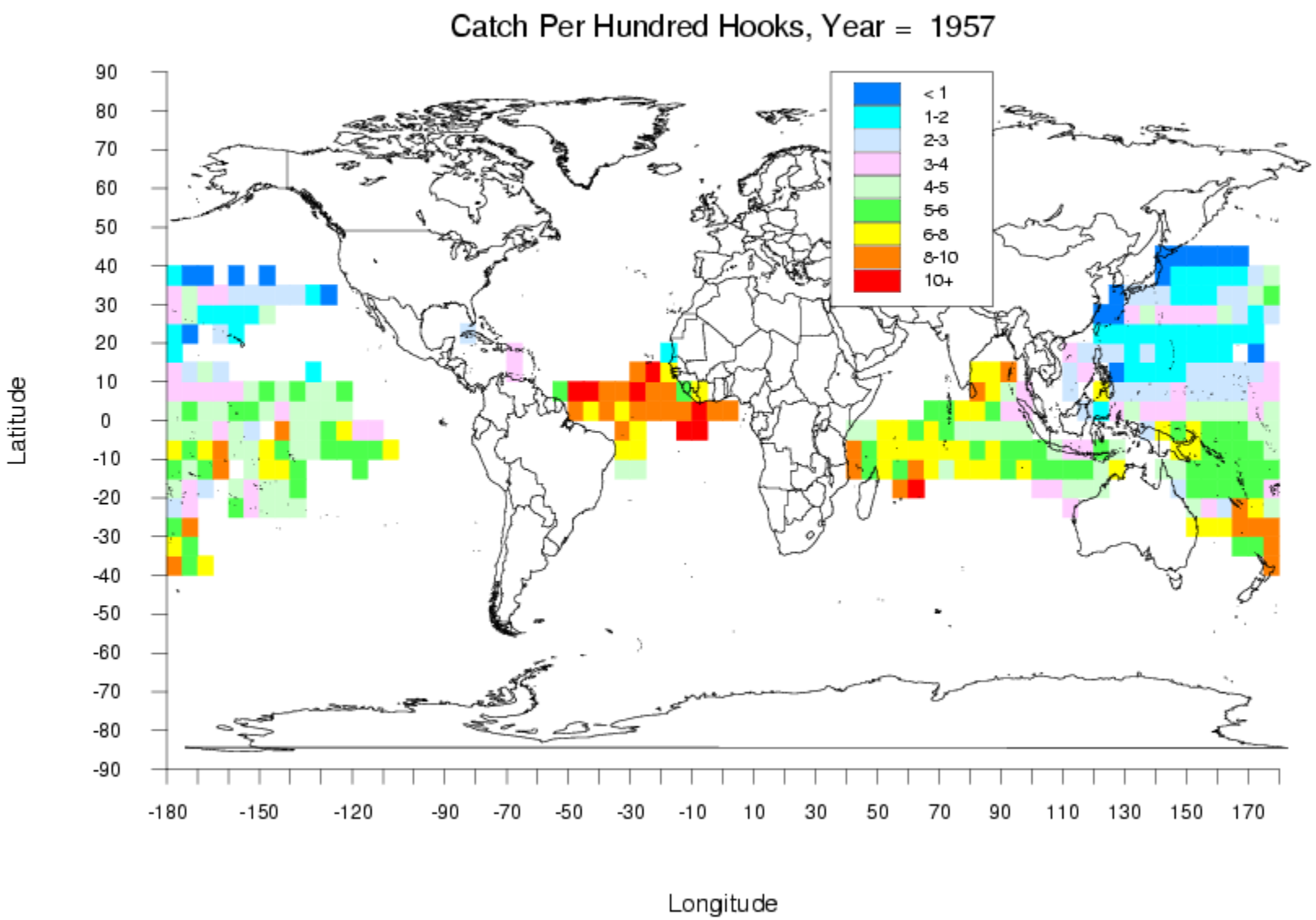

Catch Per Hundred Hooks, Year = 1952
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

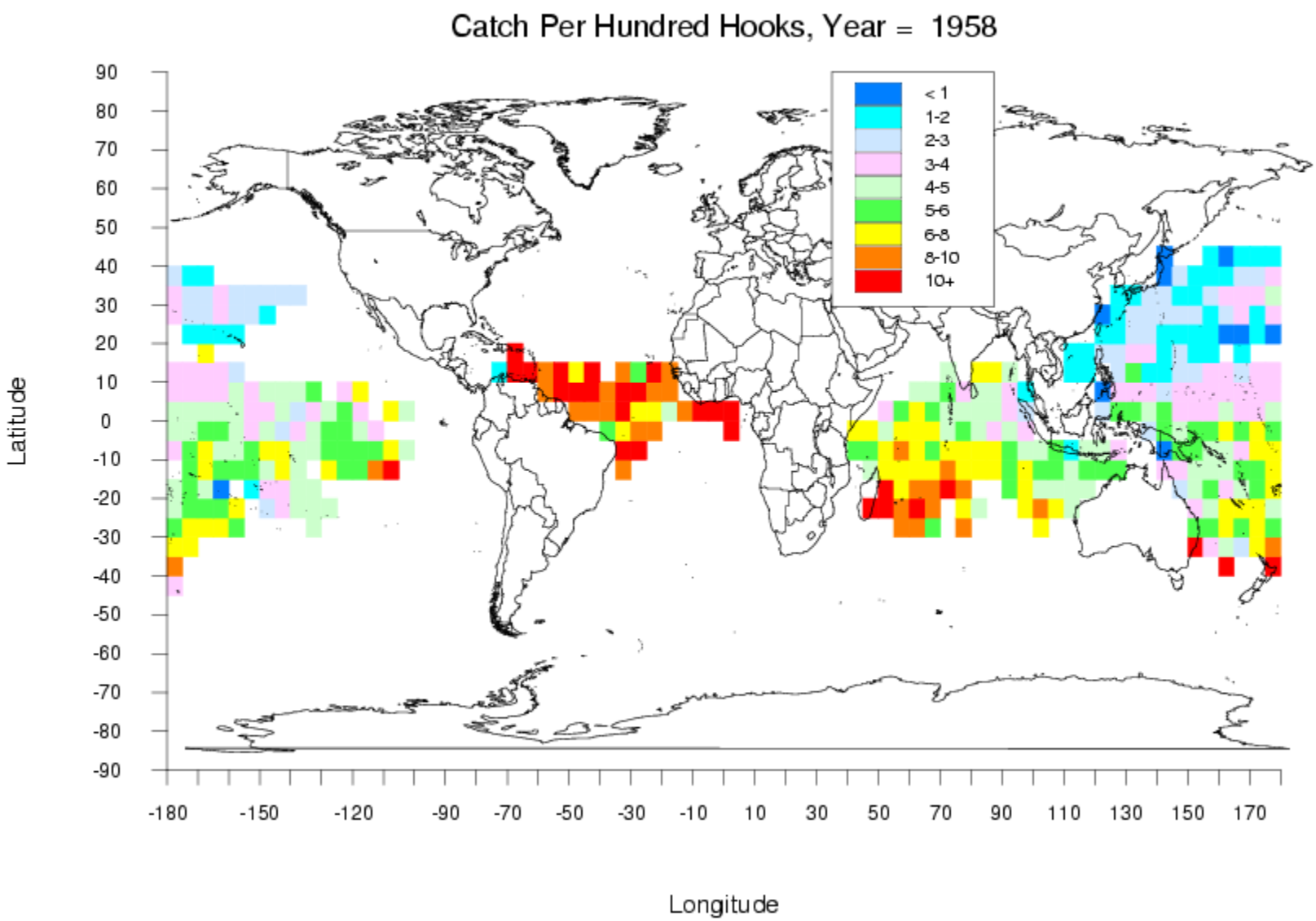

Catch Per Hundred Hooks, Year = 1953
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

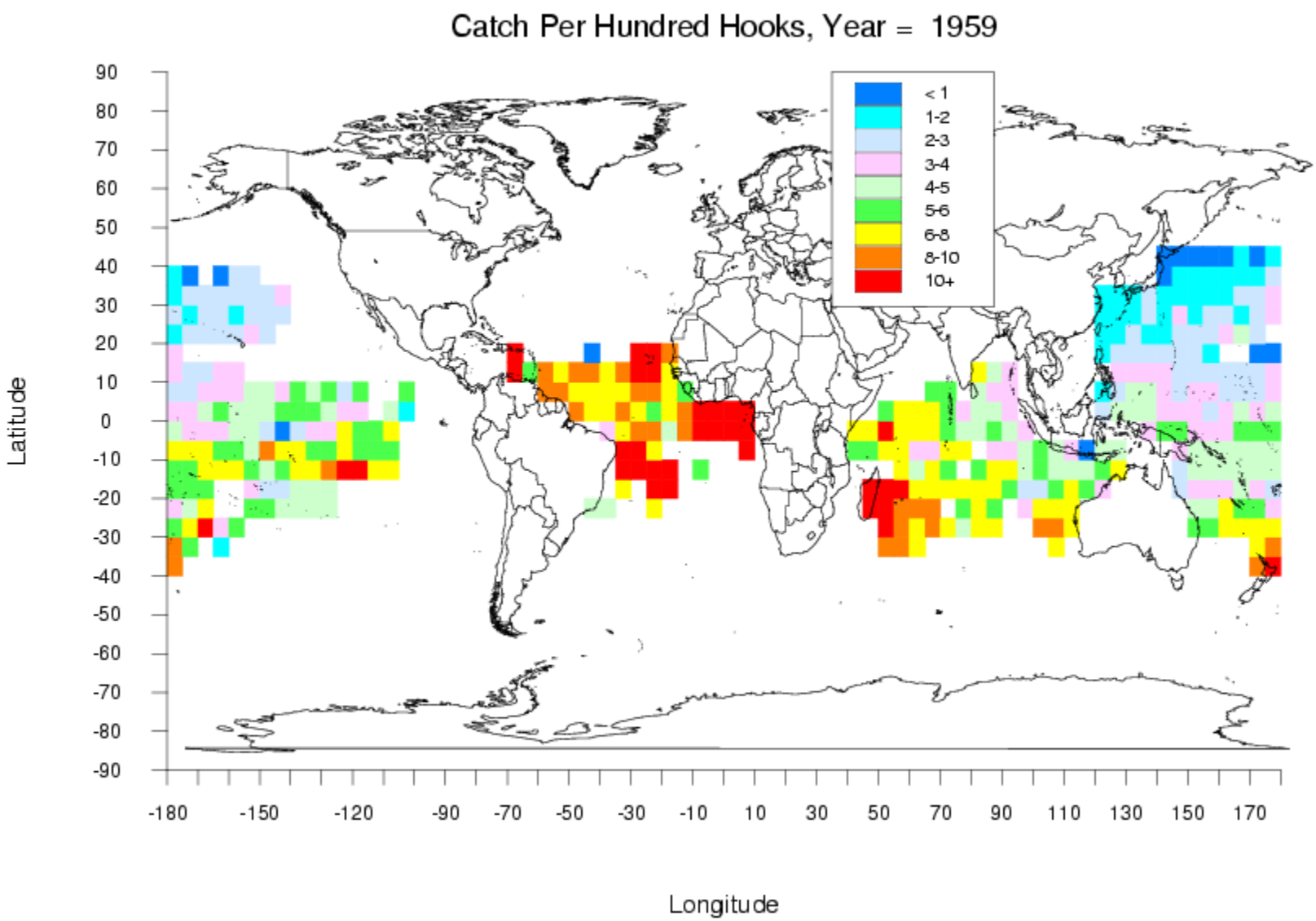

Catch Per Hundred Hooks, Year = 1954
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

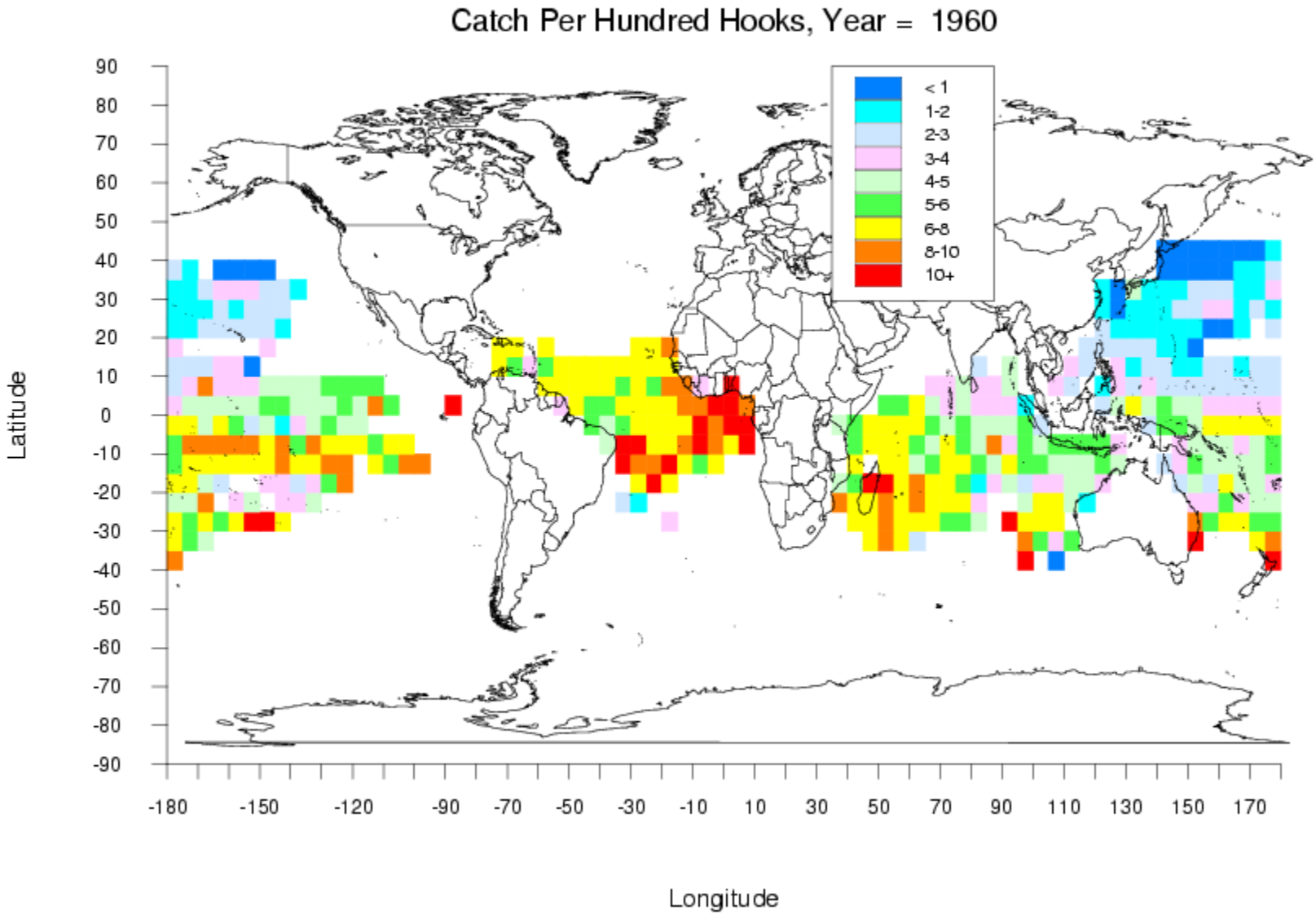

Catch Per Hundred Hooks, Year = 1955
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

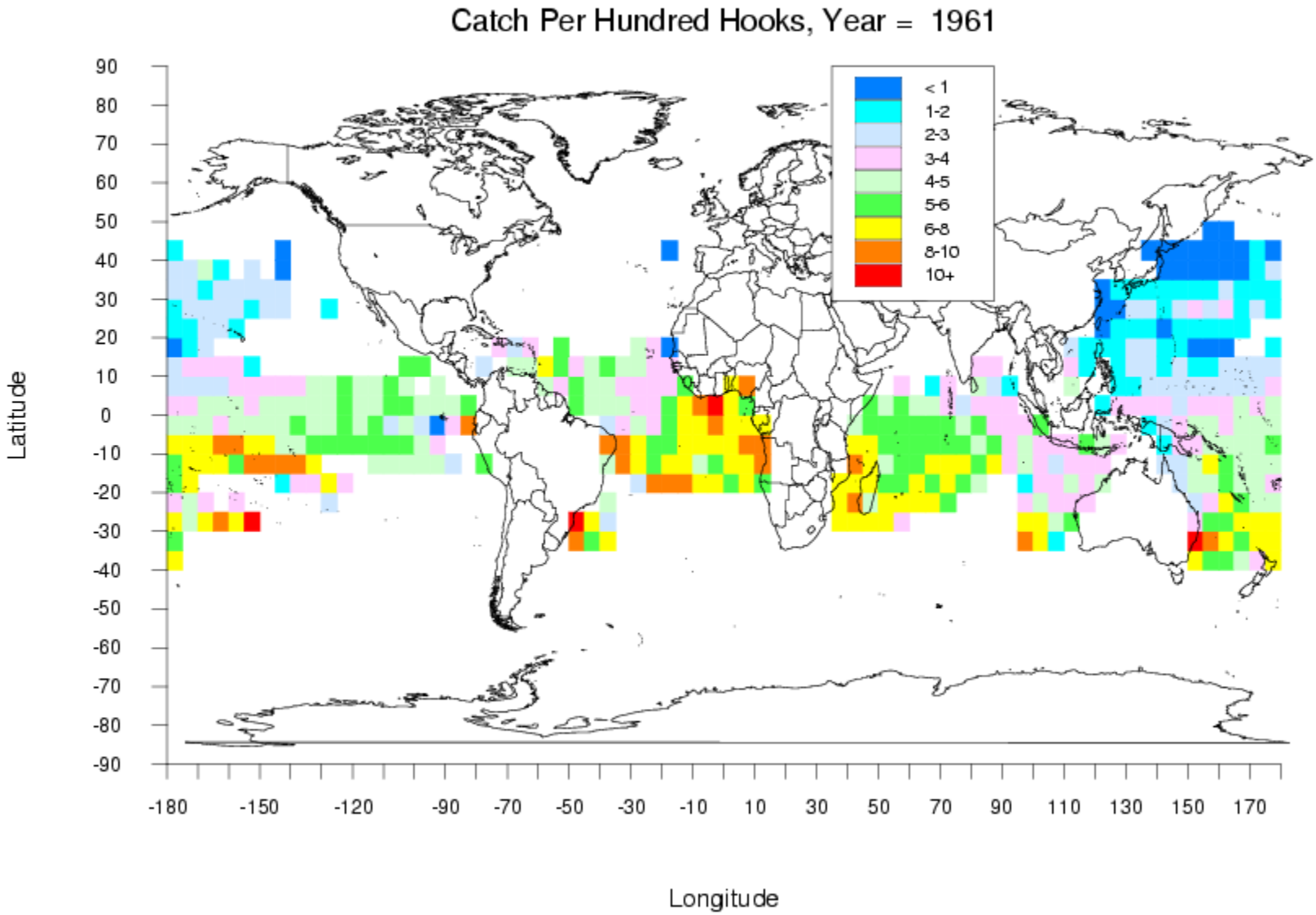

Catch Per Hundred Hooks, Year = 1956
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

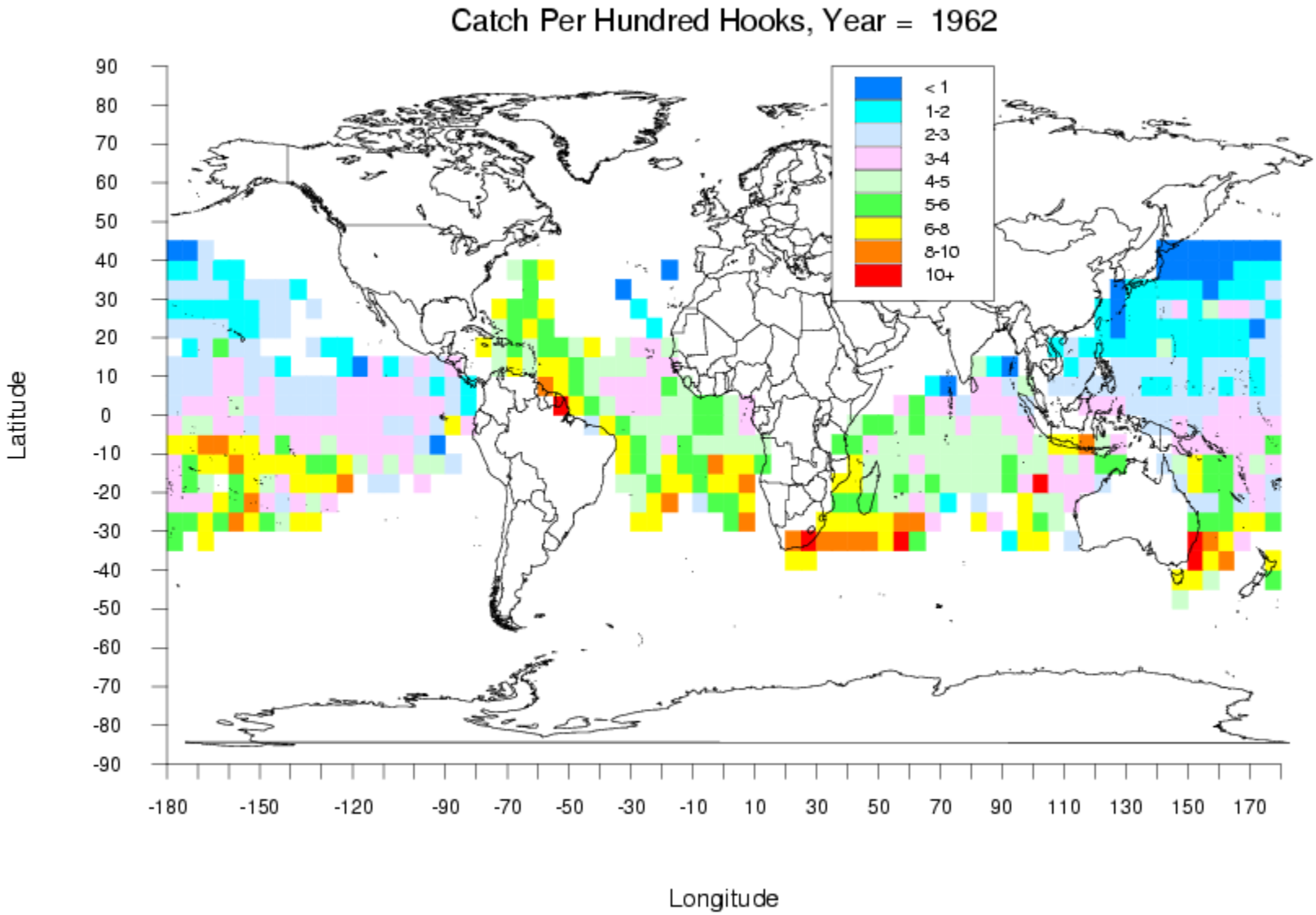

Catch Per Hundred Hooks, Year = 1957
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

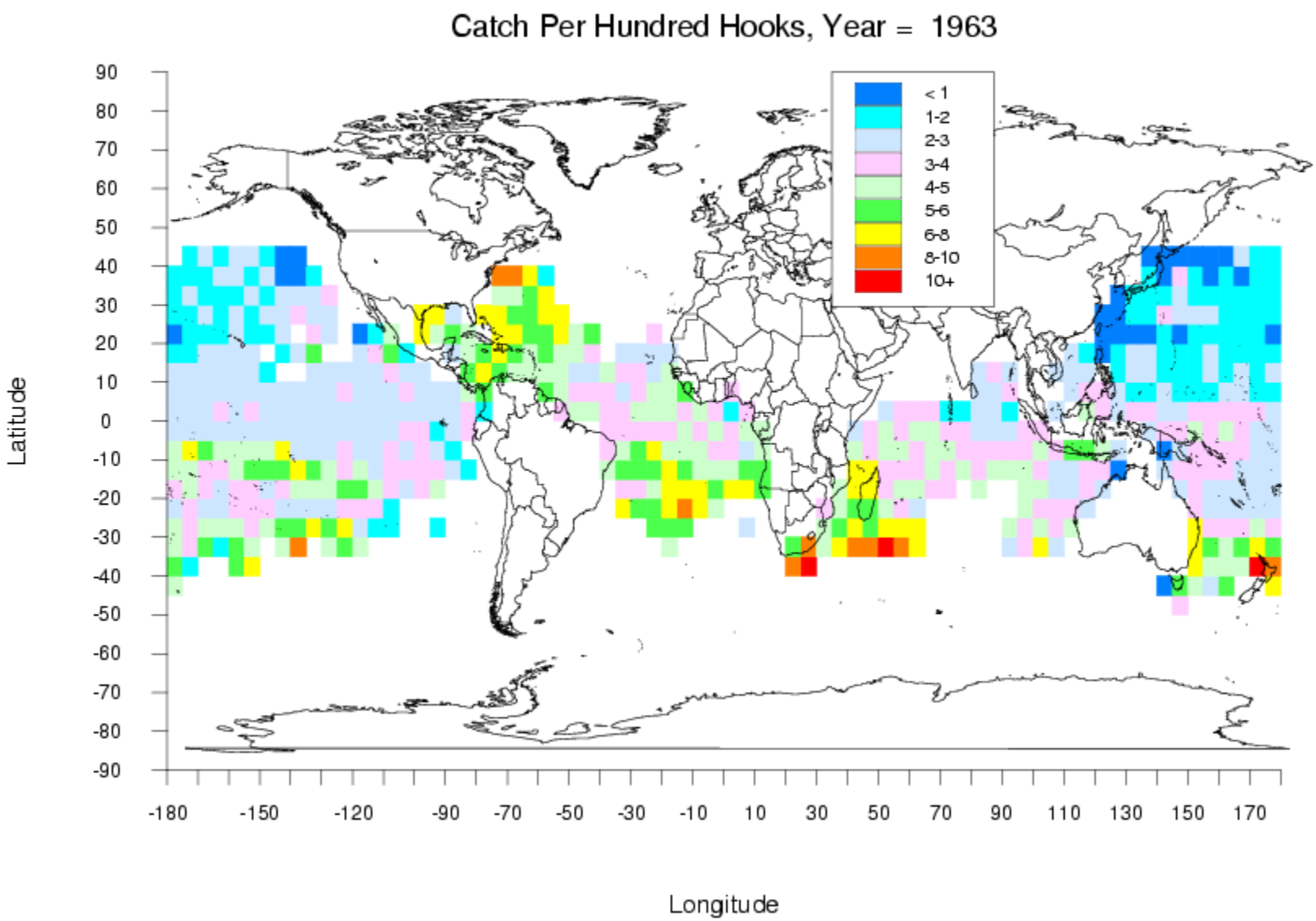

Catch Per Hundred Hooks, Year = 1958
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

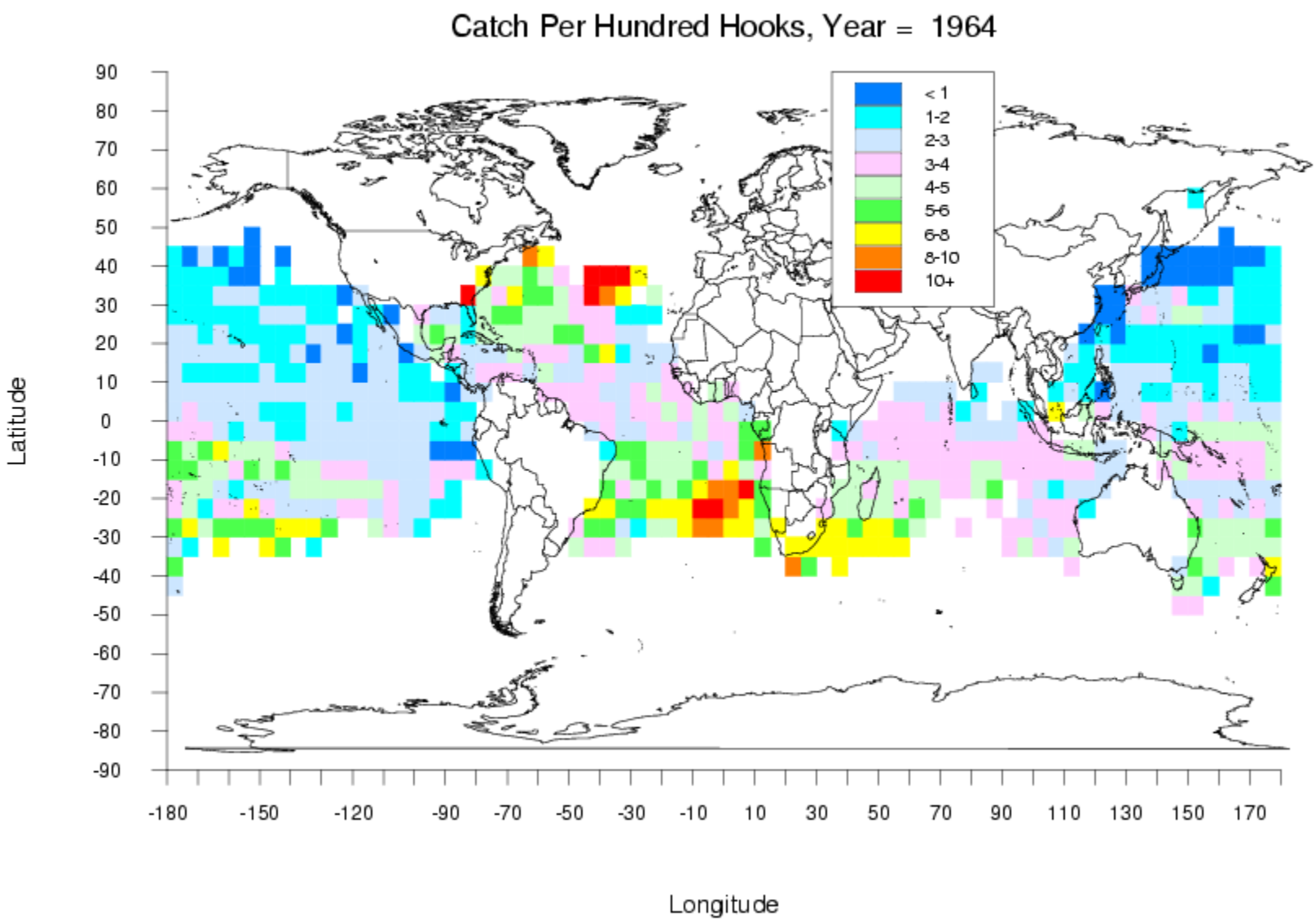

Catch Per Hundred Hooks, Year = 1959
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

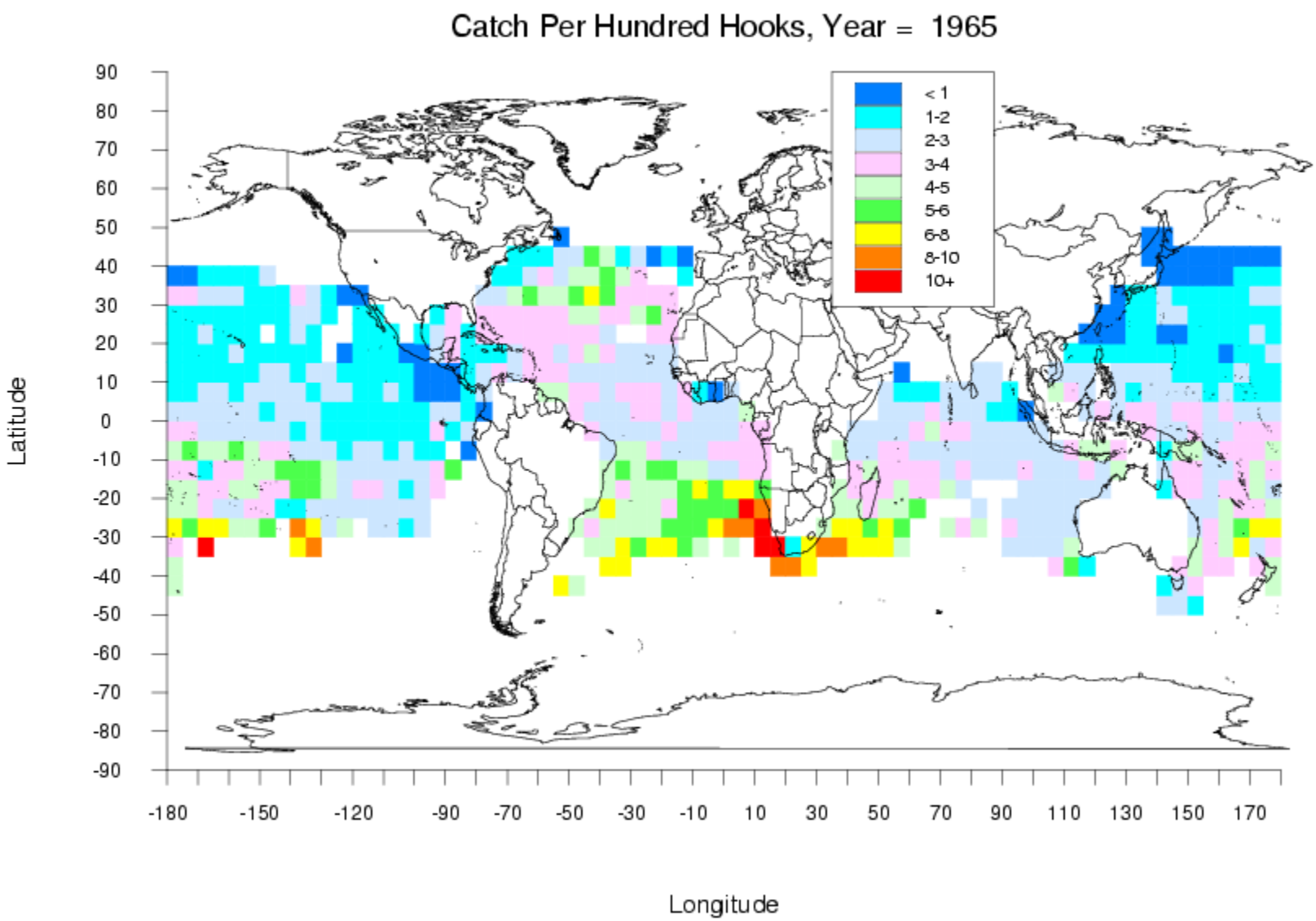

Catch Per Hundred Hooks, Year = 1960
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

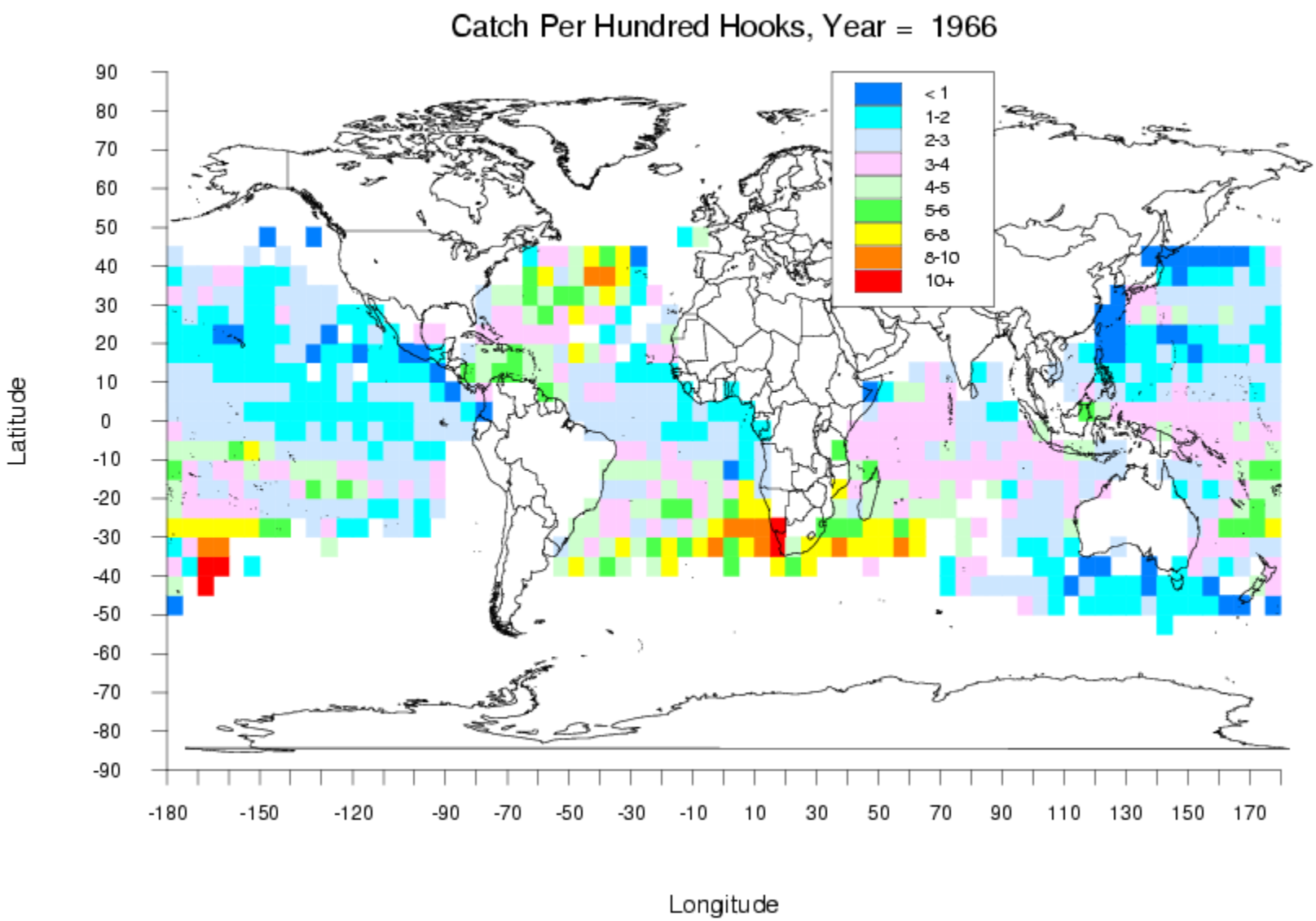

Catch Per Hundred Hooks, Year = 1961
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

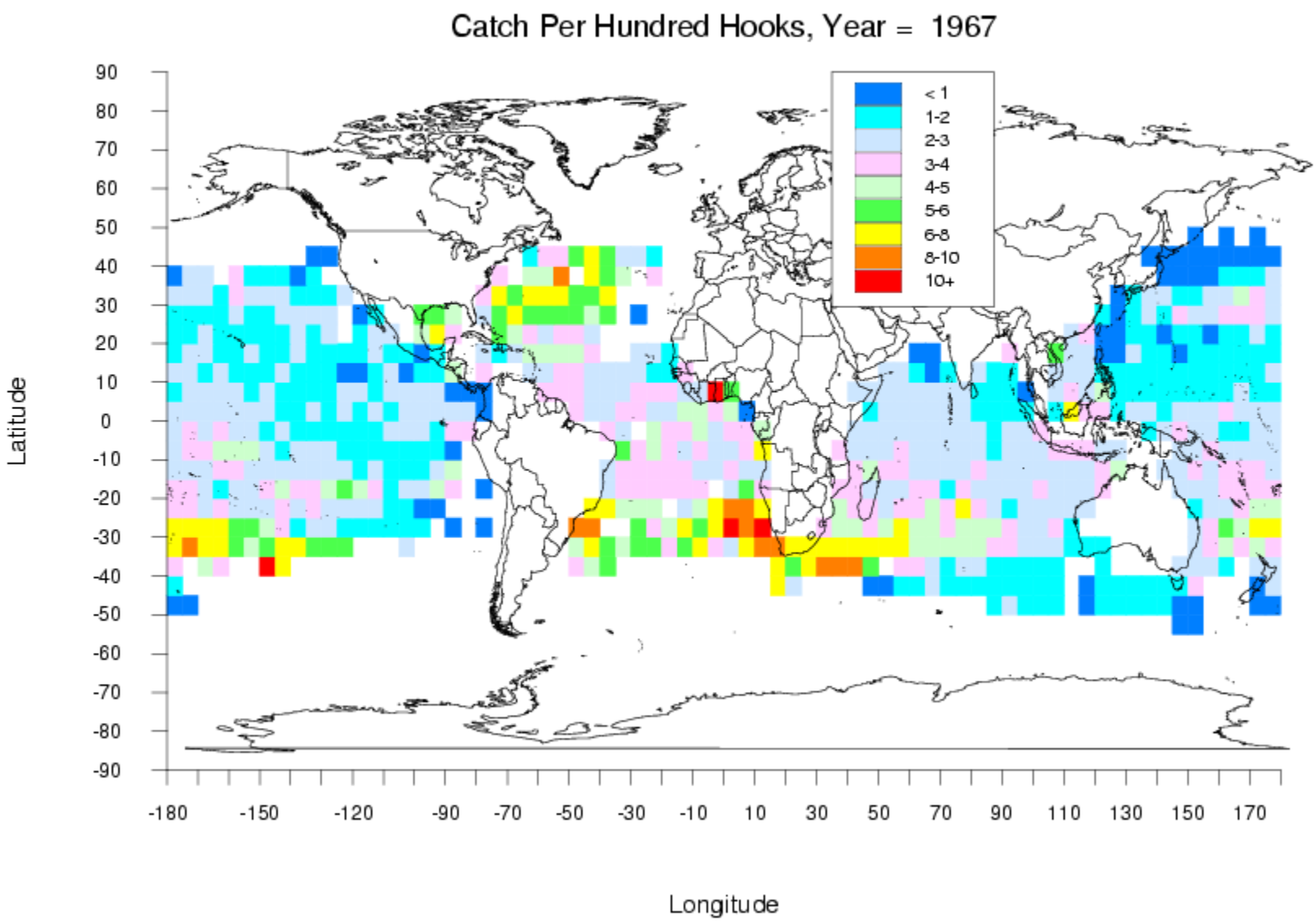

Catch Per Hundred Hooks, Year = 1962
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

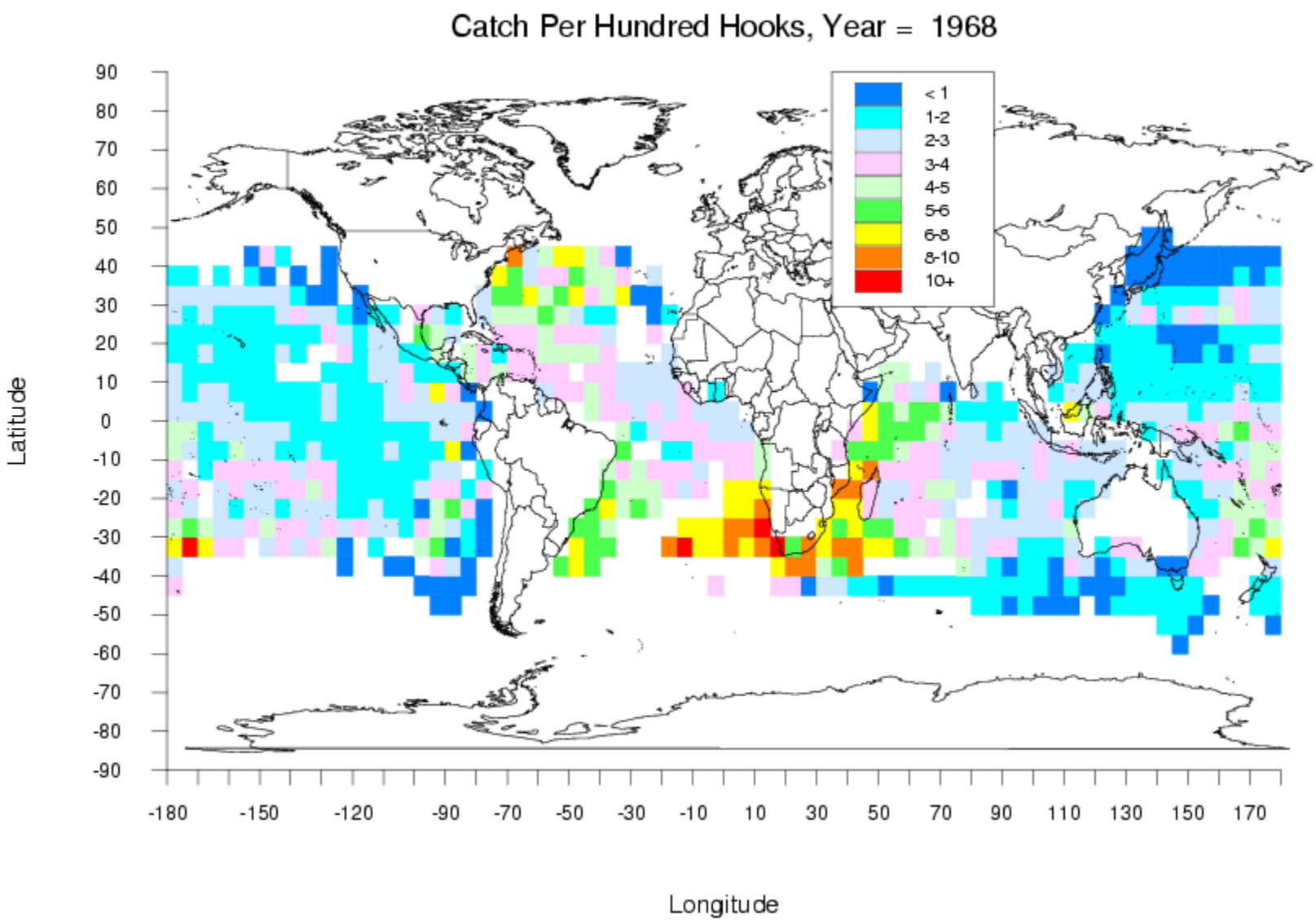

Catch Per Hundred Hooks, Year = 1963
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

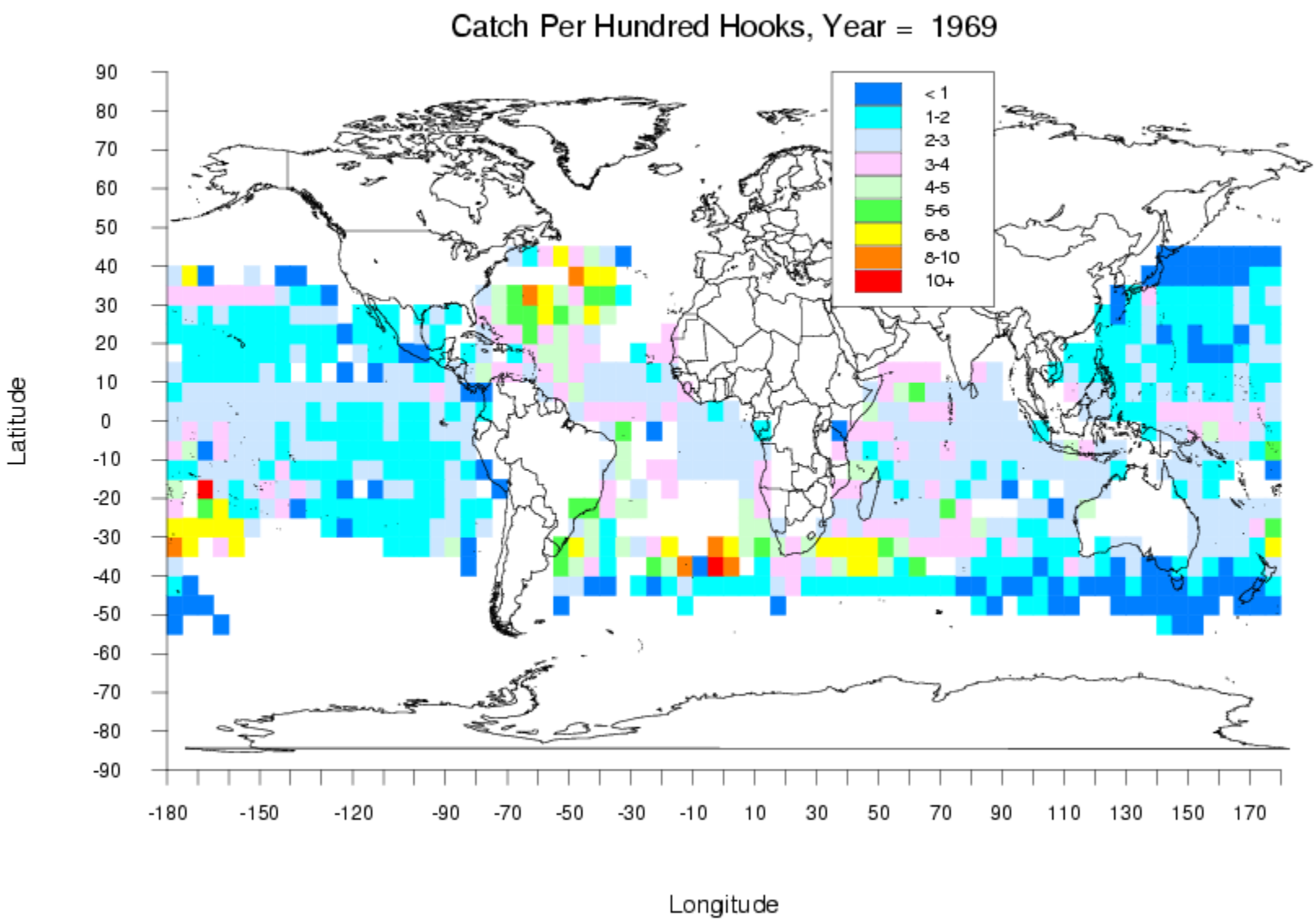

Catch Per Hundred Hooks, Year = 1964
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude


Catch Per Hundred Hooks, Year = 1965
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude


Catch Per Hundred Hooks, Year = 1966
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude


Catch Per Hundred Hooks, Year = 1967
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude


Catch Per Hundred Hooks, Year = 1968
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude


Catch Per Hundred Hooks, Year = 1969
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
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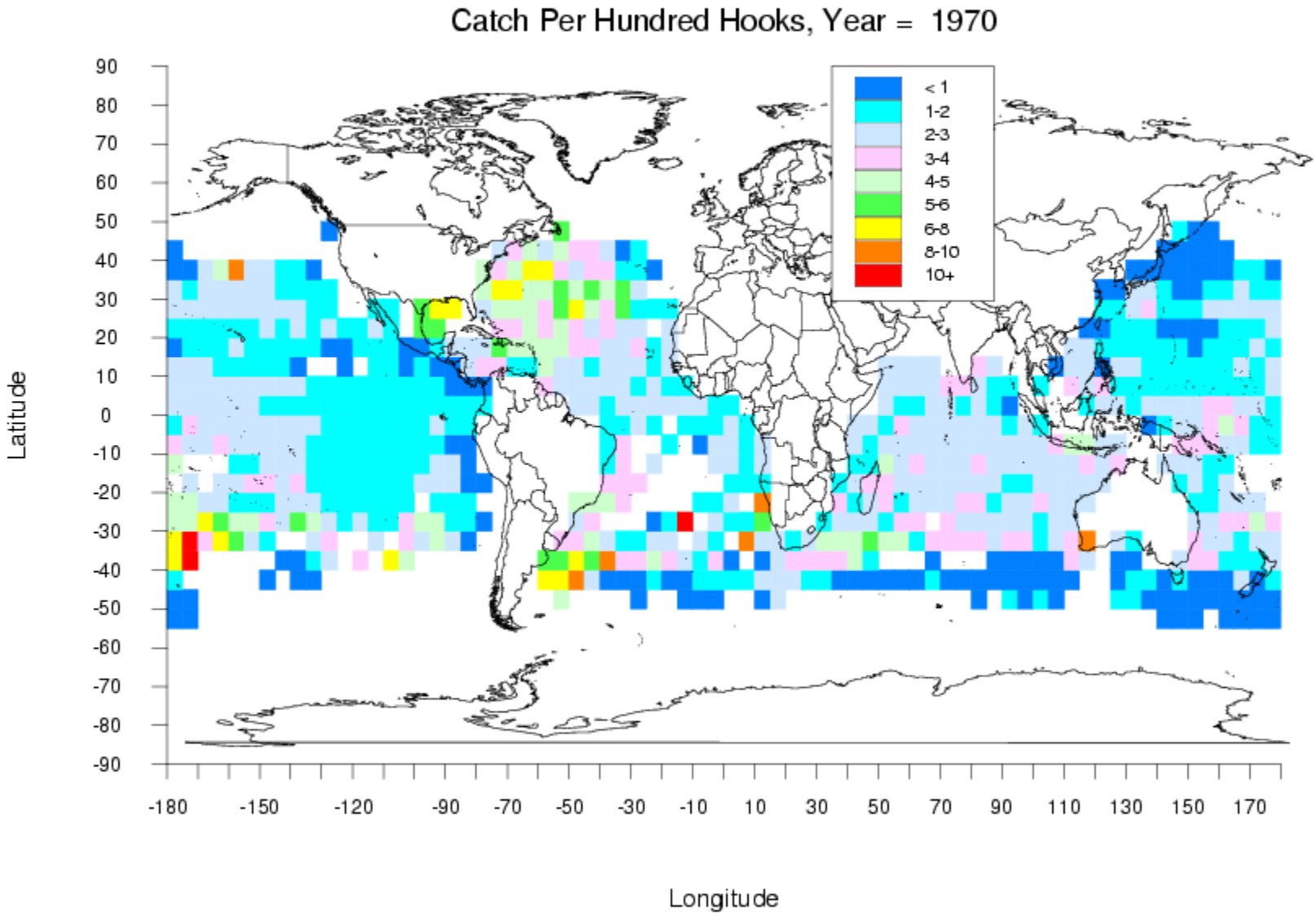
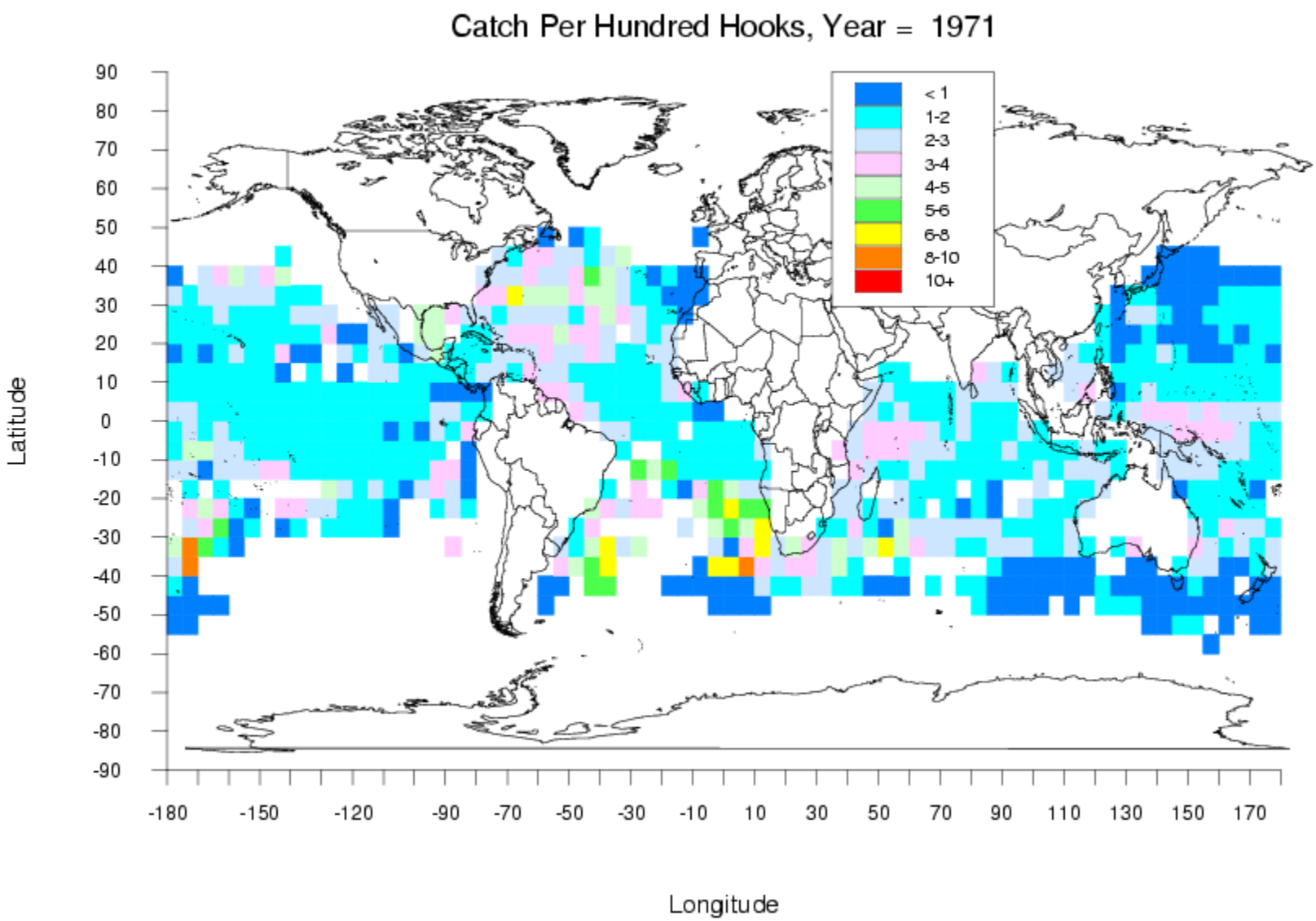
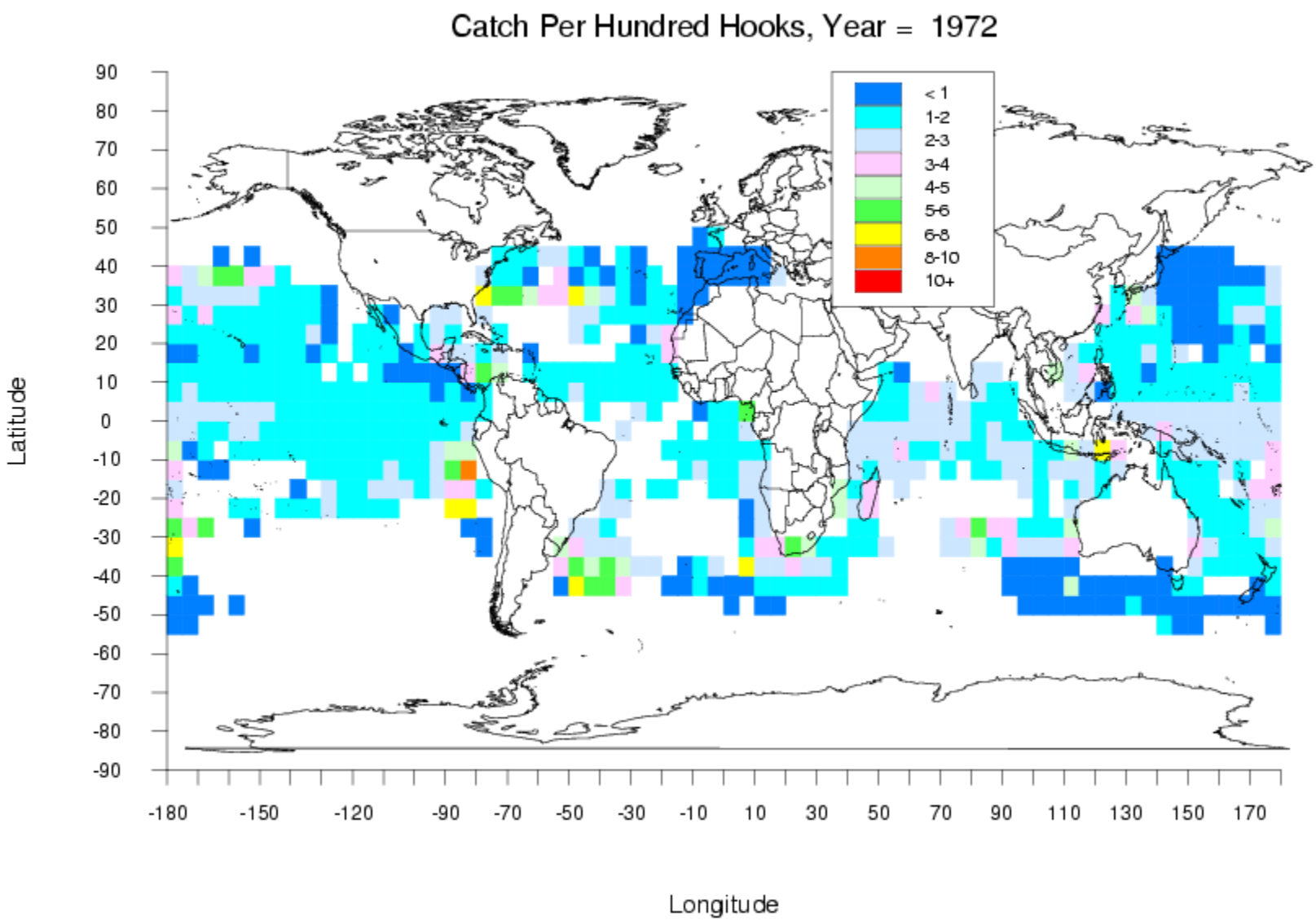
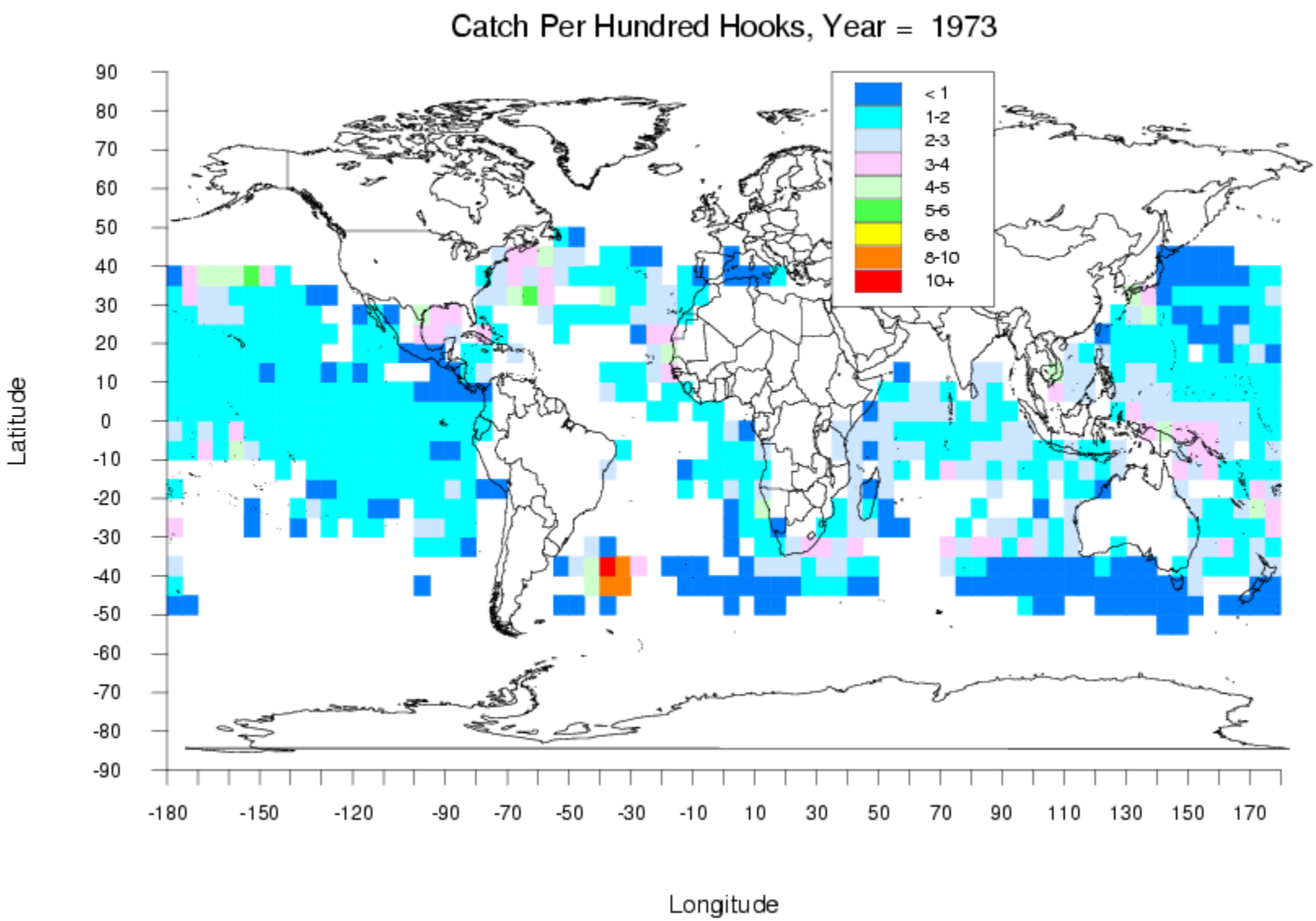
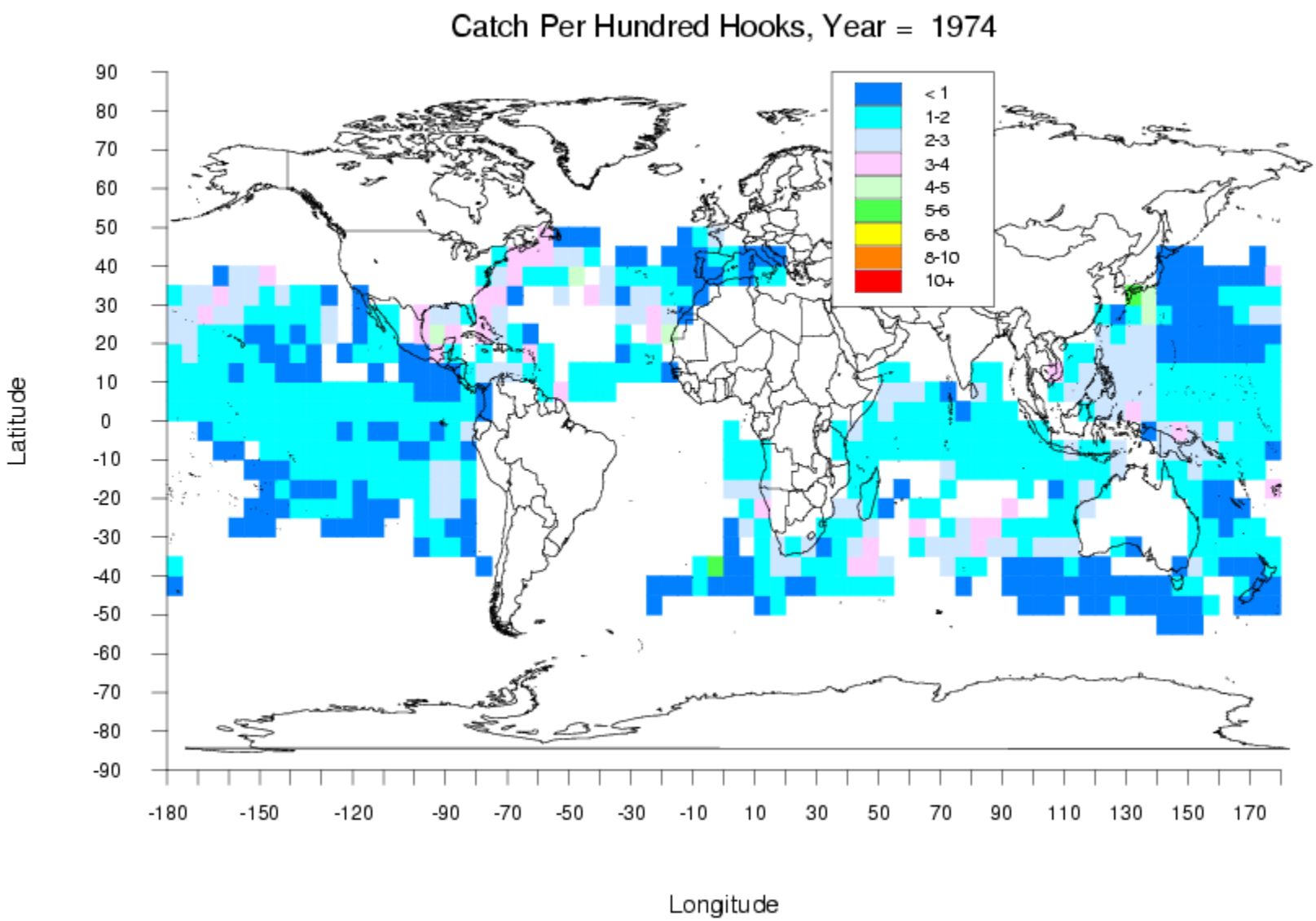
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

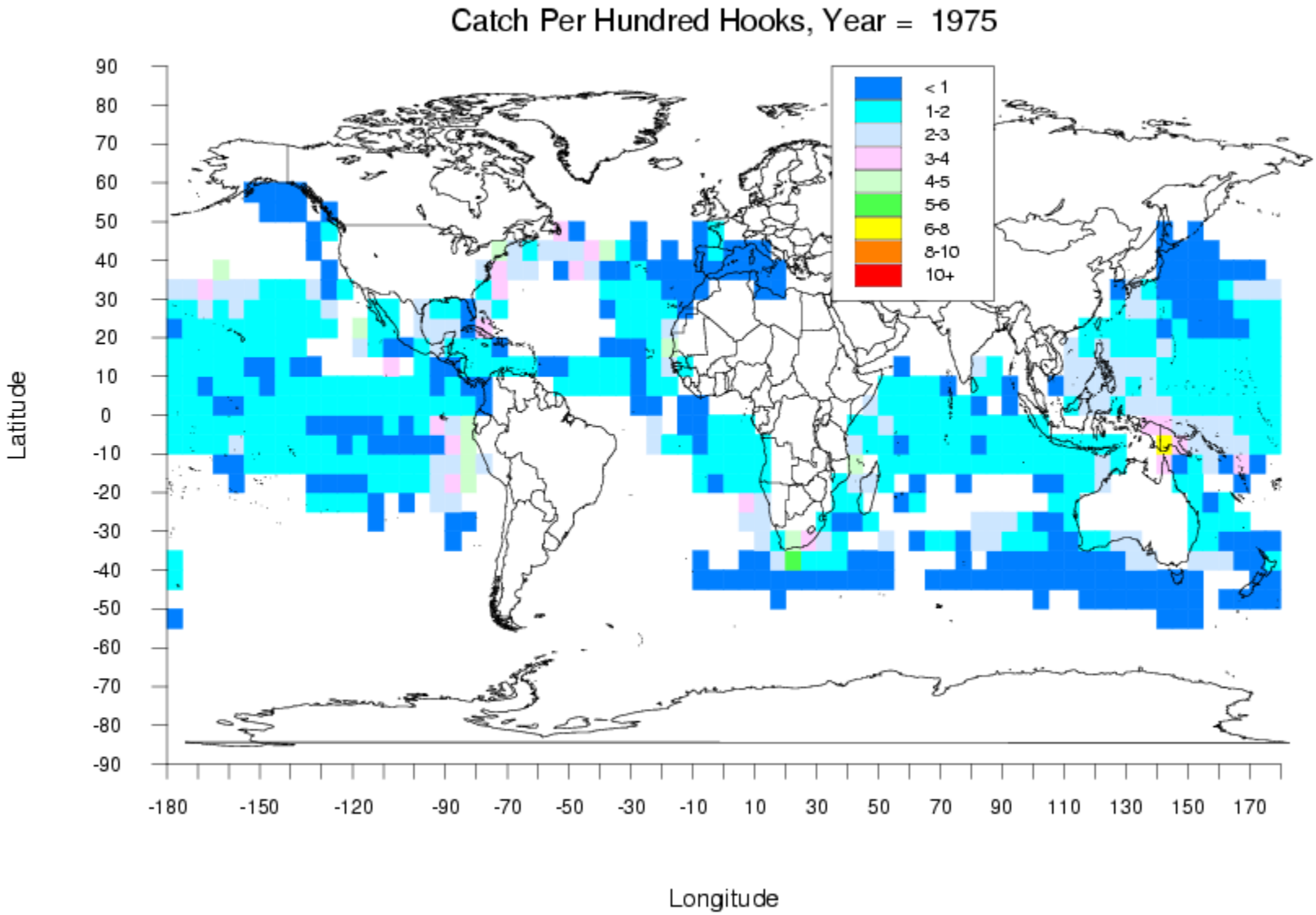

Catch Per Hundred Hooks, Year = 1970
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

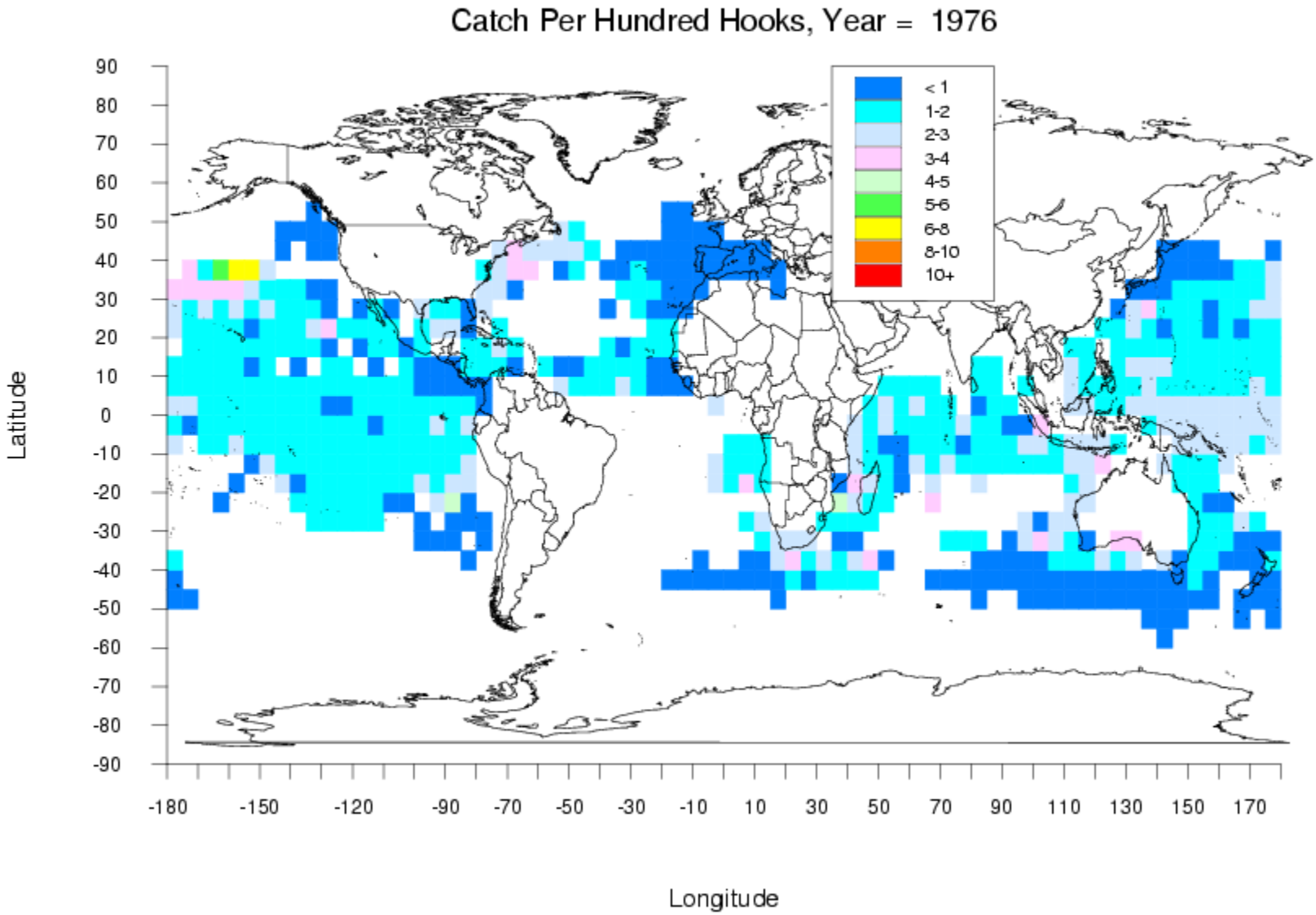

Catch Per Hundred Hooks, Year = 1971
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

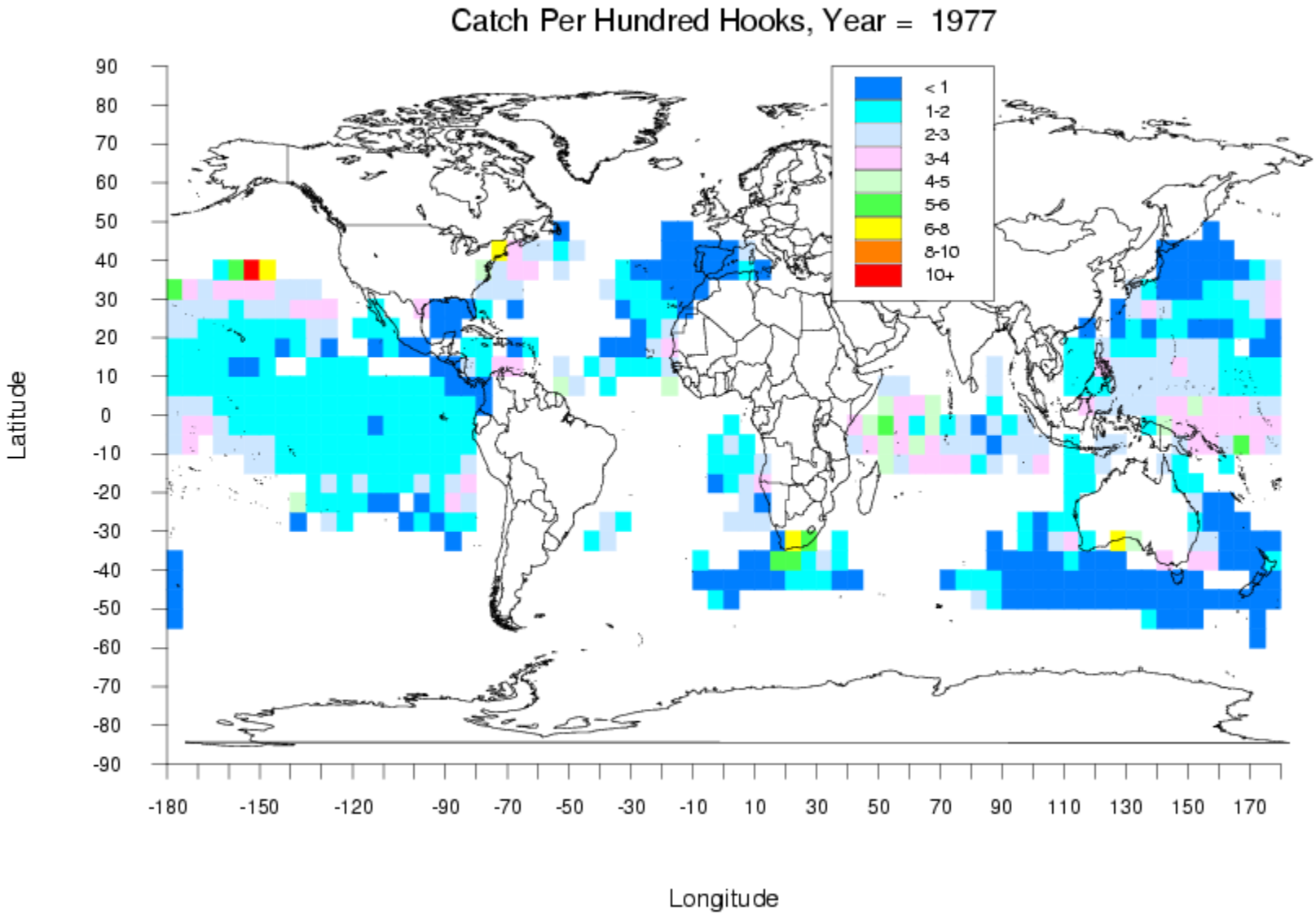

Catch Per Hundred Hooks, Year = 1972
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

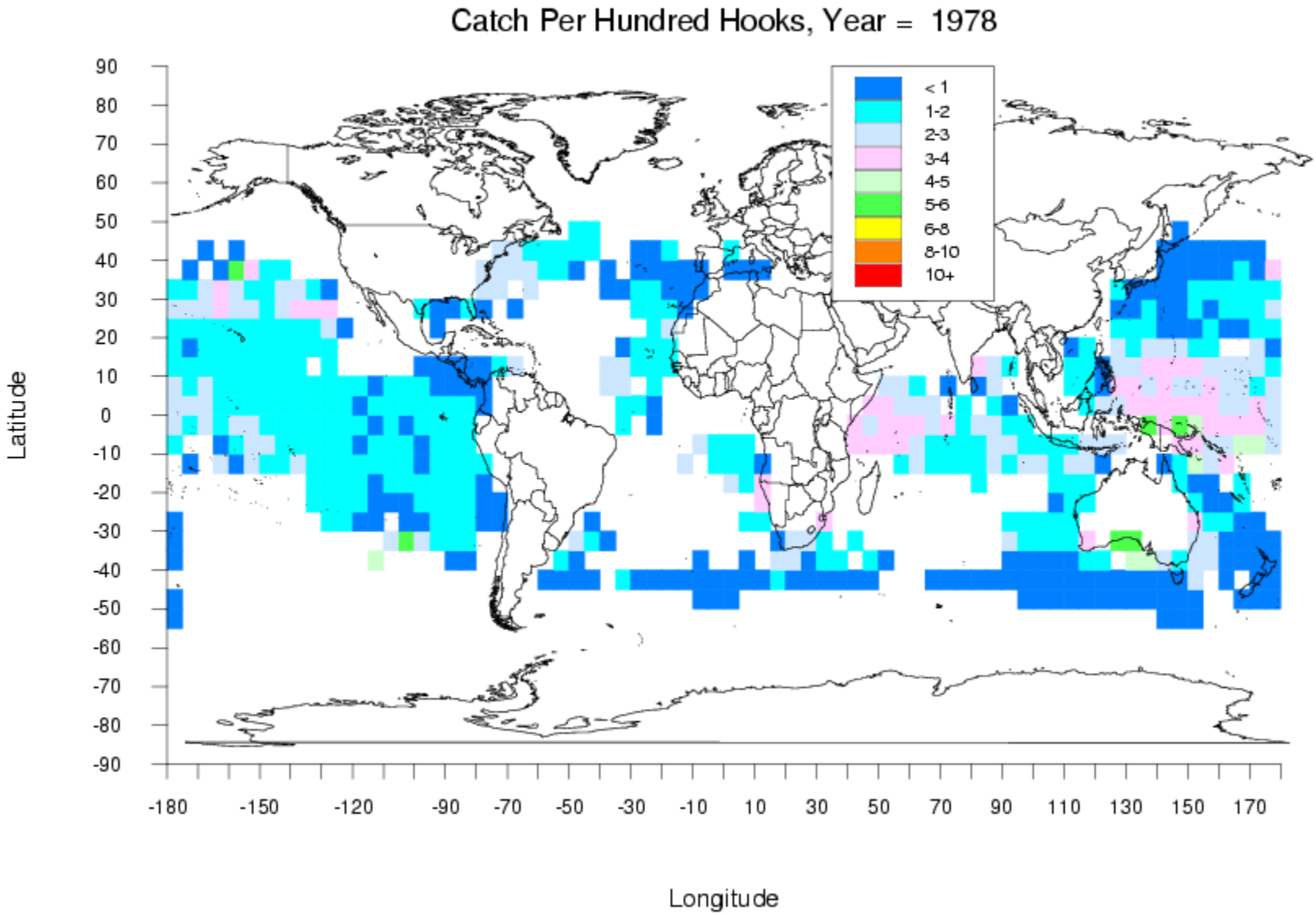

Catch Per Hundred Hooks, Year = 1973
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

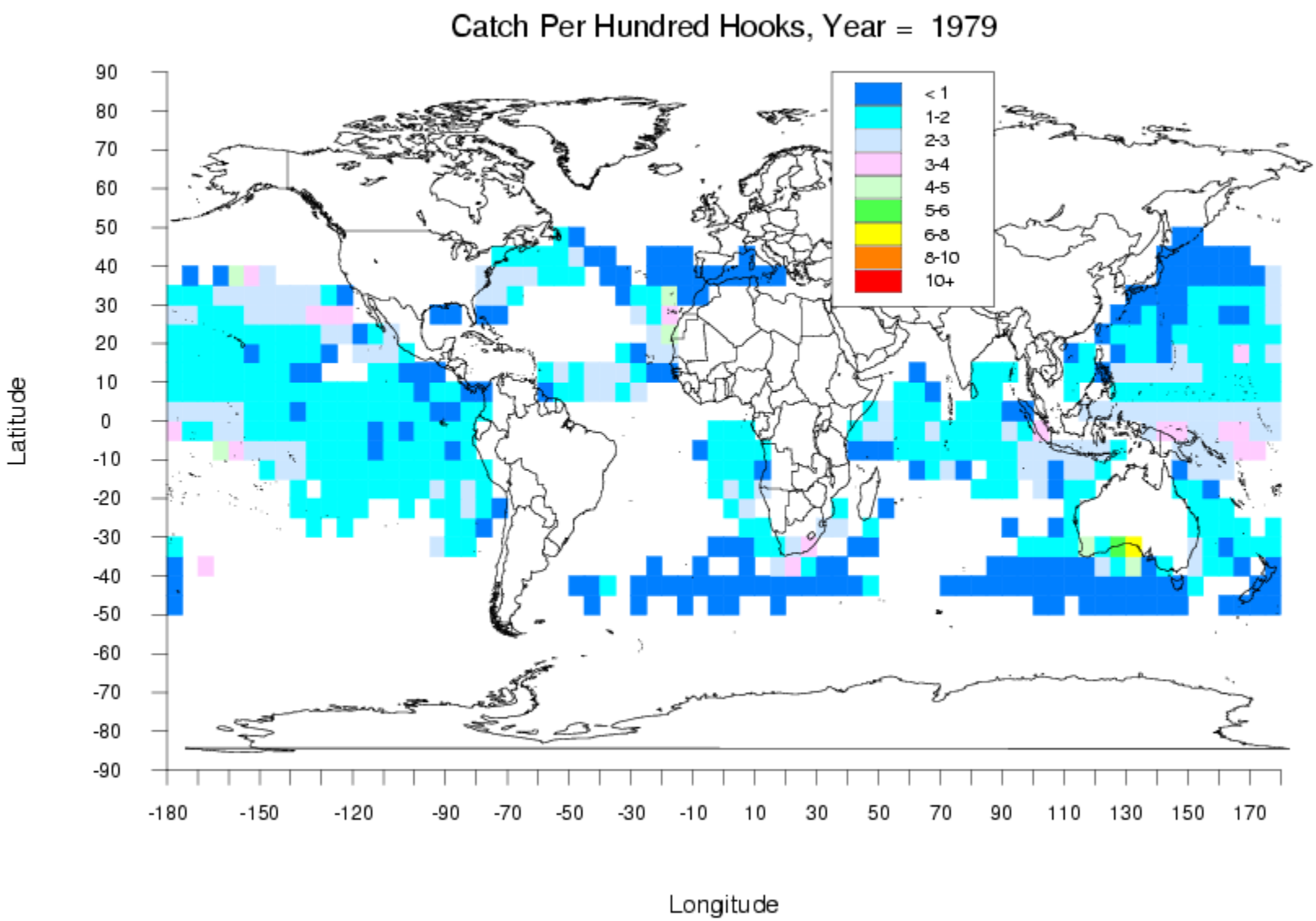

Catch Per Hundred Hooks, Year = 1974
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

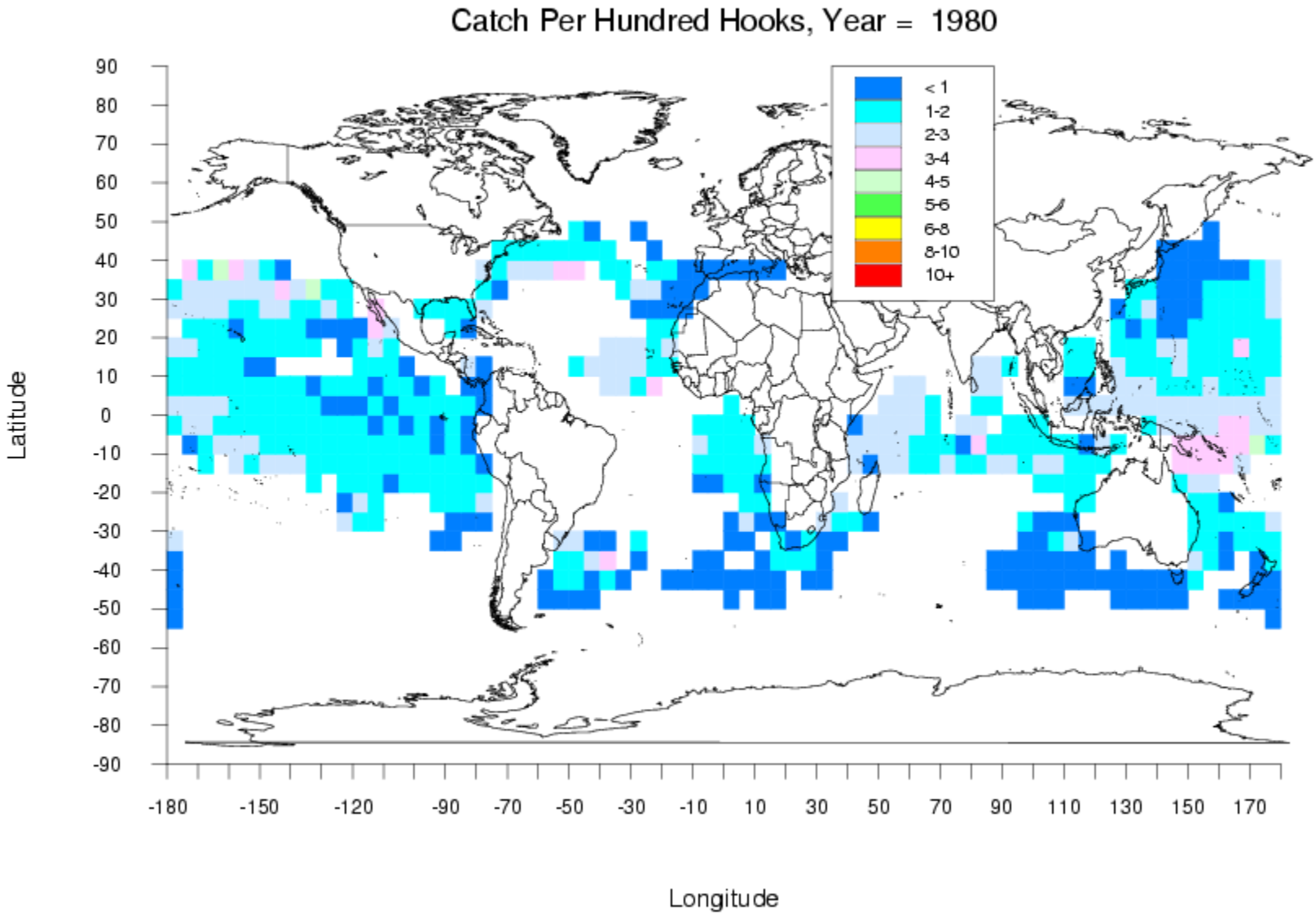

Catch Per Hundred Hooks, Year = 1975
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude


Catch Per Hundred Hooks, Year = 1976
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude


Catch Per Hundred Hooks, Year = 1977
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude


Catch Per Hundred Hooks, Year = 1978
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

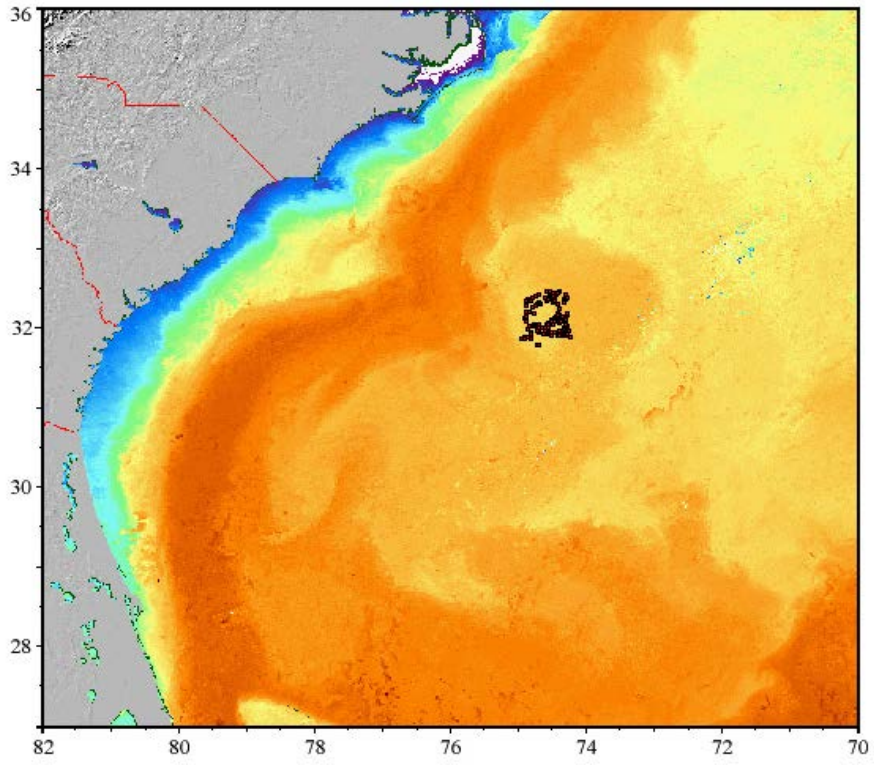

Catch Per Hundred Hooks, Year = 1979
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

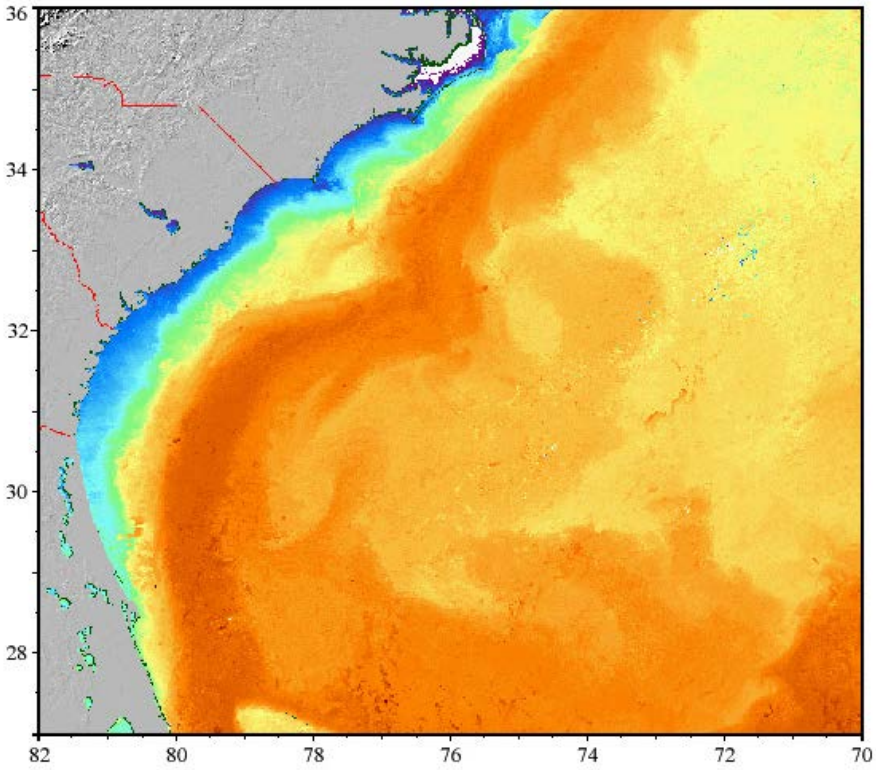

Catch Per Hundred Hooks, Year = 1980
< 1
1-2
2-3
3-4
4-5
5-6
6-8
8-10
10+
Latitude
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-180
-150
-120
-90
-70
-50
-30
-10
10
30
50
70
90
110
130
150
170
Longitude

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 gangion was monofilament

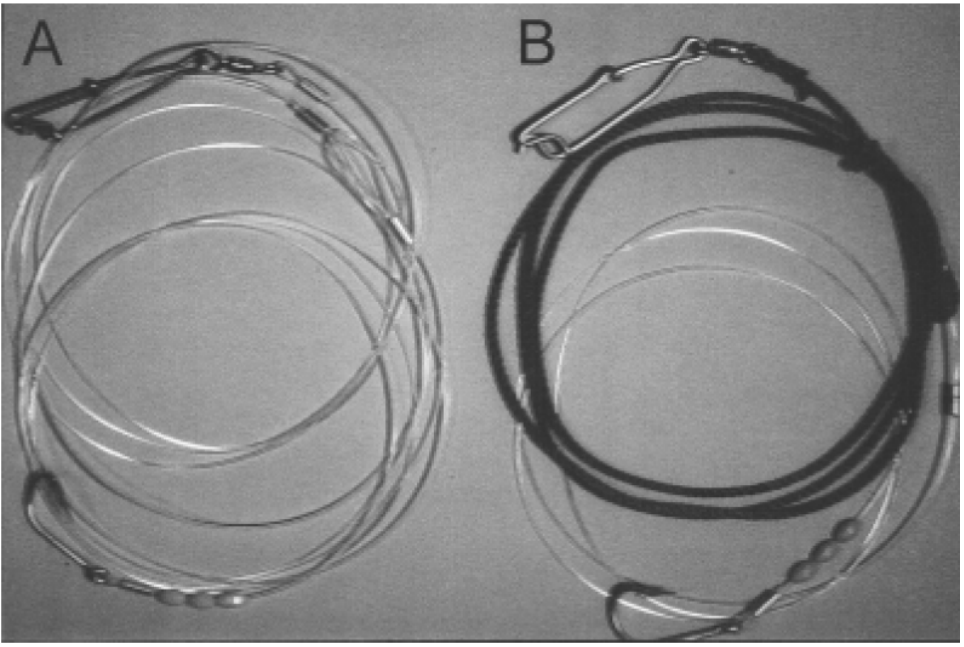
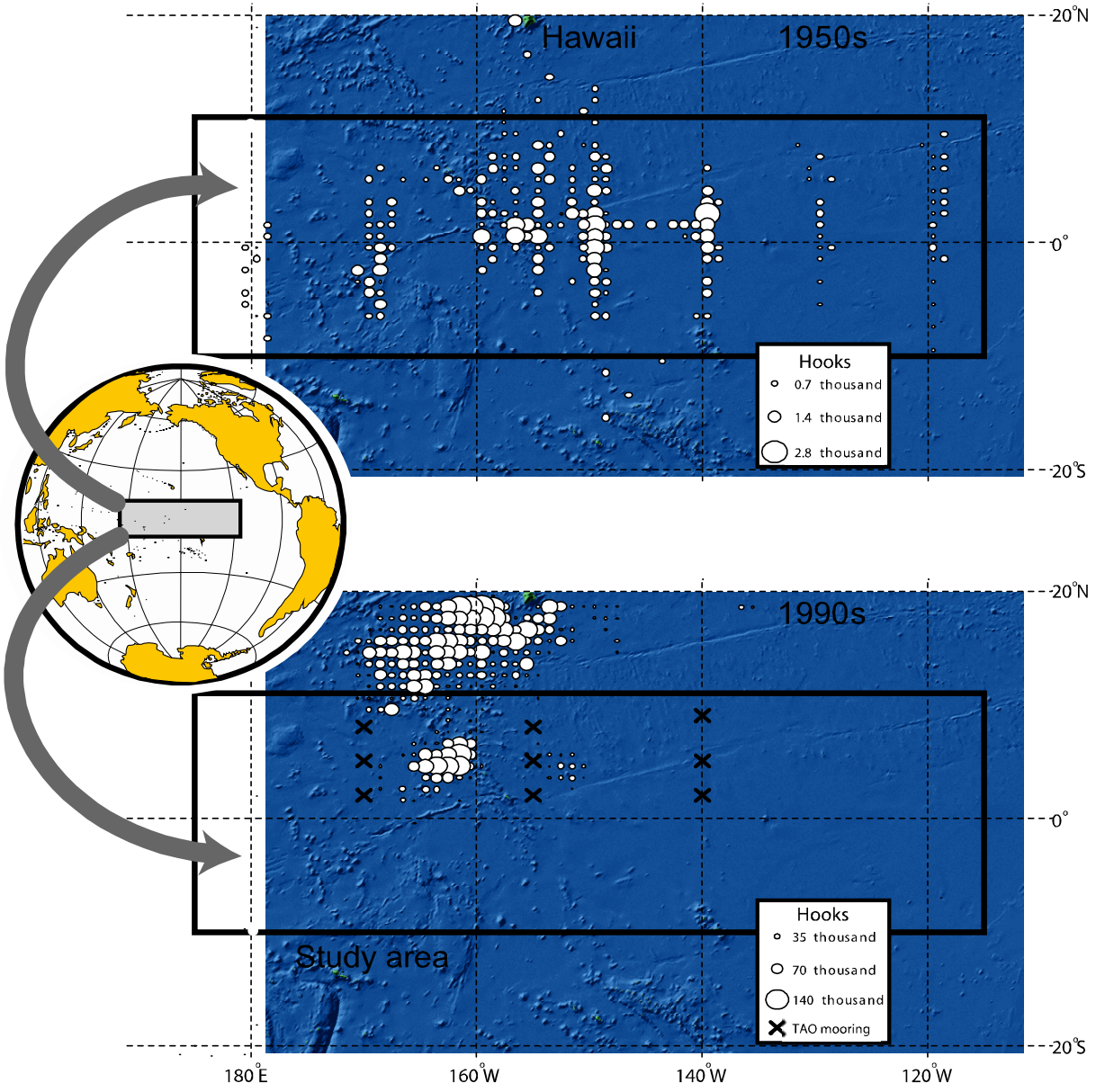


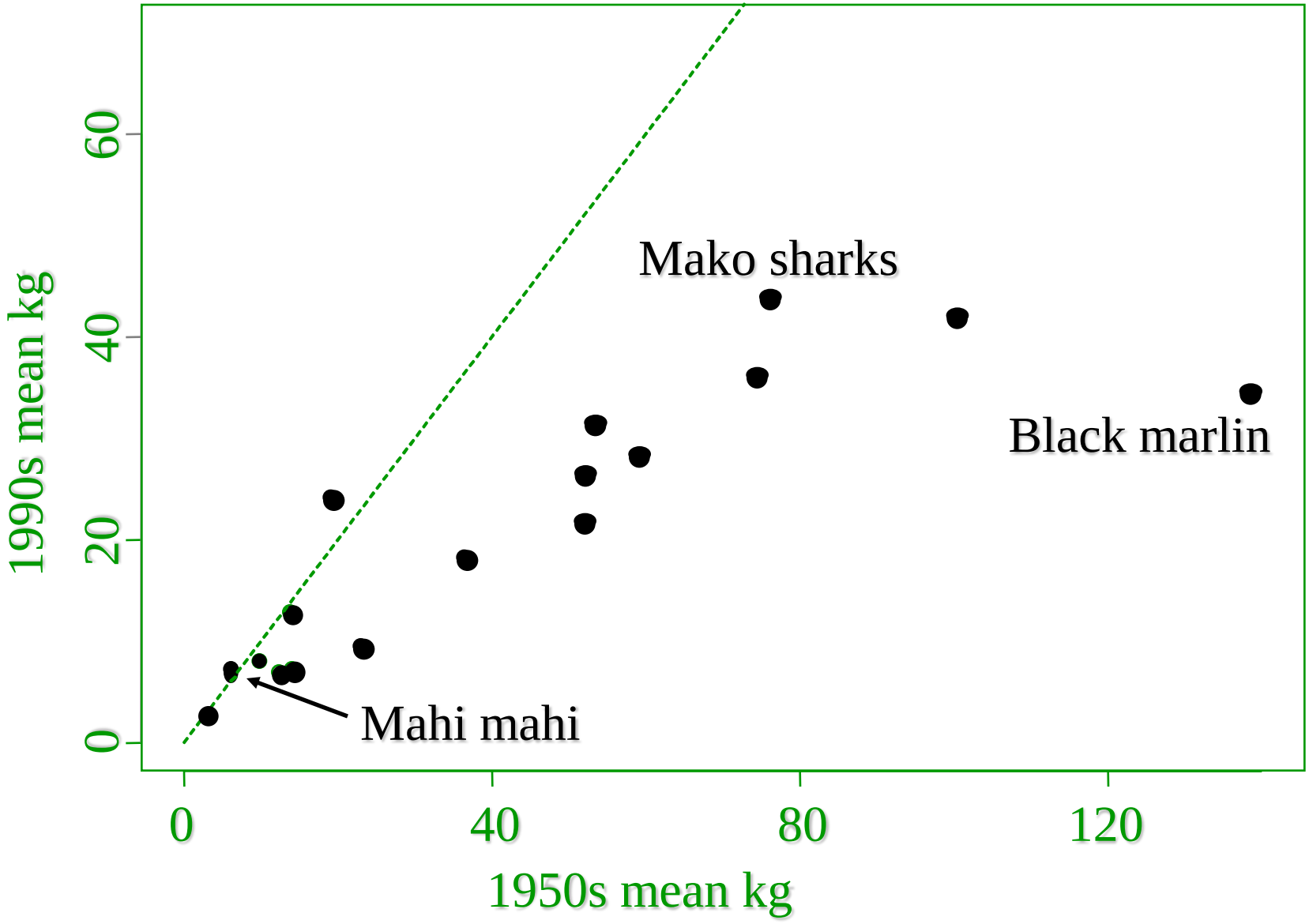
Figure 3

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

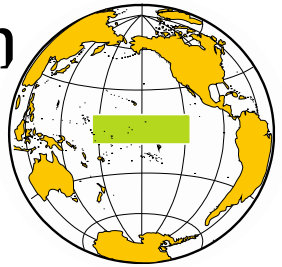
Species	Gangion	*n*
Swordfish	M	260
	B	128
Yellowfin tuna	M	9
	B	1
Mako shark	M	58
	B	39
Blue shark	M	225
	B	116
White marlin	M	47
	B	13
Dolphinfish	M	27
	B	10
Stingray	M	63
	B	31
Loggerhead turtle	M	40
	B	26
Total	M	729
	B	364

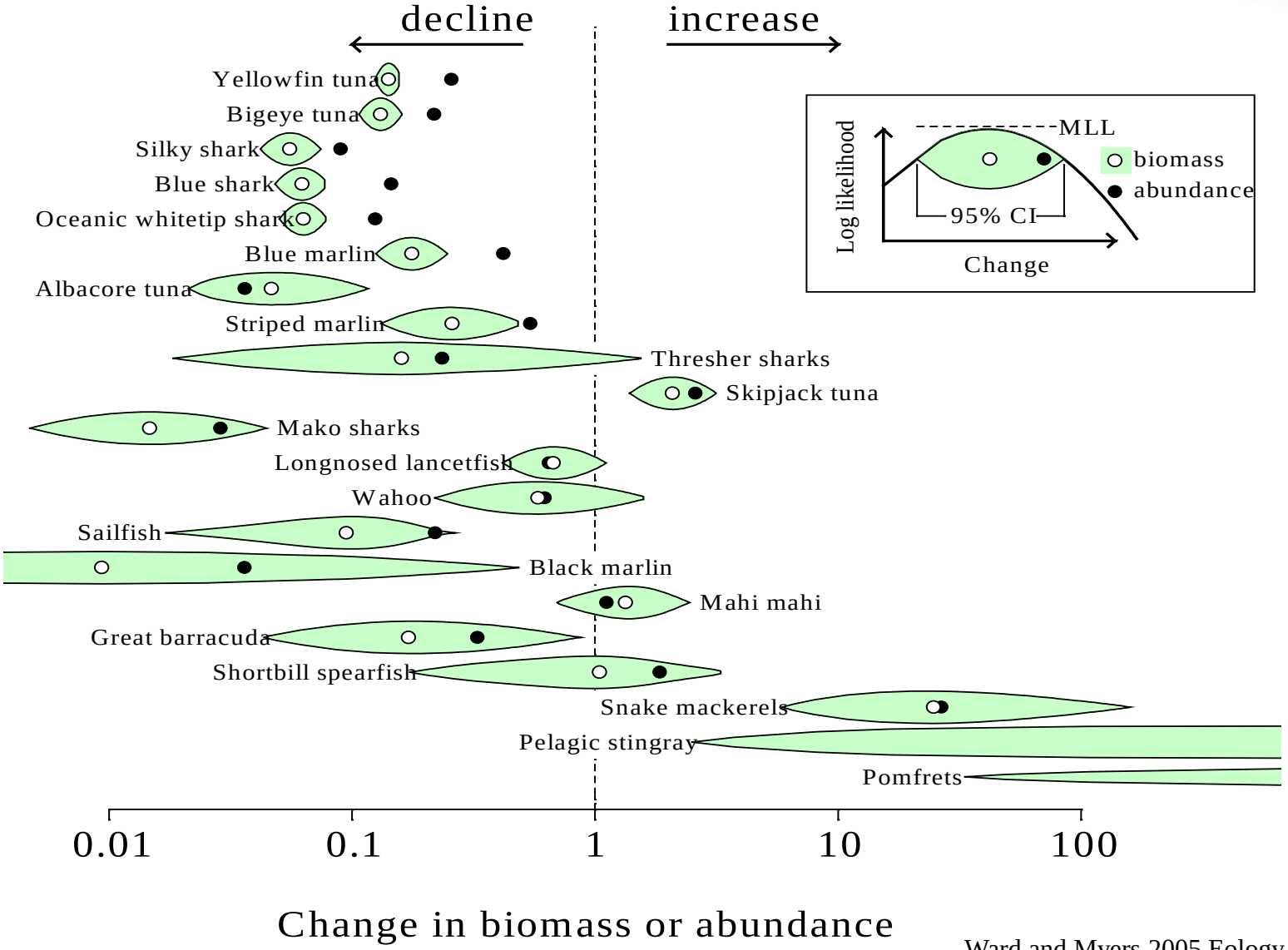

Hawaii
1950s
20°N
0°
20°S
Hooks
0.7 thousand
1.4 thousand
2.8 thousand
1990s
20°N
0°
20°S
Hooks
35 thousand
70 thousand
140 thousand
TAO mooring
Study area
180°E
160°W
140°W
120°W

Change in body size

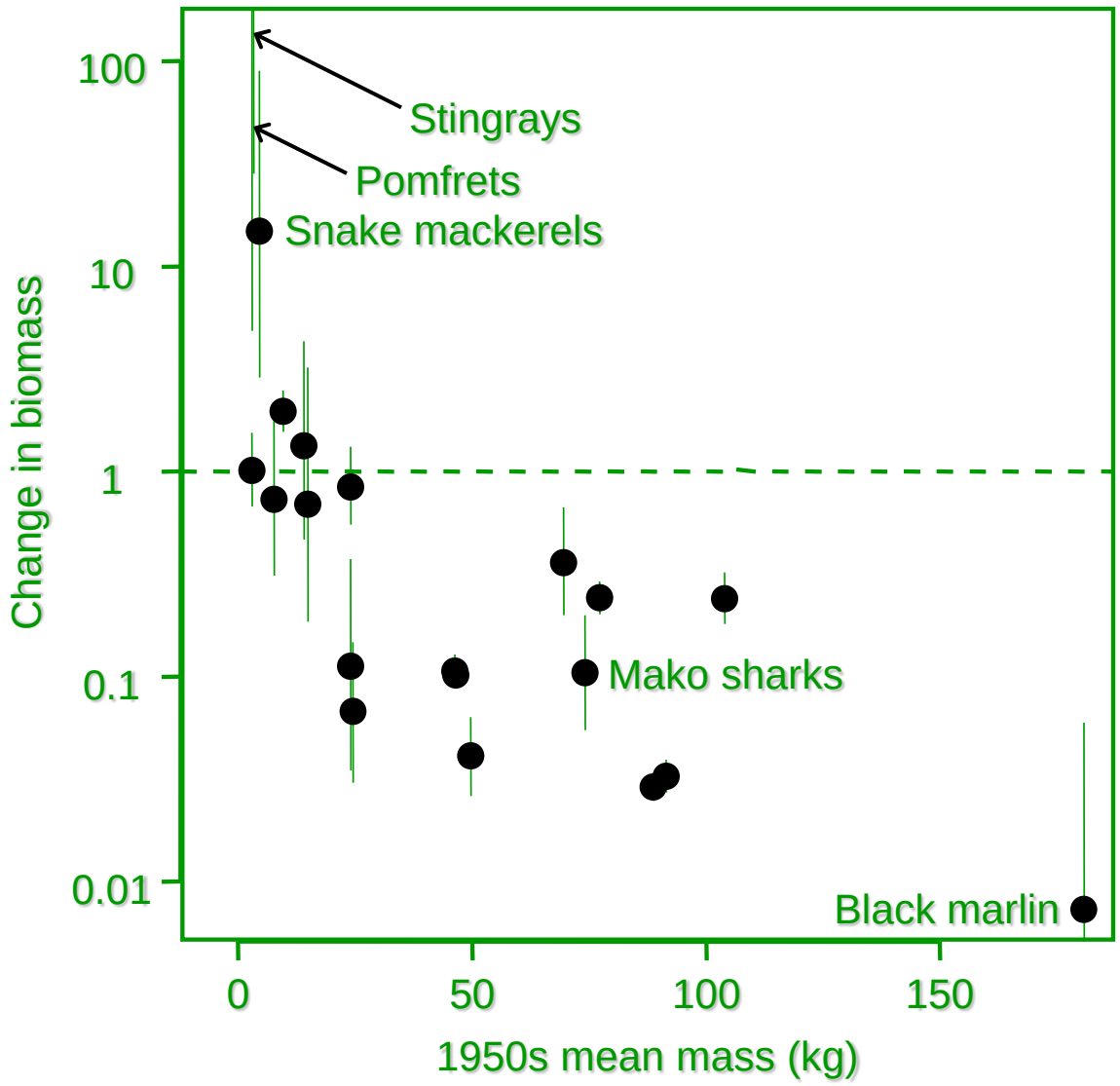


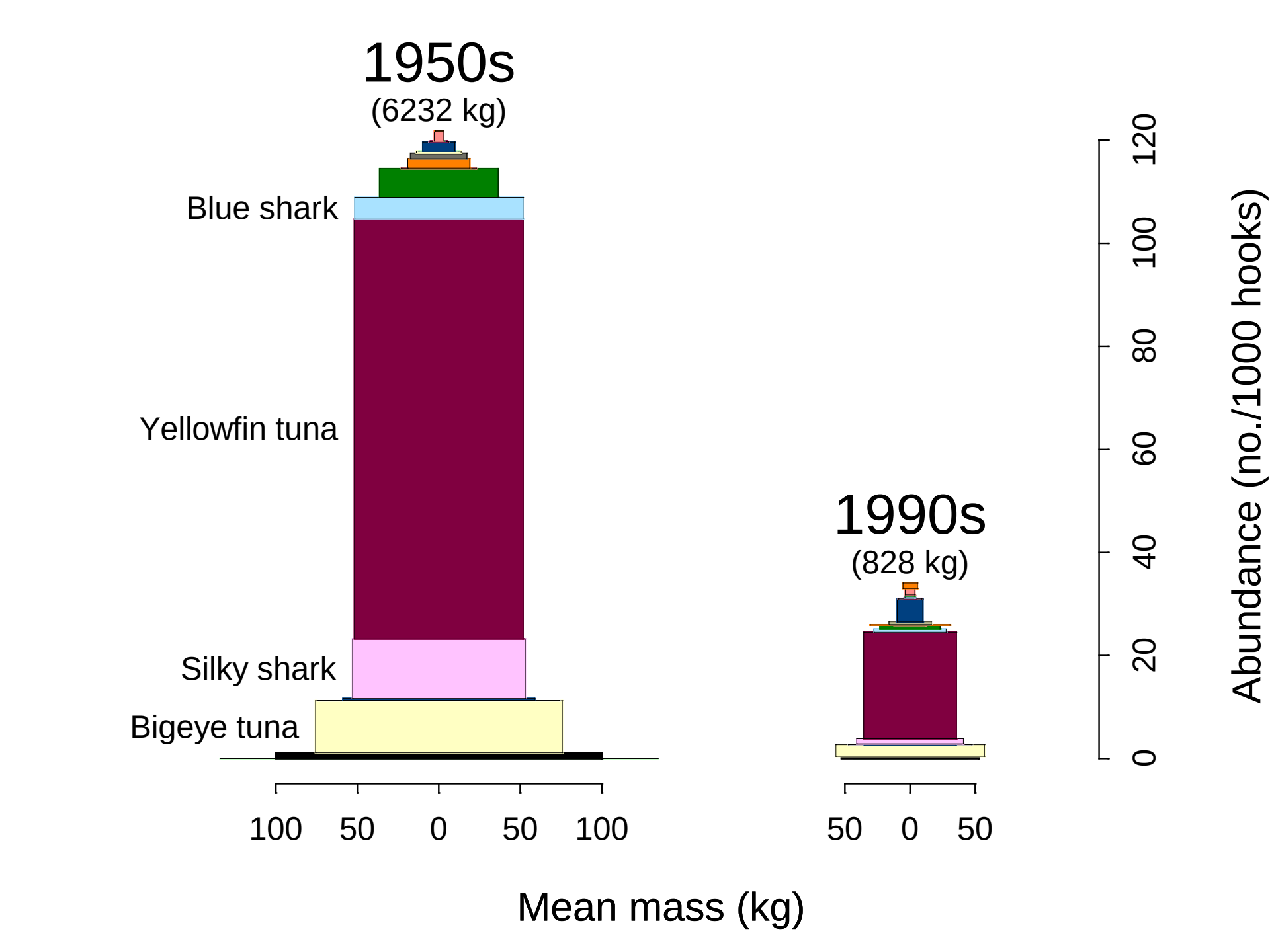
Analysis repeated using independent research data





Ward and Myers 2005 Eology


Stingrays
Pomfrets
Snake mackerels
Mako sharks
Black marlin
100
10
1
0.1
0.01
Change in biomass
0
50
100
150
1950s mean mass (kg)


1950s
(6232 kg)
Blue shark
Yellowfin tuna
Silky shark
Bigeye tuna
100
50
0
50
100
1990s
(828 kg)
50
0
50
Mean mass (kg)
0
20
40
60
80
100
120
Abundance (no./1000 hooks)

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 *et al.* (2001)	Pacific
	High	no	Mattews *et al*. (1977)	Atlantic
Yellowfin tuna	High	low	Moteki *et al.* (2001)	Pacific
	High	low	Mattews *et al*. (1977)	Atlantic
Albacore	High	High	Mattews *et al*. (1977)	Atlantic
Sword fish	High	low	Moteki *et al.* (2001)	Pacific

PRELIMINARY STOMACH CONTENTS ANALYSIS OF PELAGIC FISH COLLECTED BY SHOYO-MARU 2002 RESEARCH CRUISE IN THE ATLANTIC OCEAN

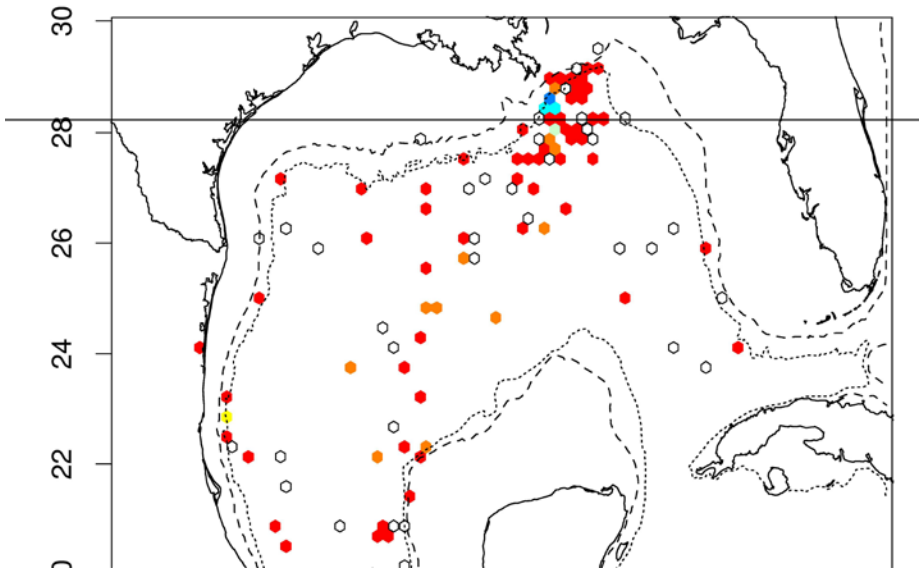
Keisuke Satoh[1], Kotaro Yokawa[1], Hirokazu Saito[1], Hiromasa Matsunaga[1], Hiroaki Okamoto[1] and Yuji Uozumi[1]

Col. Vol. Sci. Pap. ICCAT, 56(3): 1096-1114 (2004)

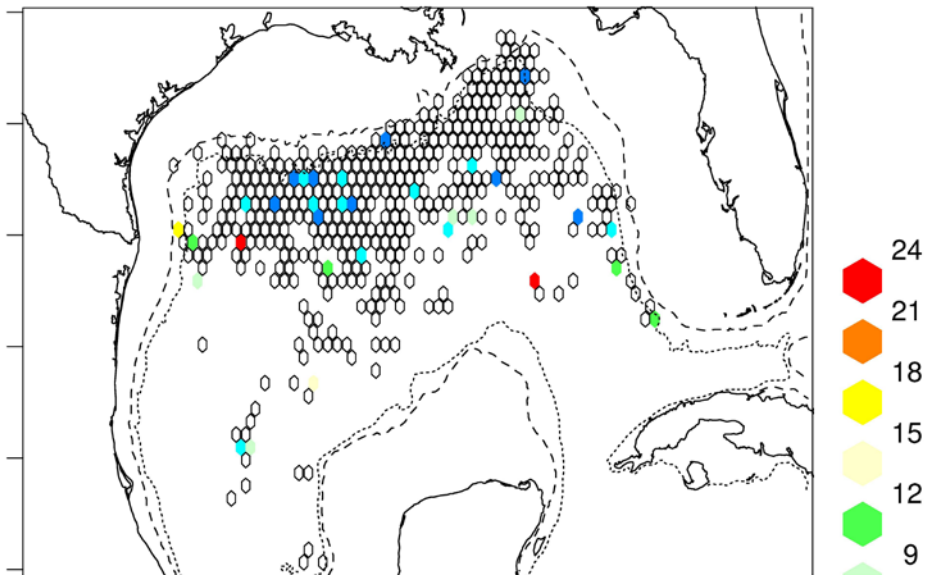
Loss of sharks in the Gulf of Mexico

300 fold decline – no one noticed

[redacted]



1950's

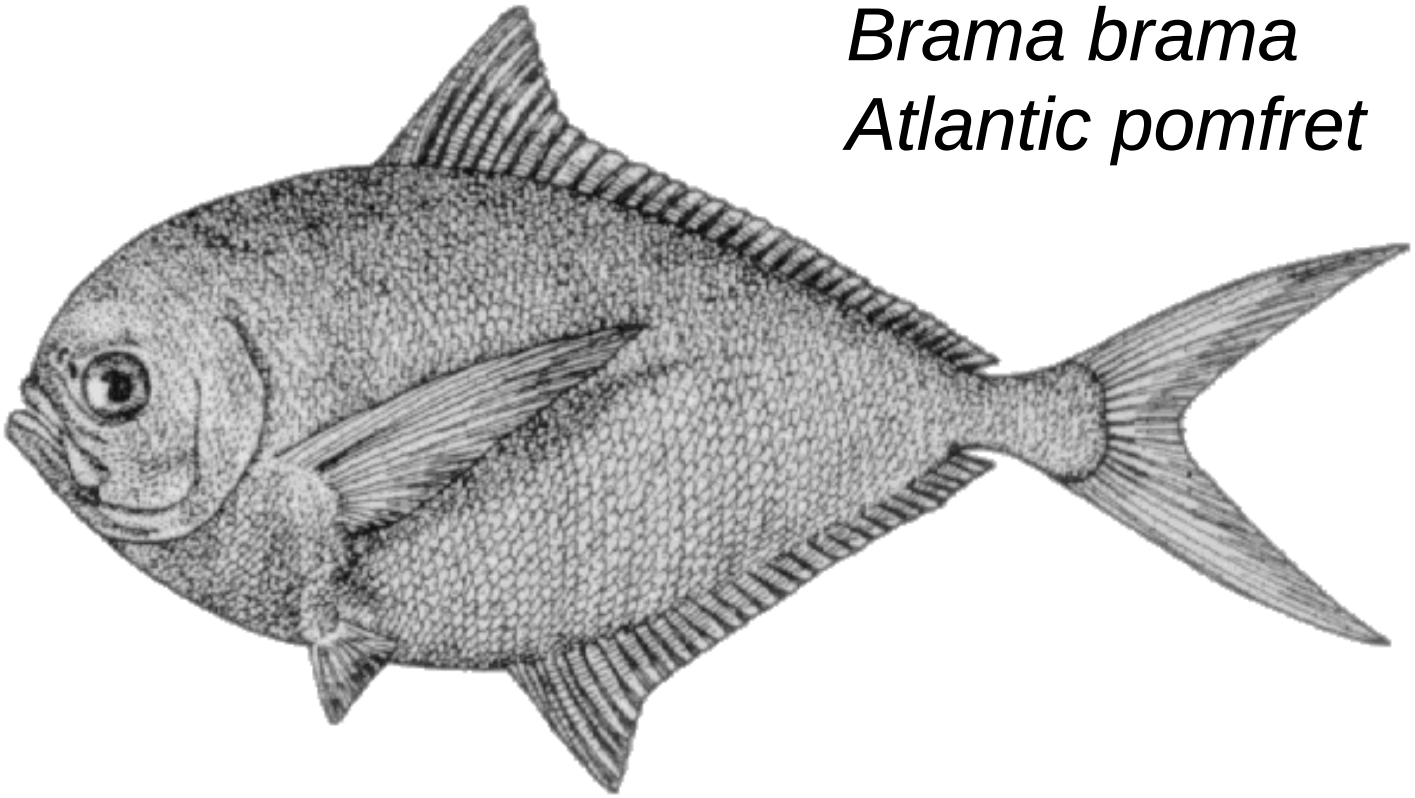


1990's

Oceanic Whitetip captures per 10,000 hooks

Many thanks to NMFS for data and advice

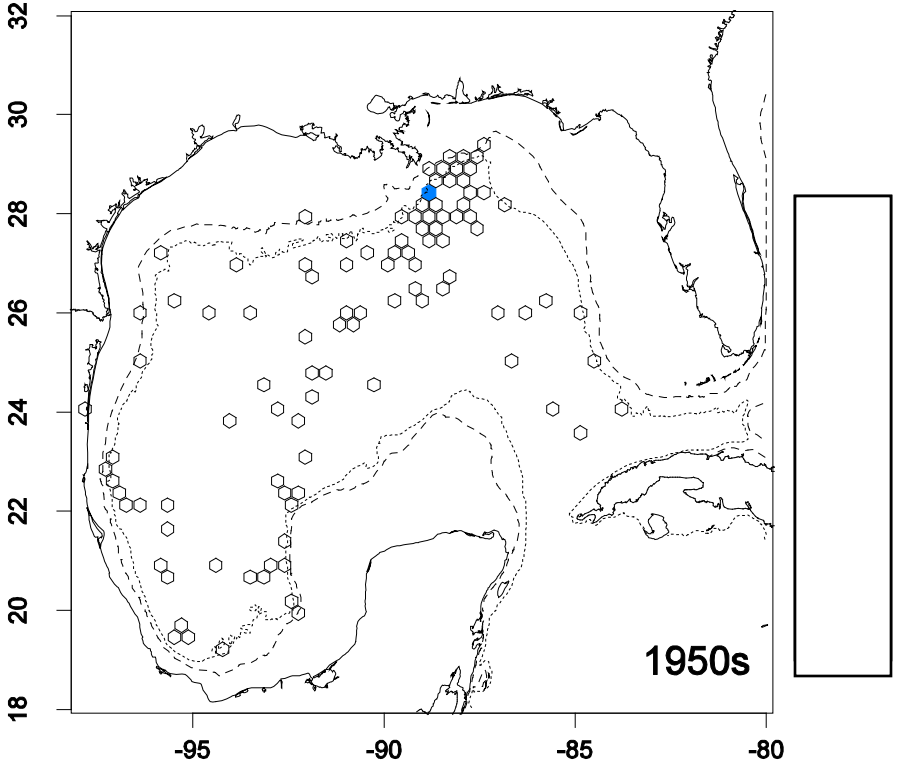
What about prey fish?

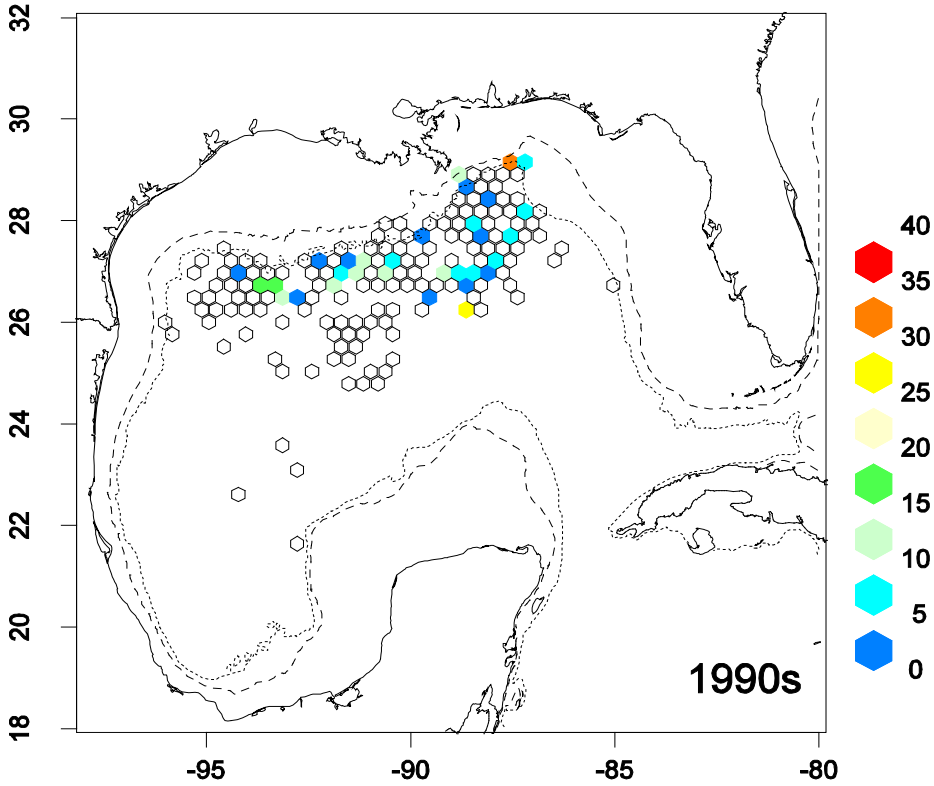


Brama brama
Atlantic pomfret

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

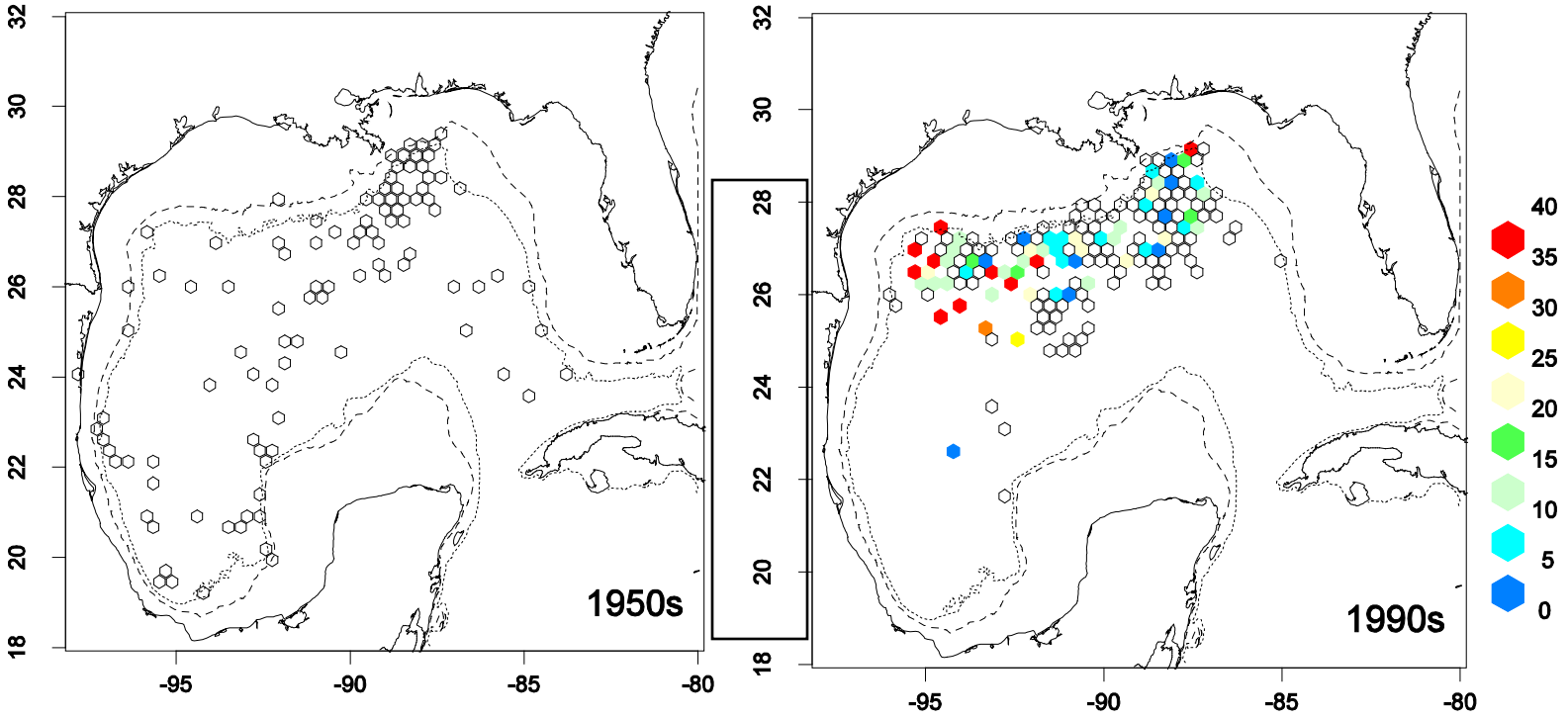
Many thanks to NMFS for data and advice

The Rise of the Marine Mesopredators

Pelagic Sting Ray
Pteroplatytrygon violacea

Photos from Phillip Colla, photography

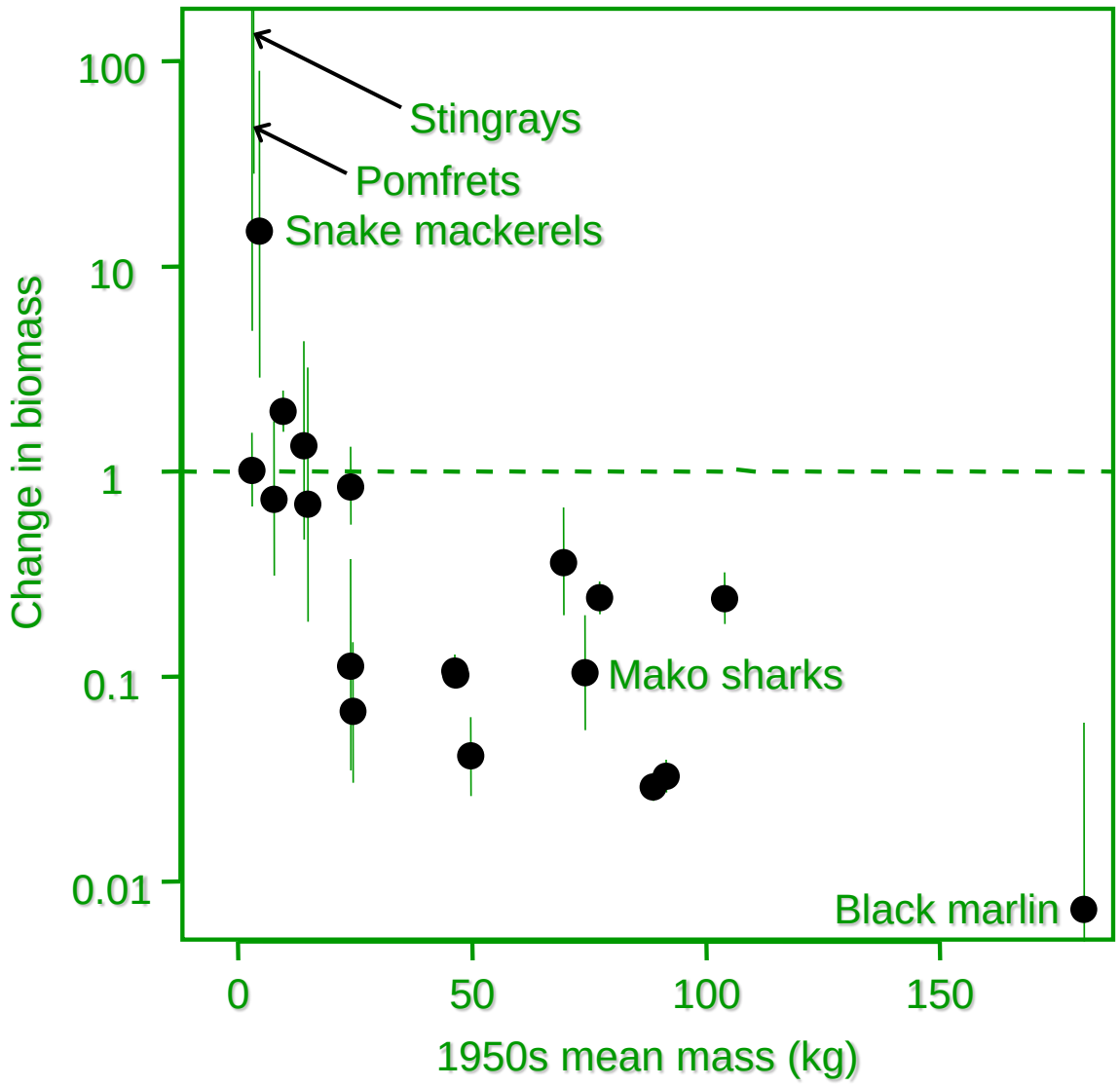
Explosion of Pelagic Stingrays in the Gulf of Mexico
~1000 fold increase – no one noticed

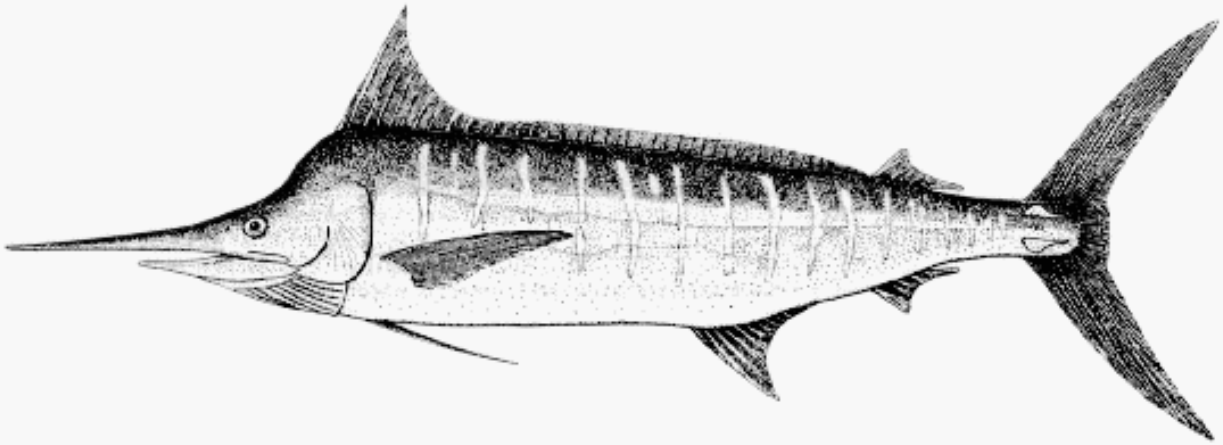


1950’s 1990’s

Pelagic stingray captures per 10,000 hooks

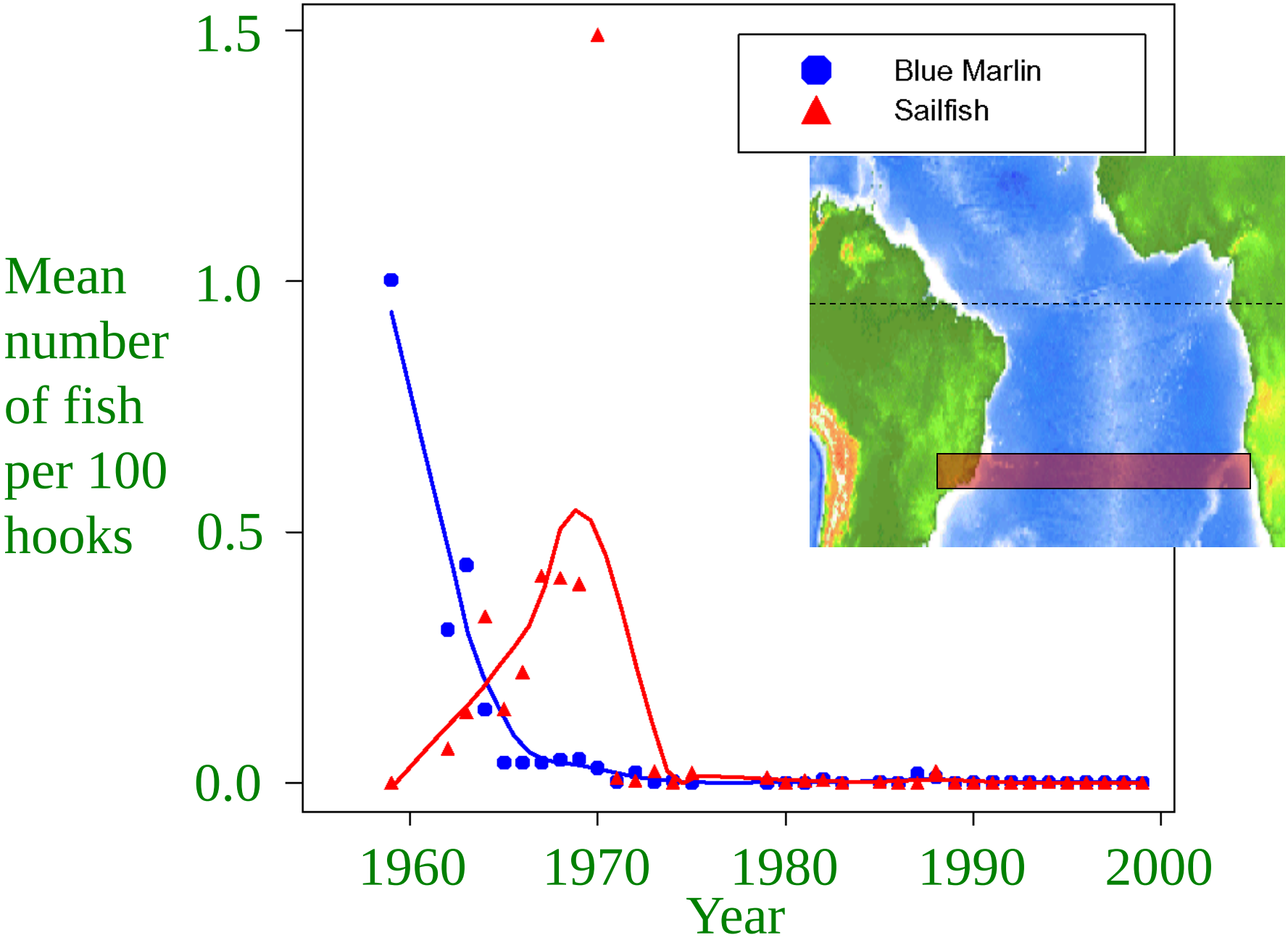
Many thanks to NMFS for data and advice

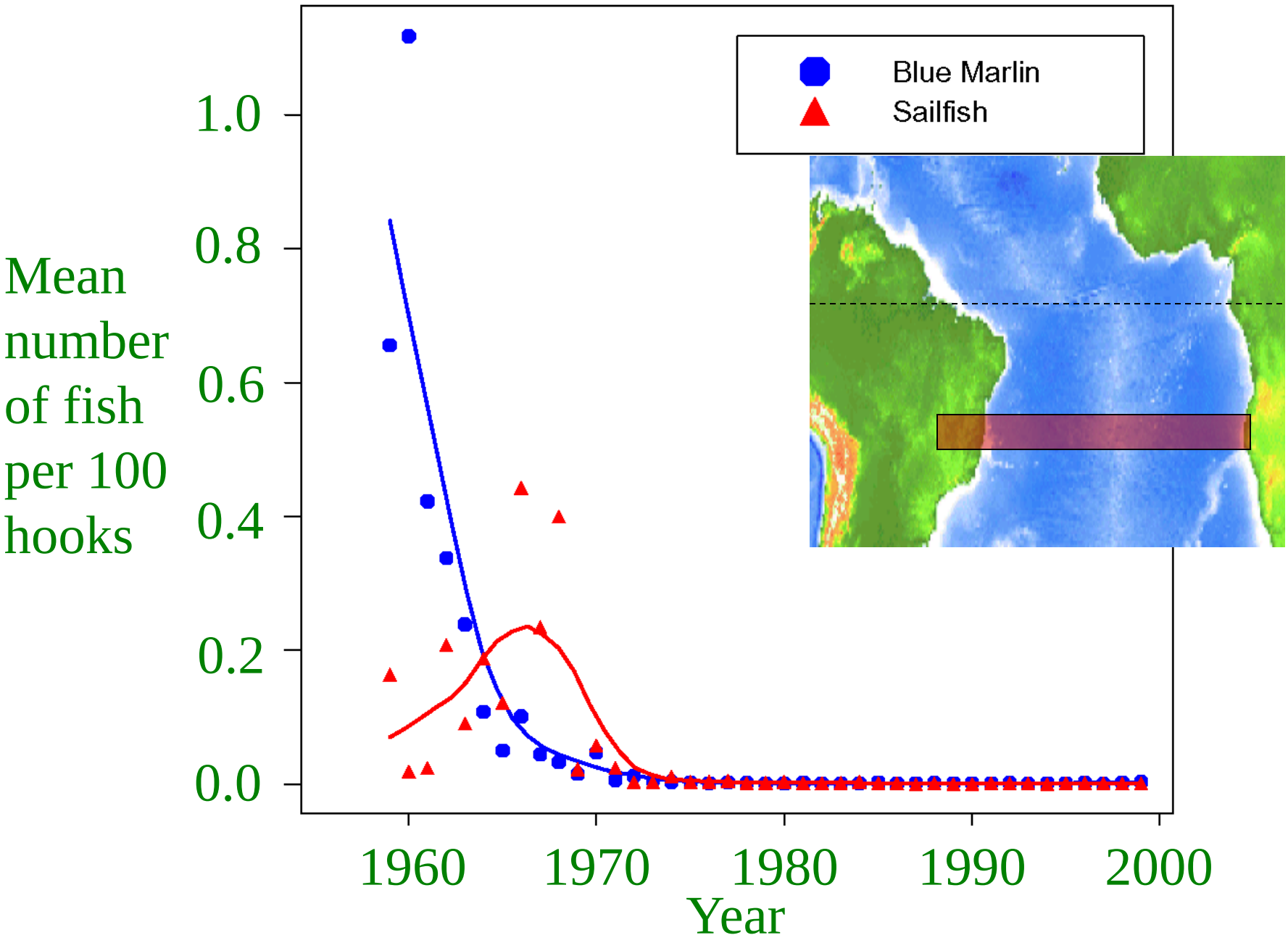

Stingrays
Pomfrets
Snake mackerels
Mako sharks
Black marlin
100
10
1
0.1
0.01
Change in biomass
0
50
100
150
1950s mean mass (kg)

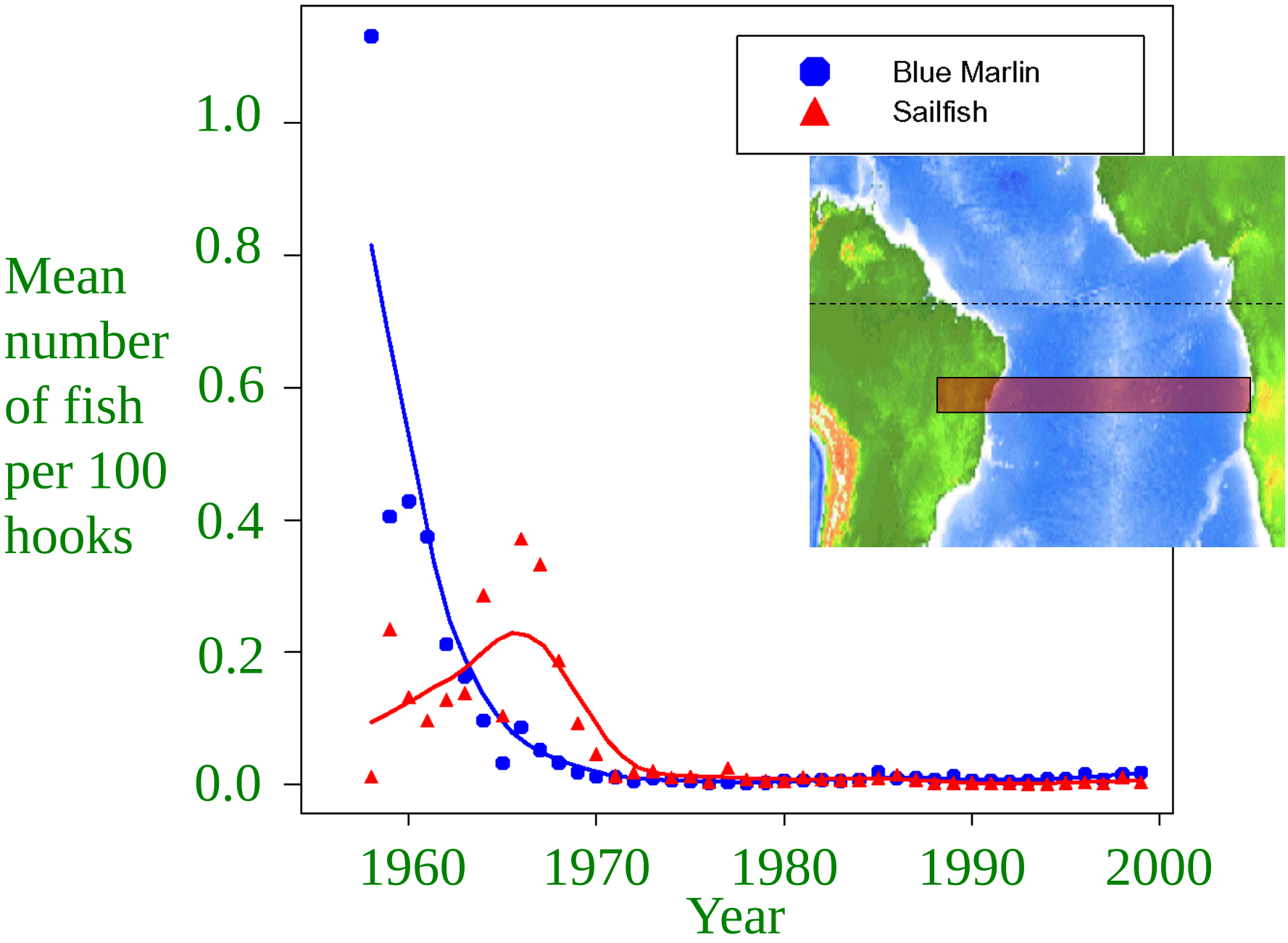


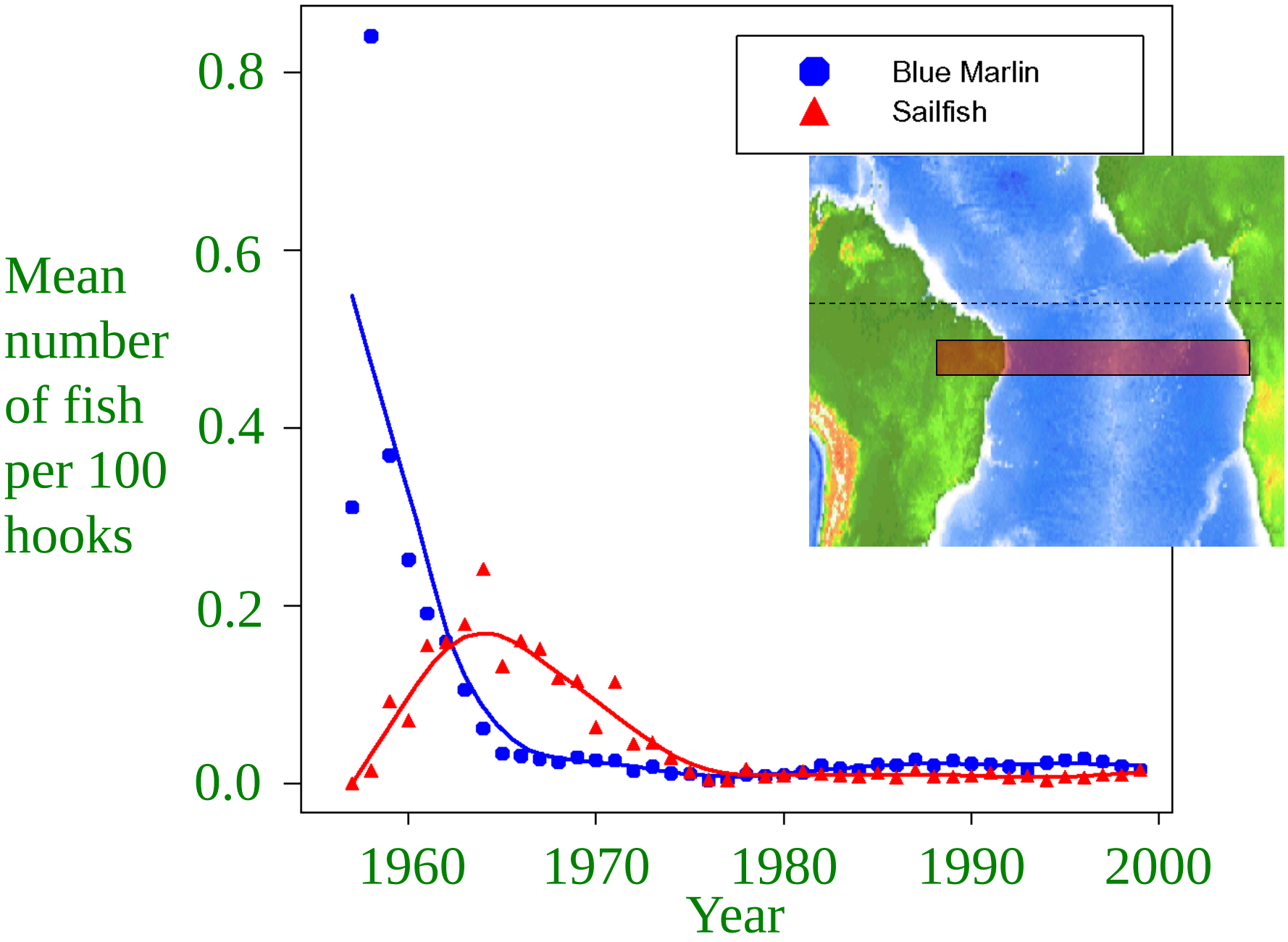
Blue marlin (*Makaira nigricans)*

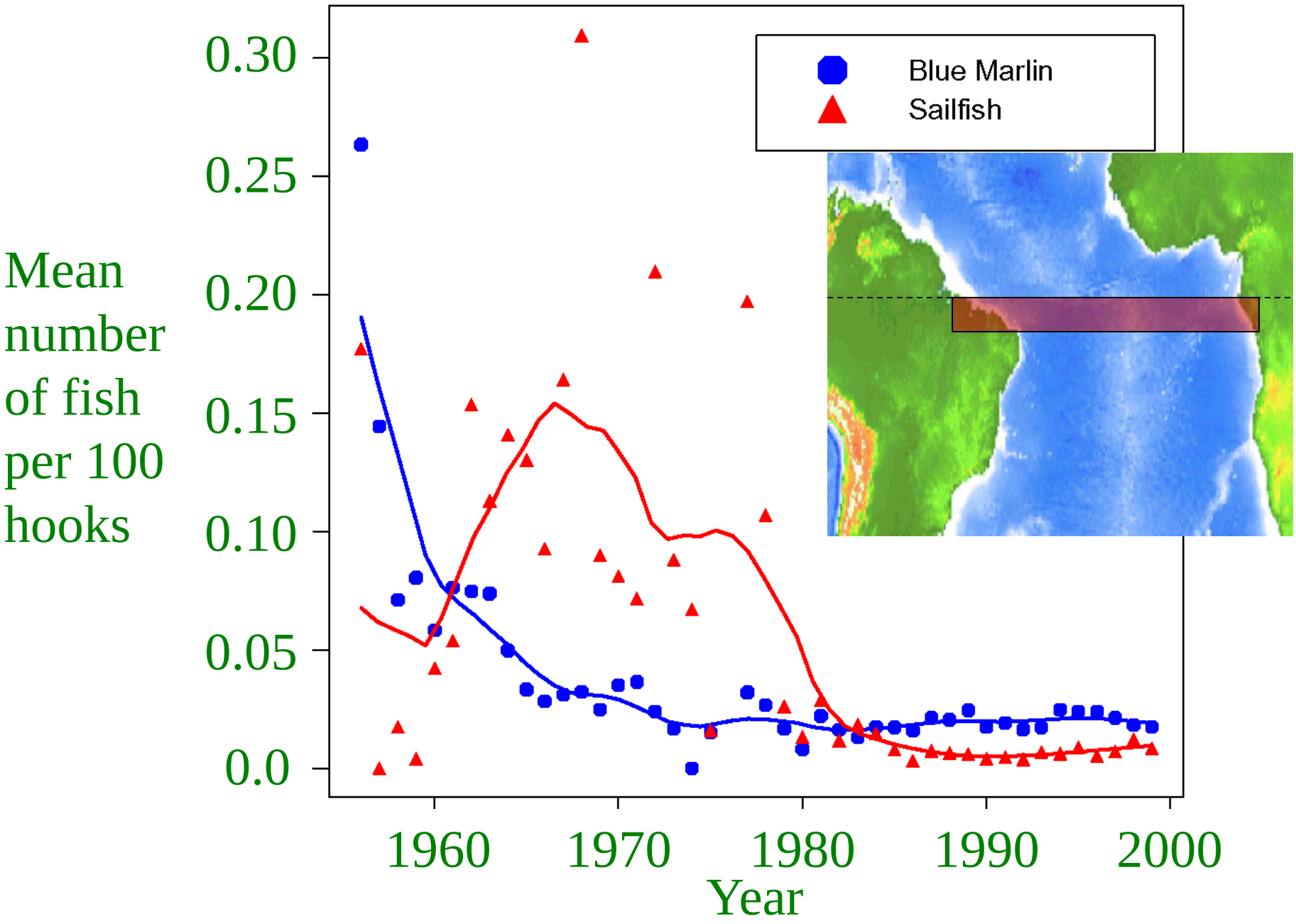
Sailfish (*Istiophorus albicans)*

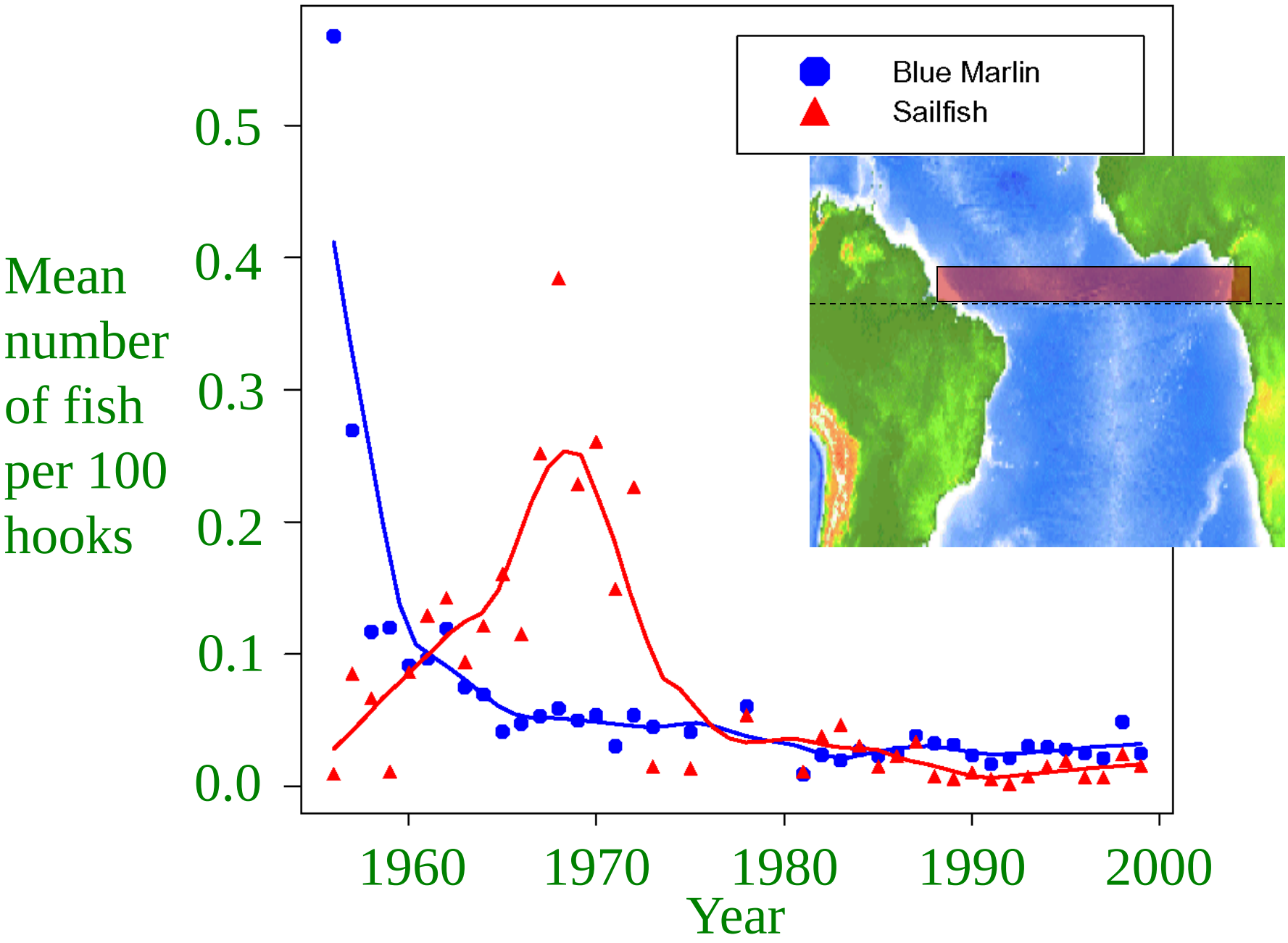

Mean number of fish per 100 hooks
1.5
1.0
0.5
0.0
Blue Marlin
Sailfish
1960
1970
1980
1990
2000
Year


Blue Marlin
Sailfish
Mean number of fish per 100 hooks
1.0
0.8
0.6
0.4
0.2
0.0
1960
1970
1980
1990
2000
Year


Blue Marlin
Sailfish
Mean number of fish per 100 hooks
1.0
0.8
0.6
0.4
0.2
0.0
1960
1970
1980
1990
2000
Year


Blue Marlin
Sailfish
Mean number of fish per 100 hooks
0.0
0.2
0.4
0.6
0.8
1960
1970
1980
1990
2000
Year

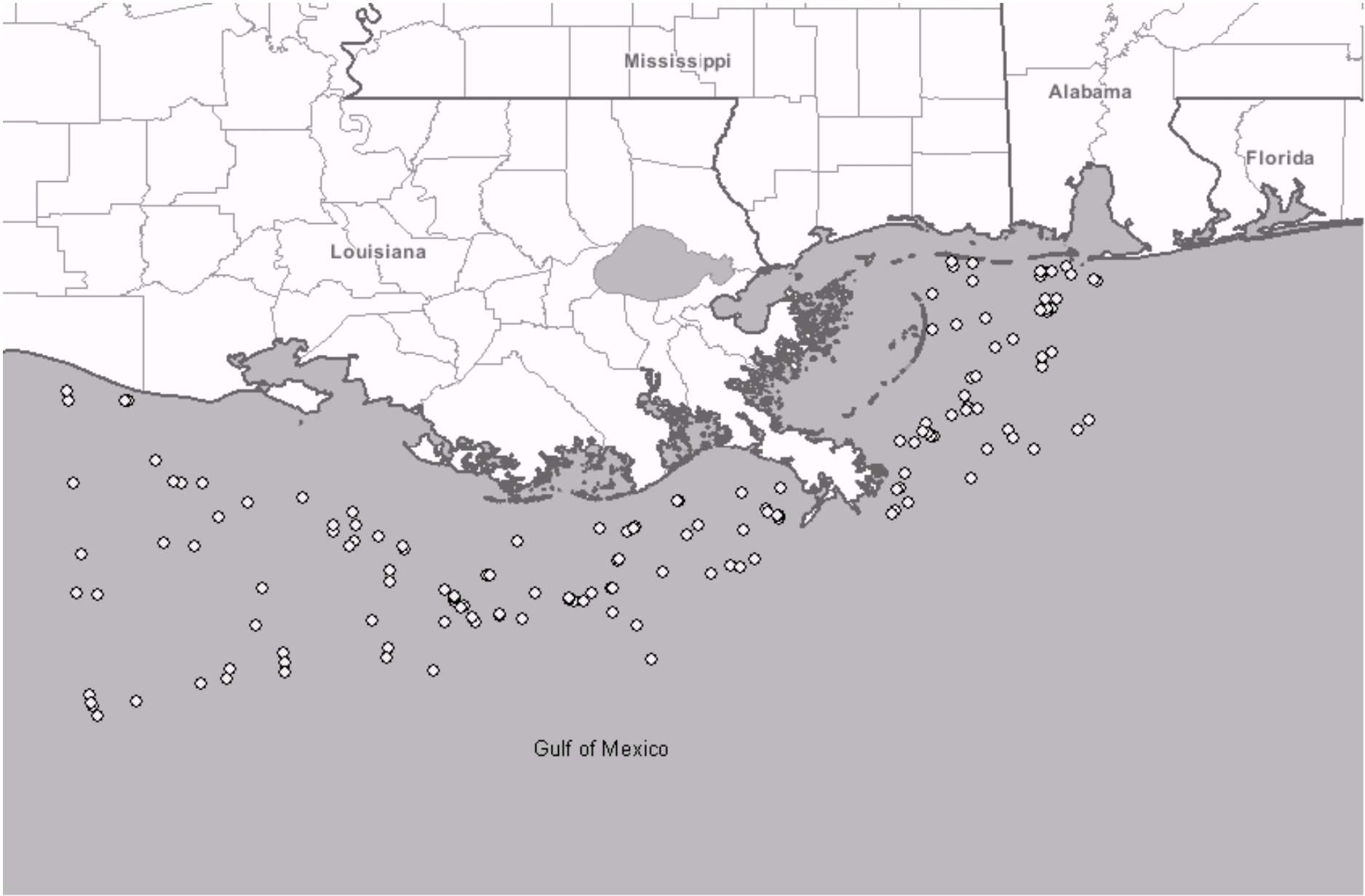

Mean number of fish per 100 hooks
0.30
0.25
0.20
0.15
0.10
0.05
0.0
1960
1970
1980
1990
2000
Year
Blue Marlin
Sailfish

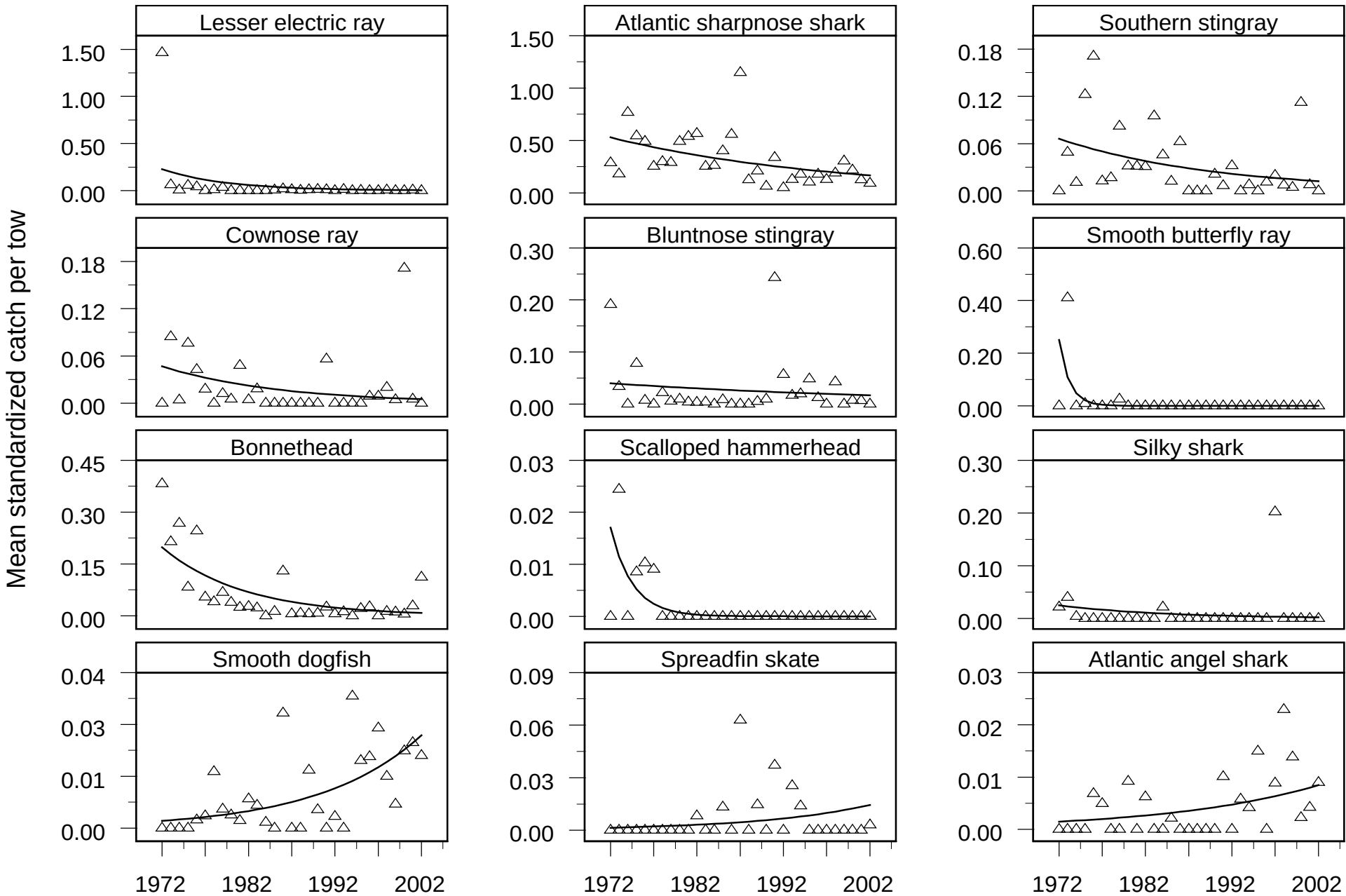

Blue Marlin
Sailfish
Mean number of fish per 100 hooks
0.0
0.1
0.2
0.3
0.4
0.5
1960
1970
1980
1990
2000
Year

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

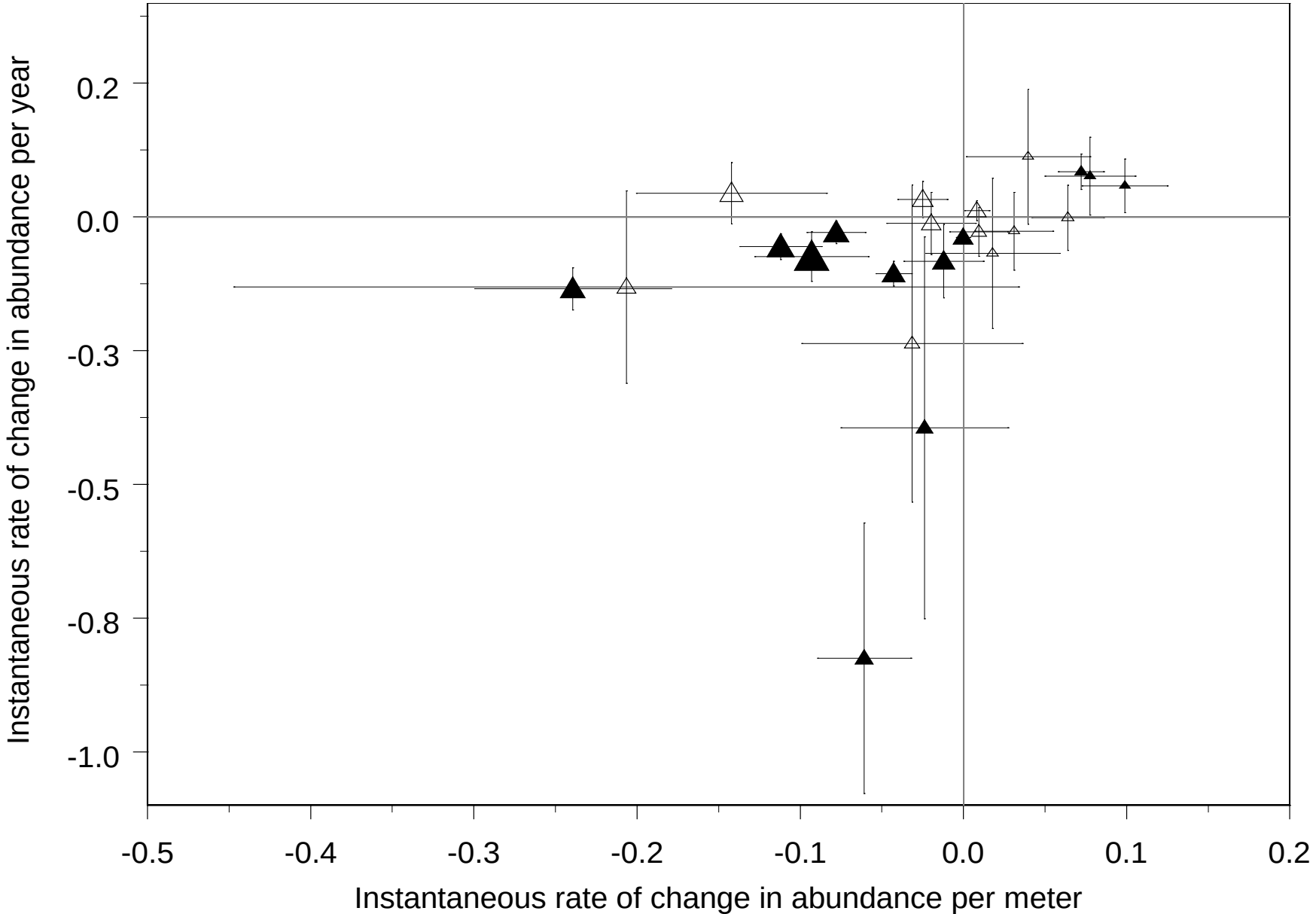
FMAP (Future of Marine Animal Populations)
part of the Sloan Census of Life http://www.fmap.ca
Pew Global Sharks Assessment http://www.globalsharks.ca

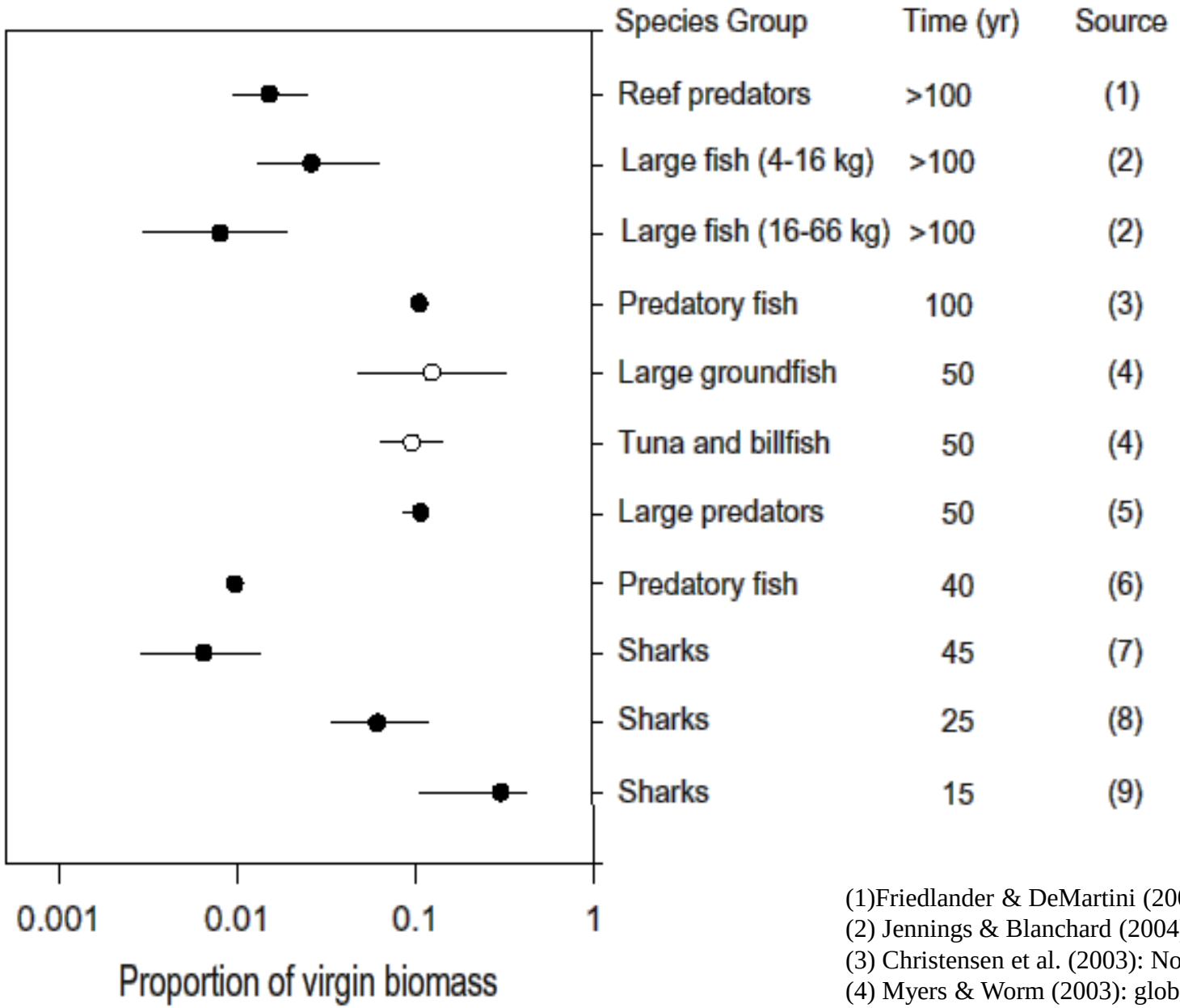
Is shrimp trawling driving sharks and rays extinct?




Mean standardized catch per tow
Lesser electric ray
Atlantic sharpnose shark
Southern stingray
Cownose ray
Bluntnose stingray
Smooth butterfly ray
Bonnethead
Scalloped hammerhead
Silky shark
Smooth dogfish
Spreadfin skate
Atlantic angel shark
1972
1982
1992
2002

Shallow species are going extinct
Deep species are increasing





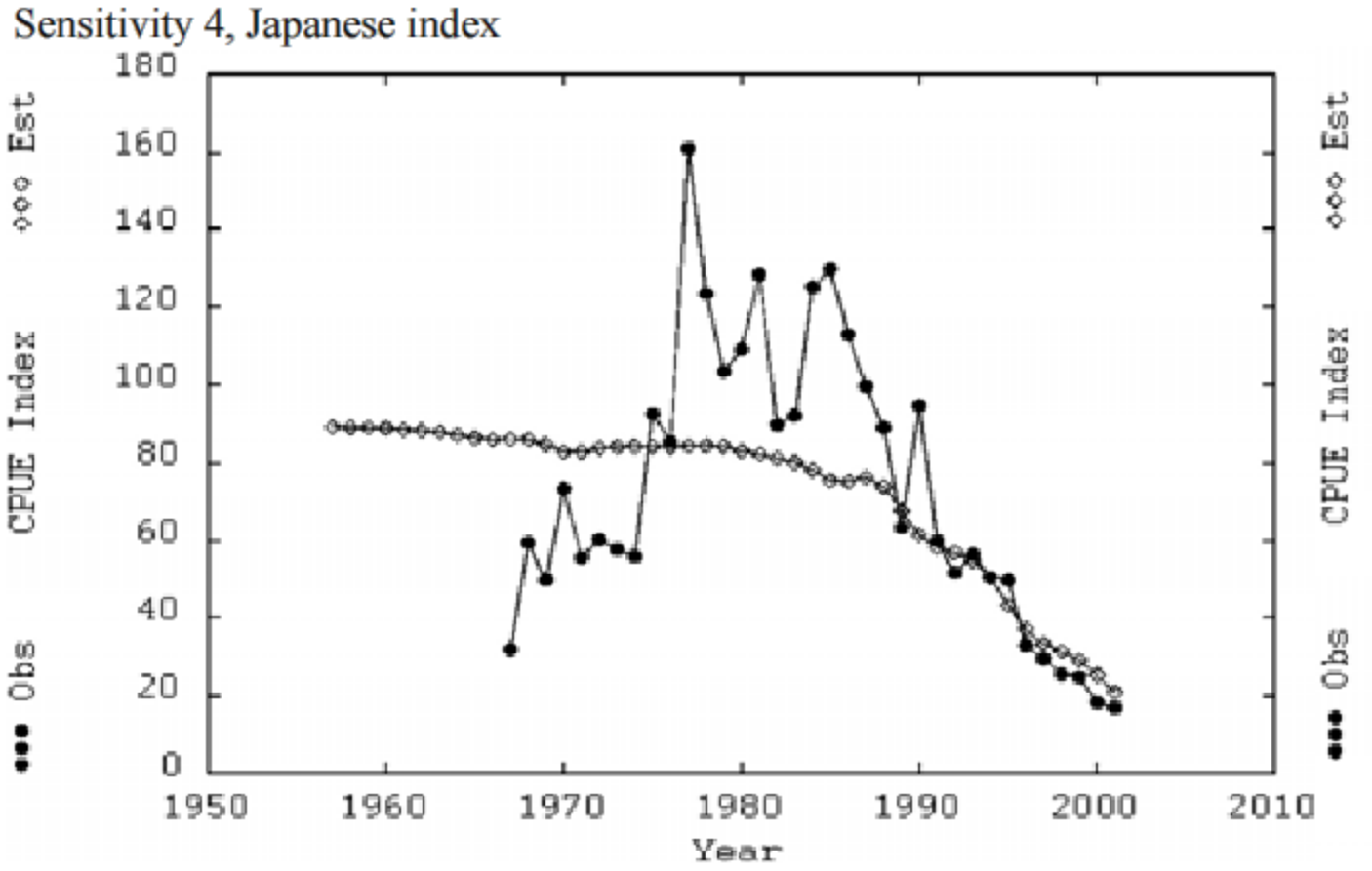
Source: Myers and Worm 2005.
Proc. R. Soc. Lond. B (2005)

(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.

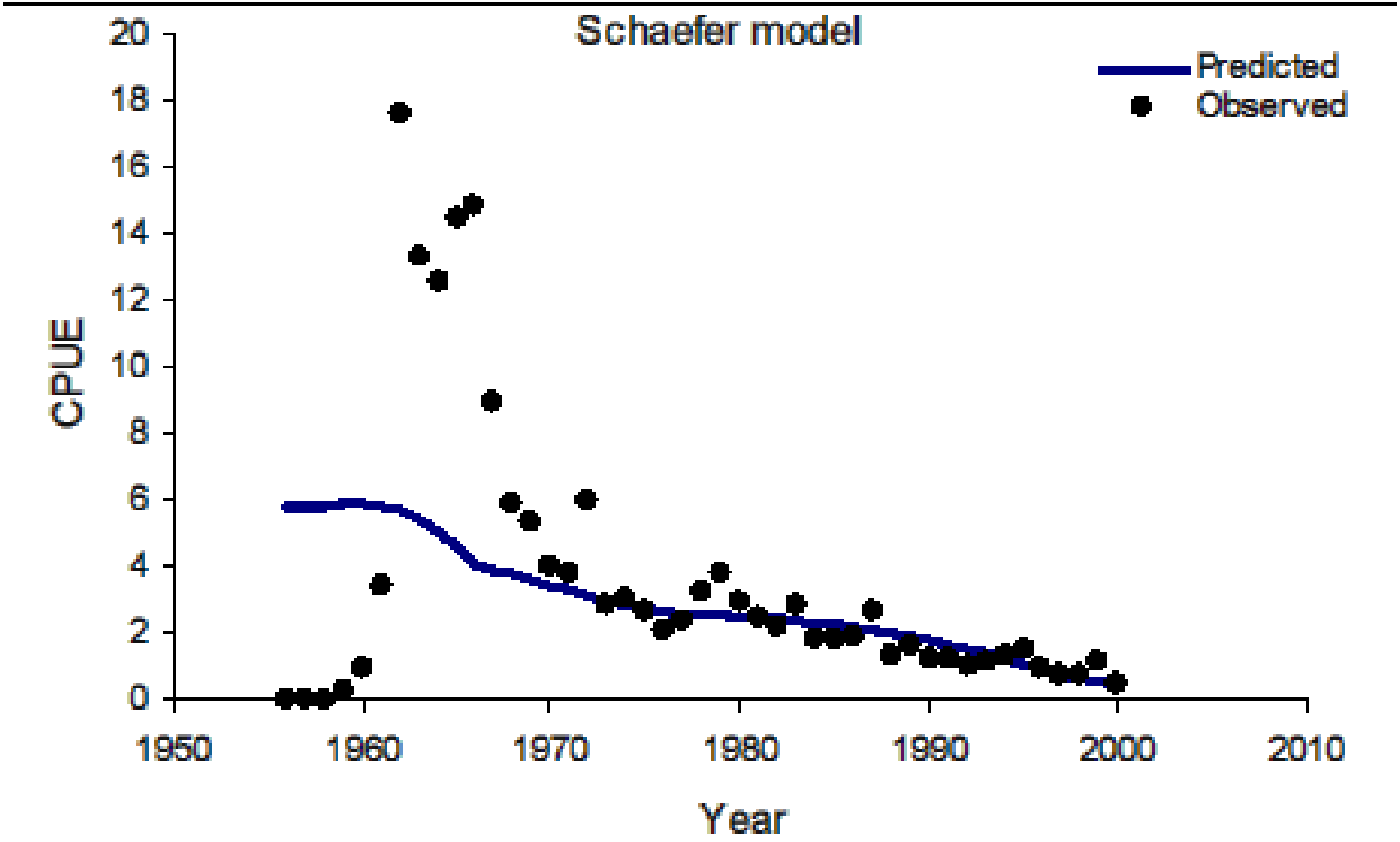
Not only have large predators declined by at least a fact
10, but mesopredators have often increased by at least a
factor of 10.

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.

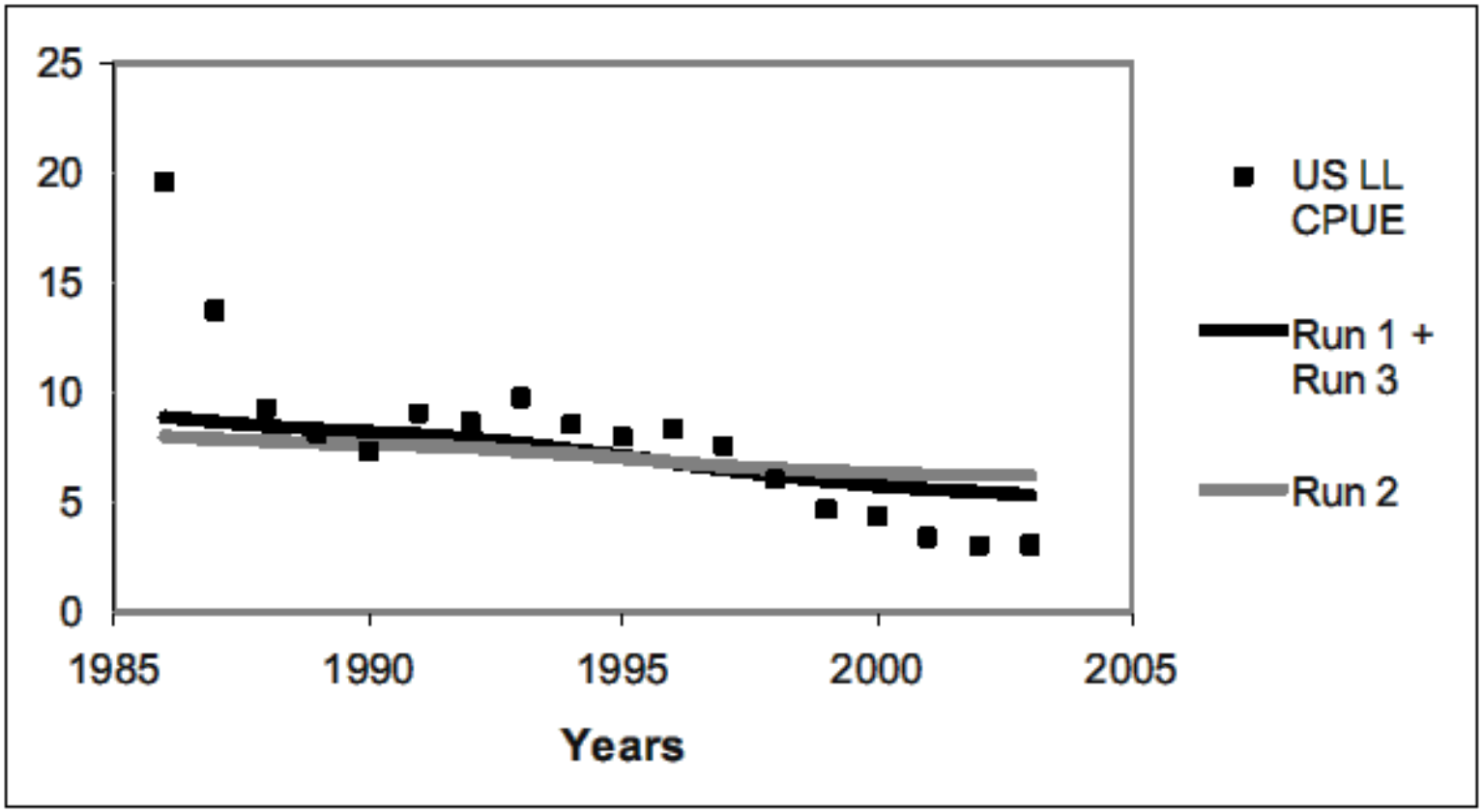
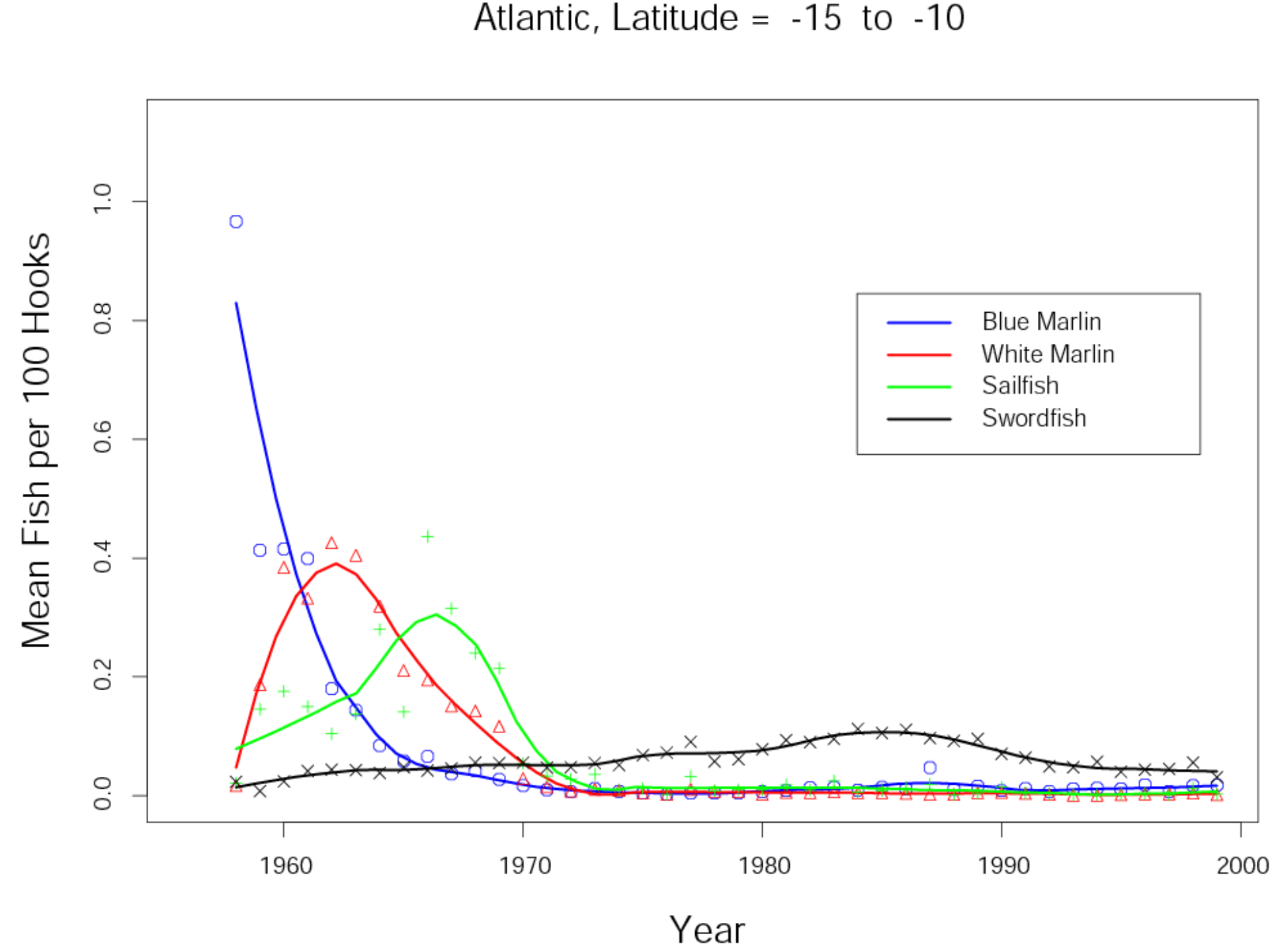
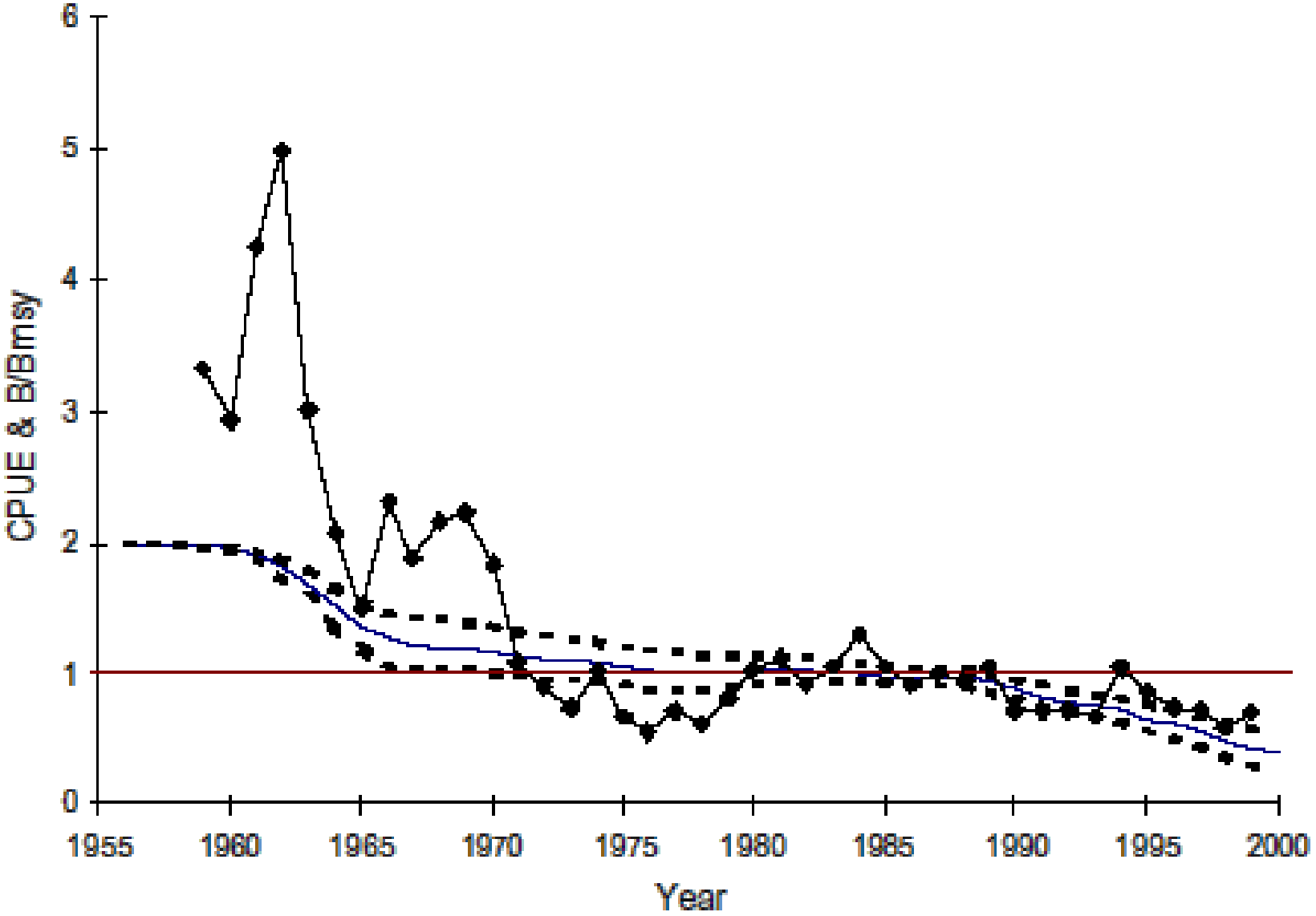


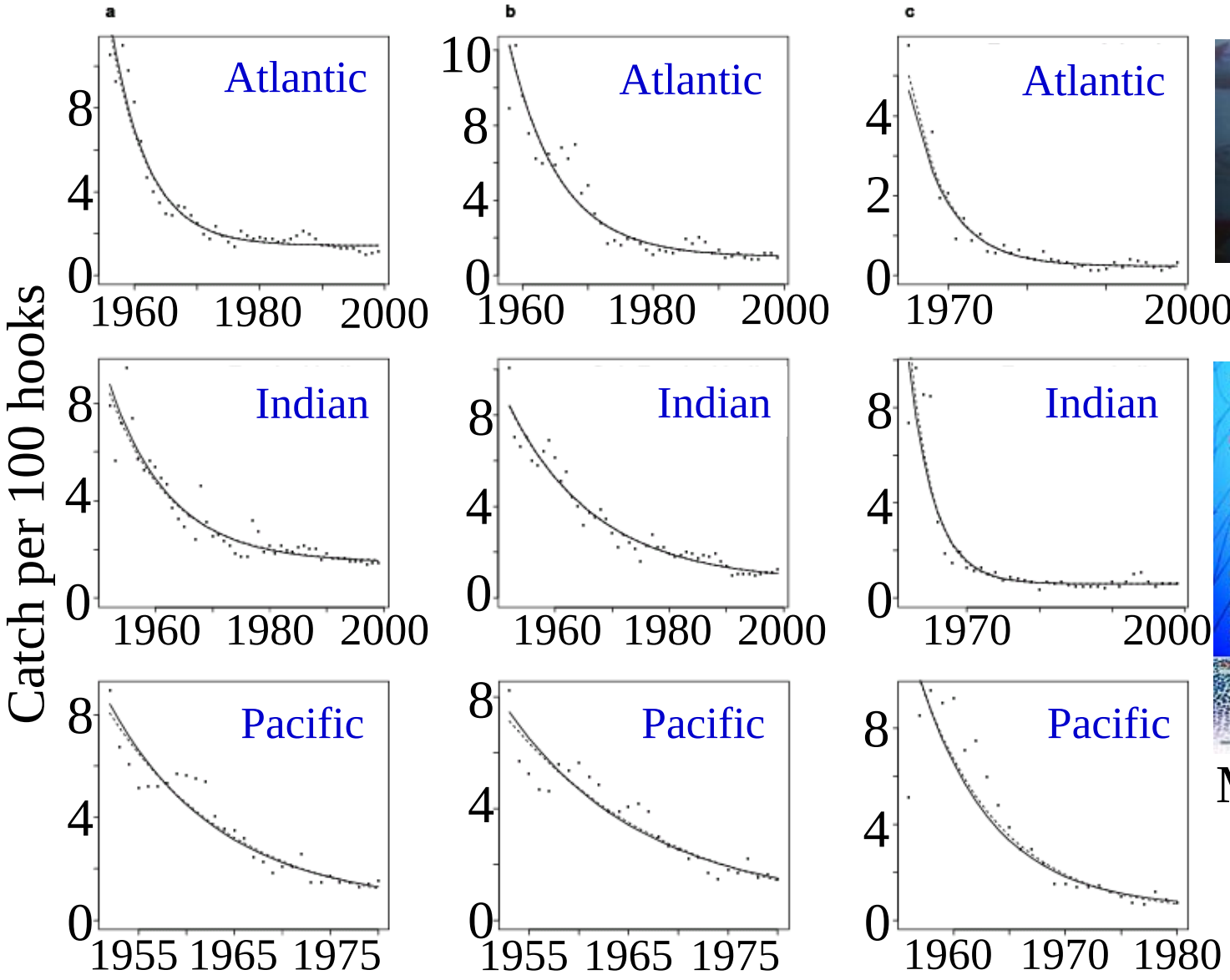
Figure 10 (above). Fit of the model to the North Atlantic blue shark CPUE data for each of the runs considered.


Atlantic, Latitude = -15 to -10
Mean Fish per 100 Hooks
0.0
0.2
0.4
0.6
0.8
1.0
1960
1970
1980
1990
2000
Year
Blue Marlin
White Marlin
Sailfish
Swordfish

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

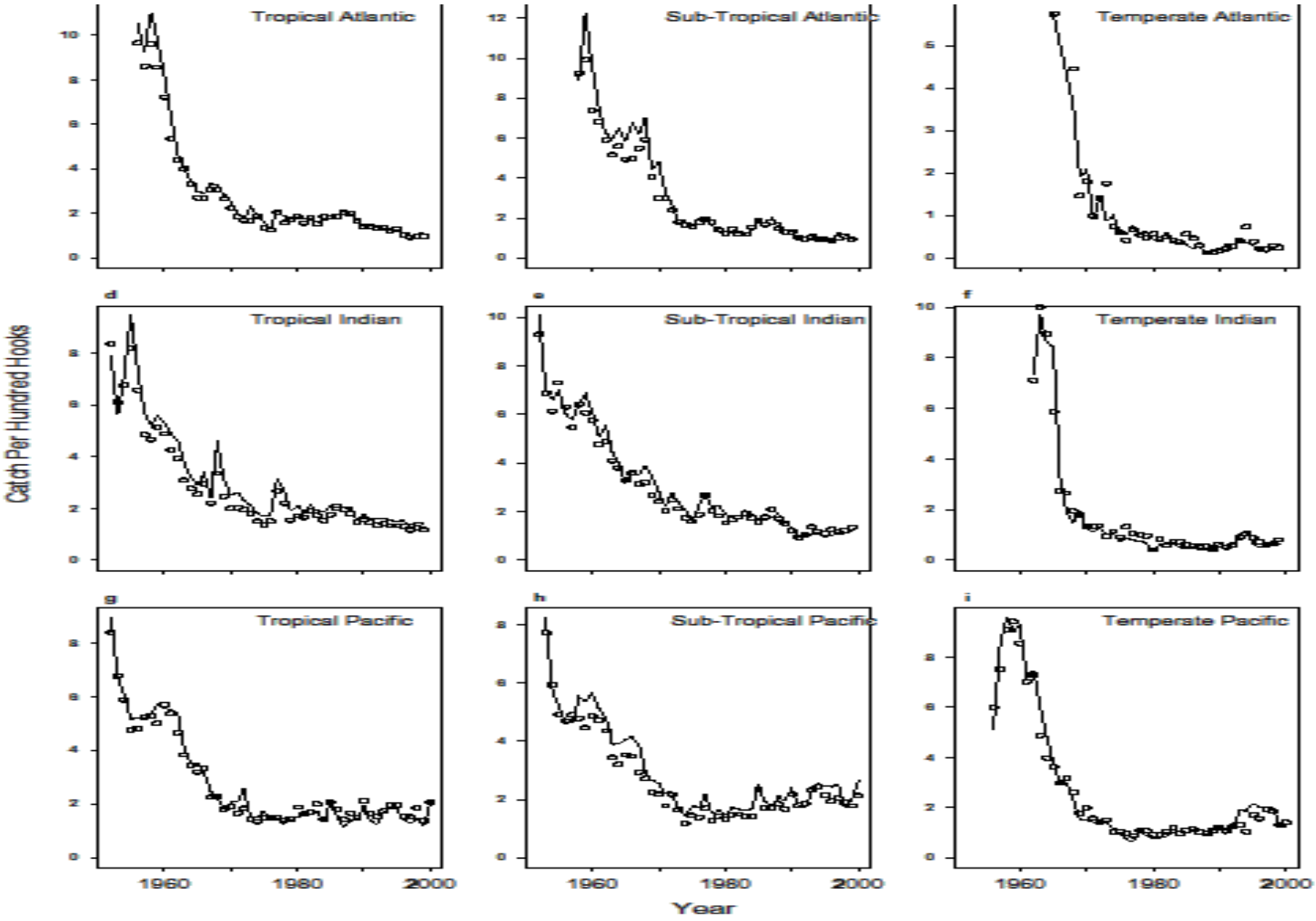


Common patterns of decline



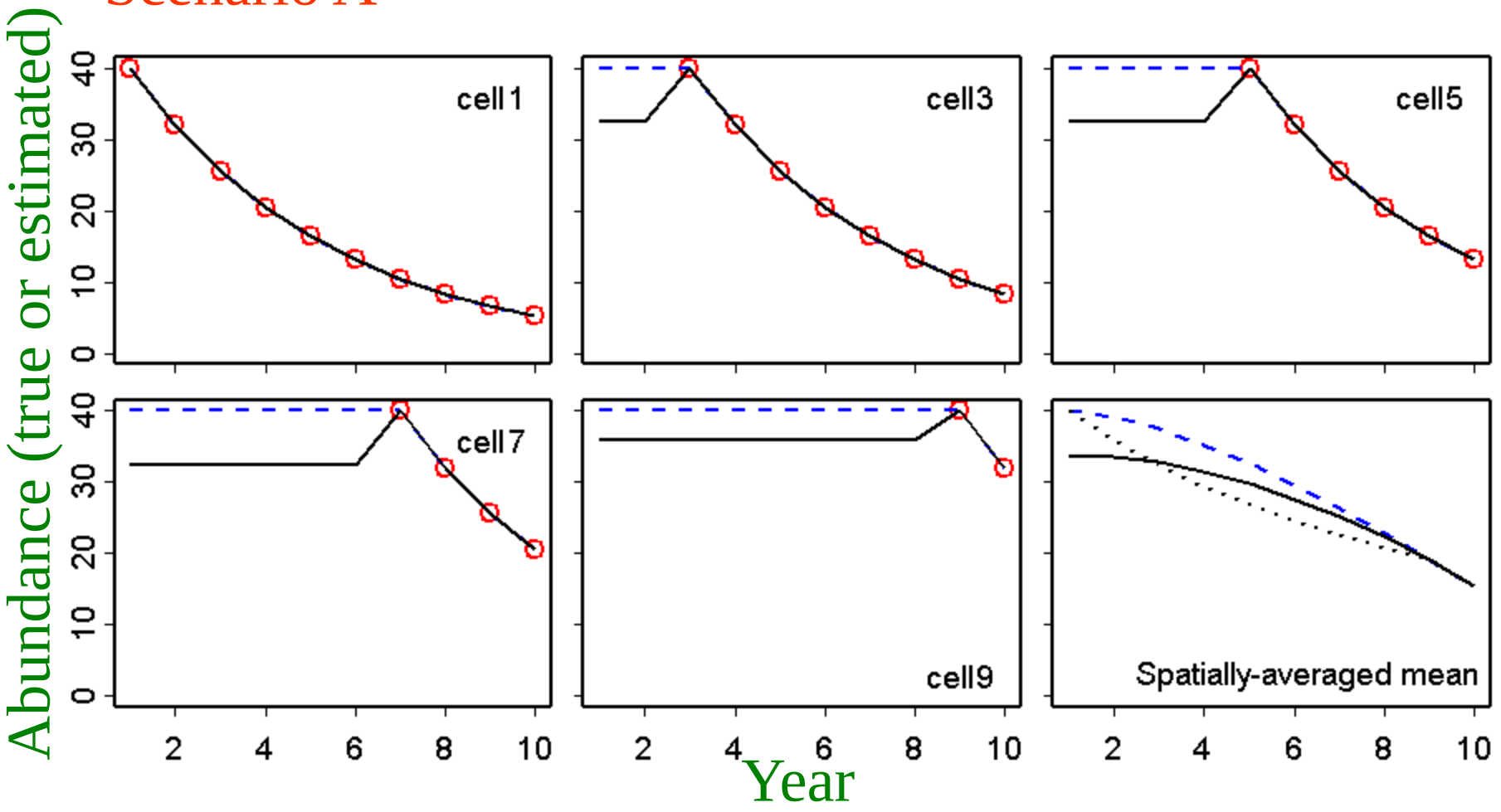
Myers and Worm (2003)

RED HERRING 1: RATIO ESTIMATION



RED HERRING 2: SPATIAL ESTIMATION

Scenario A



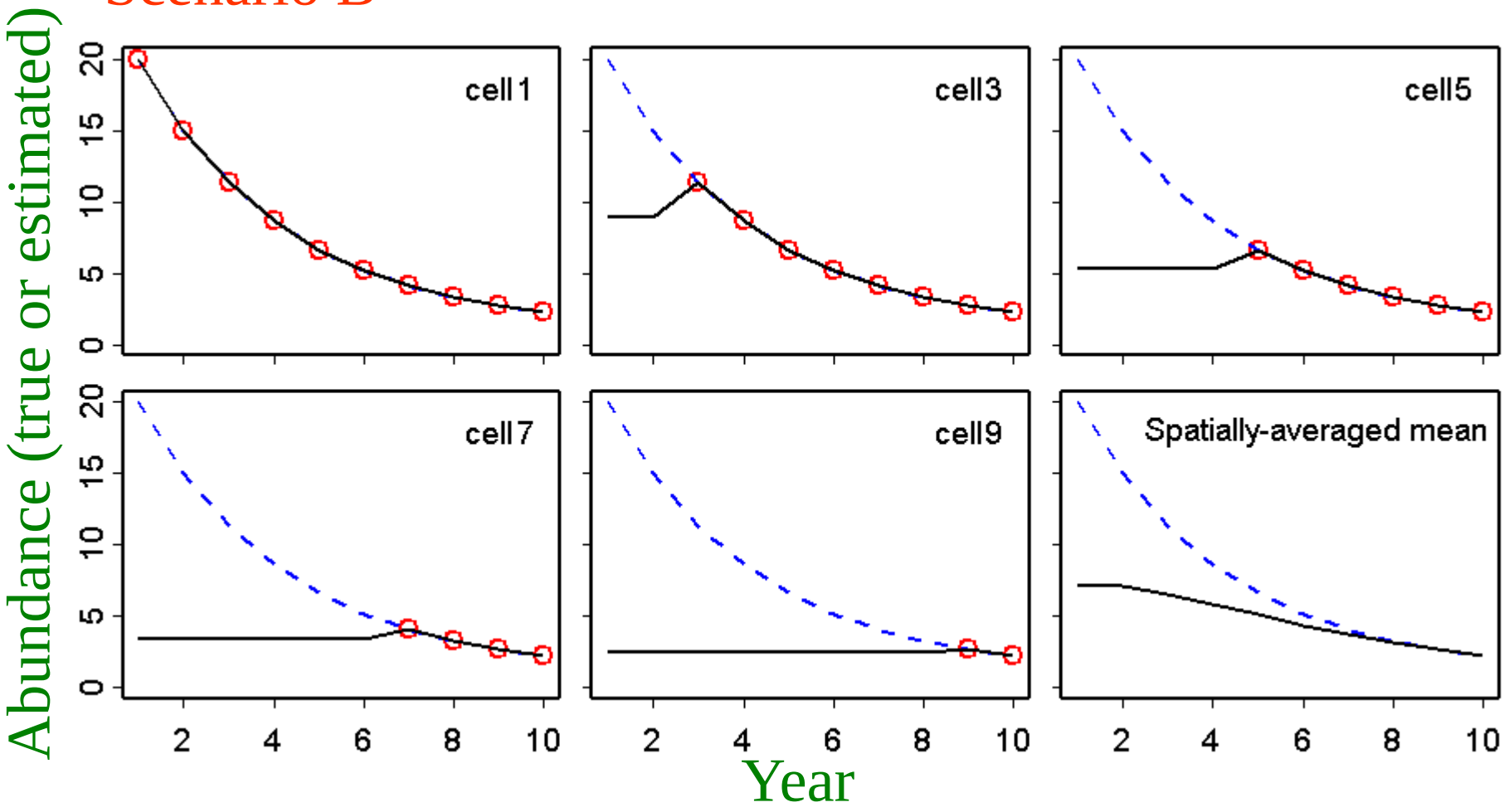
True population

Abundance estimate from CPUE

Abundance estimate, Walters' method

Spatial estimate, Myers and Worm's method

Scenario B

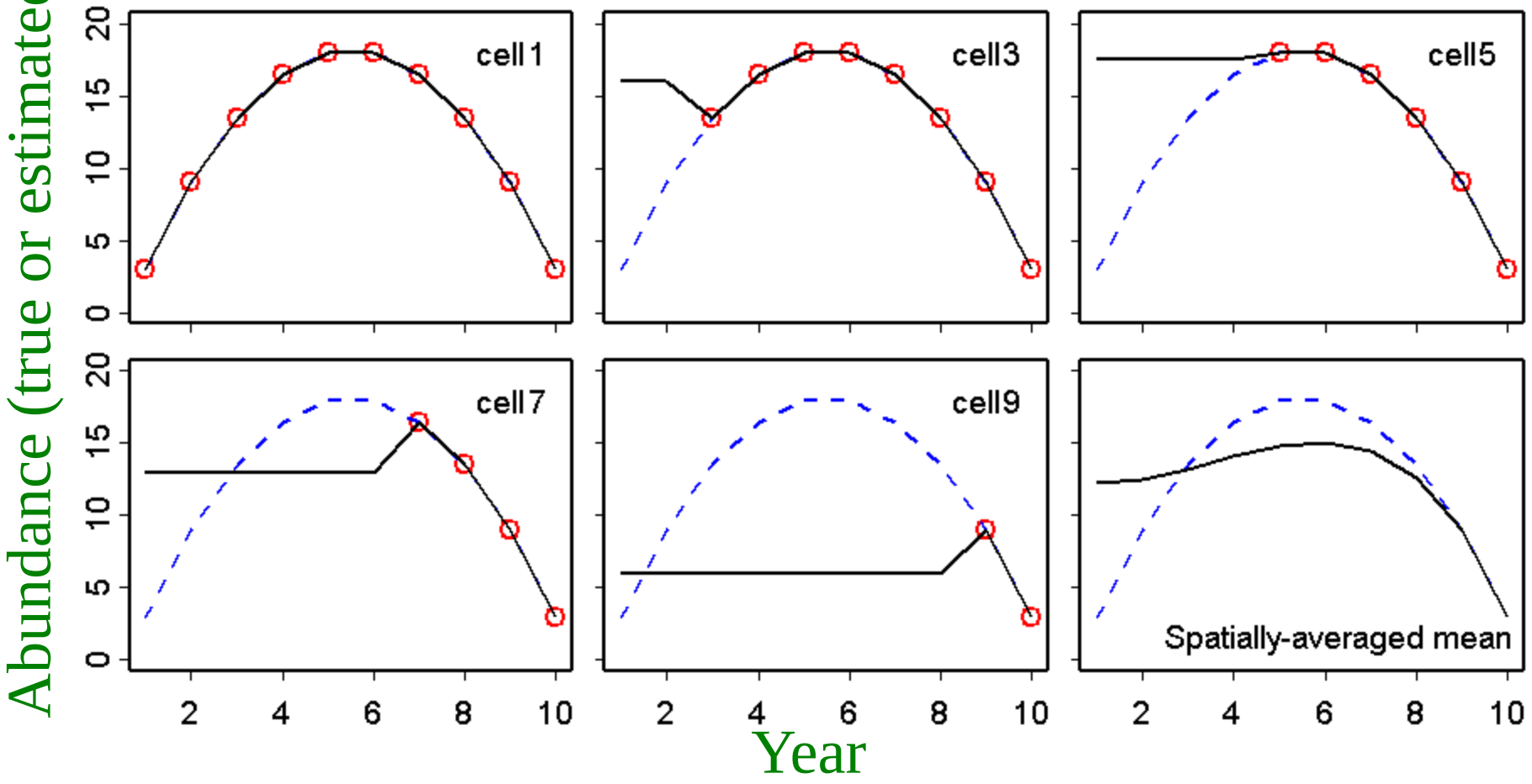


True population

Abundance estimate from CPUE

Abundance estimate, Walters' method

Scenario C



True population

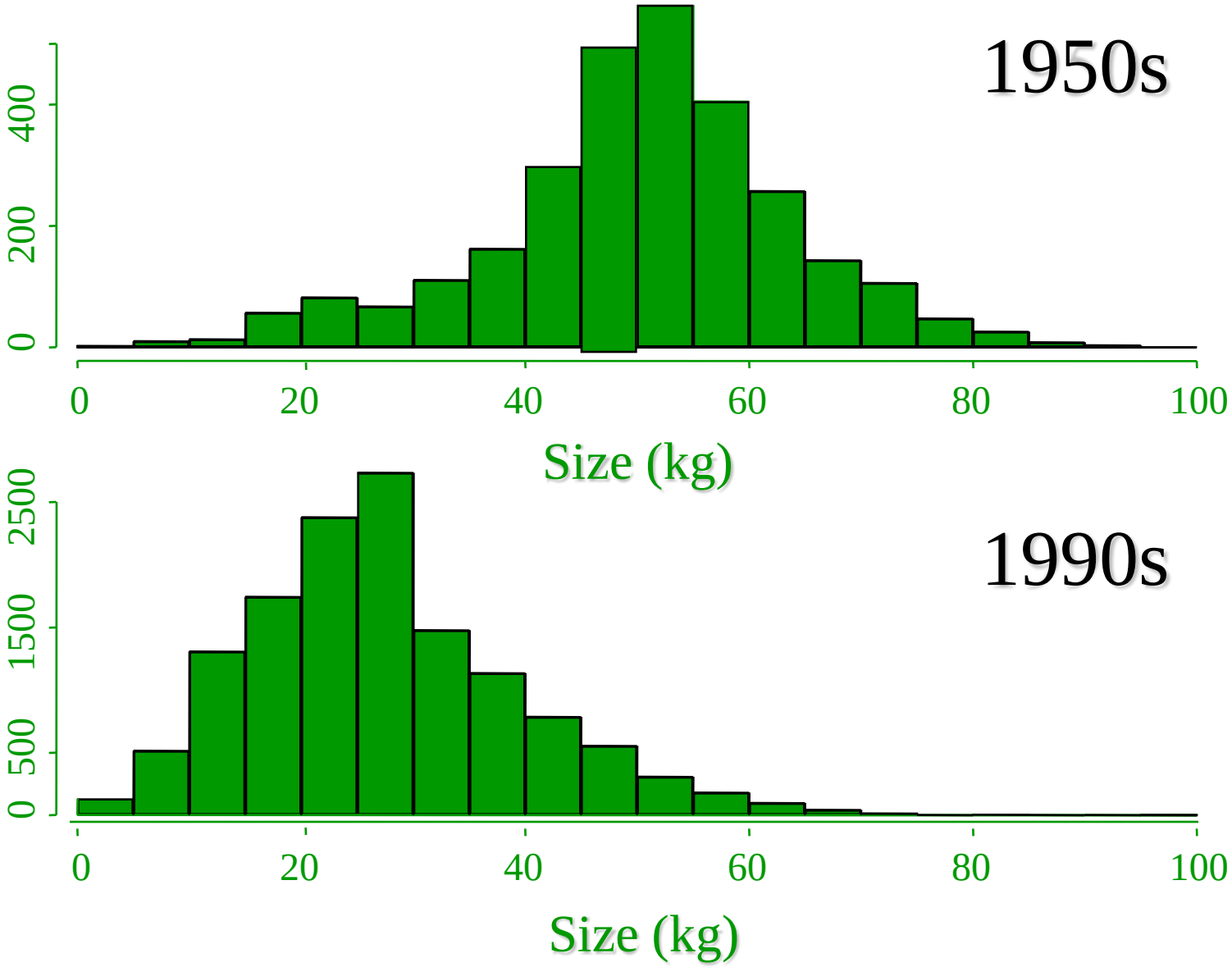
Abundance estimate from CPUE

Abundance estimate, Walters' method

These estimates are conservative: 1.

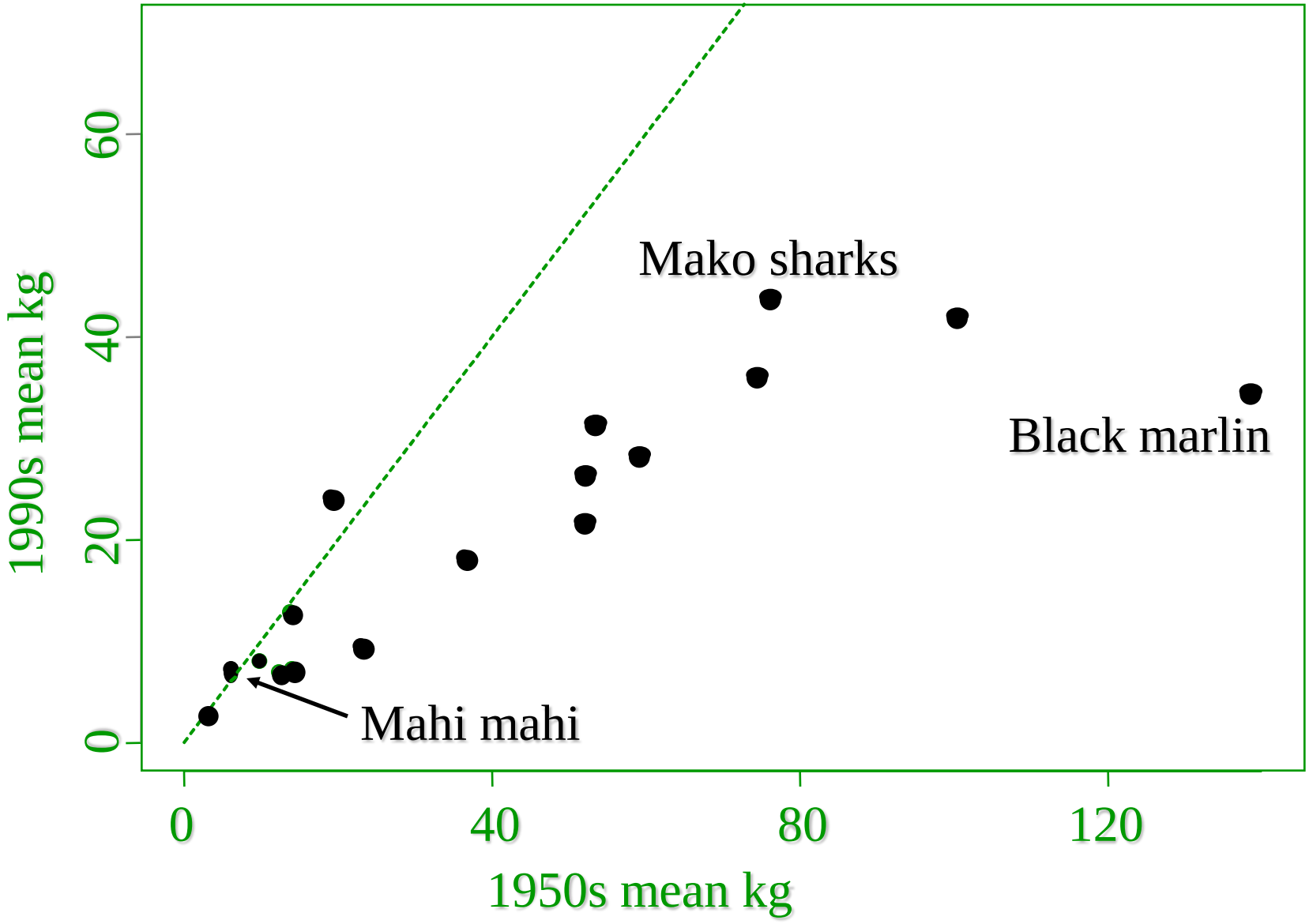
Bits of tuna did not count; ~25-30% of tropical tunas were initially not counted because of shark damage.

These estimates are conservative: 2 (fish are smaller)

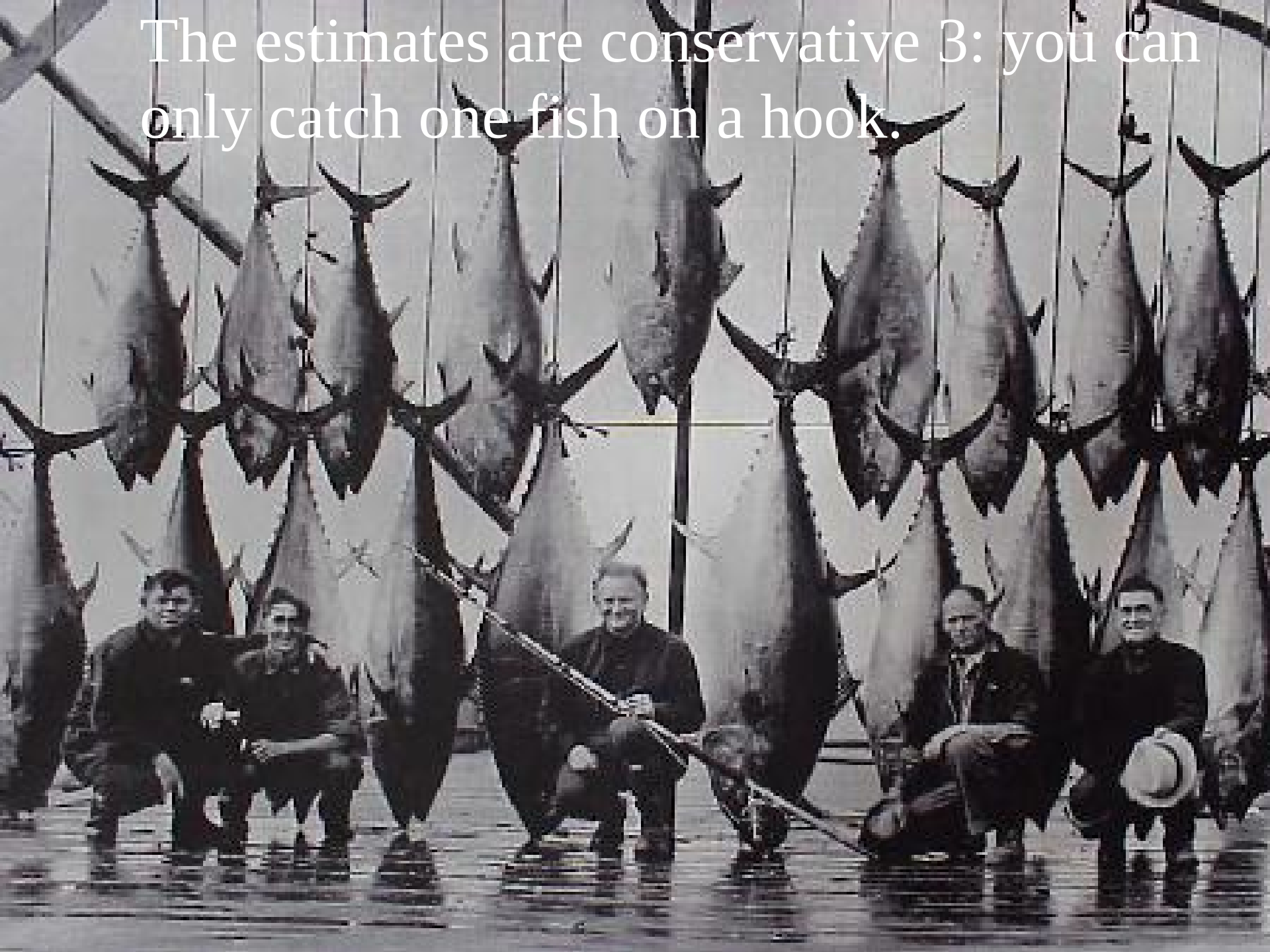


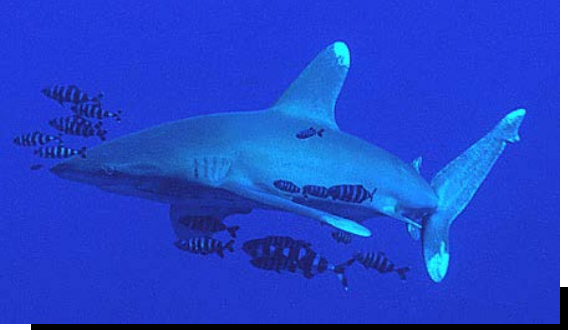
Yellowfin tuna – equitorial Pacific

Change in body size

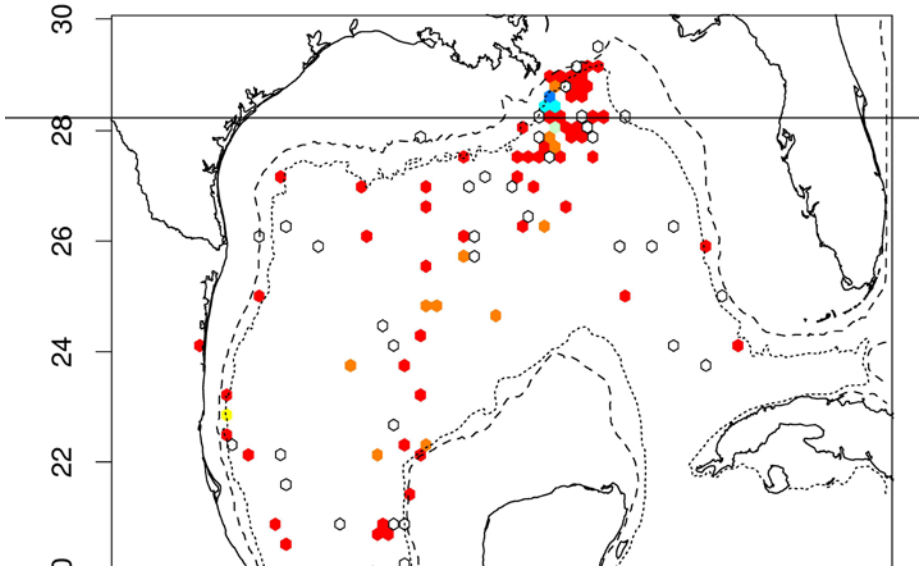



555
lbs.
LBS.
1135
CABO
BLANCO

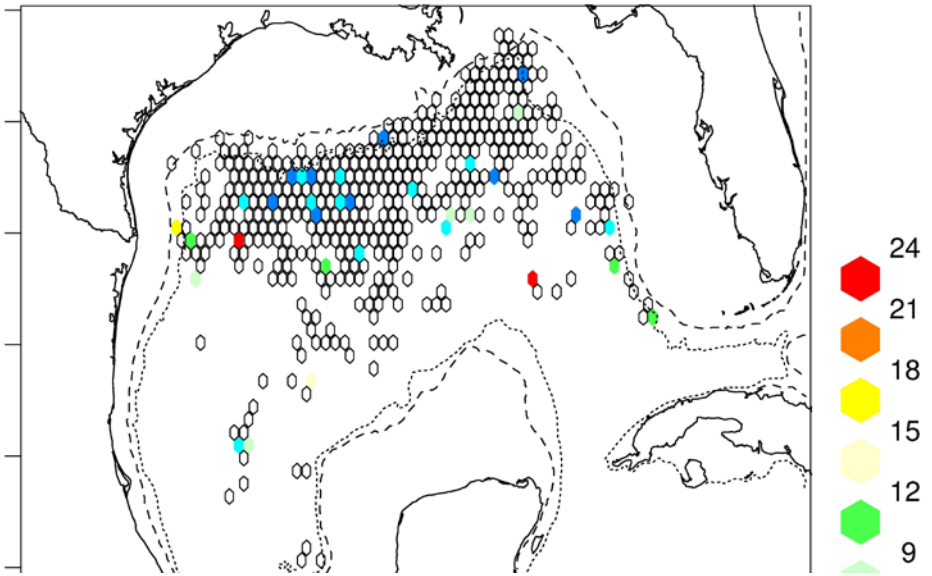

The estimates are conservative 3: you can only catch one fish on a hook.



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



1950's



1990's

Oceanic Whitetip captures per 10,000 hooks

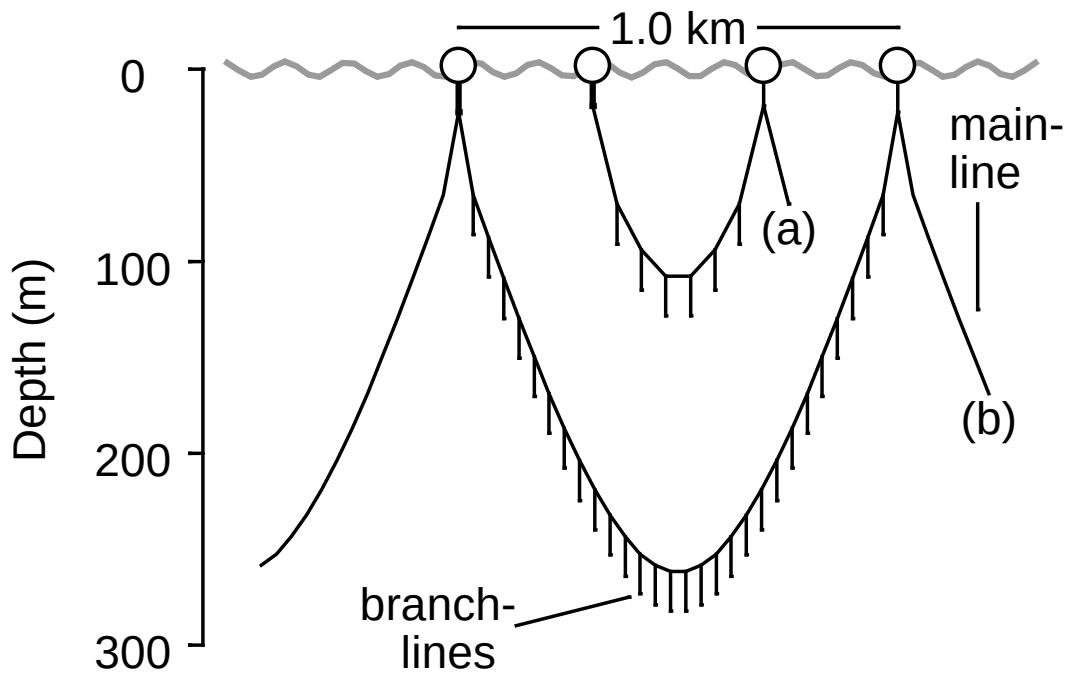
Baum and Myers, submitted to Ecology Letters

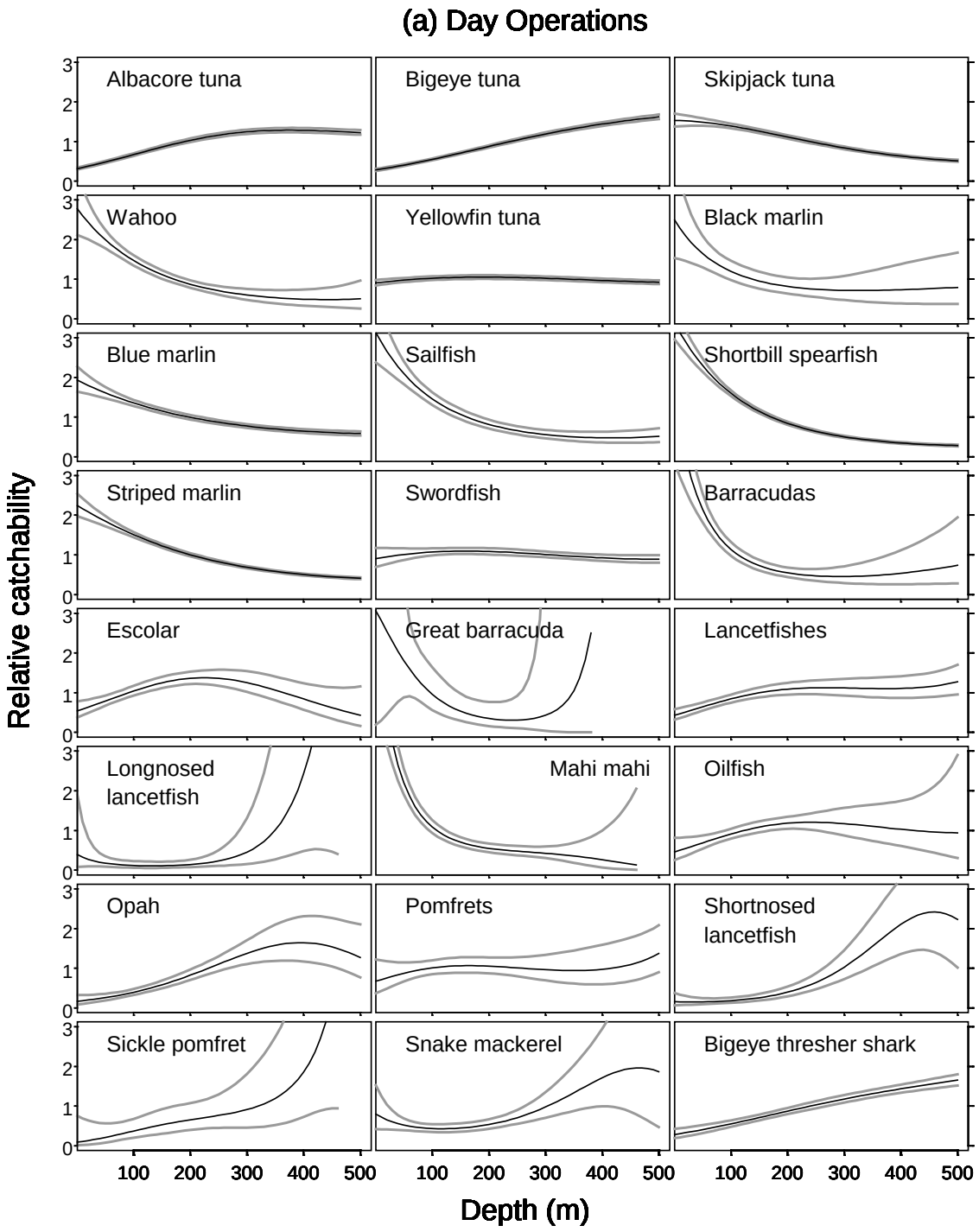
These estimates are conservative 5: The oceans were not virgin.

- 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.

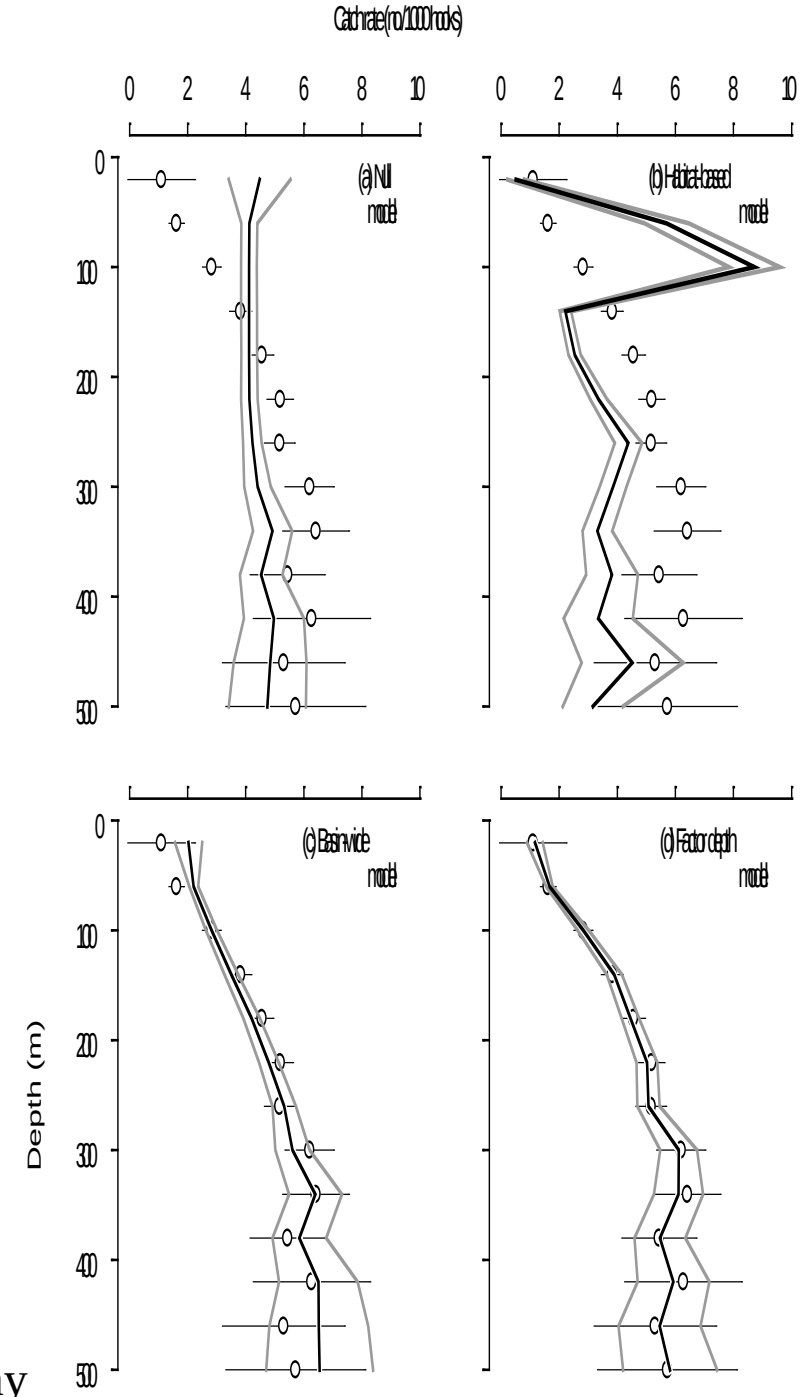
These estimates are conservative 7:
changes in depth increases overall efficiency.

Ward and Myers in press CJFAS


1.0 km
0
100
200
300
Depth (m)
main-
line
(a)
(b)
branch-
lines


(a) Day Operations
Albacore tuna
Bigeye tuna
Skipjack tuna
Wahoo
Yellowfin tuna
Black marlin
Blue marlin
Sailfish
Shortbill spearfish
Striped marlin
Swordfish
Barracudas
Escolar
Great barracuda
Lancetfishes
Longnosed lancetfish
Mahi mahi
Oilfish
Opah
Pomfrets
Shortnosed lancetfish
Sickle pomfret
Snake mackerel
Bigeye thresher shark
Relative catchability
0
1
2
3
100
200
300
400
500
Depth (m)

(This approach shows that non-statistical “habitat models” do not appear to work: results for bigeye tuna)

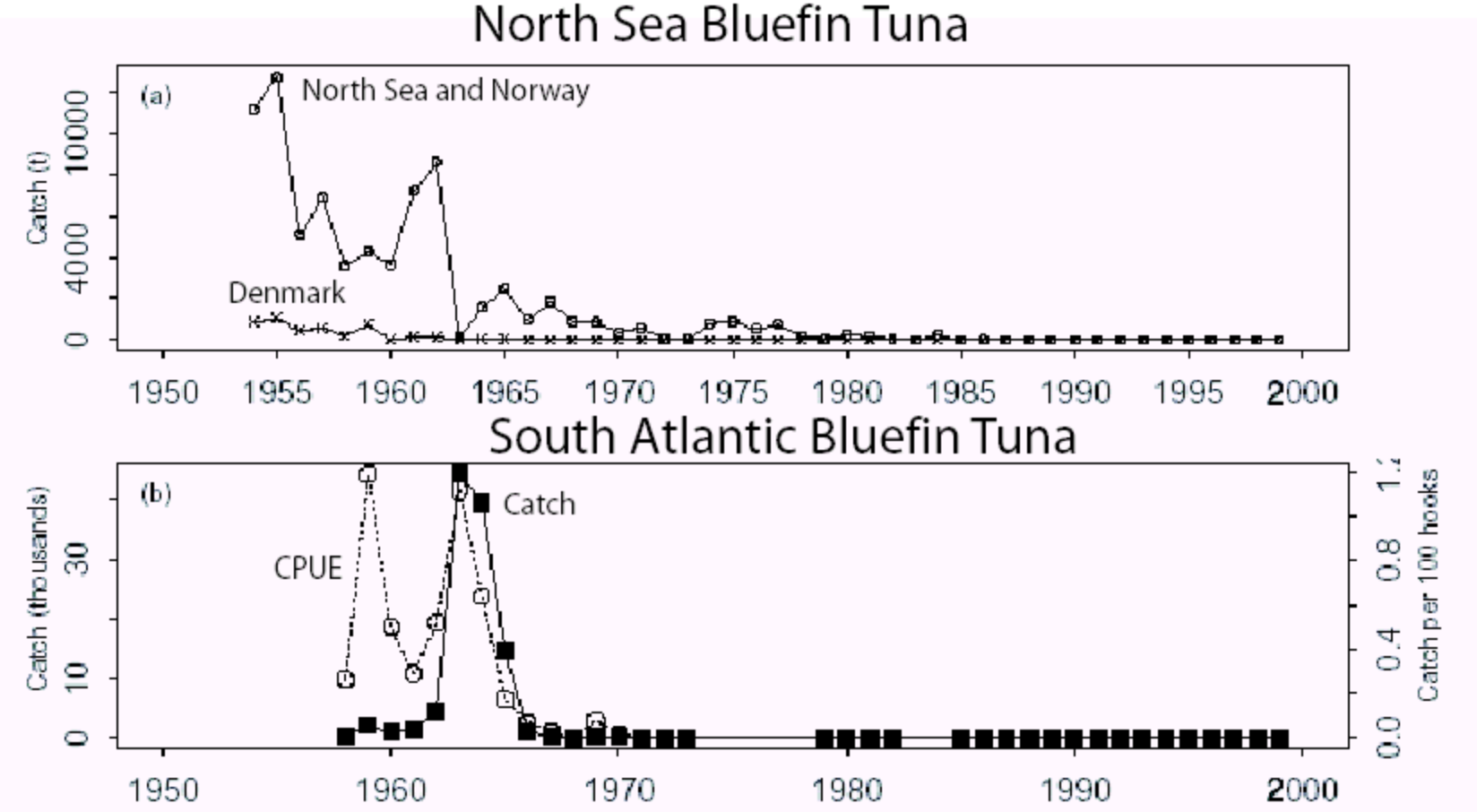


Ward and Myers in review Fisheries Oceanography

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

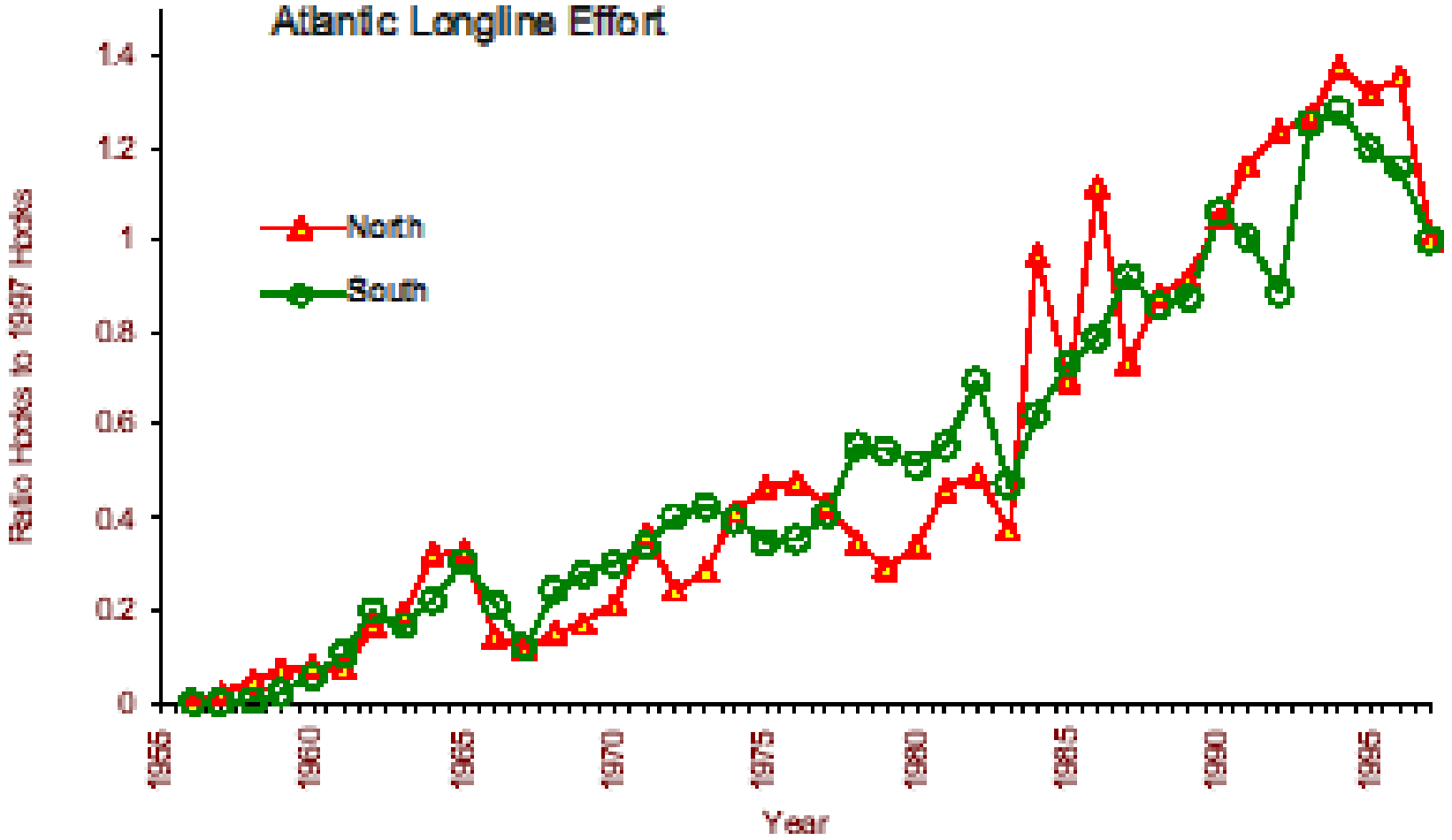


Perceived Contradiction in Initial Rapid Decline in CPUE

- 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

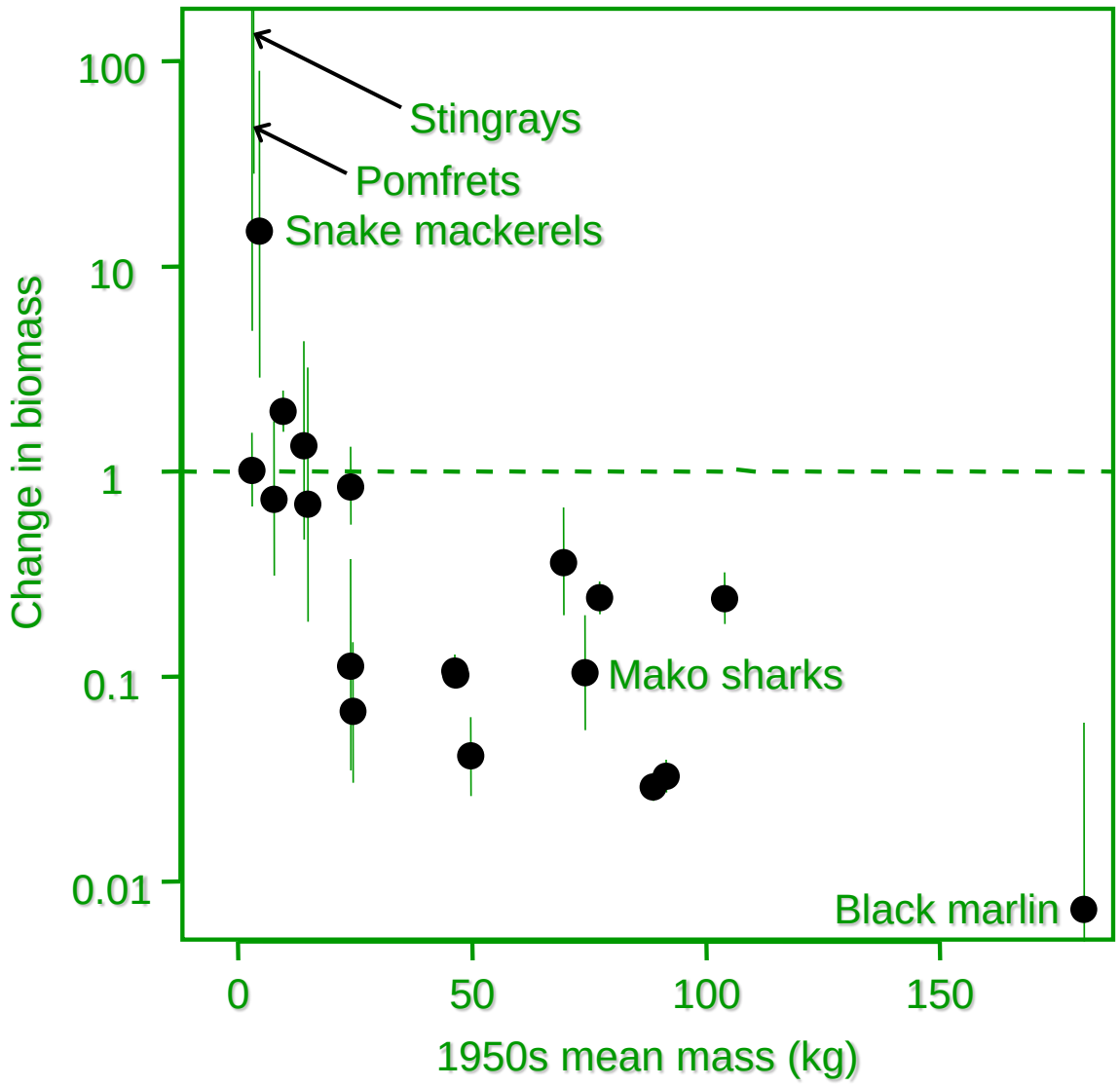
3. Present fishing mortality due to longlines is around 0.6

Perceived Contradiction in Initial Rapid Decline in CPUE

IF catchability is constant

THEN the population dynamics are impossible.

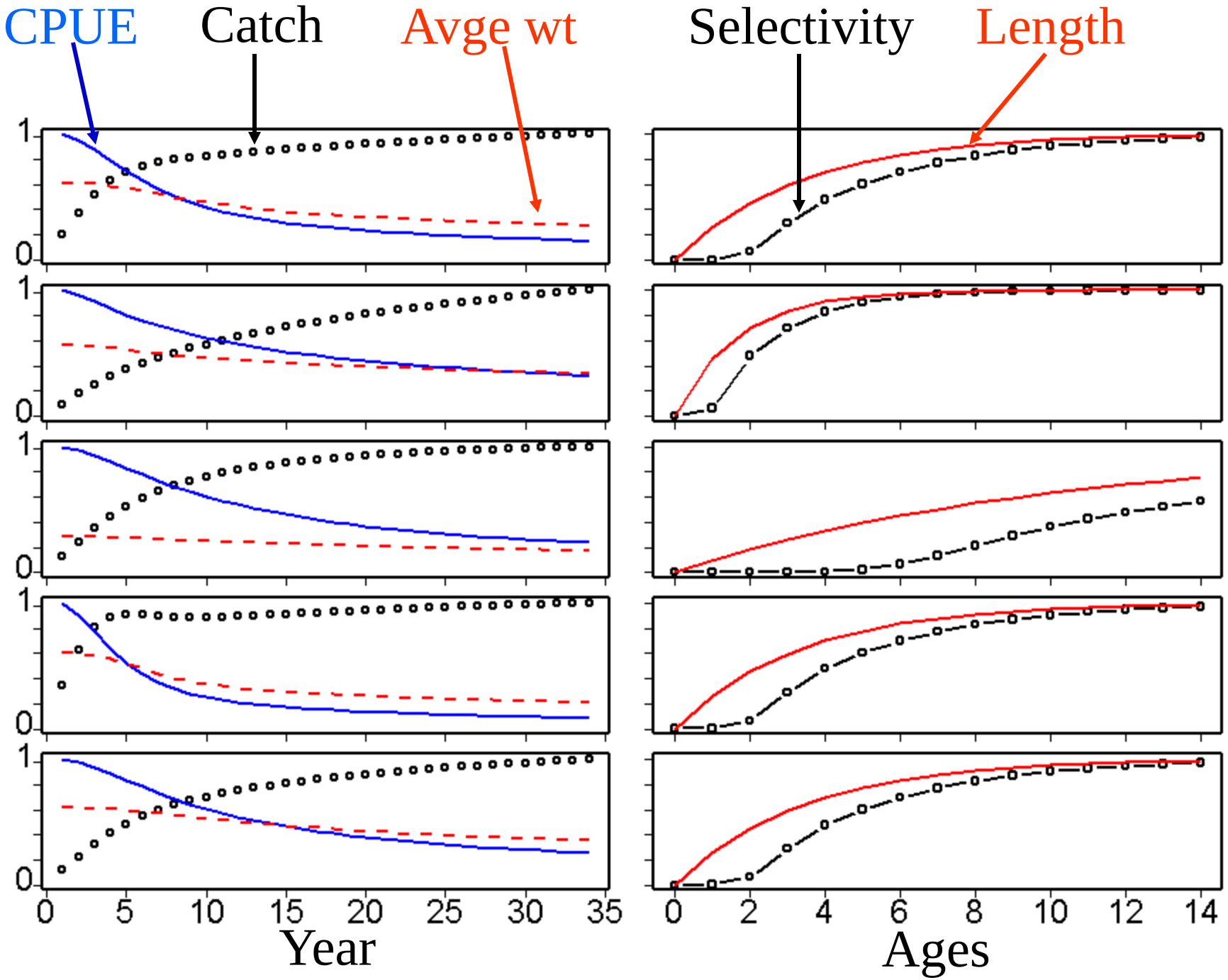
However, catchability decreases with size and size has declined

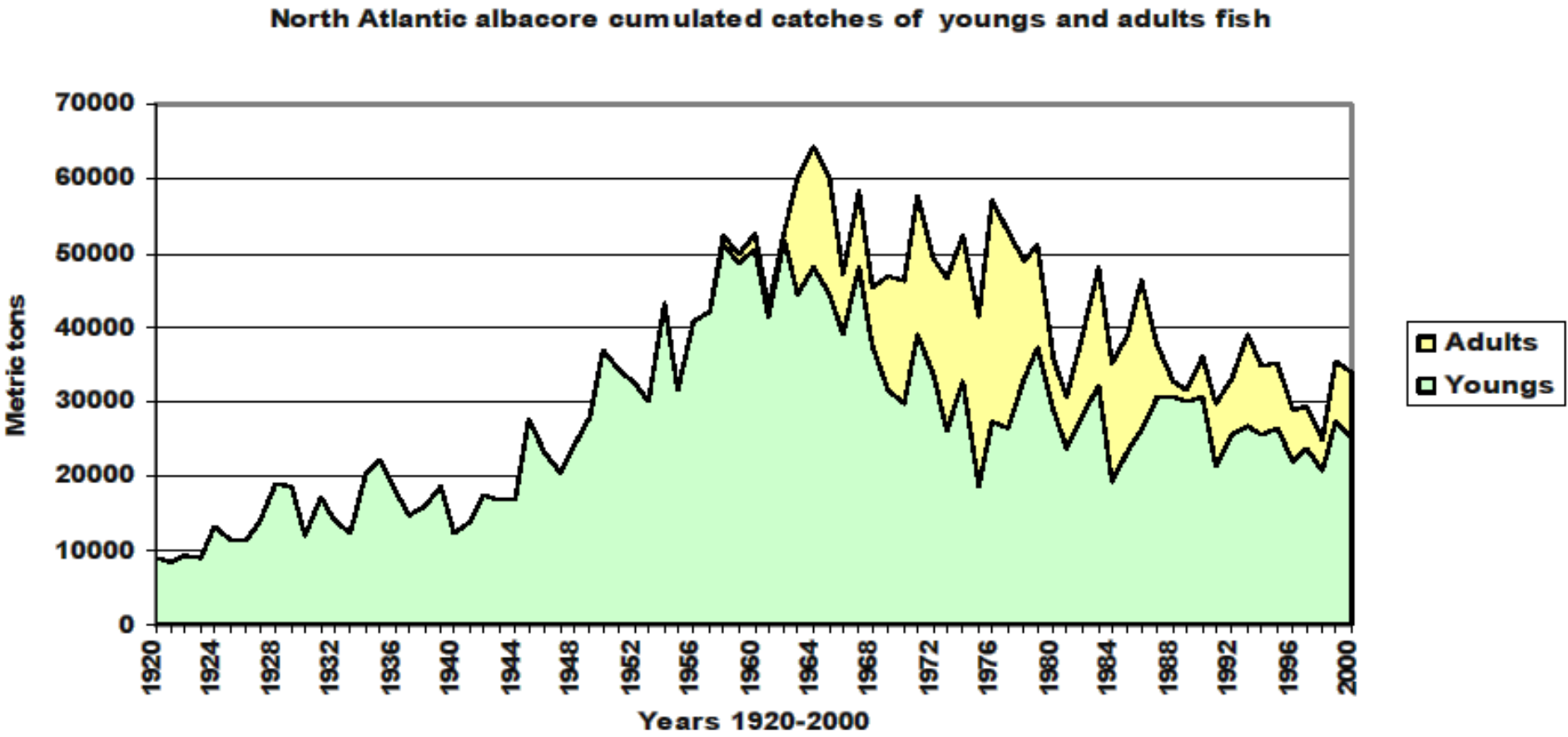

Stingrays
Pomfrets
Snake mackerels
Mako sharks
Black marlin
100
10
1
0.1
0.01
Change in biomass
0
50
100
150
1950s mean mass (kg)


555
lbs.
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
Avge wt
Selectivity
Length
1
0
0
5
10
15
20
25
30
35
Year
0
2
4
6
8
10
12
14
Ages


North Atlantic albacore cumulated catches of youngs and adults fish
70000
60000
50000
40000
30000
20000
10000
0
Metric tons
1920
1924
1928
1932
1936
1940
1944
1948
1952
1956
1960
1964
1968
1972
1976
1980
1984
1988
1992
1996
2000
Years 1920-2000
Adults
Youngs

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

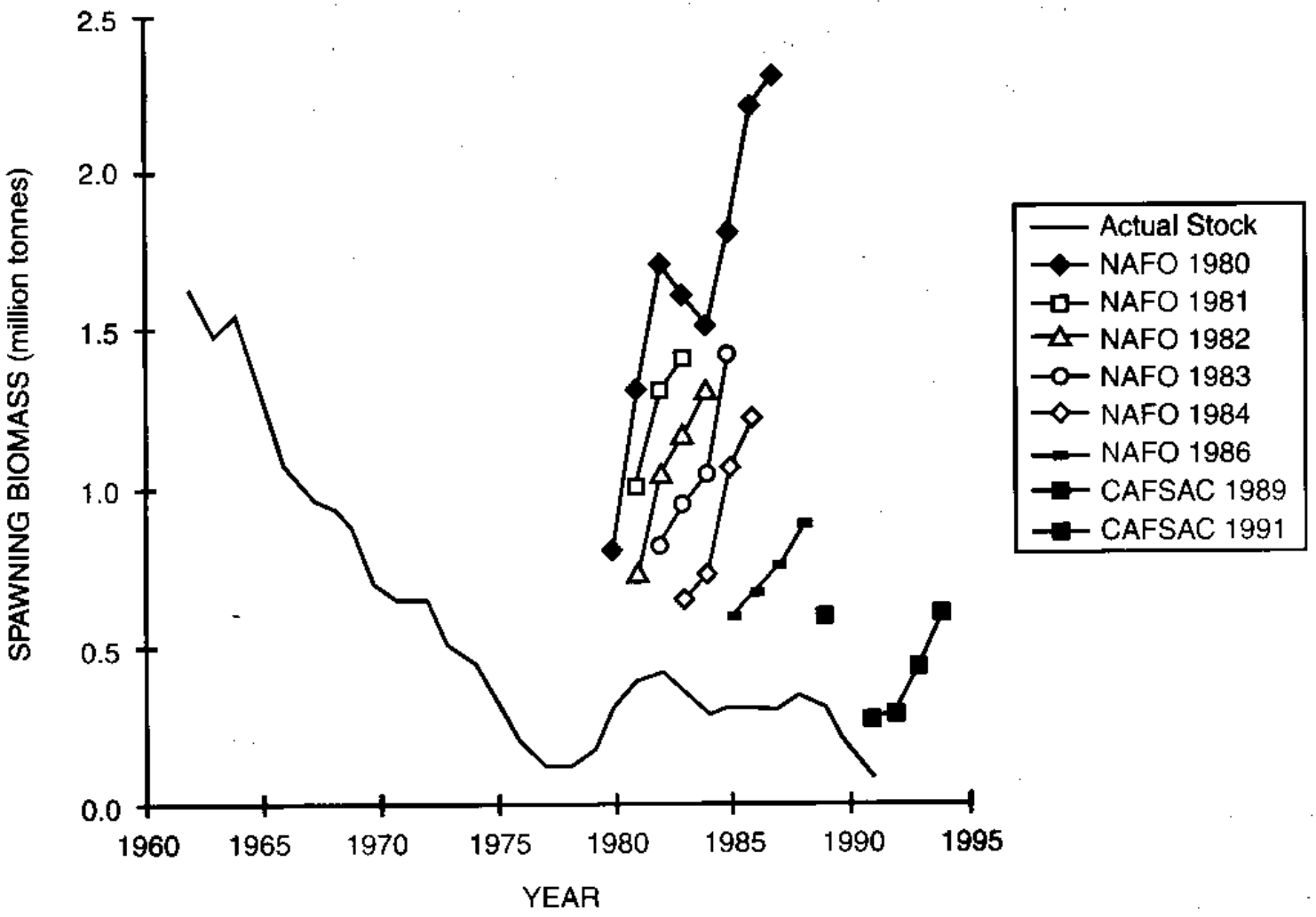


Fig. 3. Recent reconstruction, using virtual population analysis, of the Newfoundland northern cod decline, compared with estimates and projections published in various years after Canada took over the fishery under extended jurisdiction. VPA estimates based on data in Baird *et al.* (1992) (see also 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.

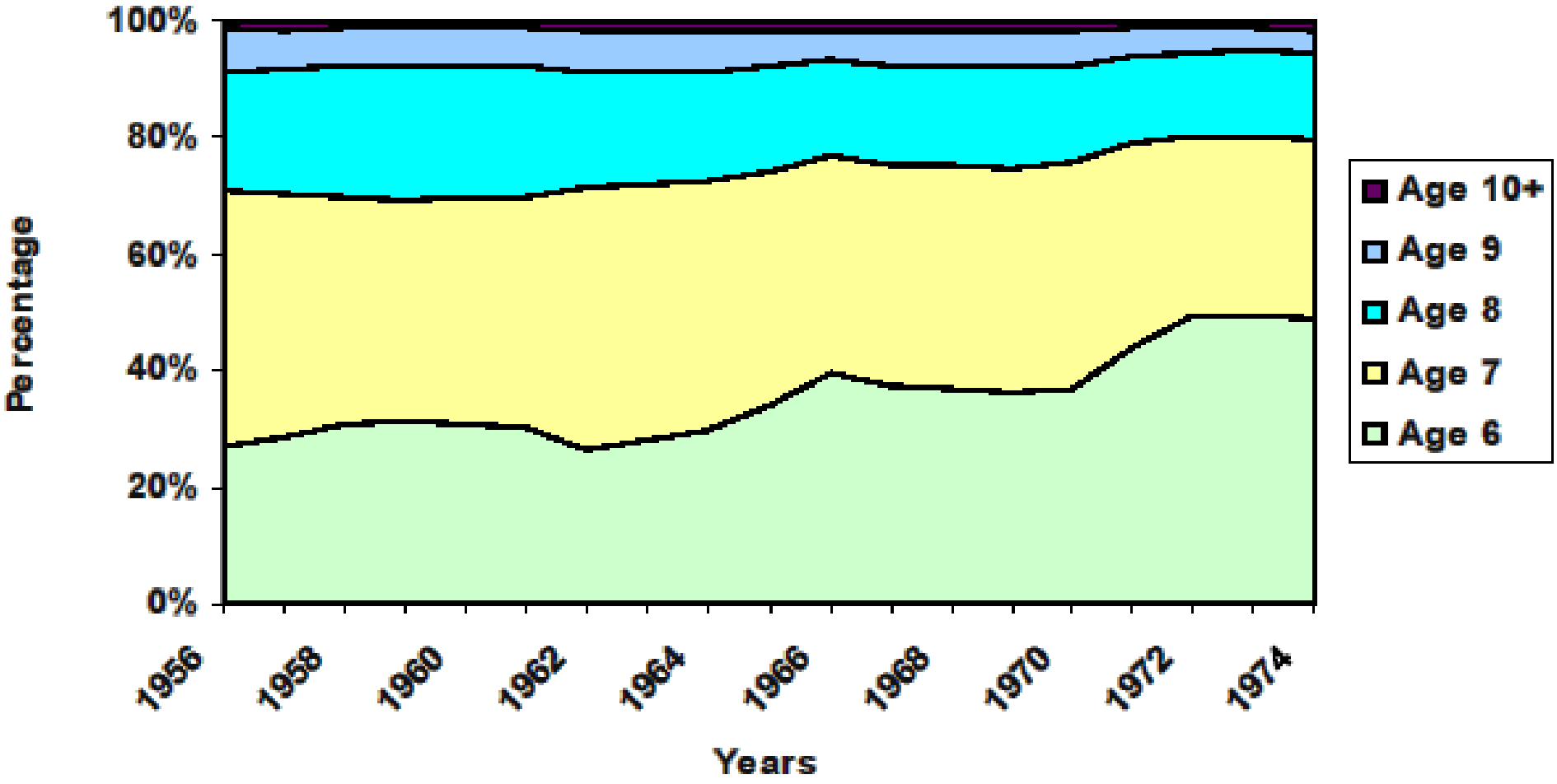


Figure 7 : Evolution of contribution of age classes 6 to 10+ computed by Morita (1977) in longliners albacore catches, 1956-1974.

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

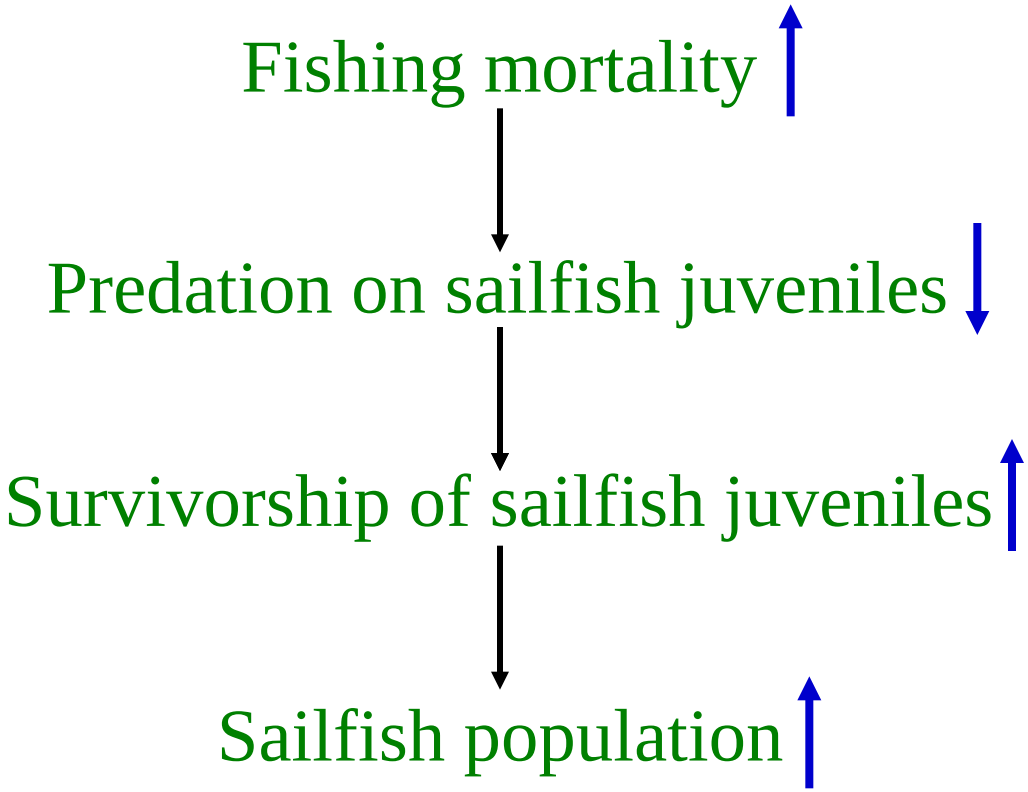
despite massive denial

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

Marine ecosystem robustness and the collaps marine fisheries

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

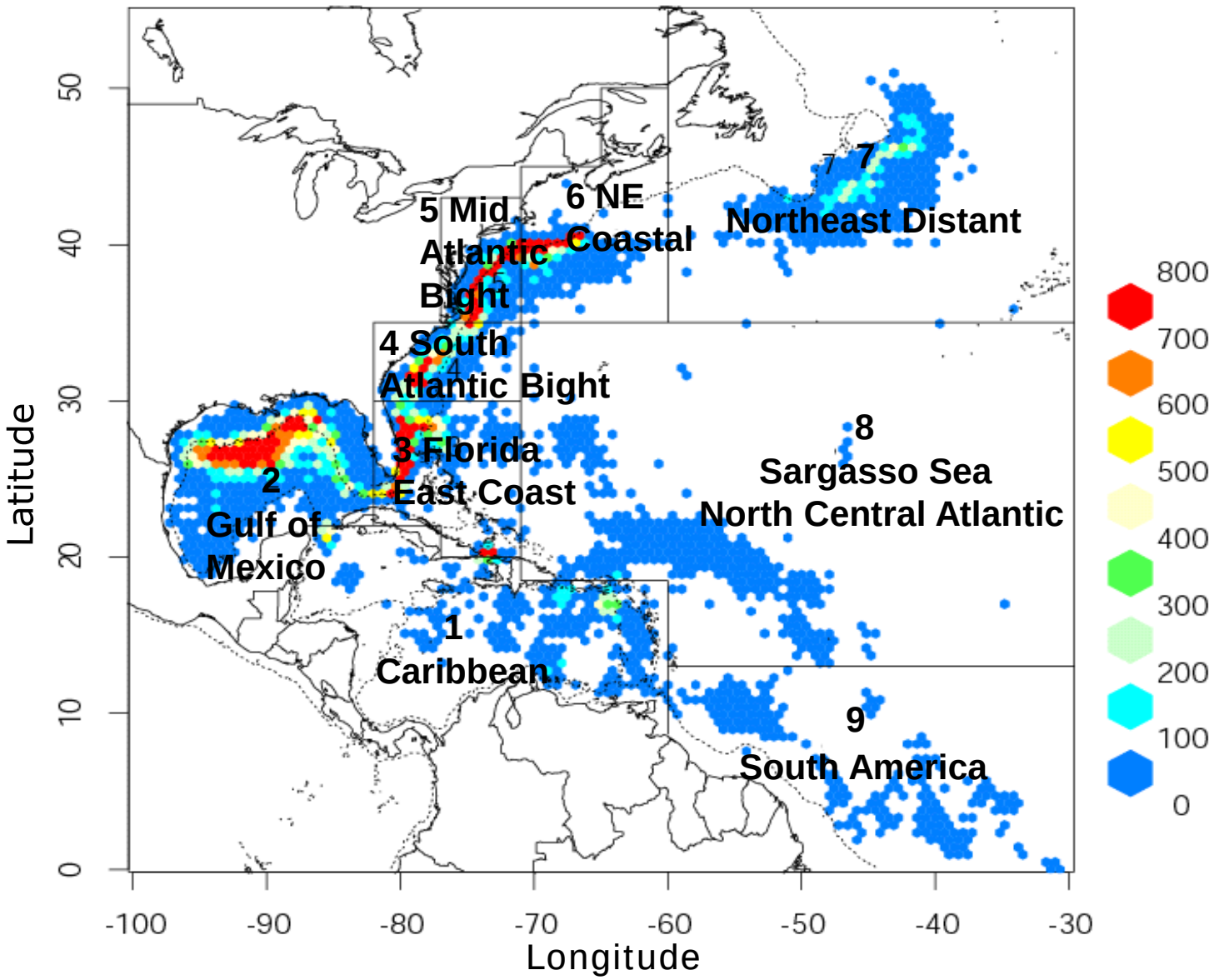
One hypothesis:



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.

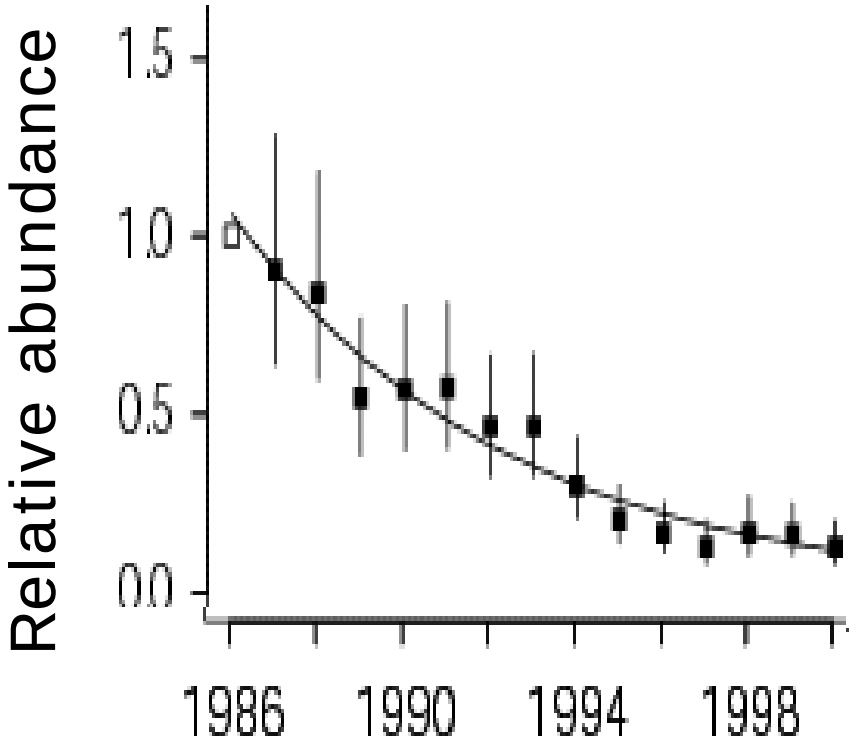
However, it also has great benefits.

To act is to live.

To be suppressed is to die.

Hammerhead sharks

Sphyrna lewini



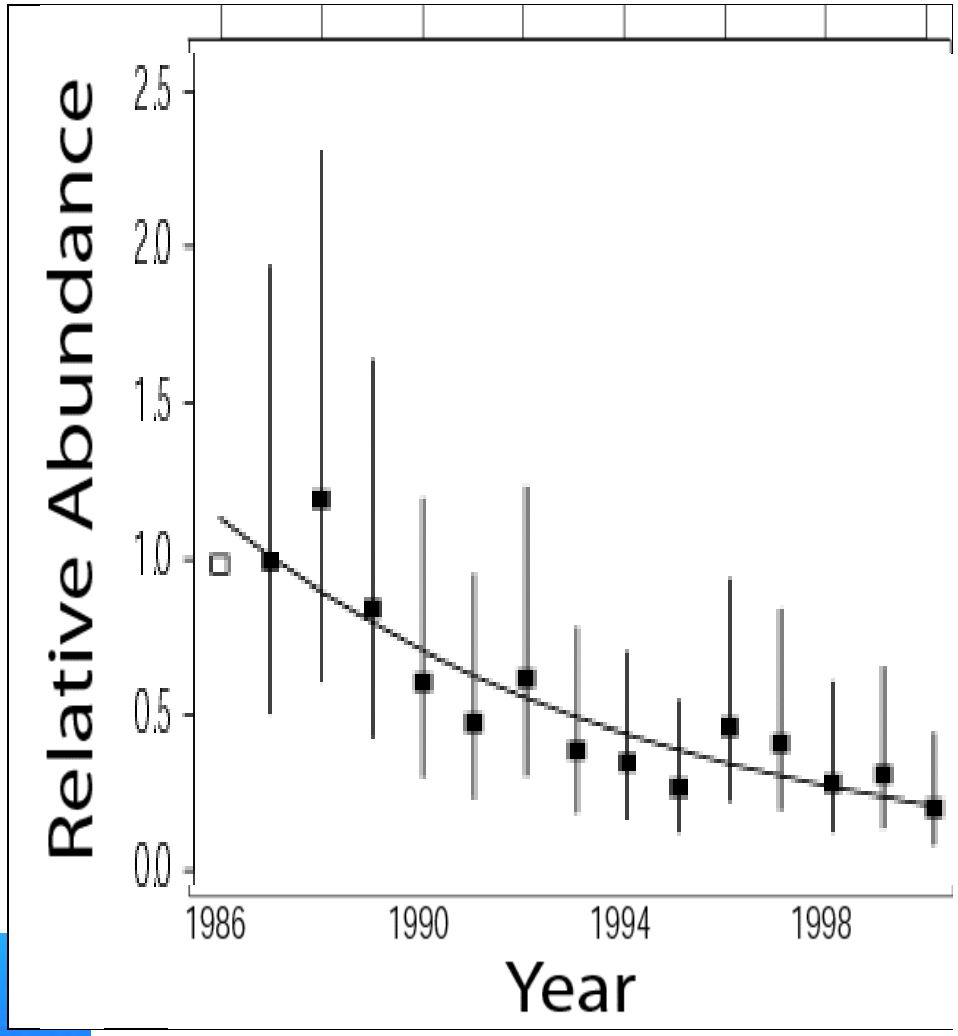
Science. Jan. 2003. J.K. Baum, R.A. Myers, D.G. Kehler, B. Worm, S.J. Harley, P.A. Doherty

The rest of the slides are back up.


90% OF EVERY
BIG FISH
SPECIES
WIPED OUT

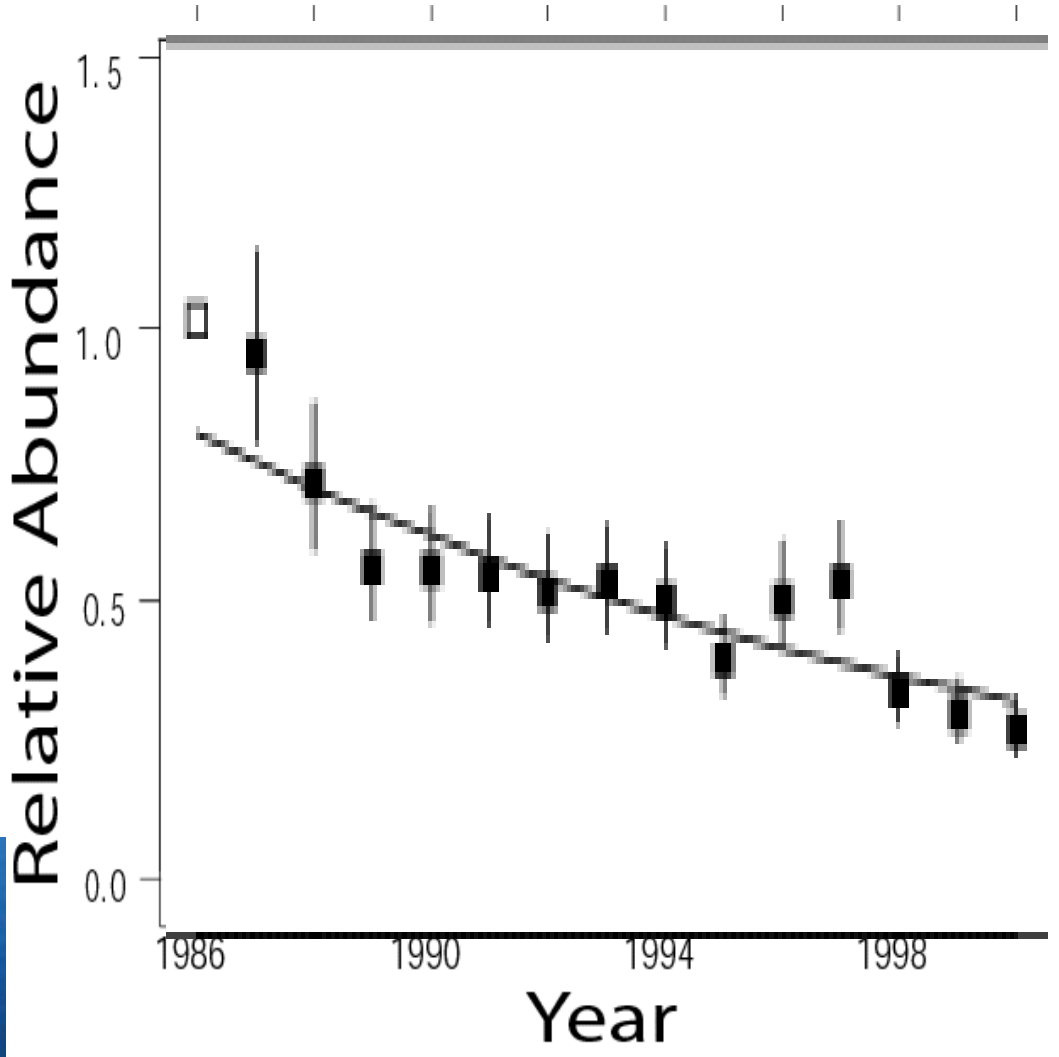
Thresher sharks

Alopias spp.

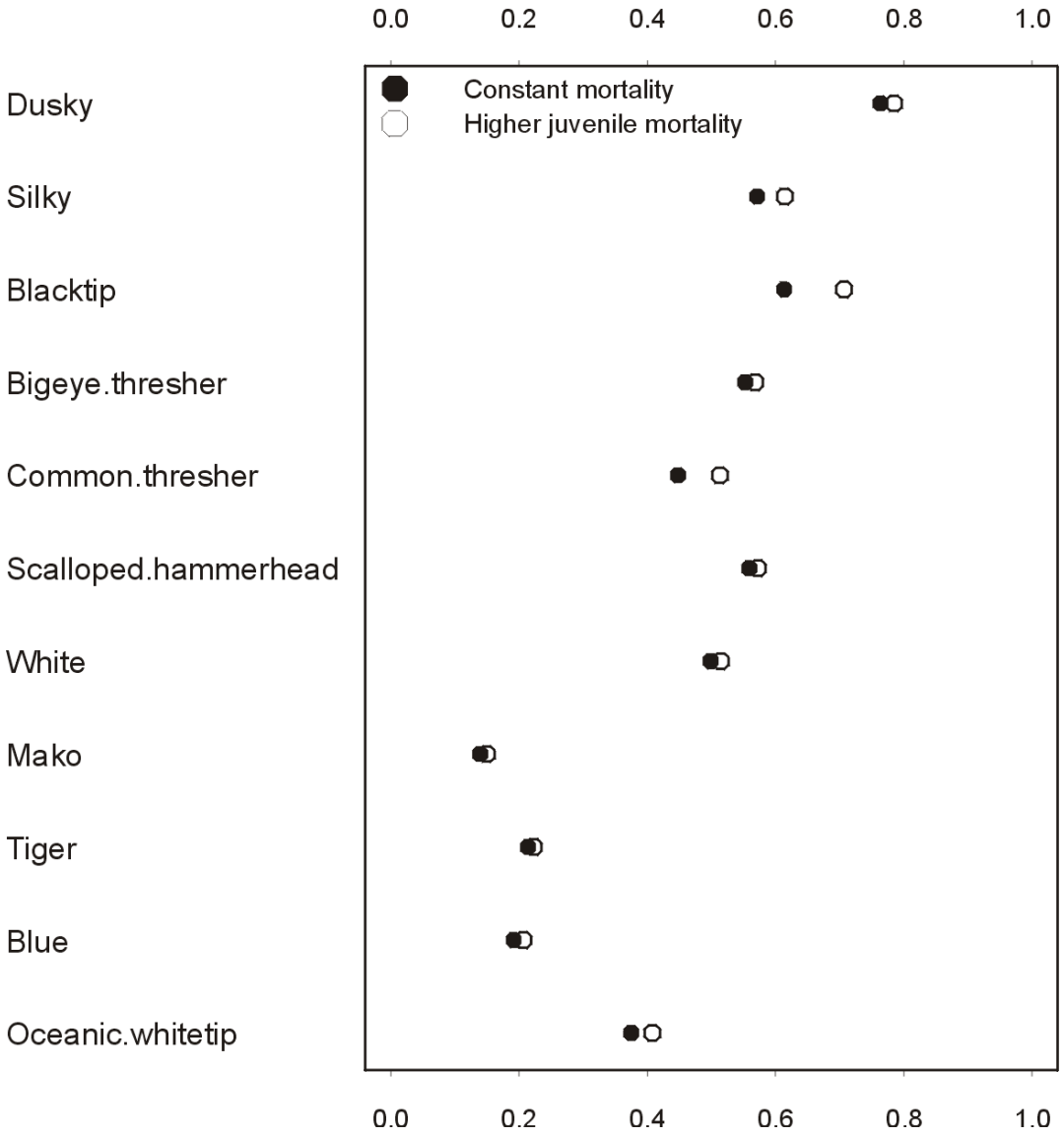


Blue sharks

Prionace glauca

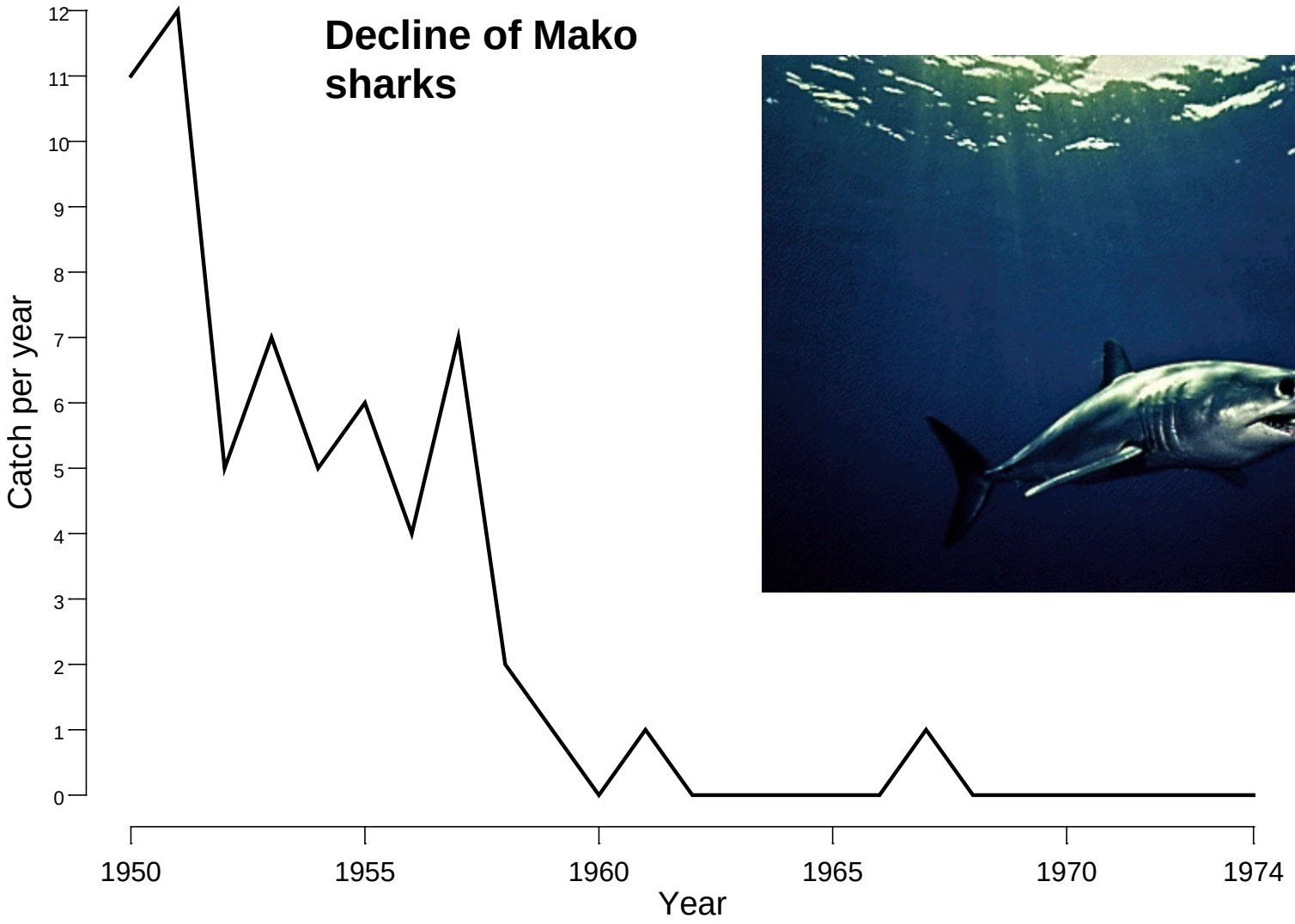


Proportional reduction in current fishing mortality needed to ensure survival of shark populations



Letter from senate

Put in cod

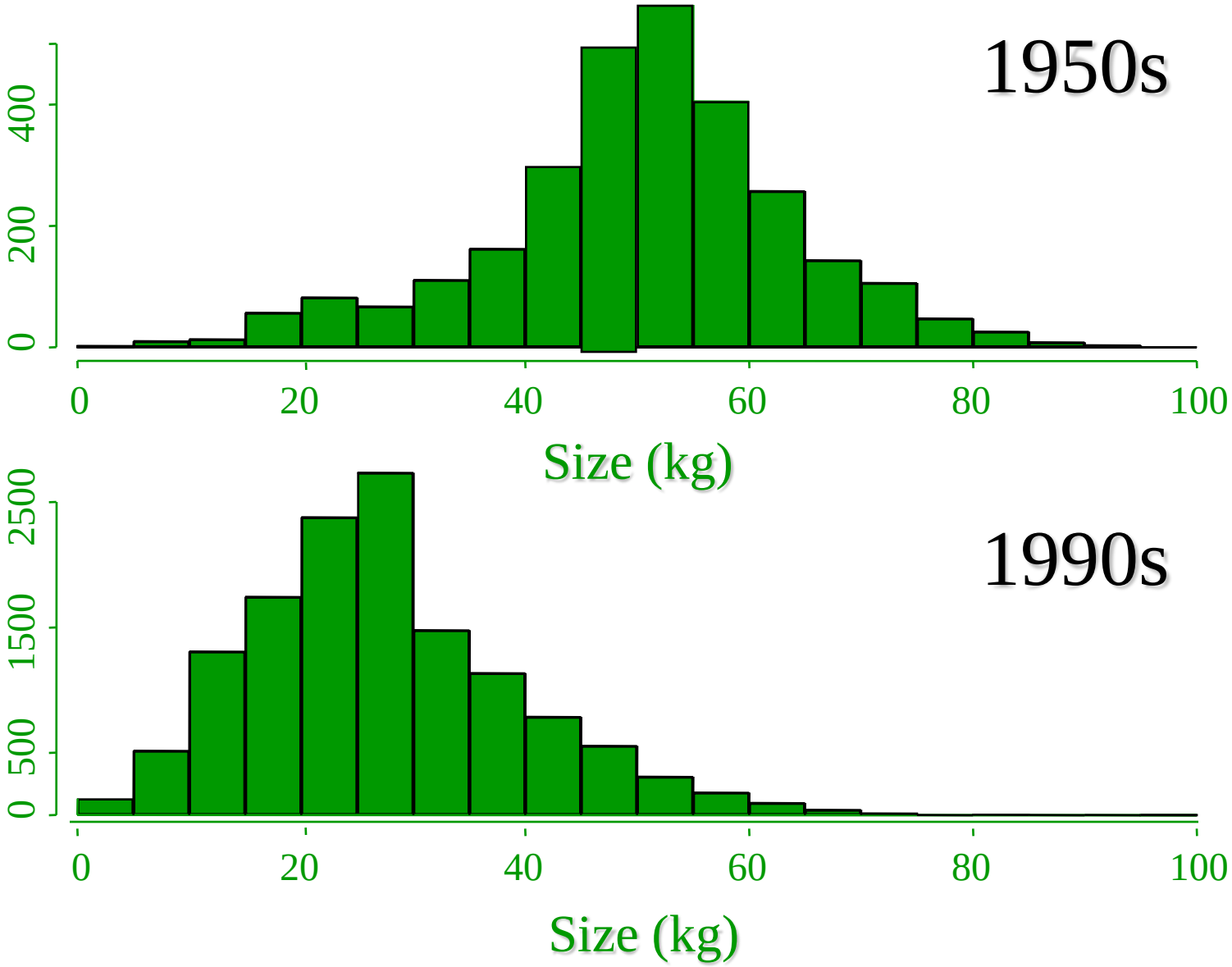


Boero F. & A. Carli 1979 – Boll. Mus. Ist. Biol. Univ. Genoa (47)

These estimates are conservative: 1.

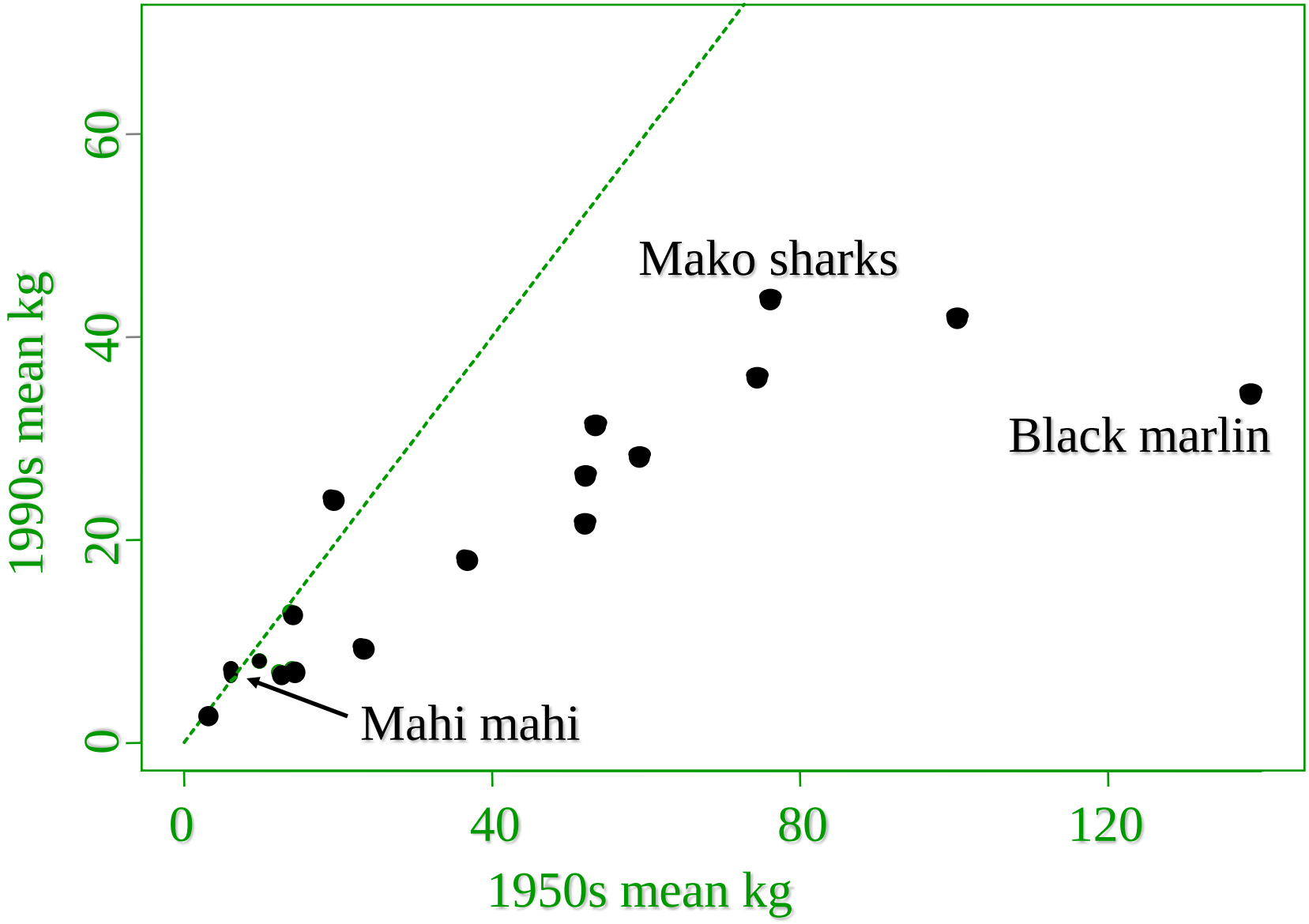
Bits of tuna did not count;
~25-30% of tropical tunas were initially not counted because of shark damage.

These estimates are conservative: 2 (fish are smaller)

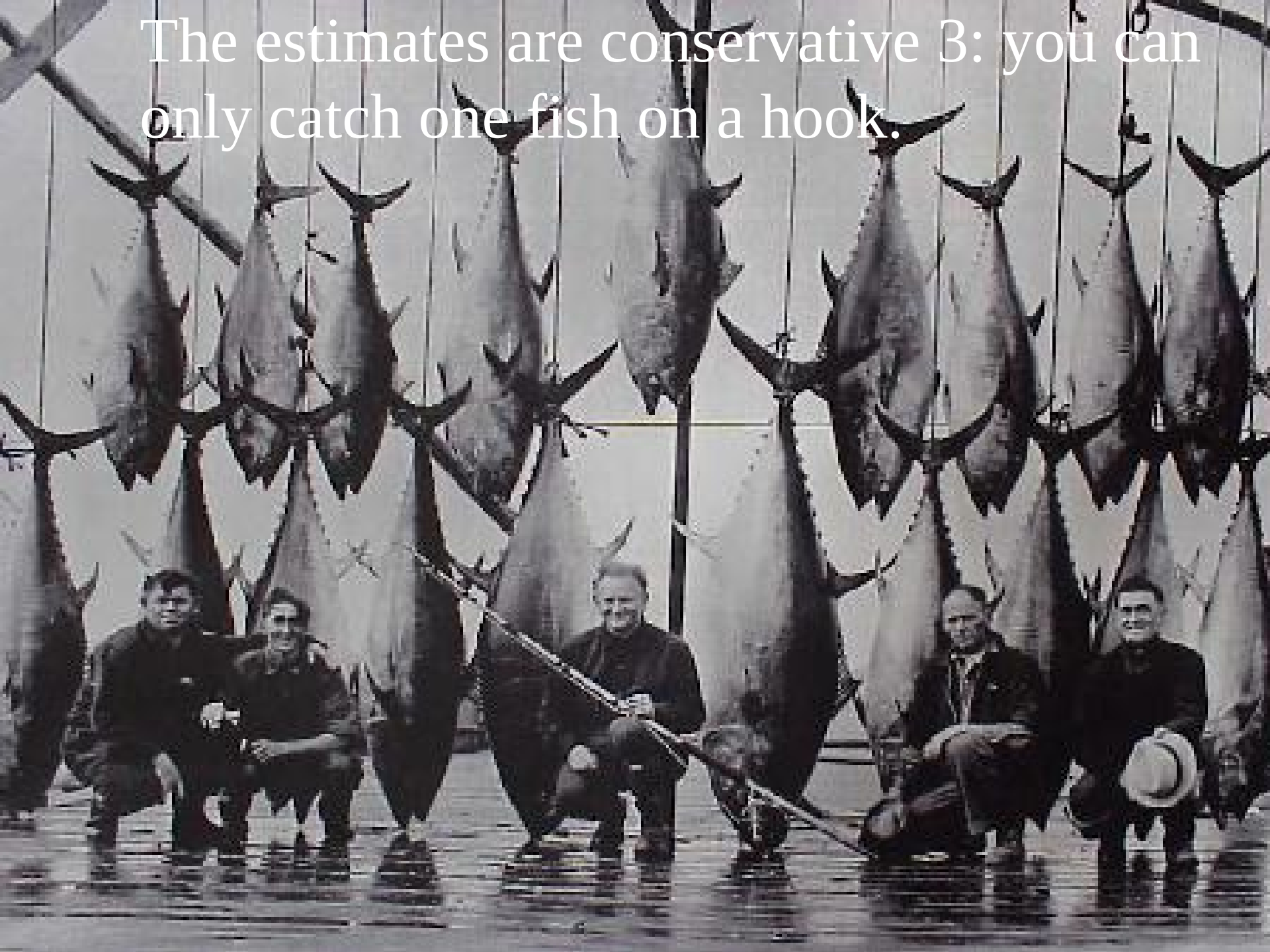


Yellowfin tuna – equitorial Pacific

Change in body size



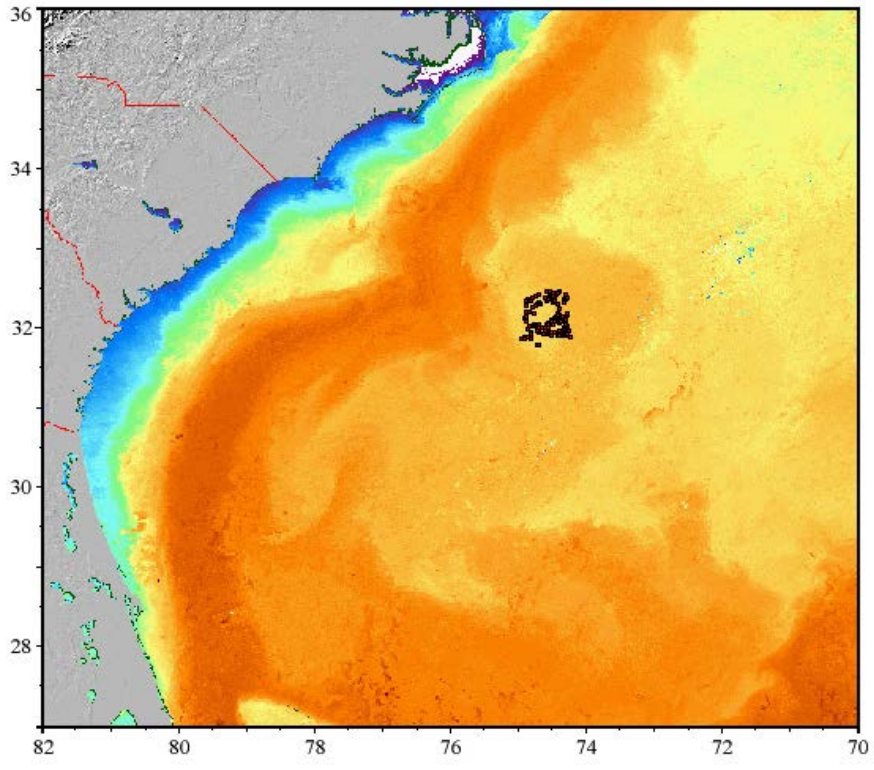

555
lbs.
LBS.
1135
CABO
BLANCO

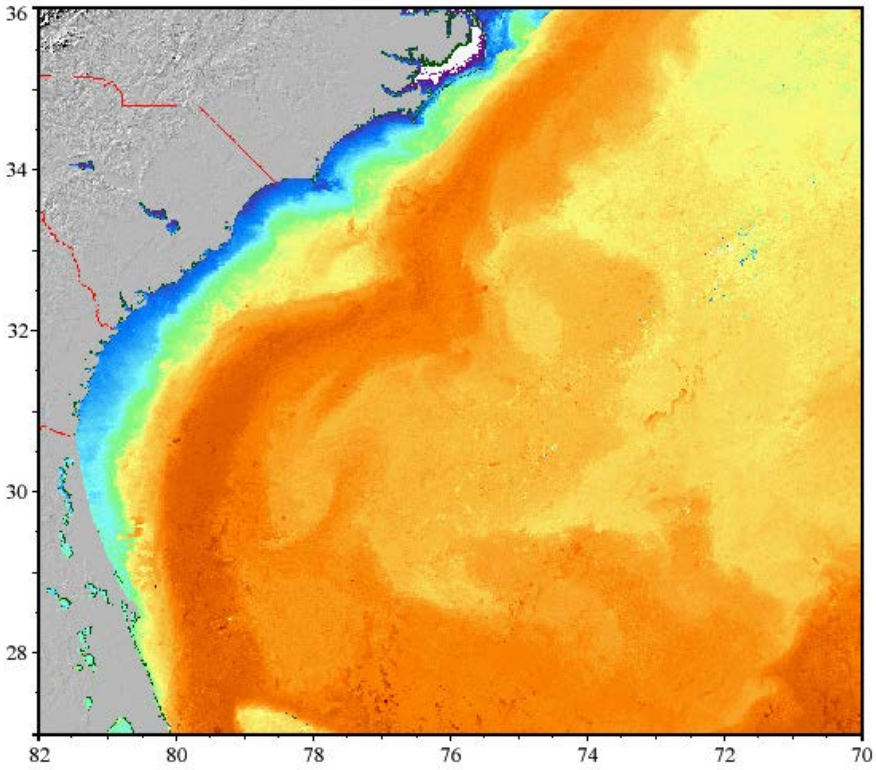

The estimates are conservative 3: you can only catch one fish on a hook.

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)).





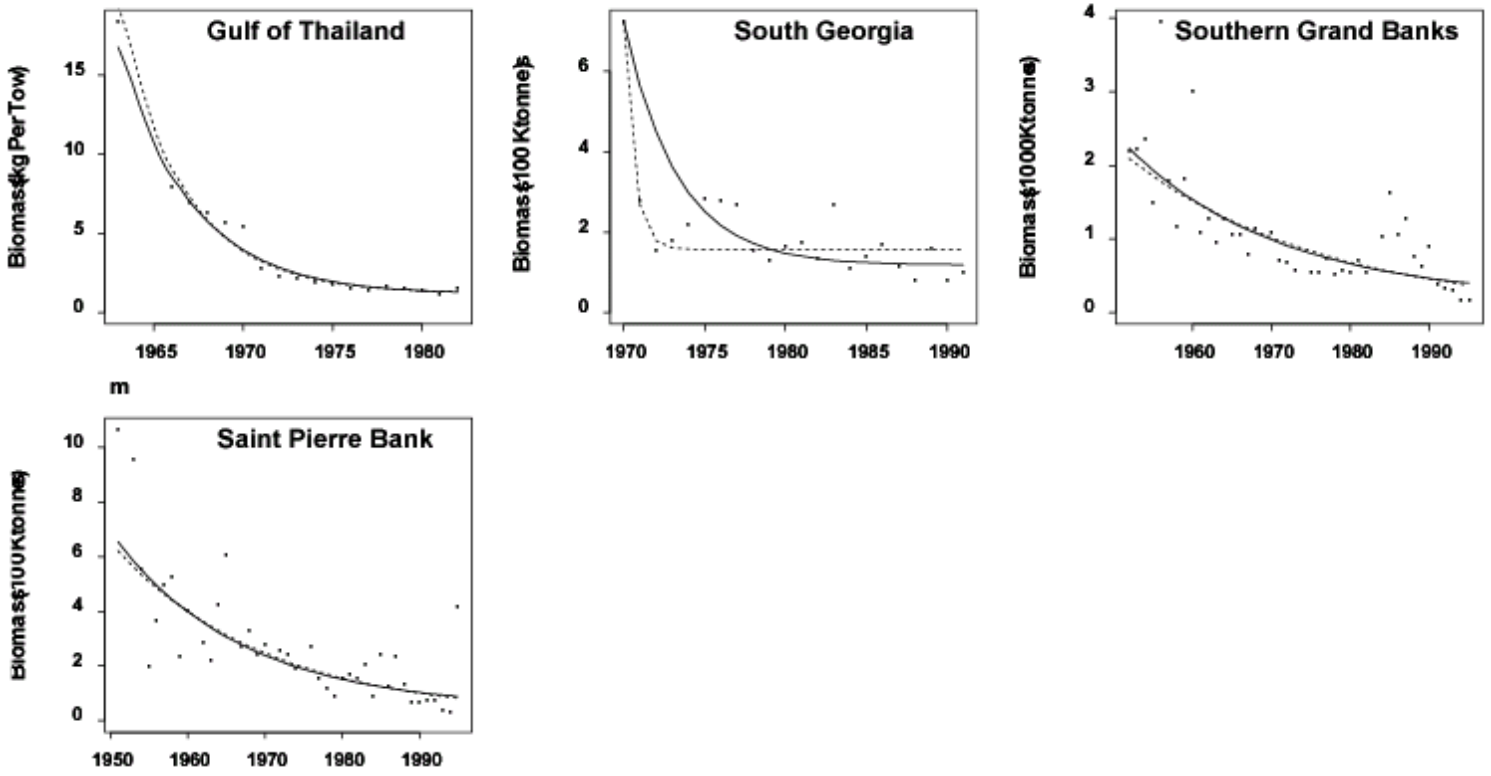
Locations of a leatherback turtle over a two week period tagged by my student Mike James that maintains its position within a cold core ring (somehow).

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

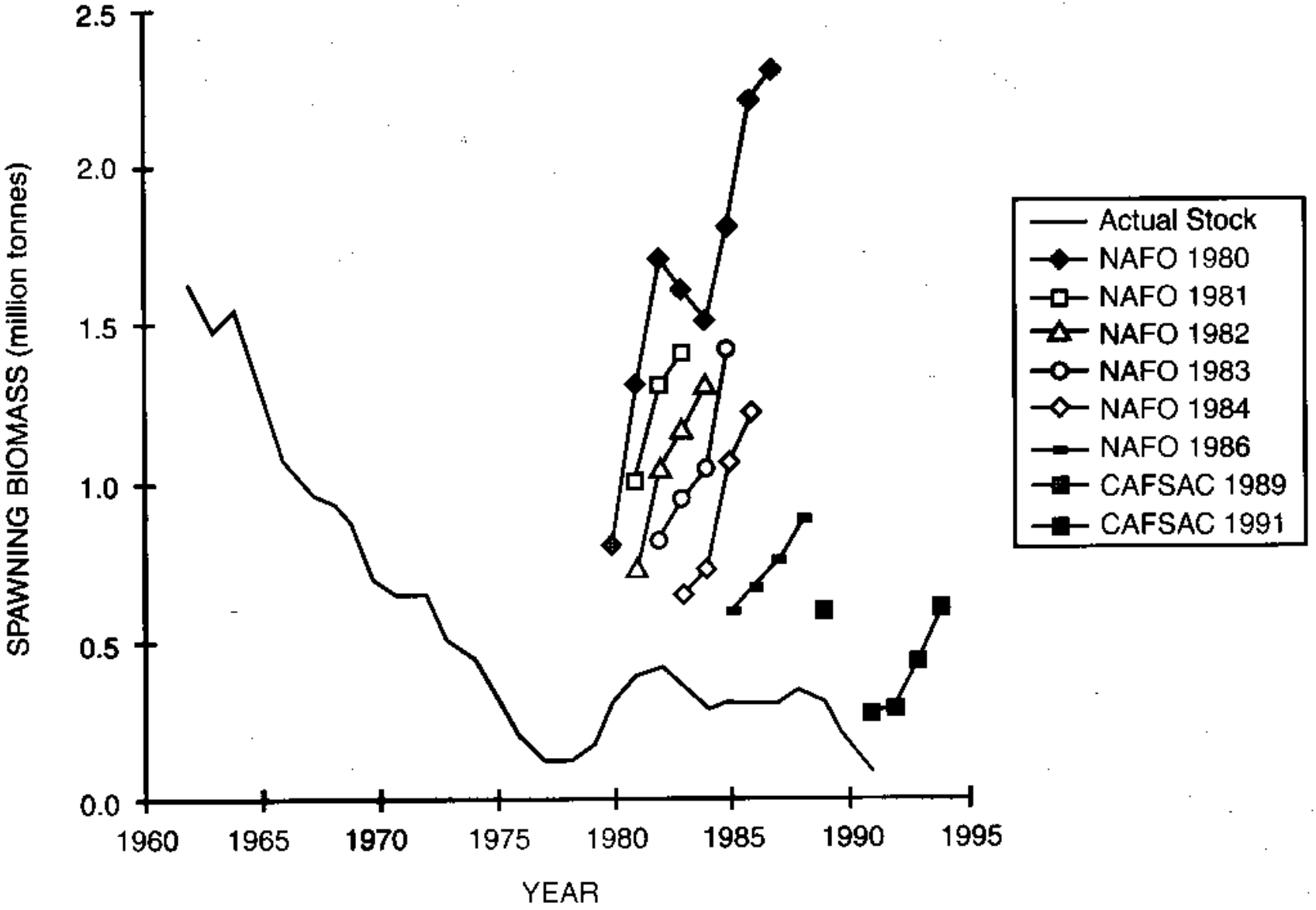
Step 8: You need emotional support. Support from colleagues and family is essential. You cannot do it (for long) by yourself.

Why is it so important.
What makes them work.

Shelf seas


Gulf of Thailand
South Georgia
Southern Grand Banks
Saint Pierre Bank
1965
1970
1975
1980
1985
1990
1960
1950

Government science was consistently wrong, and there was no effective voice from universities.



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

www.nature.com/nature

Net losses

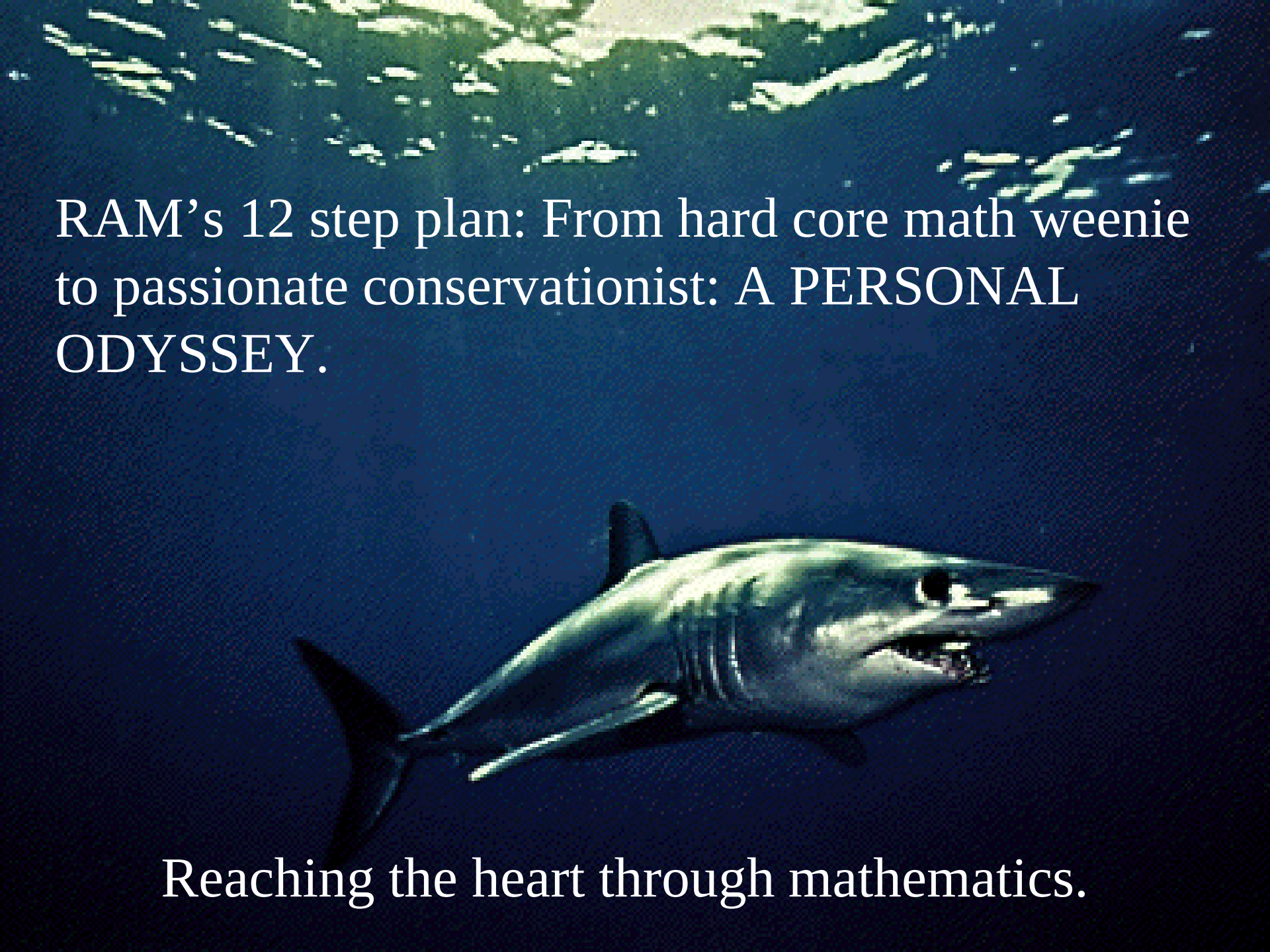
Industrialized fishing hits fish stocks

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 is 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.

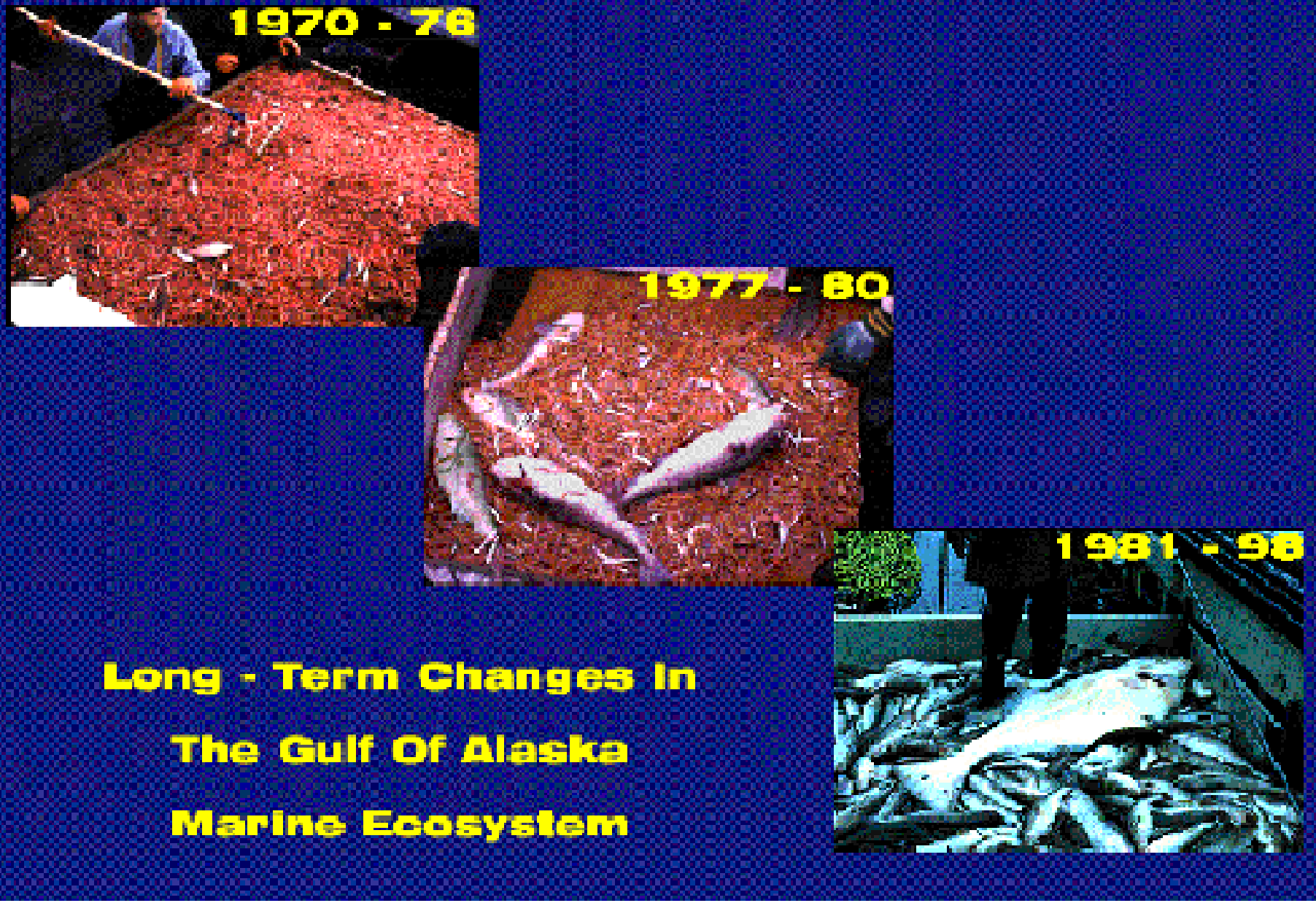
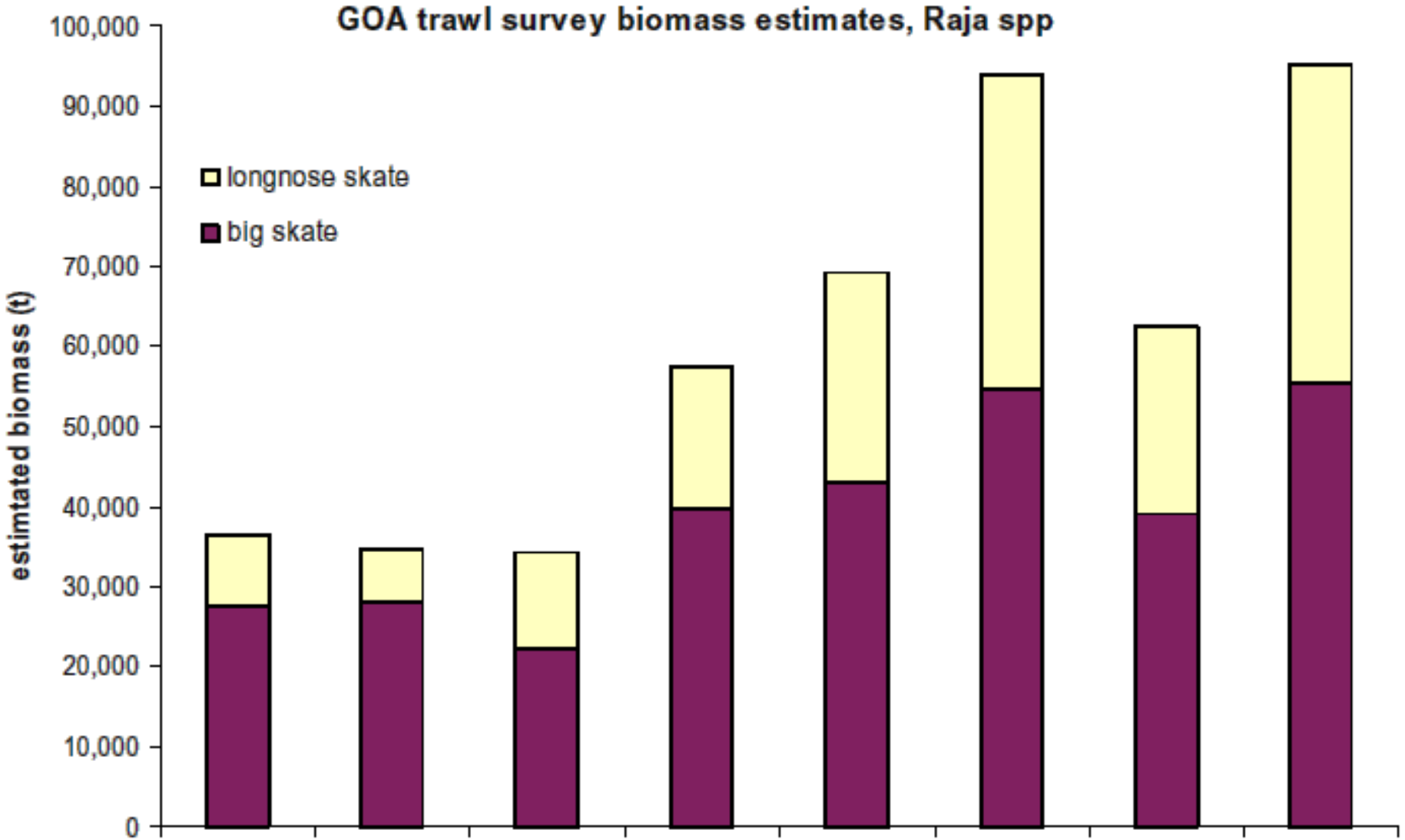


Figure stolen from Paul Anderson

- 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.



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

by

Sarah Gaichas[1], Michael Ruccio[2], Duane Stevenson[1], and Rob Swanson[3]

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
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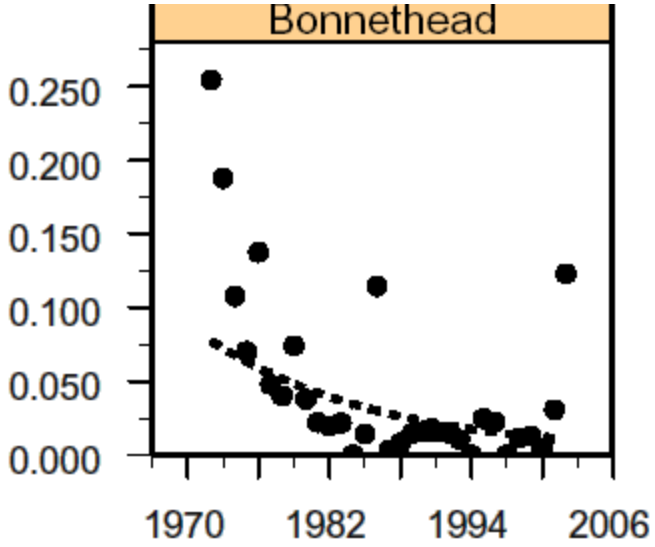
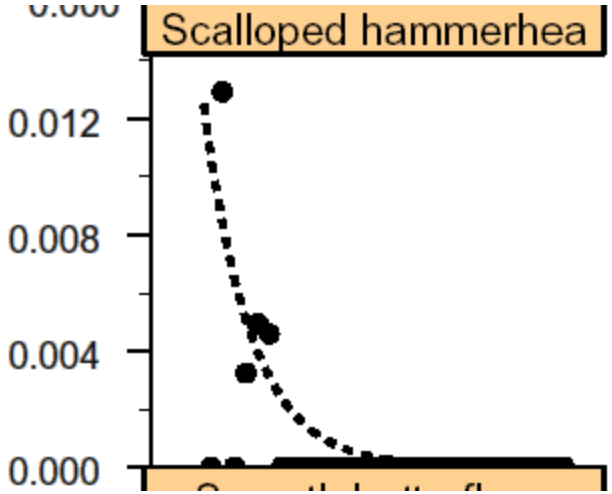
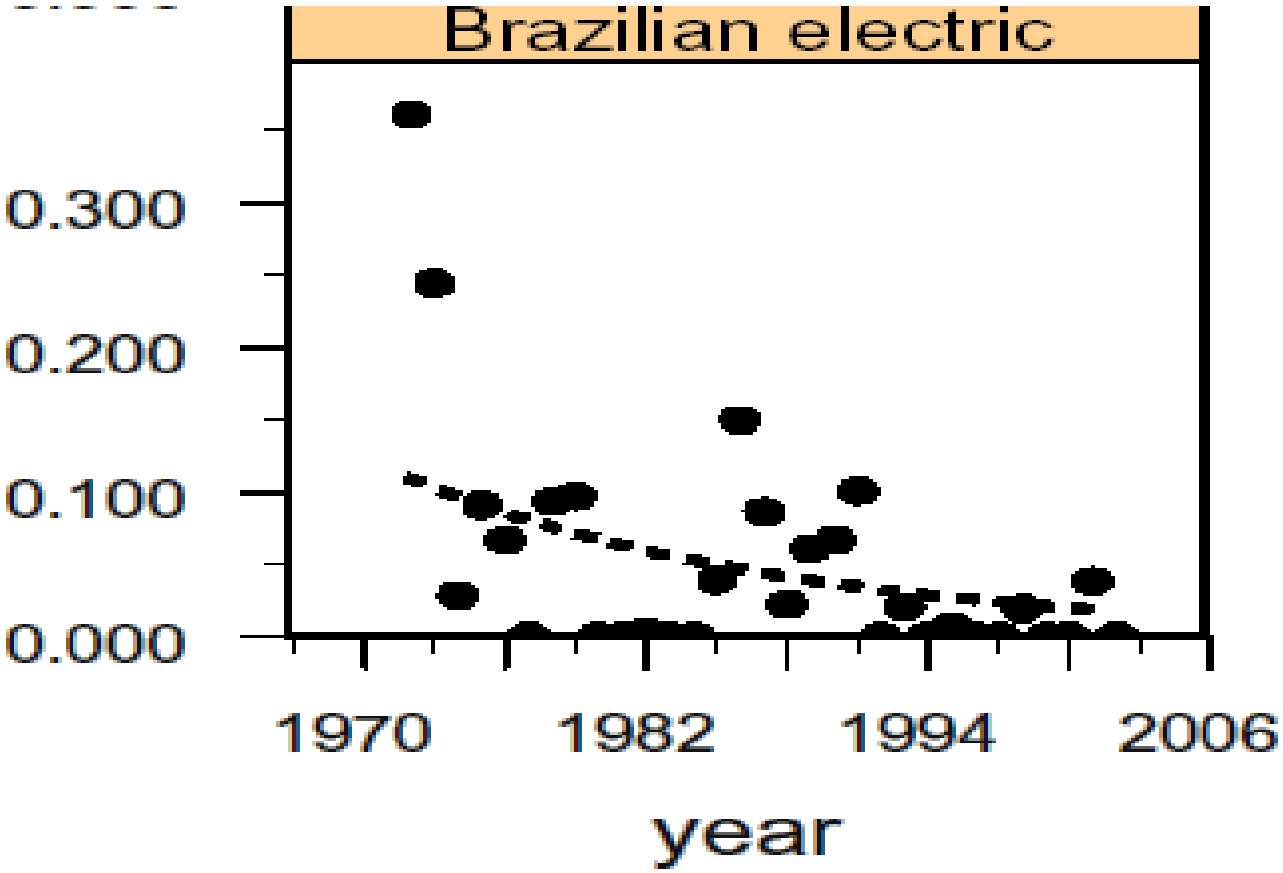
All large sharks declined



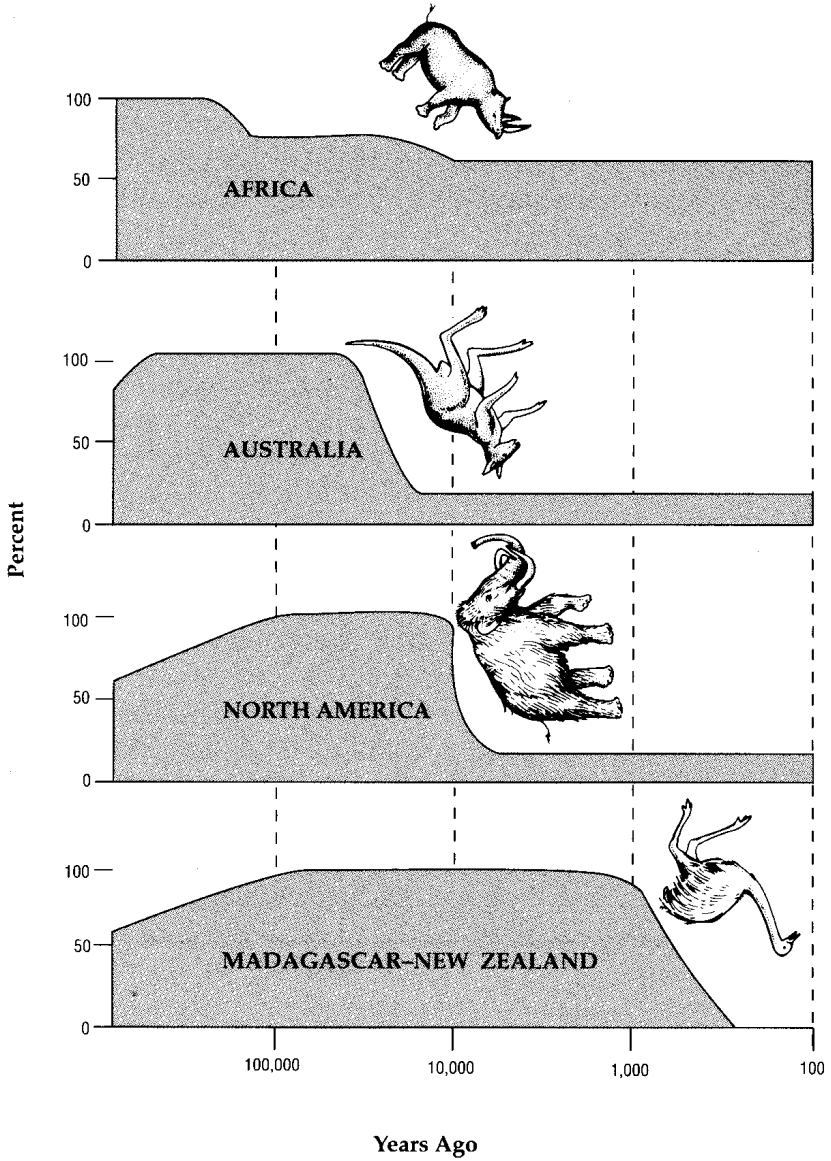


Shallow water species that do not survive discarding: large declines:



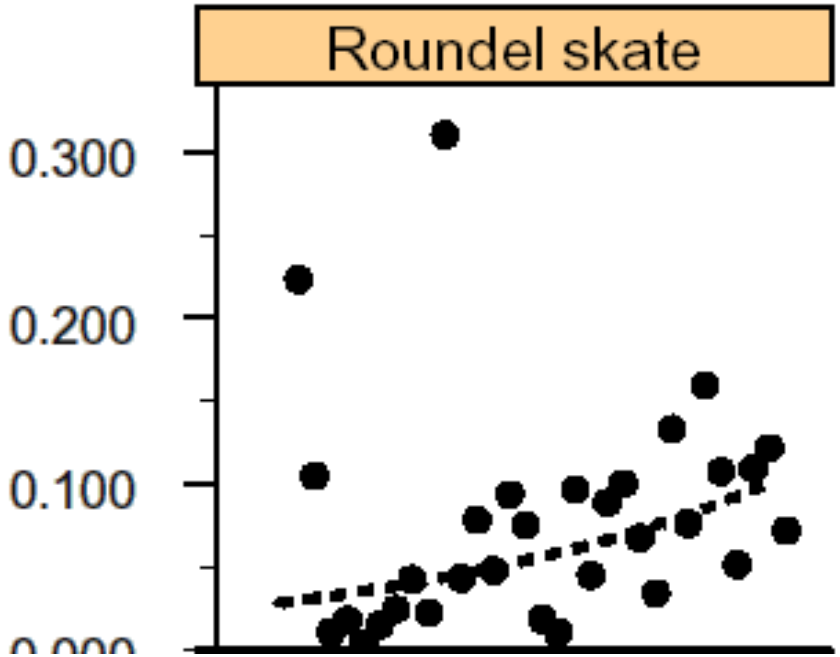
Are the pleistocene extinctions* going to be repeated in the ocean?

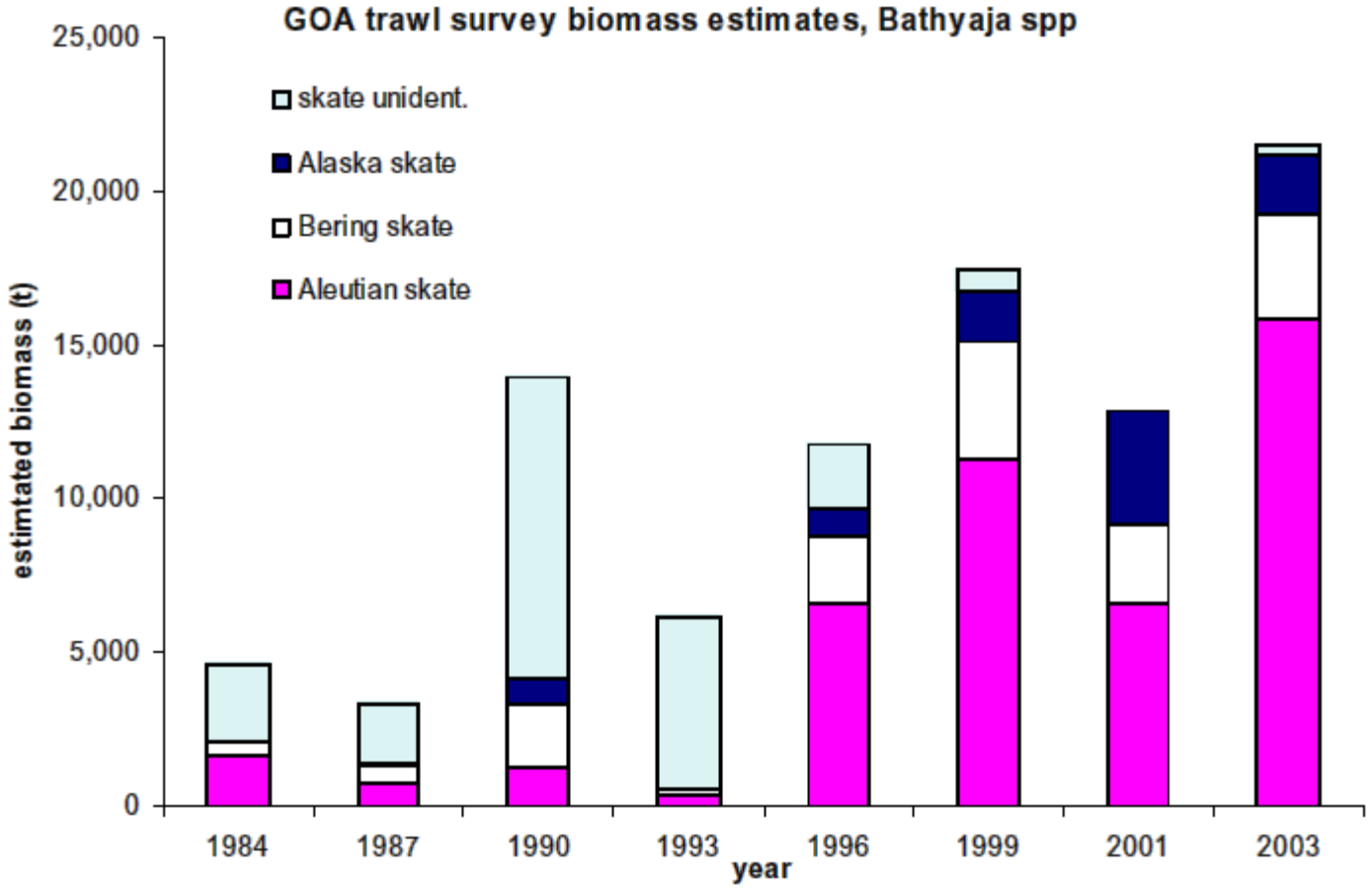
*Present North American biota has lost almost all large species –
We have no mammoths, mastodons, giant ground sloths, giant beavers, and 65 other species that weighted more than 100 kilograms.



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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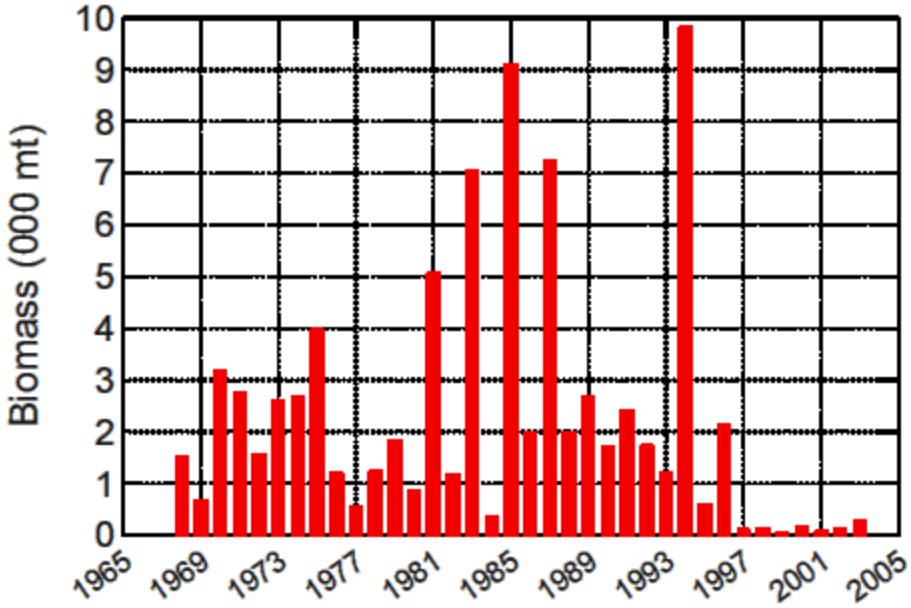
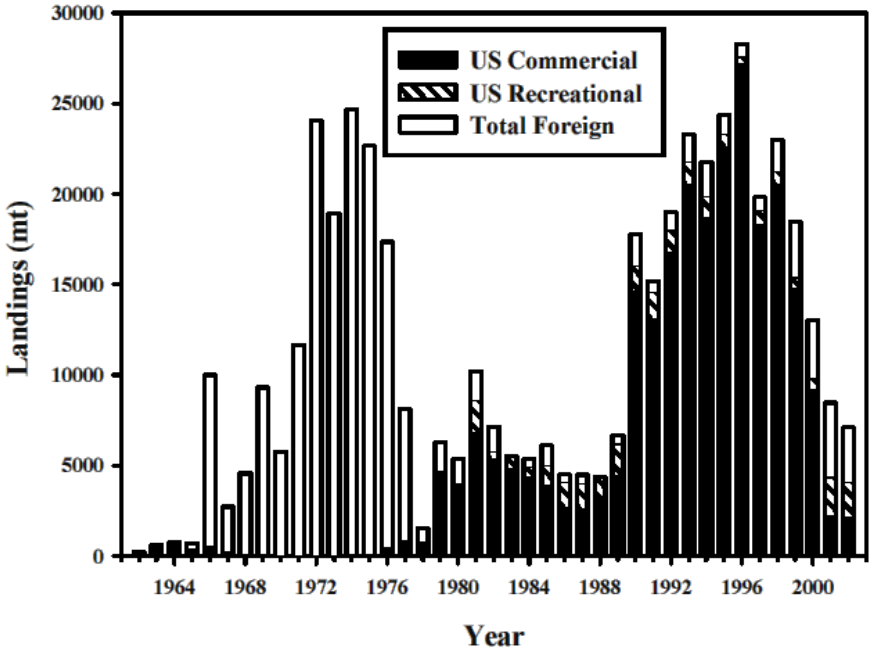
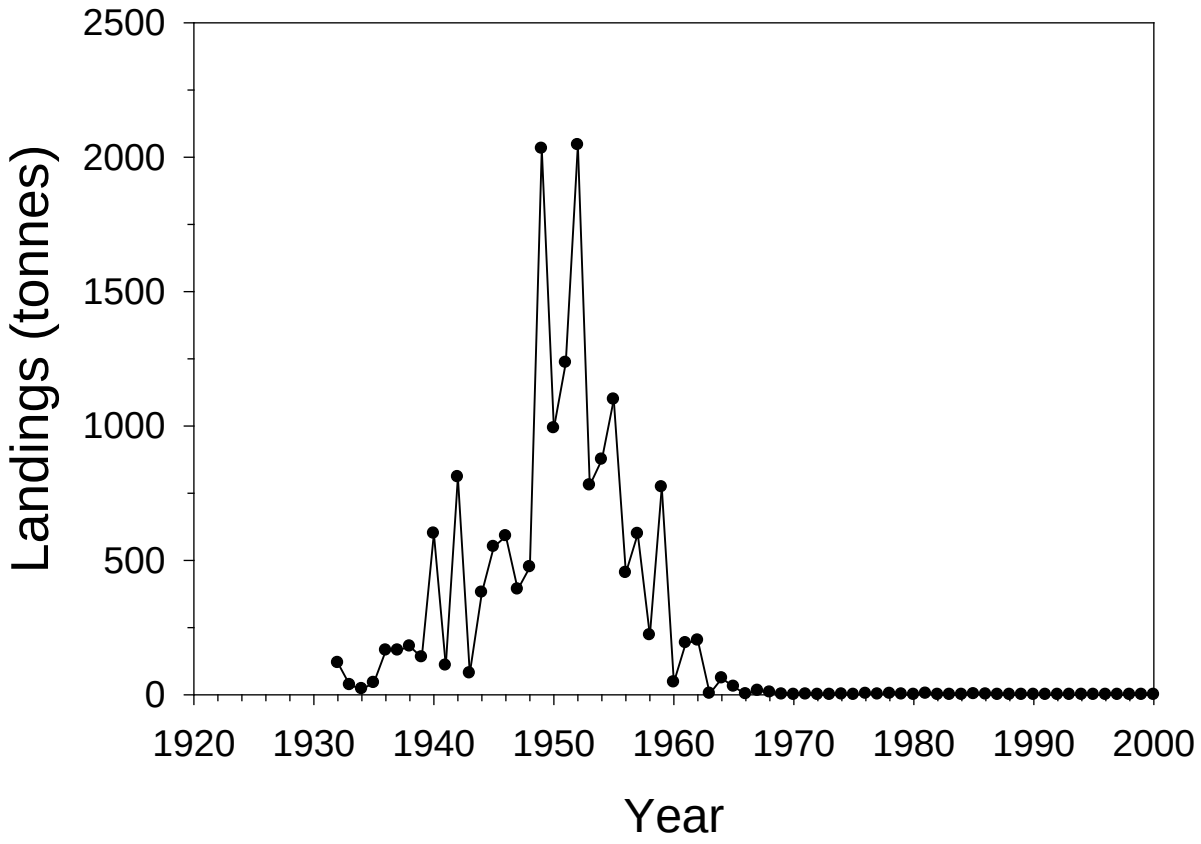
Spiny Dogfish, Northwest Atlantic: Good Science – Ugly Decisions





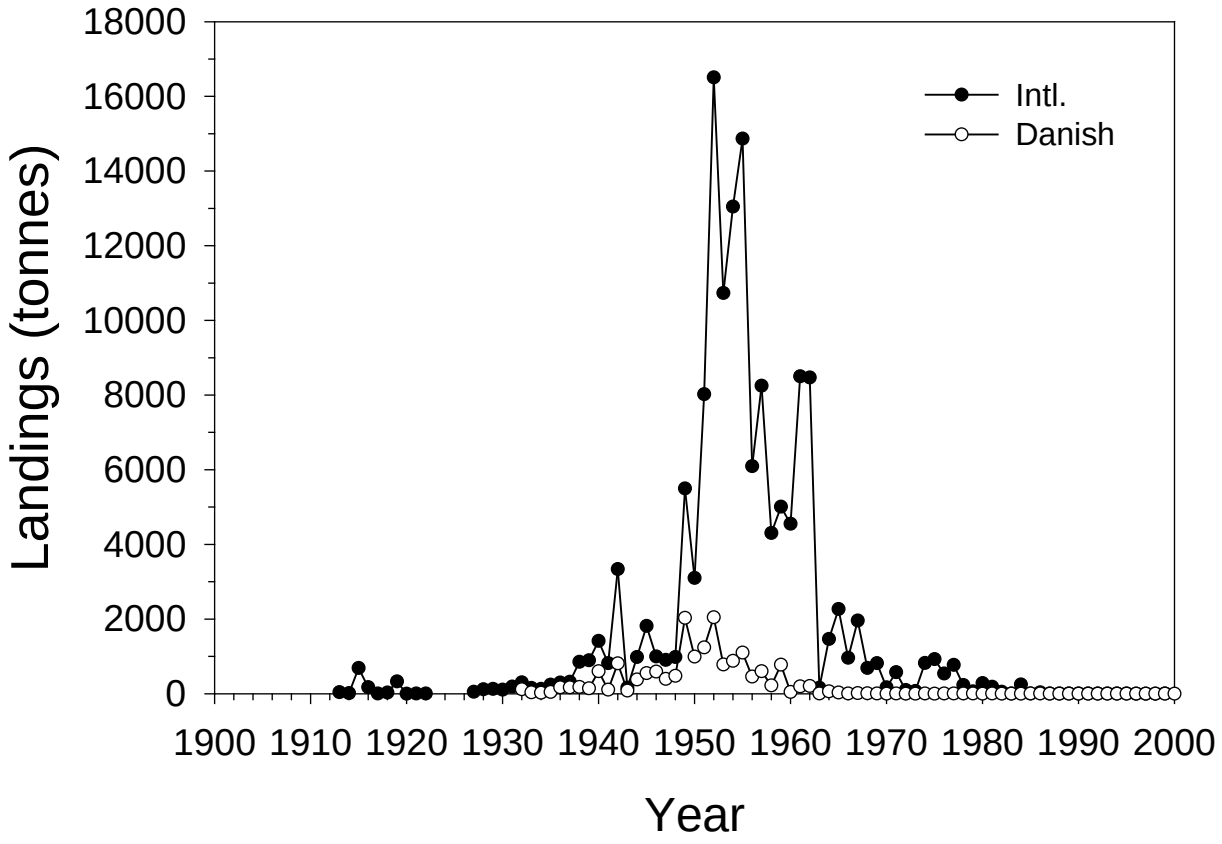
Danish Landings of Bluefin Tuna
Thunnus thynnus



DIFRES

Data source: DIFRES, ICES, FAO

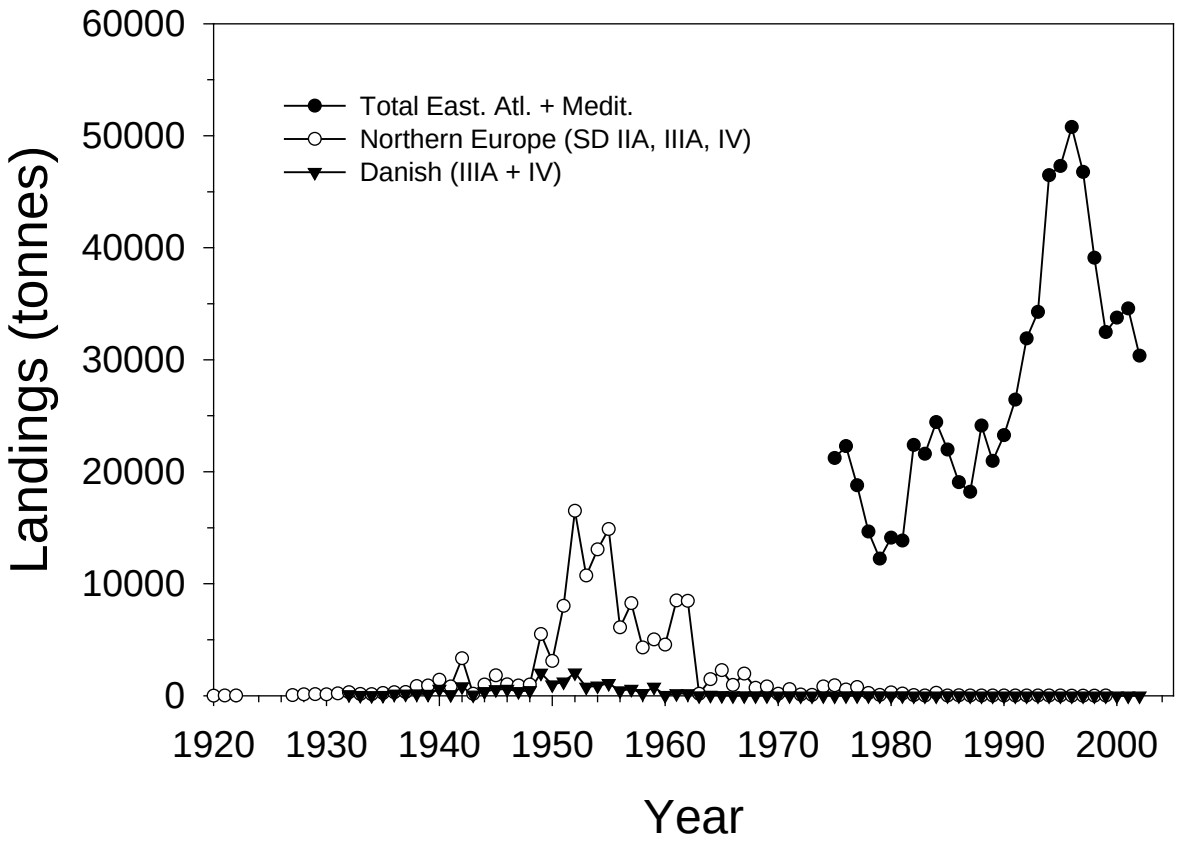
Landings of Bluefin Tuna *Thunnus thynnus* in Northern Europe*



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

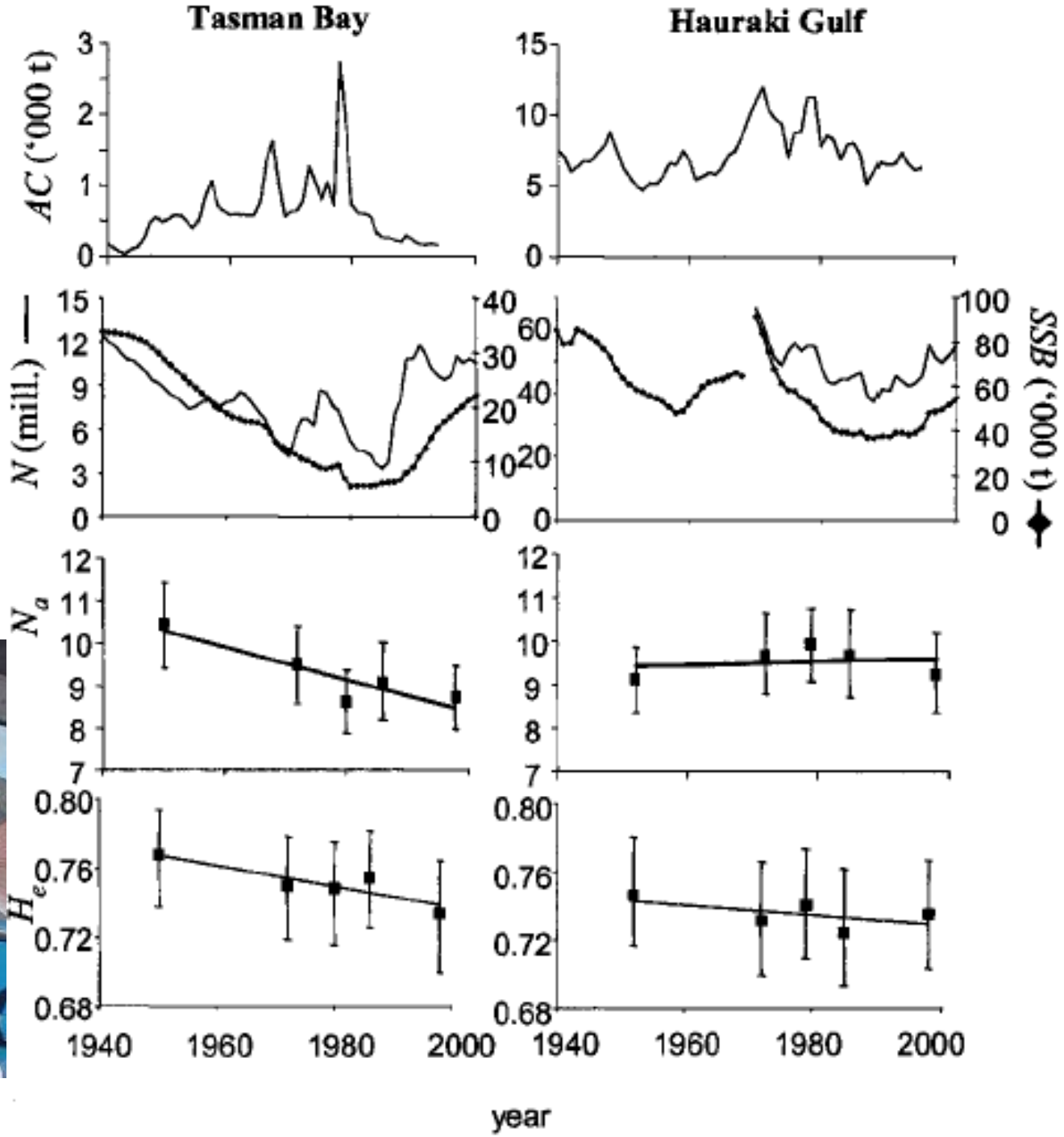
DIFRES

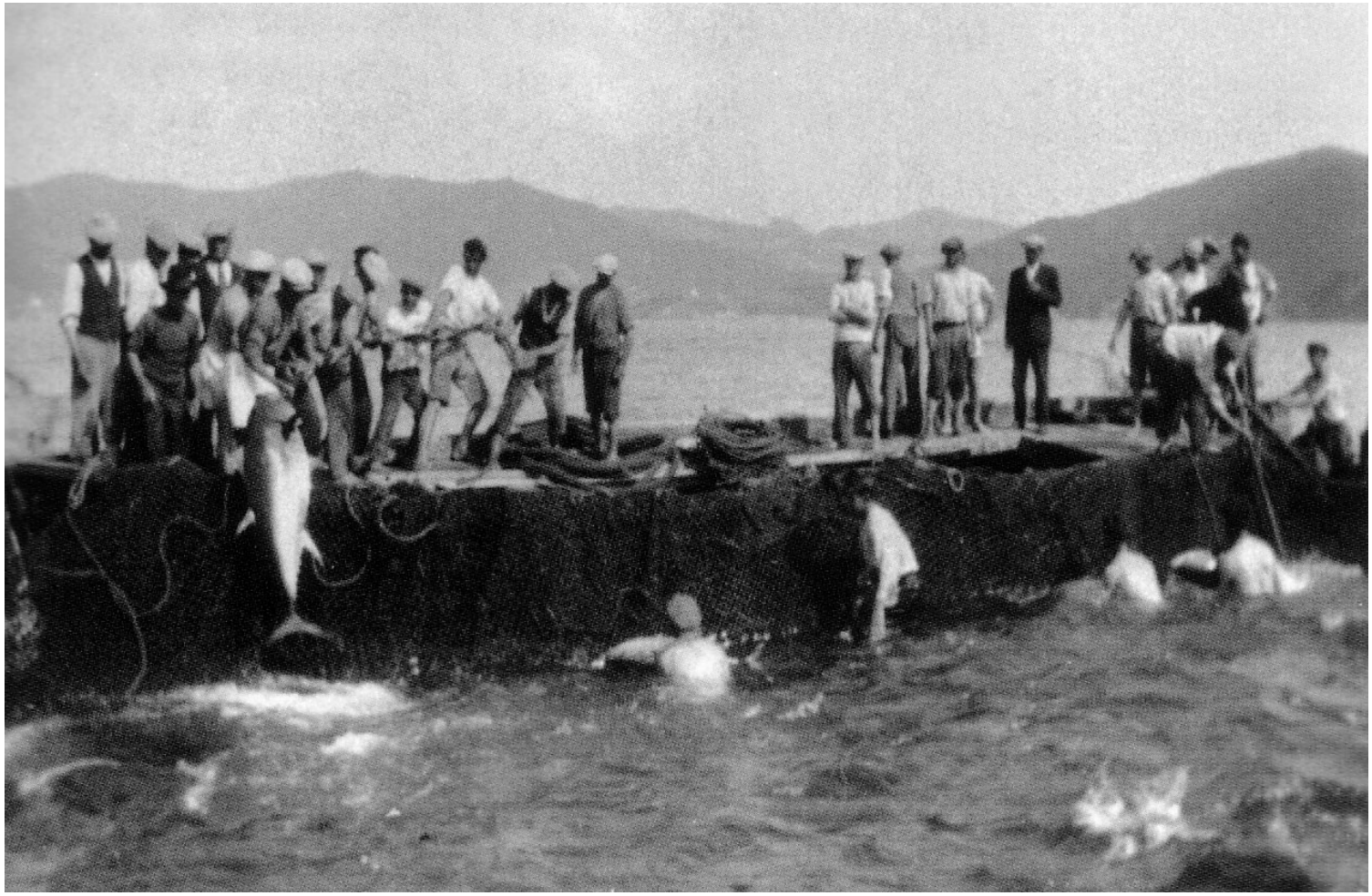
Landings of Bluefin Tuna
Thunnus thynnus in Northeast Atlantic

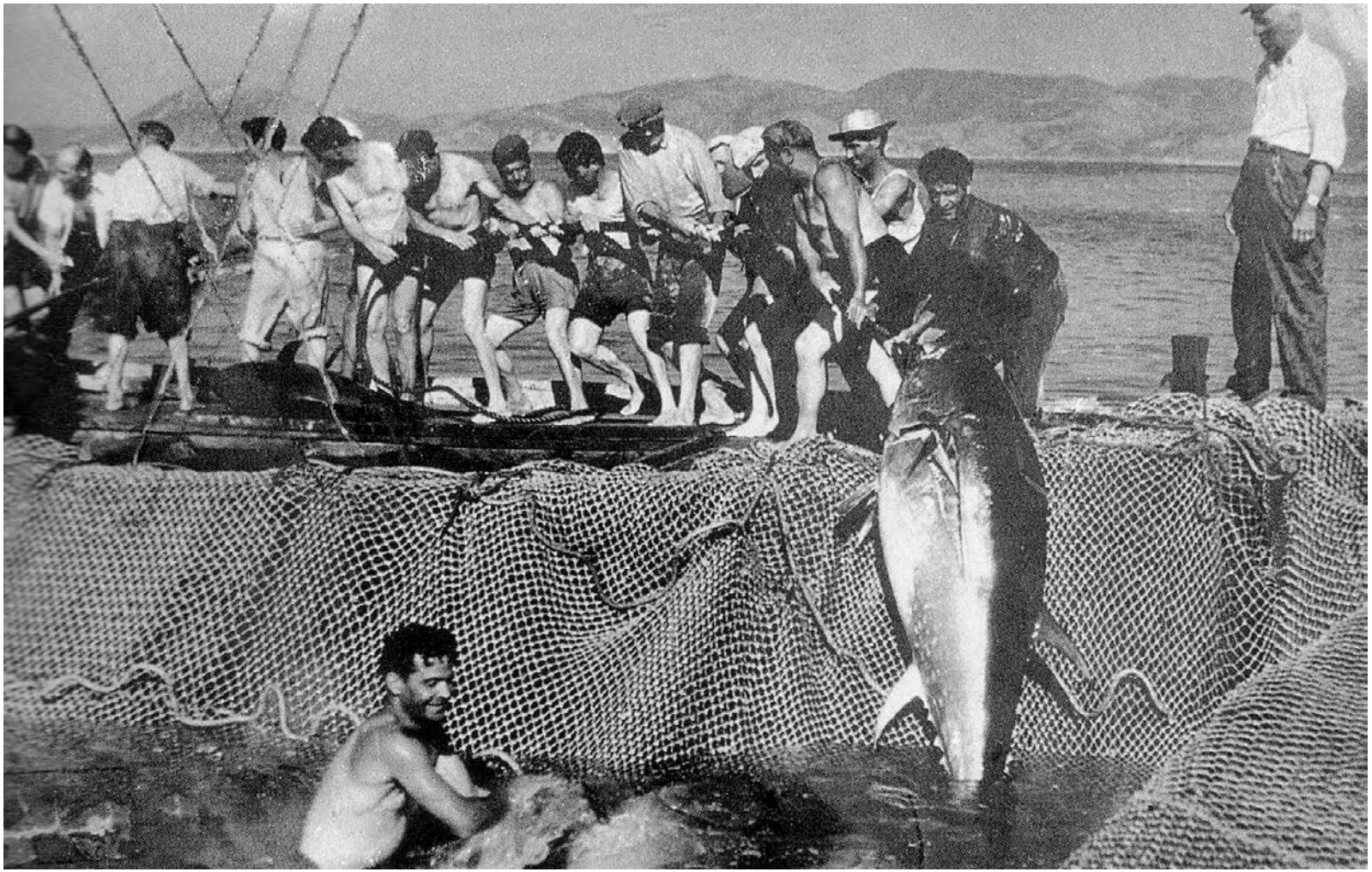


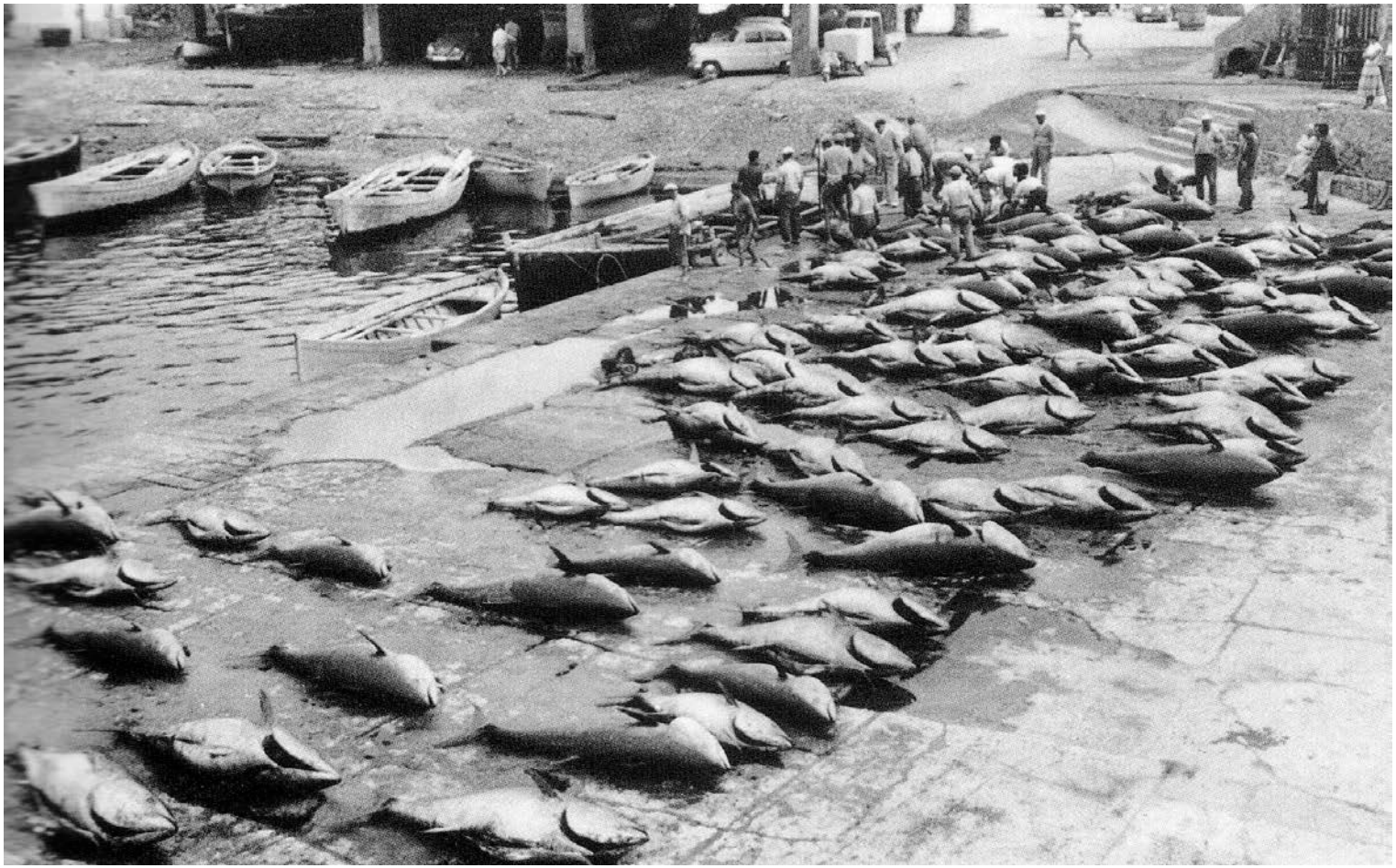
DIFRES

Hauser, et al. PNAS, 2002

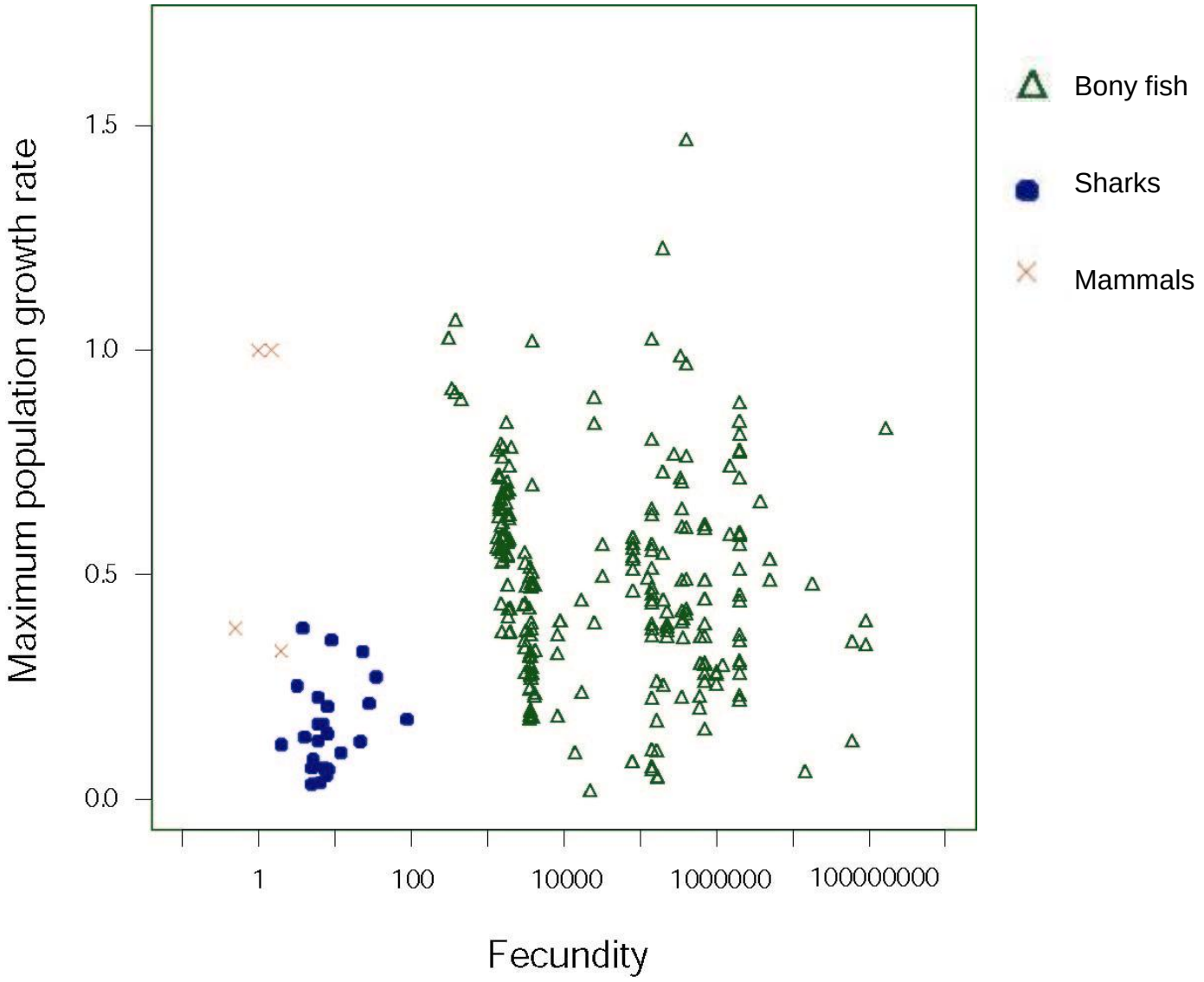




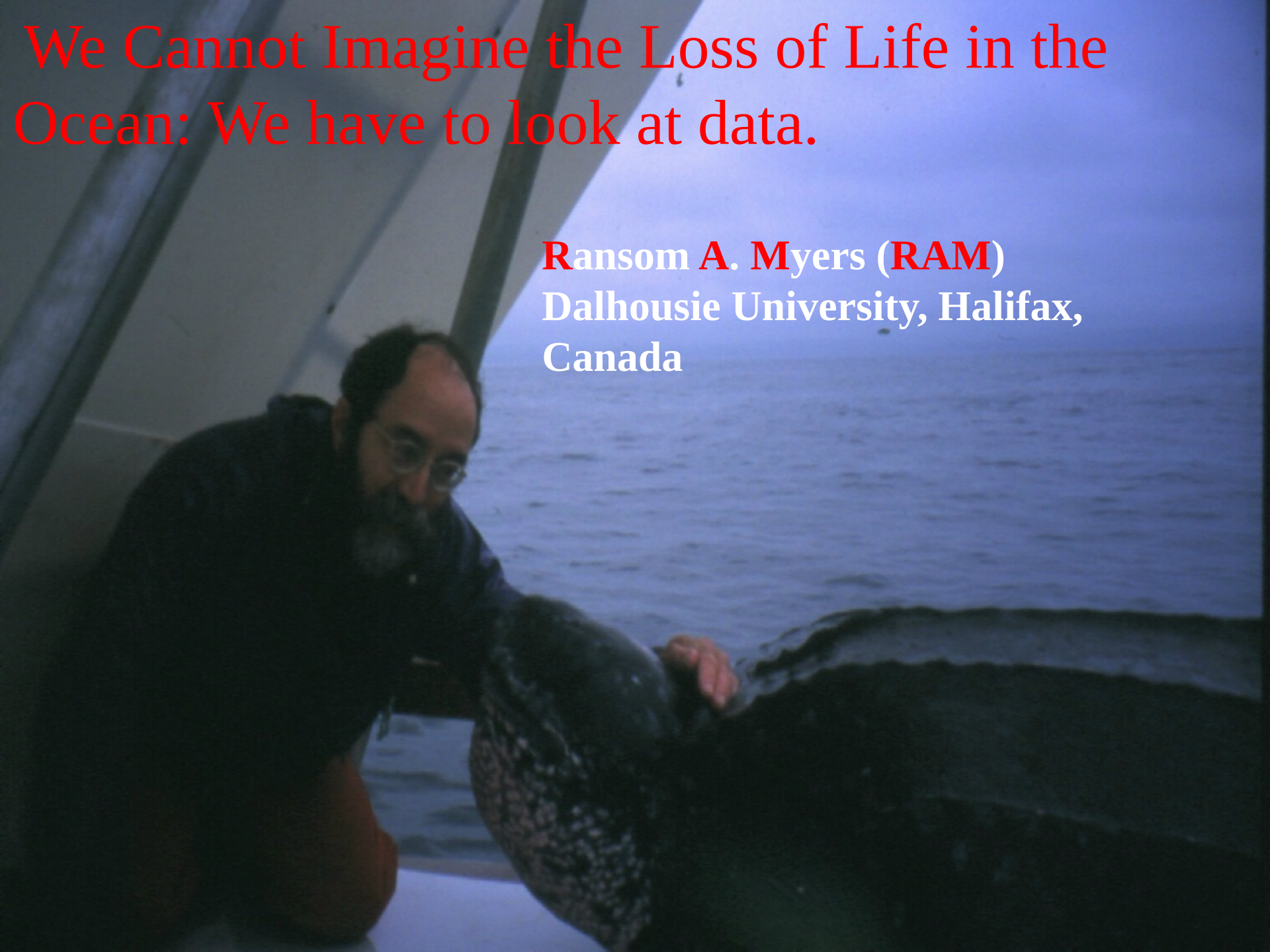




Life history of sharks…



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



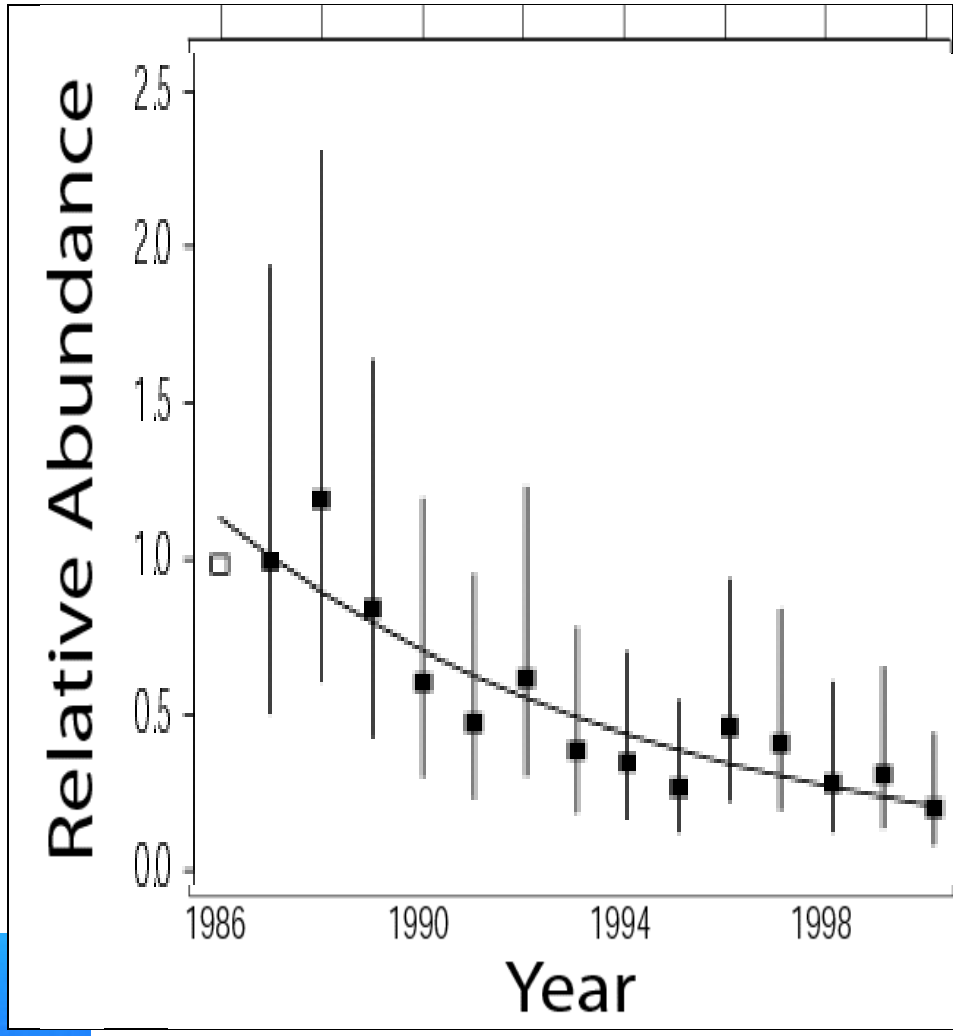
Ransom A. Myers (RAM)
Dalhousie University, Halifax, Canada

Decline of Mako sharks

Boero F. & A. Carli 1979 – Boll. Mus. Ist. Biol. Univ. Genoa (47)

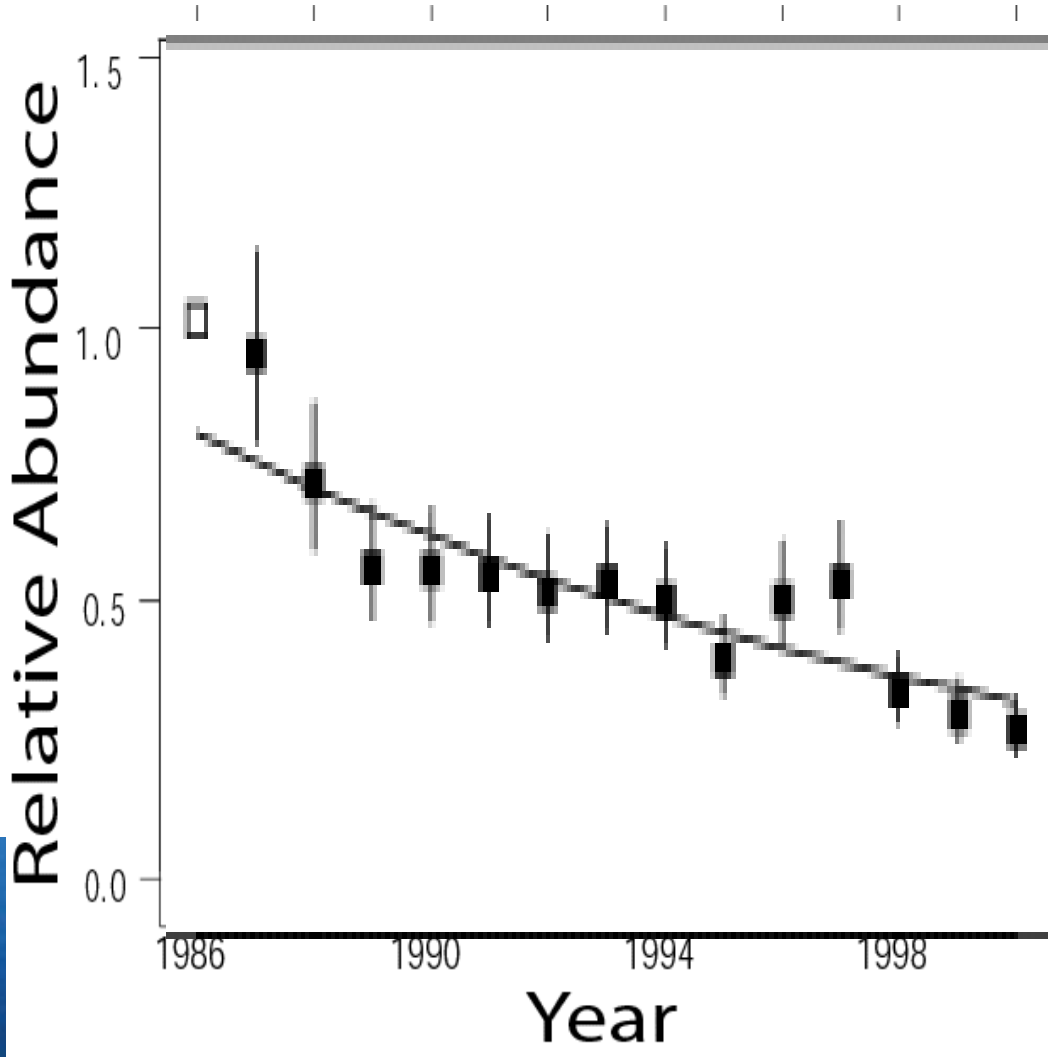
Thresher sharks

Alopias spp.

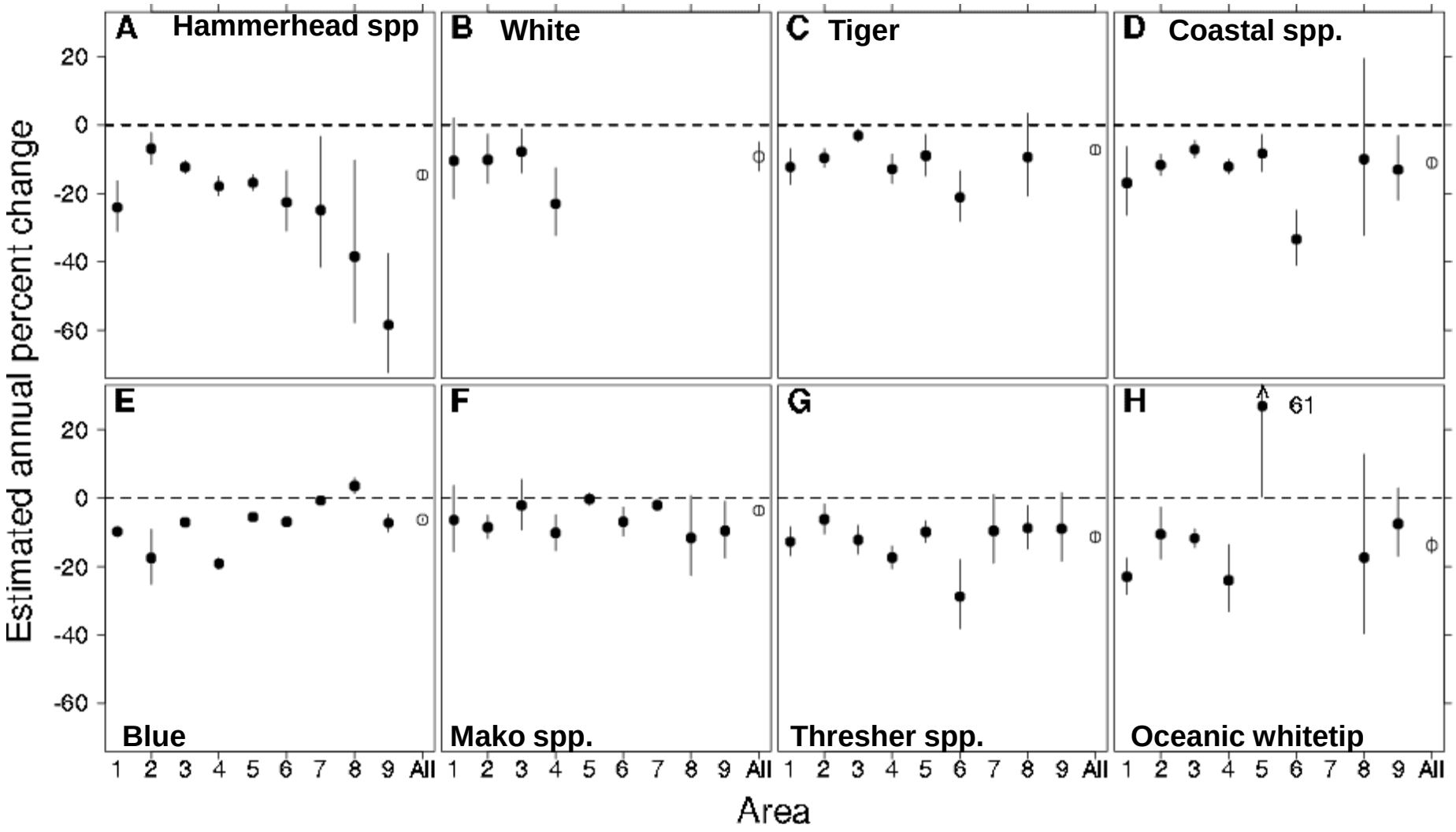


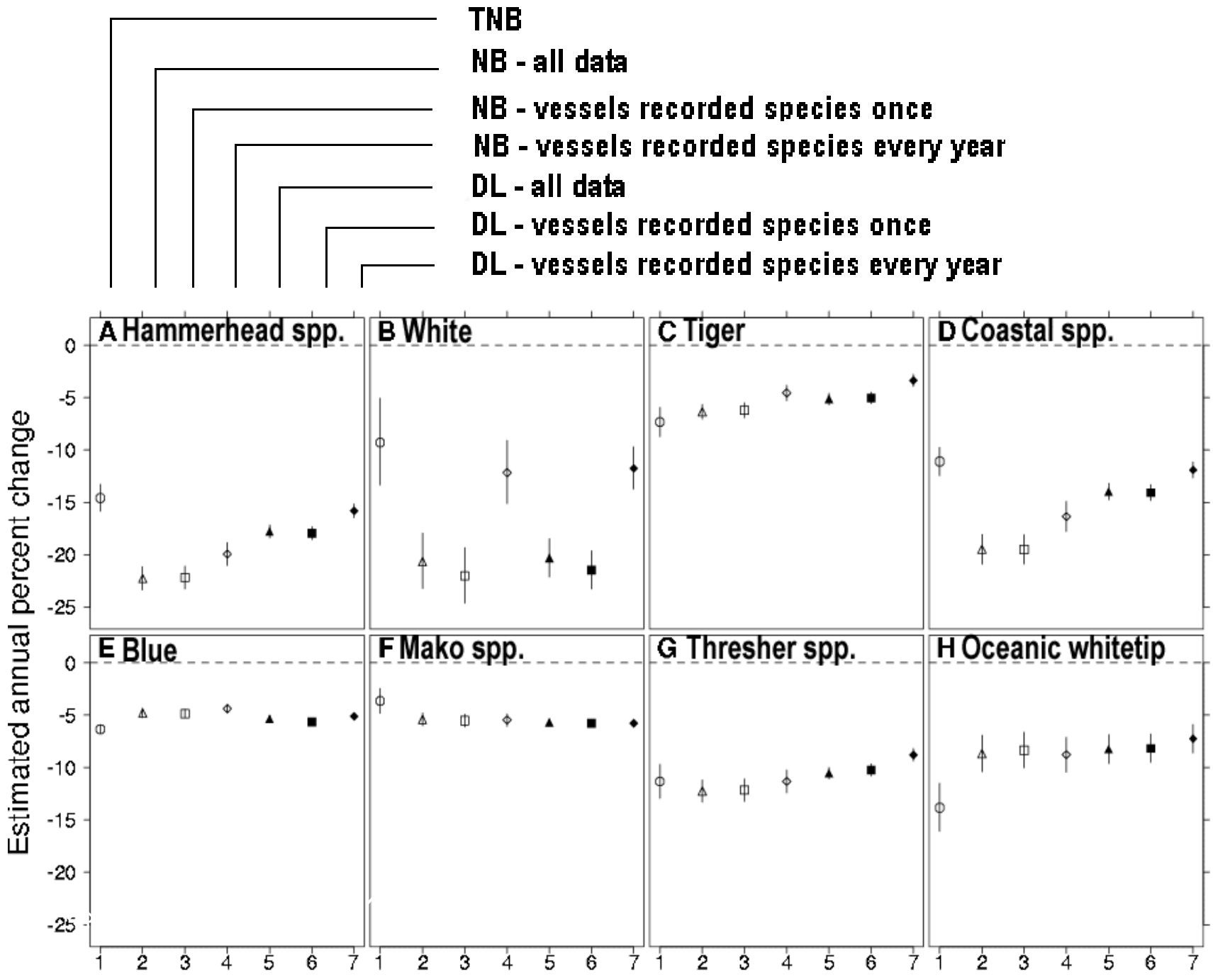
Blue sharks

Prionace glauca

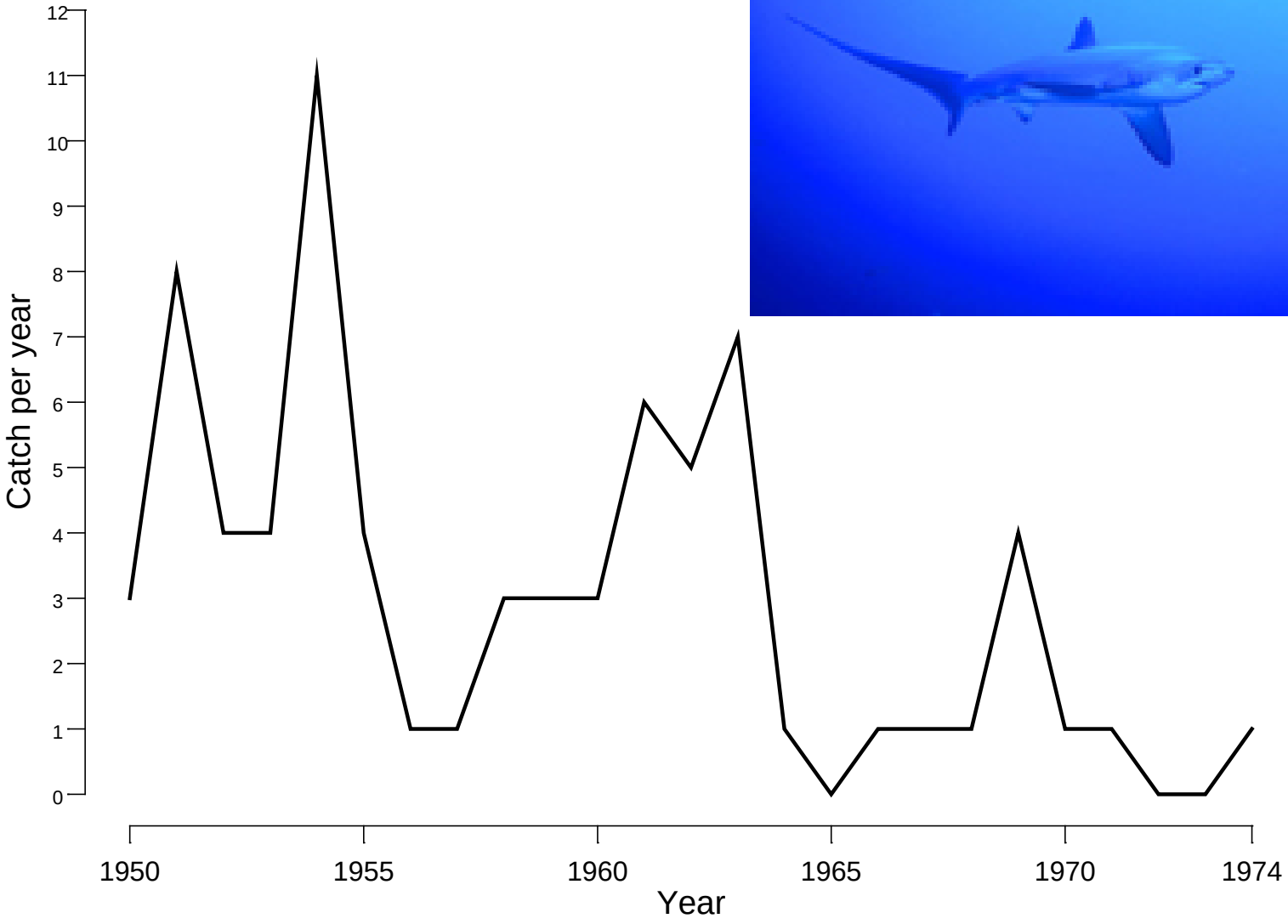


1 Caribbean
2 Gulf of Mexico
3 Florida
4 S Atlantic Bight
5 Mid Atlantic Bight
6 NE Coastal
7 NE Distant
8 Sargasso
9 S America



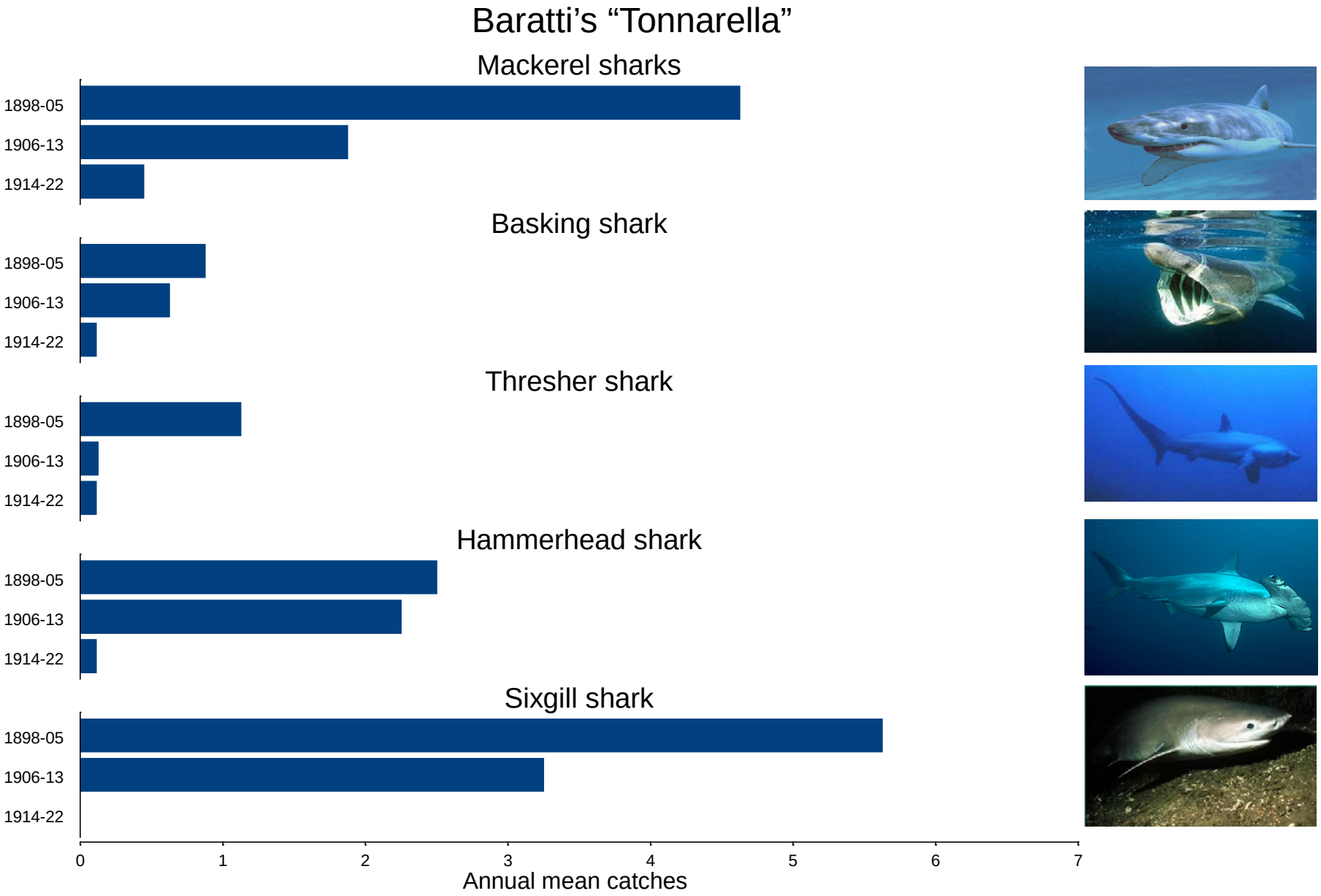

TNB
NB - all data
NB - vessels recorded species once
NB - vessels recorded species every year
DL - all data
DL - vessels recorded species once
DL - vessels recorded species every year
A Hammerhead spp.
B White
C Tiger
D Coastal spp.
E Blue
F Mako spp.
G Thresher spp.
H Oceanic whitetip
Estimated annual percent change
0
-5
-10
-15
-20
-25
1
2
3
4
5
6
7

Decline of Thresher sharks



Boero F. & A. Carli 1979 – Boll. Mus. Ist. Biol. Univ. Genoa (47)

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



Vacchi M. *et al*. 2000 - 4th-Meeting-of-the-European-Elasmobranch-Association-Proceedings

Loss of Bluefin Tuna Populations in the Atlantic