# Patterns and ecosystem impacts of **global invertebrate fisheries expansion**

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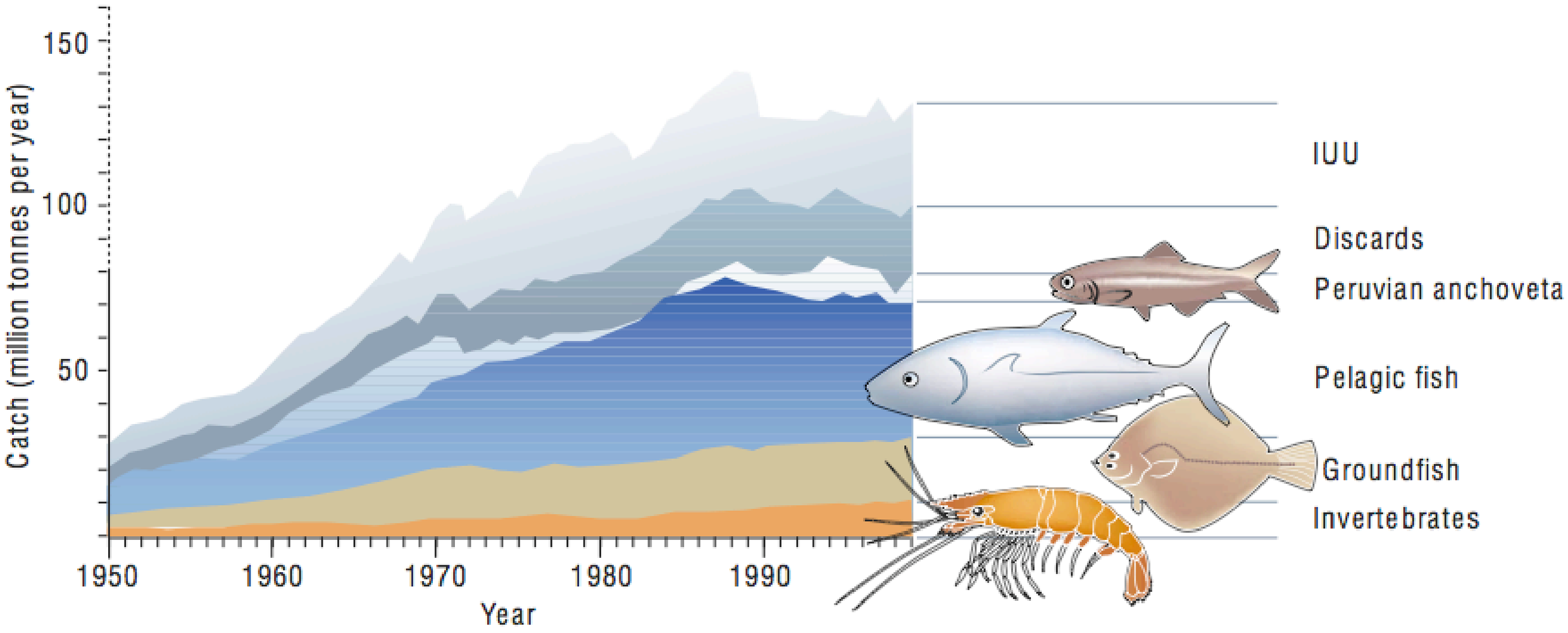
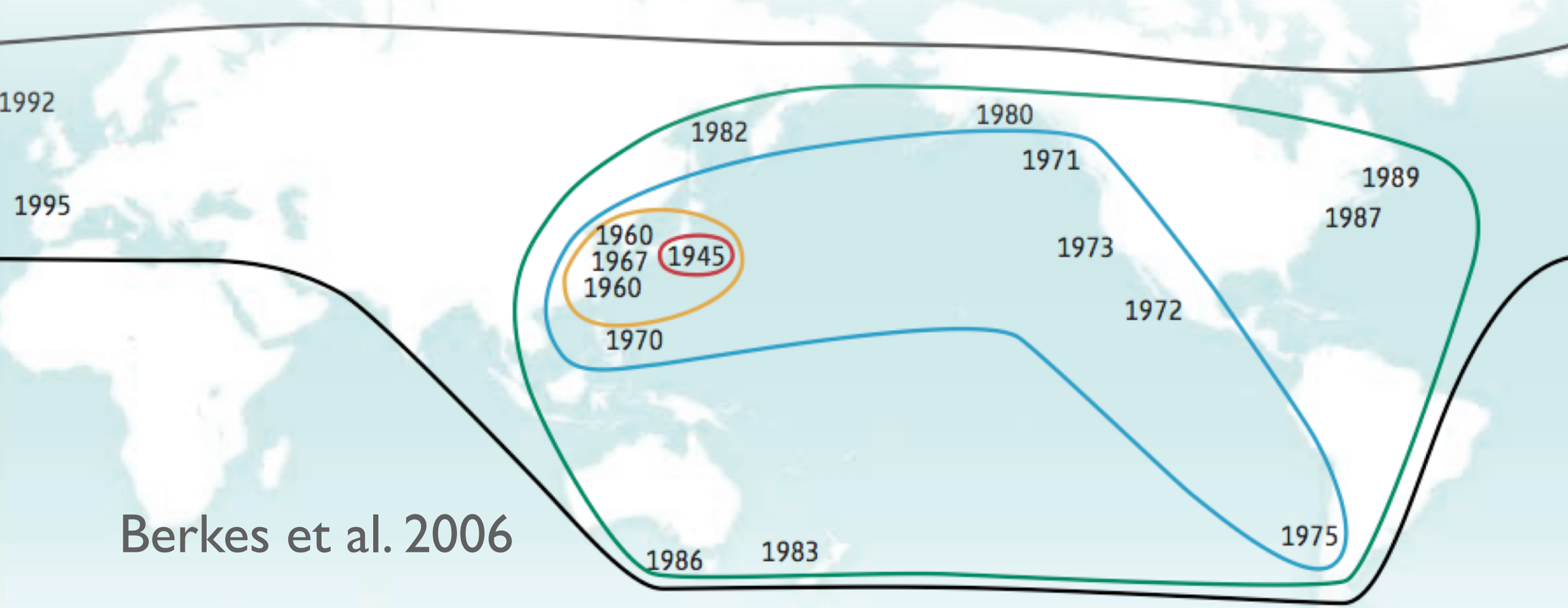
# Global expansion




Pauly et al. 2002

# Global patterns?




Berkes et al. 2006

Objective 1:

Describe the **global expansion** of invertebrate fisheries over time and space as a **whole** and by **taxonomic** groups, **functional** groups, and **gear** types.

Objective 2:

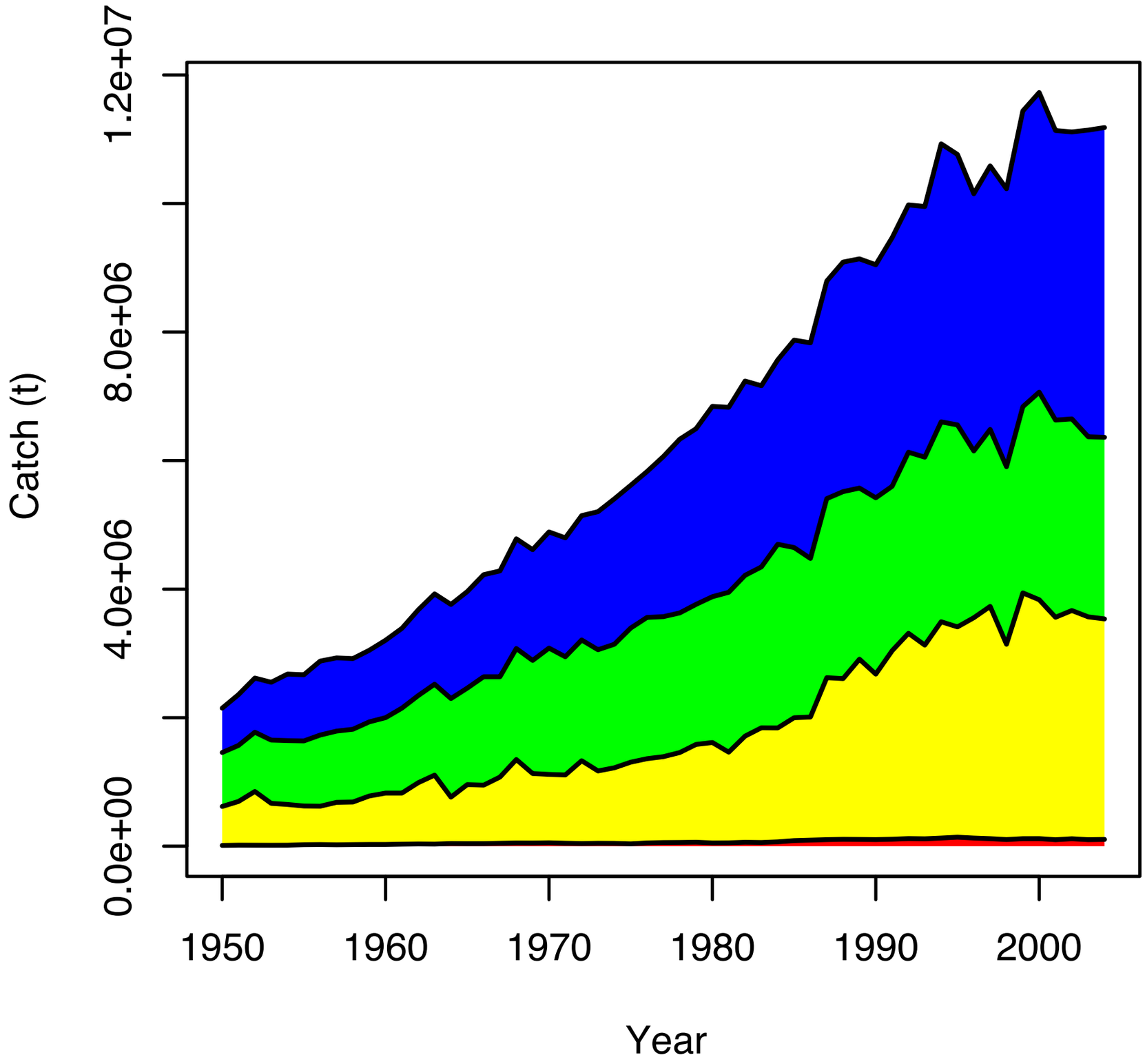
Formally identify the common **drivers** of these patterns and their potential **consequences** such as serial depletion.

Section 1:

# Global **expansion** of invertebrate fisheries

- Global expansion
- Global catch and diversity of catch

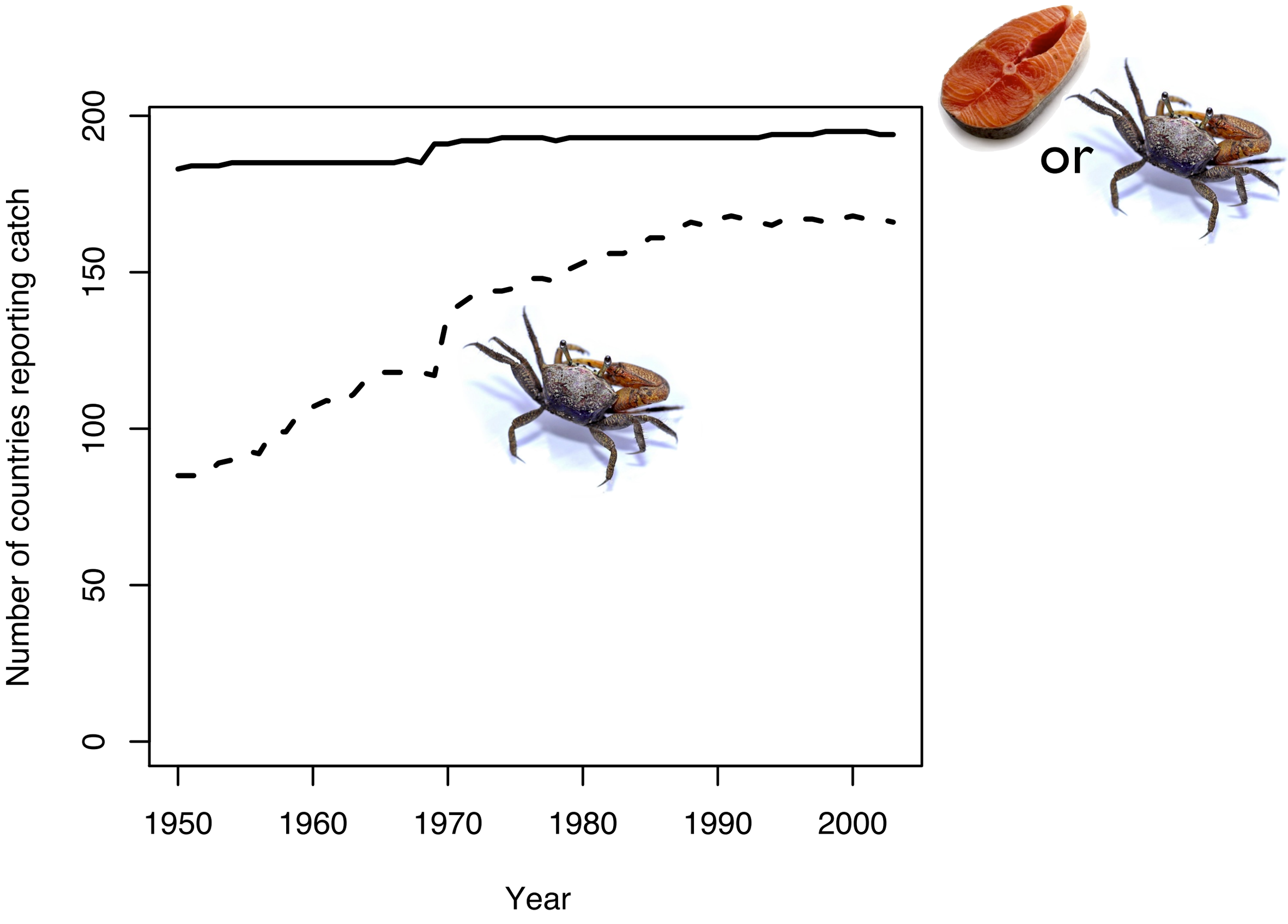
> Overall and by taxonomic groups, **at what rate** is global invertebrate **catch increasing**?


Catch (t)
0.0e+00
4.0e+06
8.0e+06
1.2e+07
1950
1960
1970
1980
1990
2000
Year

1 Global expansion

1 Global catch and diversity of catch

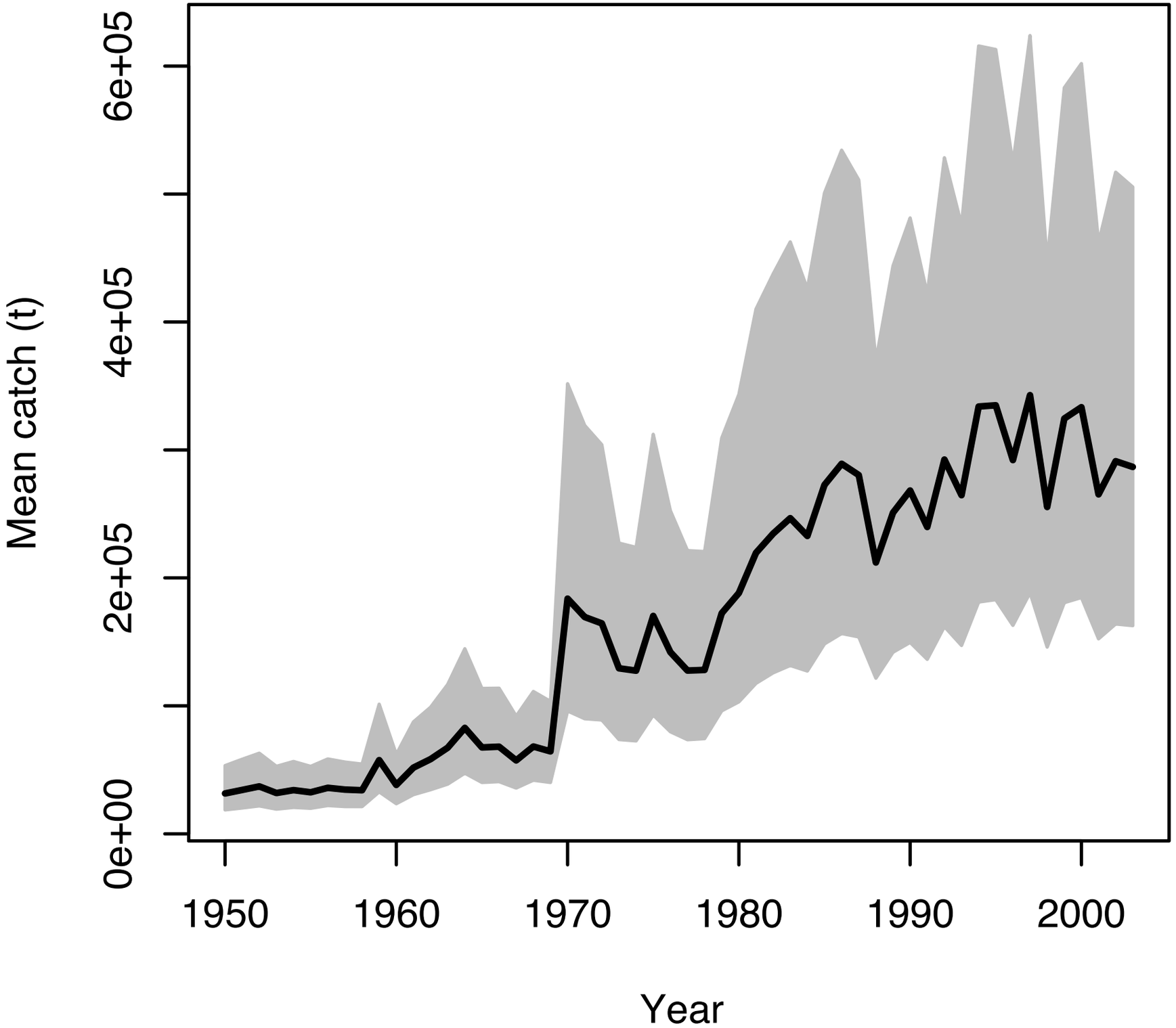
2 To what extent is **increased reporting** to FAO responsible for the trends observed in these and further analyses?


Number of countries reporting catch
0
50
100
150
200
1950
1960
1970
1980
1990
2000
Year
or

1 Global expansion

1 Global catch and diversity of catch

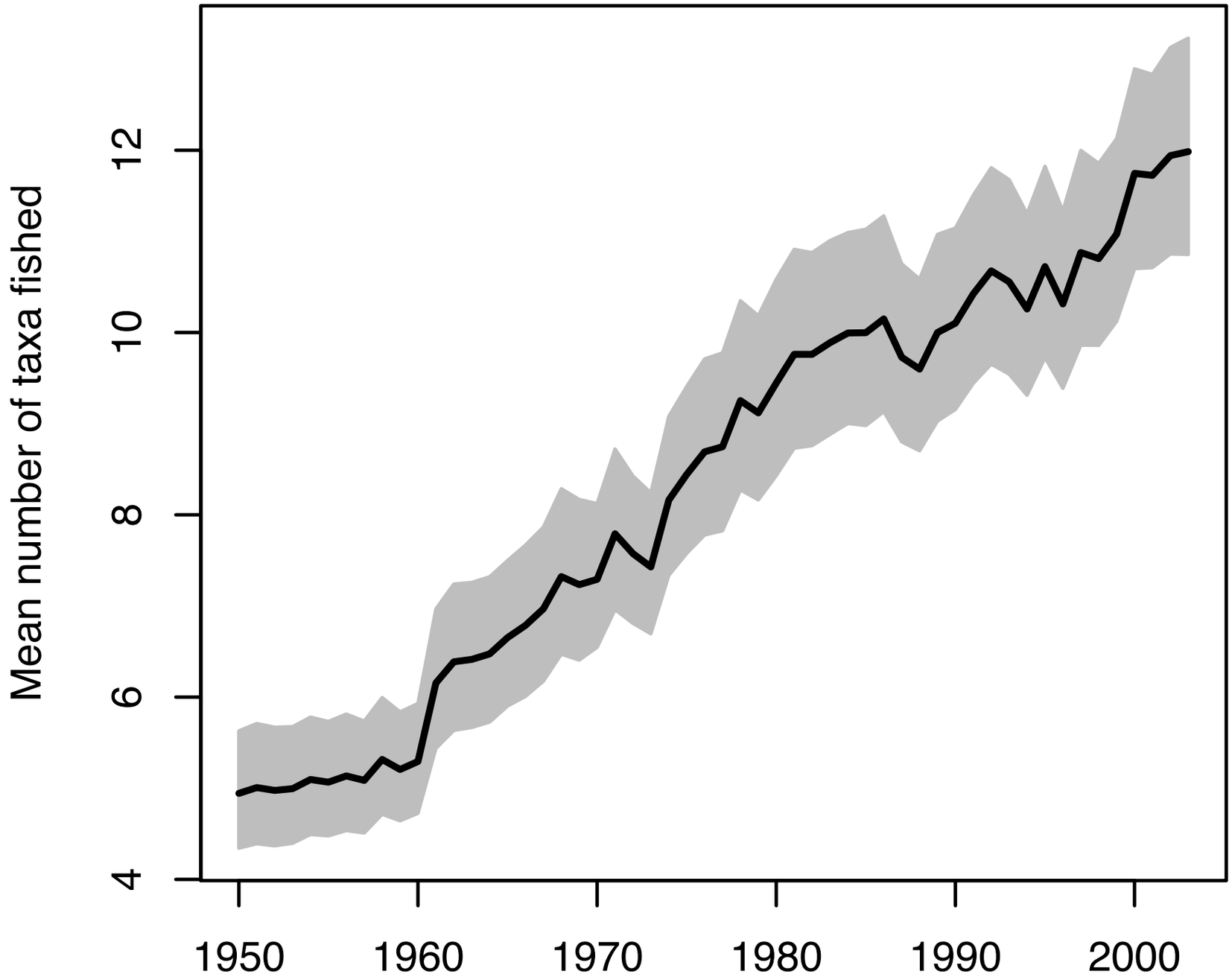
3 To what extent are those countries that are fishing invertebrates **fishing them harder**?


Mean catch (t)
0e+00
2e+05
4e+05
6e+05
1950
1960
1970
1980
1990
2000
Year

1 Global expansion

1 Global catch and diversity of catch

4 To what extent is the **diversity** of invertebrate species fished **increasing**?


Mean number of taxa fished
4
6
8
10
12
1950
1960
1970
1980
1990
2000

1 Global expansion

2 The spatial expansion

To what extent is there **spatial expansion** of invertebrate fisheries?

Percentage of countries reporting catch

0 20 40 60 80

Crustaceans

Shrimps and prawns
Lobsters

Crabs
Misc. crustaceans

Krill

0 10 20 30 40 50 60

Cephalopods

Squids
Octopi

Cuttlefishes

Misc. cephalopods

1950 1960 1970 1980 1990 2000

0 10 20 30 40 50 60

Bivalves and
Gastropods

Bivalves

Gastropods

0 5 10 15 20

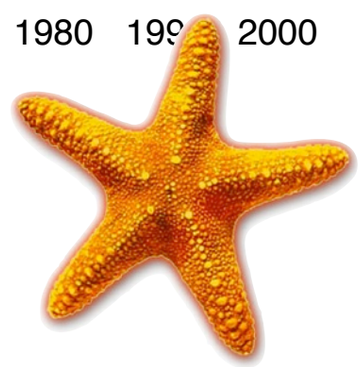
Echinoderms

Sea cucumbers

Urchins

Starfishes
Sea stars

1950 1960 1970 1980 199 2000

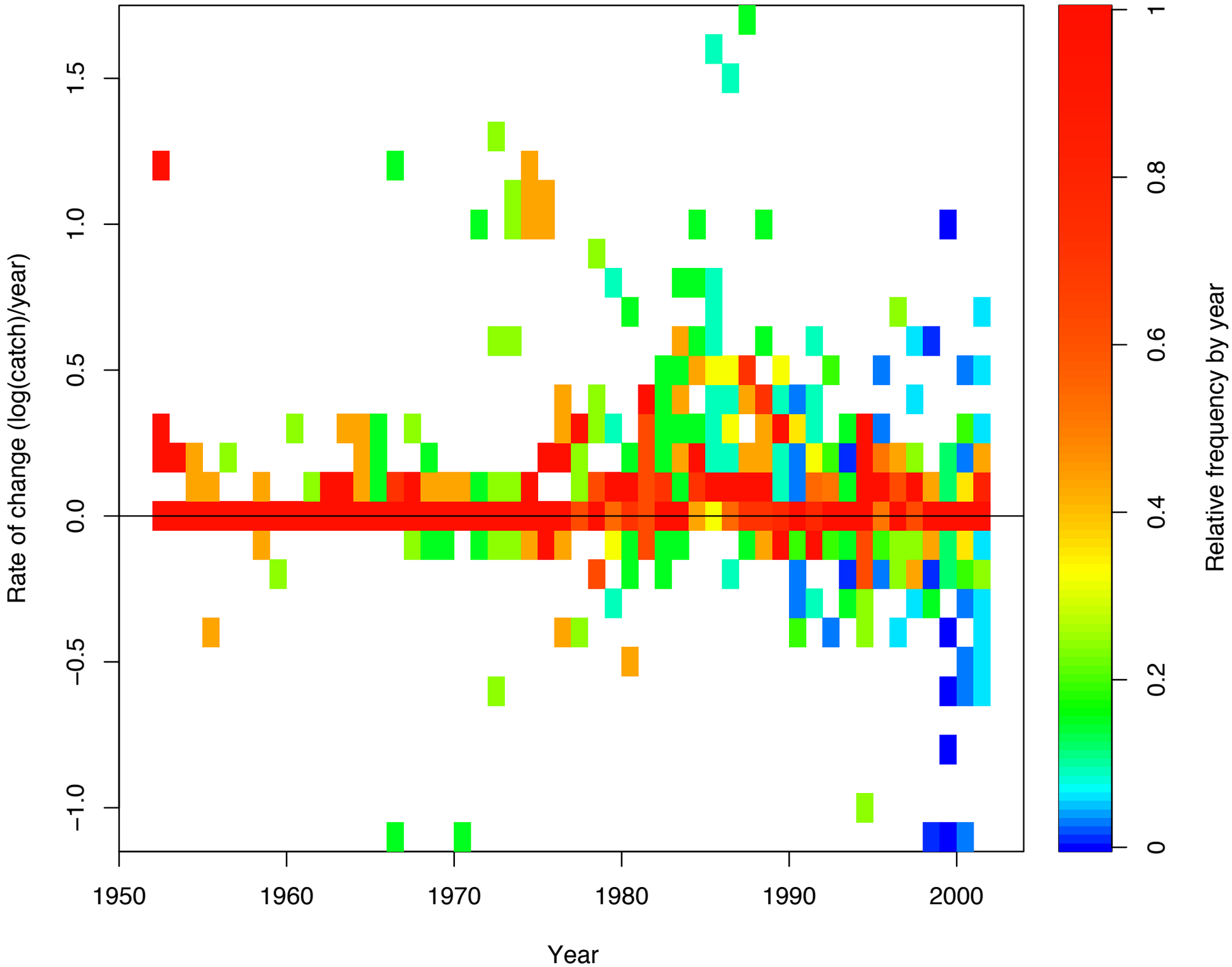


1 Global expansion

3 The underlying patterns

What are the **underlying patterns** to the overall increasing catch trends?

# Sea cucumber



1 Global expansion

4 Food-web changes

What are the trends in invertebrate fishery catch by **functional group**?

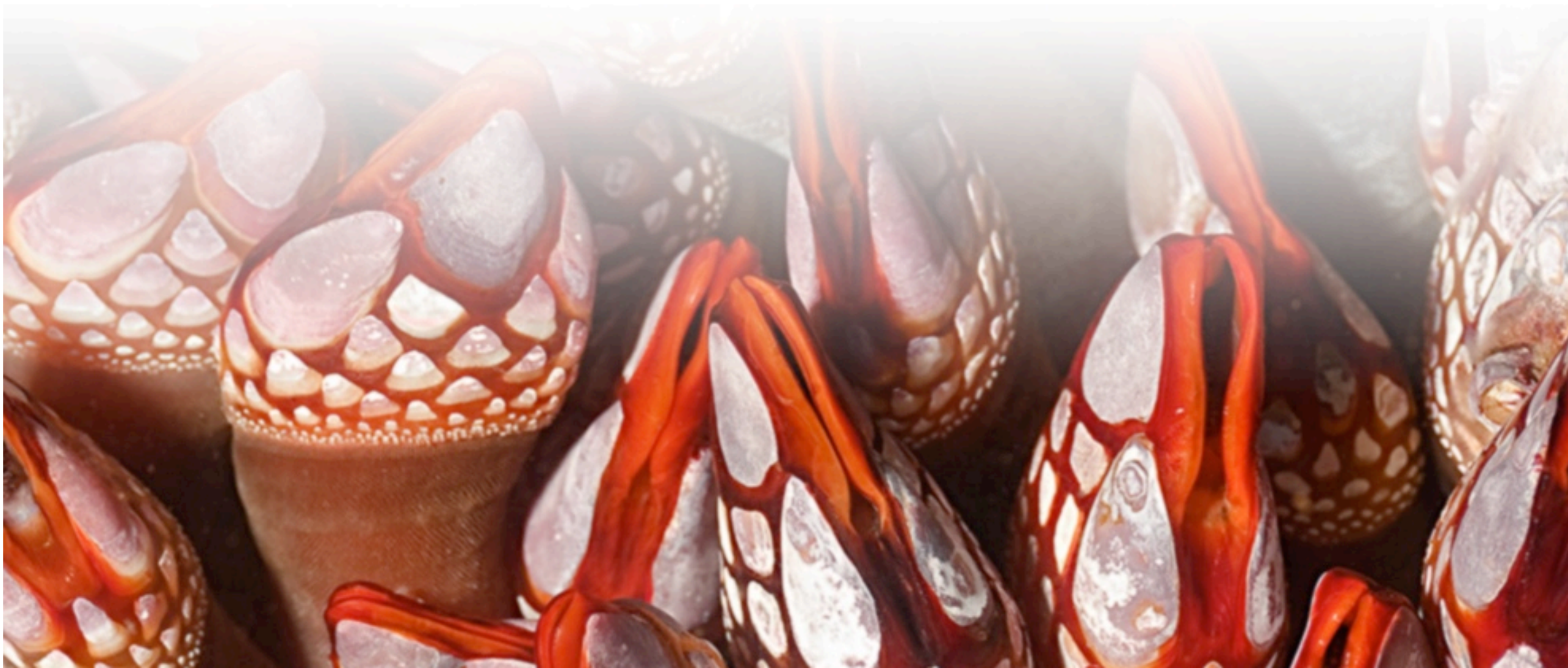
carnivores

herbivores

scavengers

filter feeders

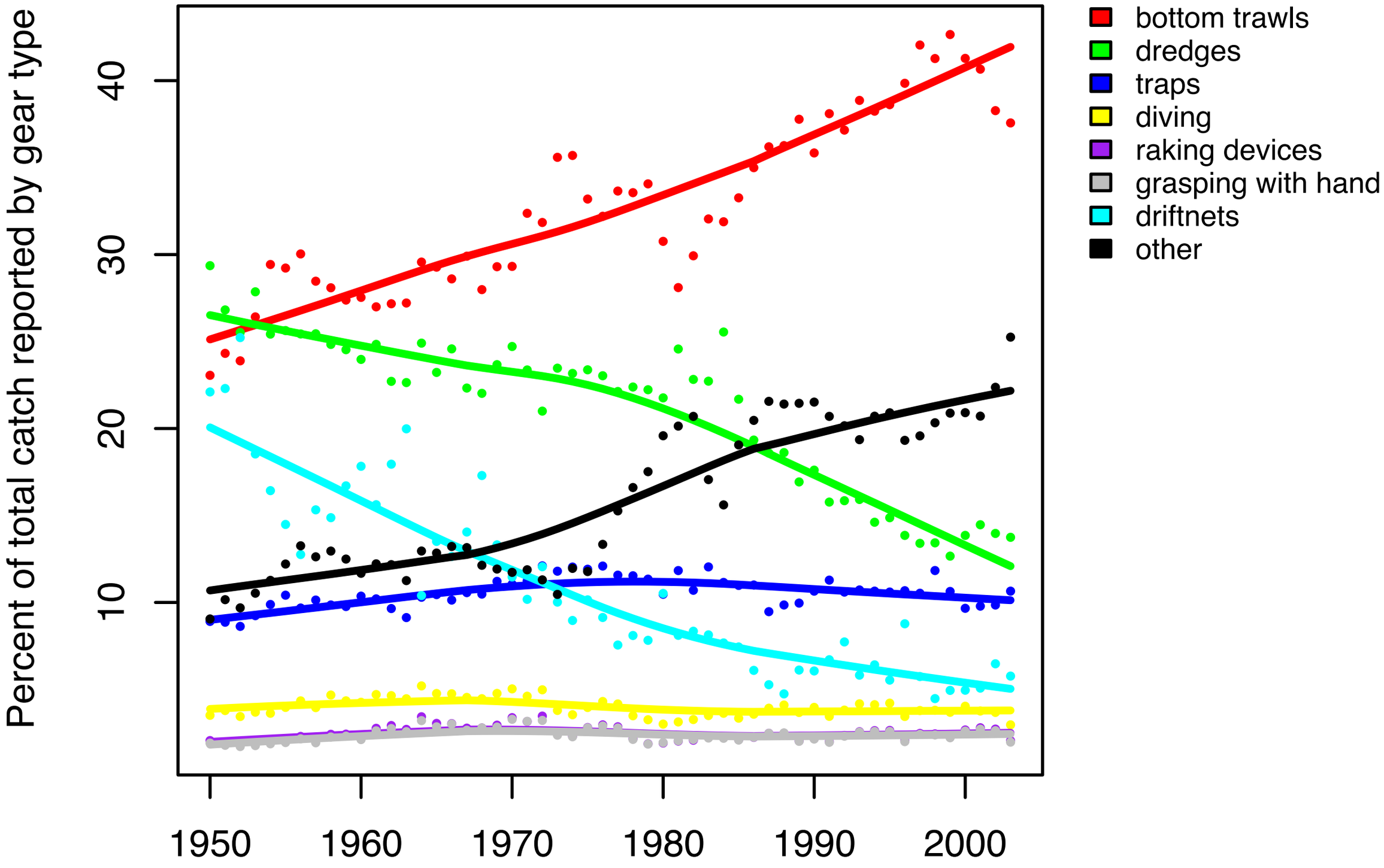
detritivores



1 Global expansion

5 Habitat impact

What are the trends in invertebrate fishery **gear type**?


Percent of total catch reported by gear type
10
20
30
40
1950
1960
1970
1980
1990
2000
bottom trawls
dredges
traps
diving
raking devices
grasping with hand
driftnets
other

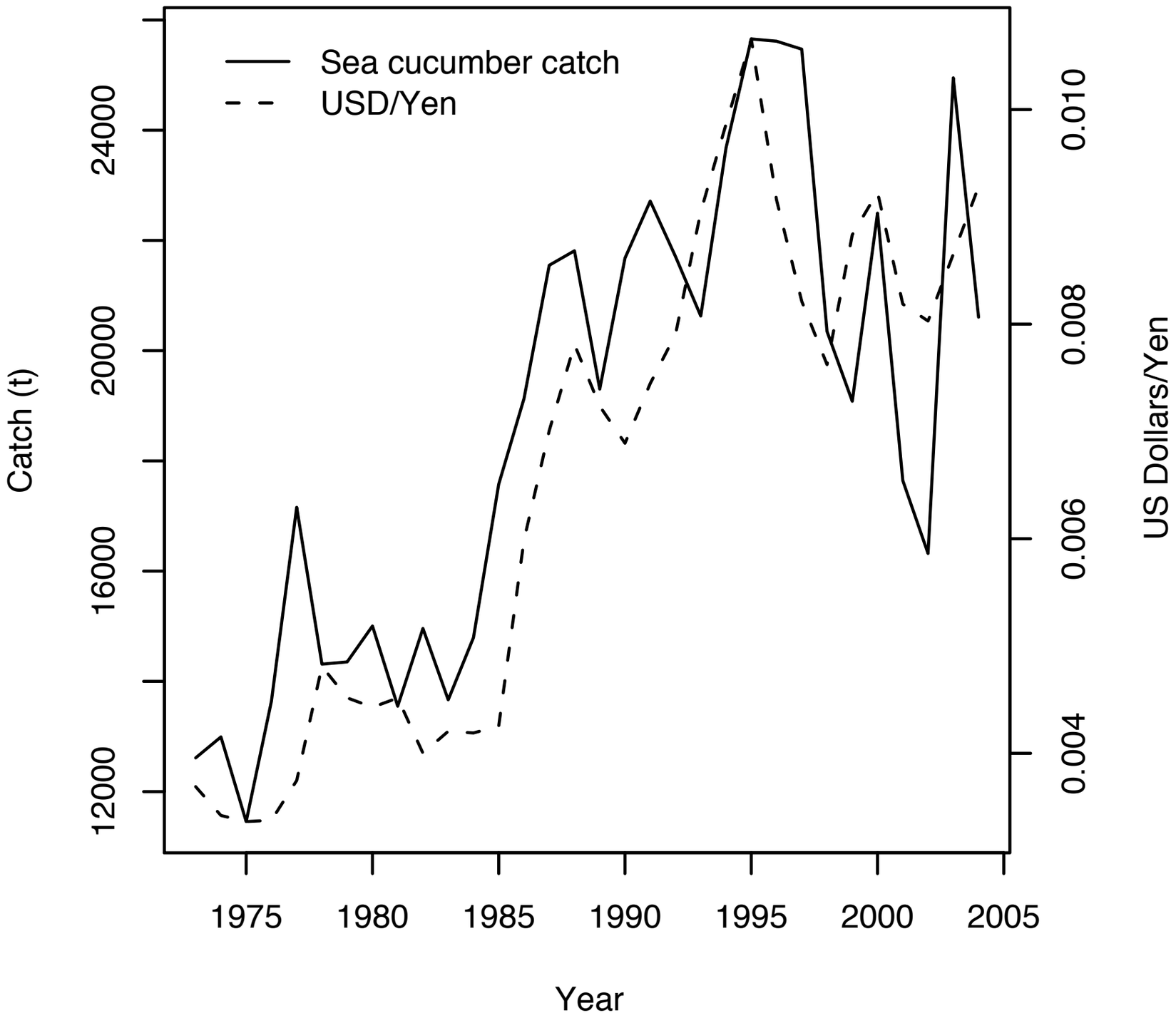
Section 2:

# Common **drivers** and **consequences**

# 2 Drivers and consequences

What are the **common drivers** of invertebrate fisheries catch?

# Sea cucumber catch & USD/Yen



Linear model:

$$Catch = \beta_1(Year) + \beta_2(Value) + \epsilon_i,\ \epsilon_i \sim N(0, \sigma^2)$$

Linear model:

$$Catch = \beta_1(Year) + \beta_2(Value) + \epsilon_i,\ \epsilon_i \sim N(0, \sigma^2)$$

Additive model:

$$Catch = f_1(Year) + f_2(Value) + \epsilon_i,\ \epsilon_i \sim N(0, \sigma^2)$$

Linear model:

$$Catch = \beta_1(Year) + \beta_2(Value) + \epsilon_i,\ \epsilon_i \sim N(0, \sigma^2)$$

Additive model:

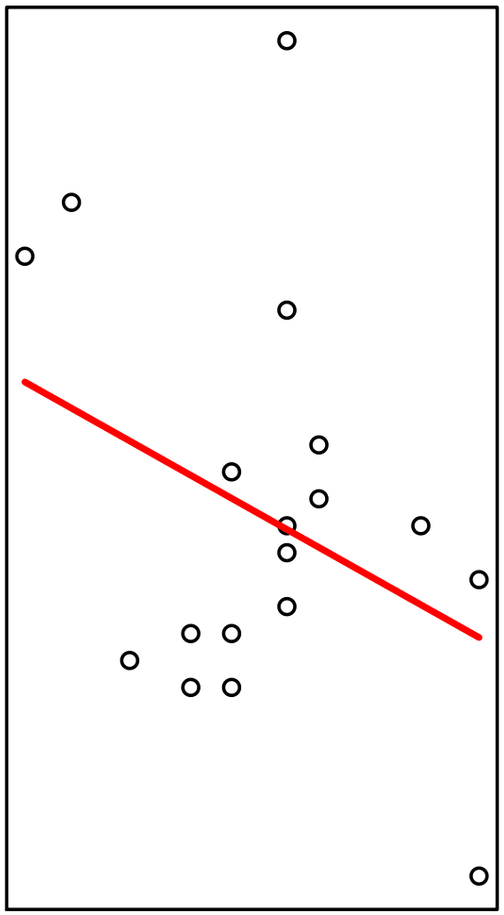
$$Catch = f_1(Year) + f_2(Value) + \epsilon_i,\ \epsilon_i \sim N(0, \sigma^2)$$

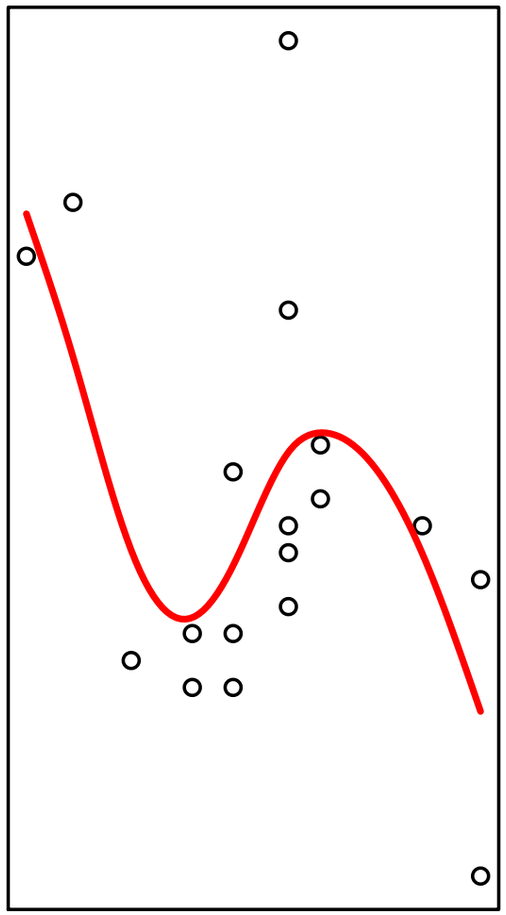
Generalized additive model:

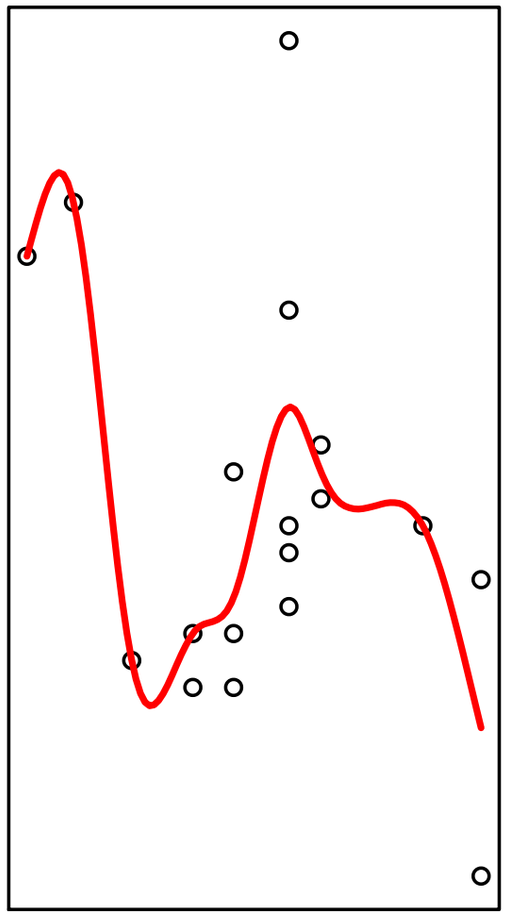
$$g\{\mathbb{E}(Catch)\} = f_1(Year_i) + f_2(Value_i),$$

$$Catch_i \sim Exponential\ distribution$$

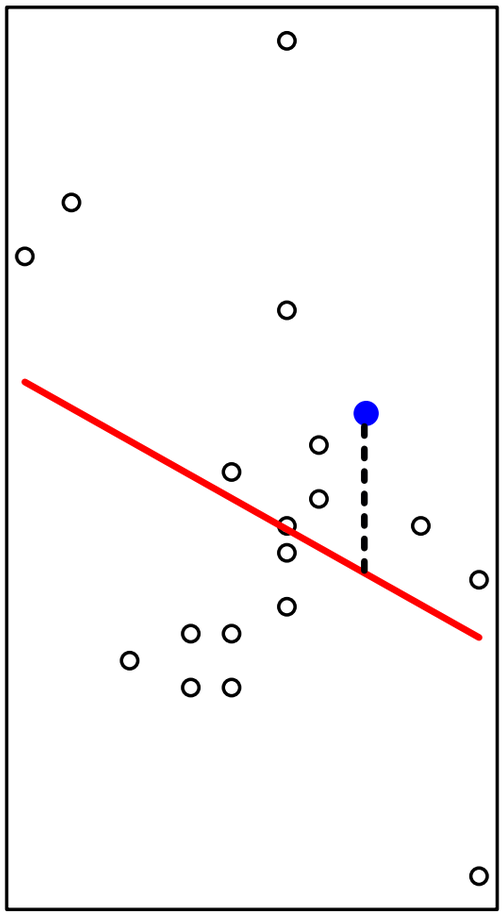
# Splines

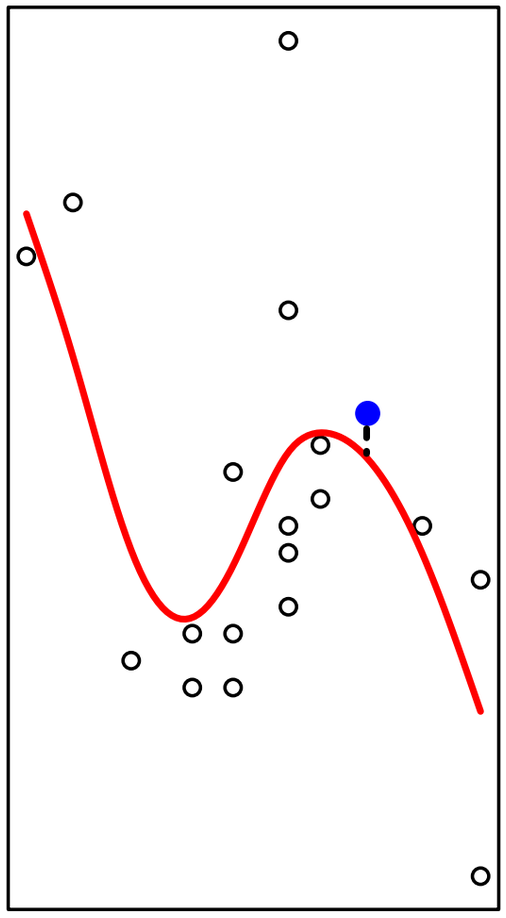


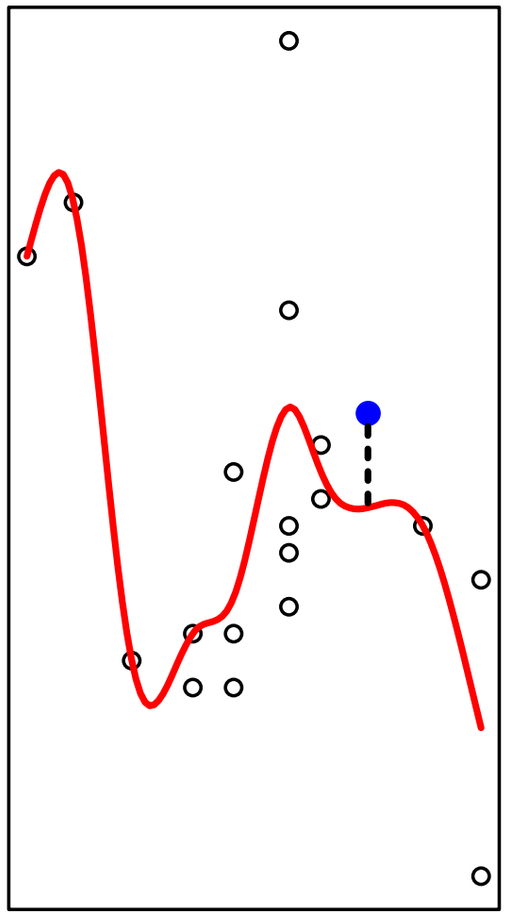




# Splines





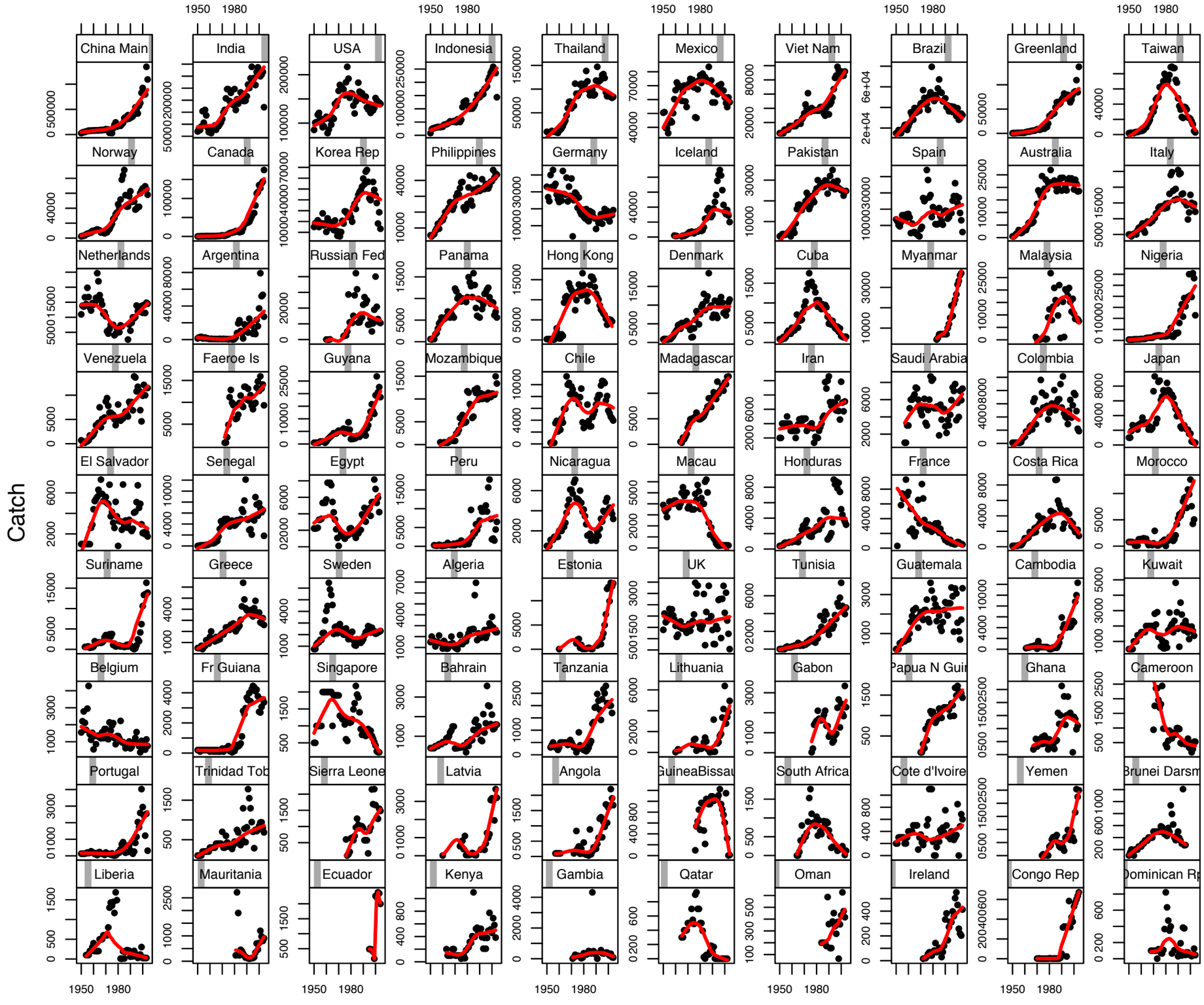


**“...it is usually better to be able to say something approximate about the right model, rather than something very precise about the wrong model.”**

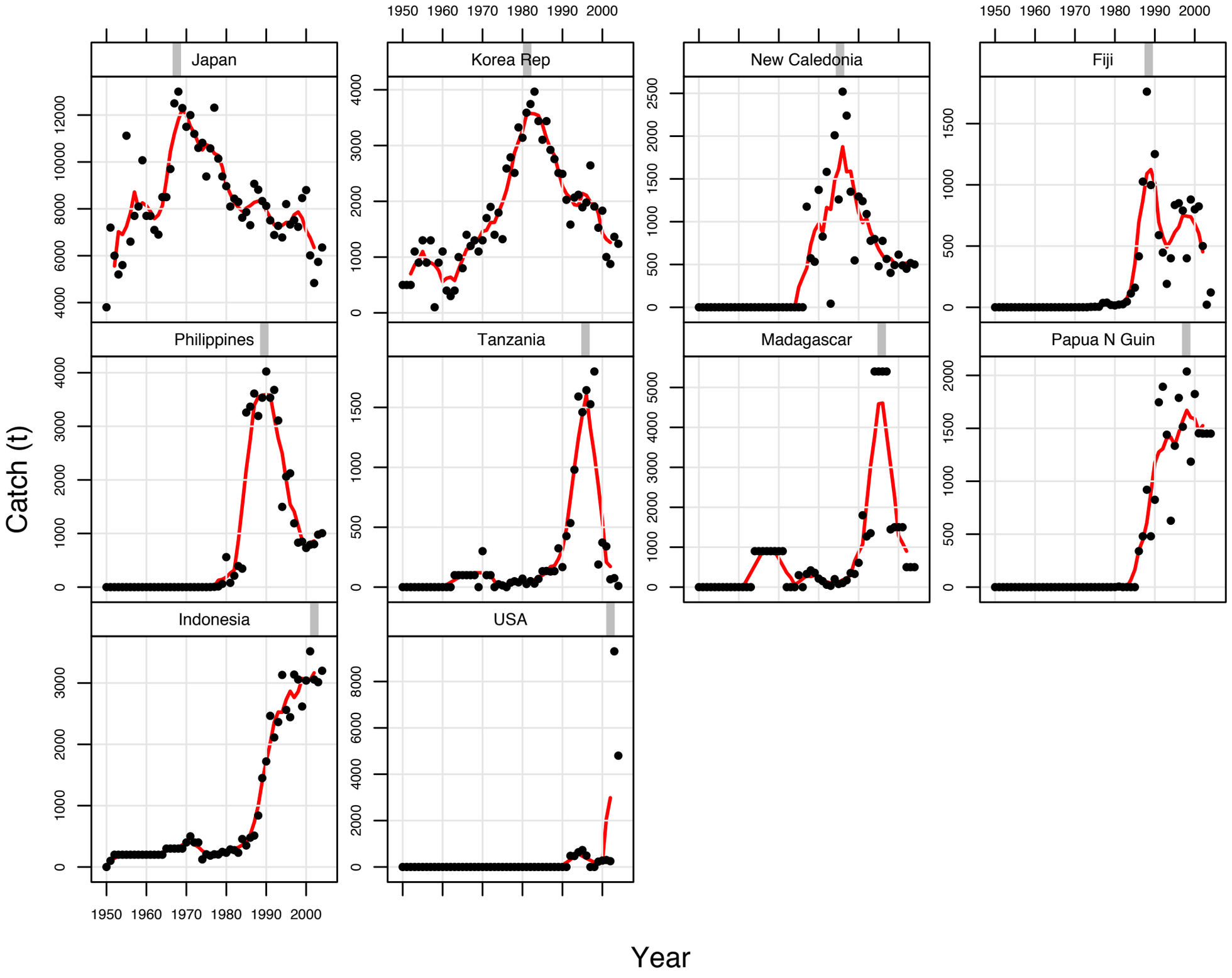
Simon Wood author of mgcv

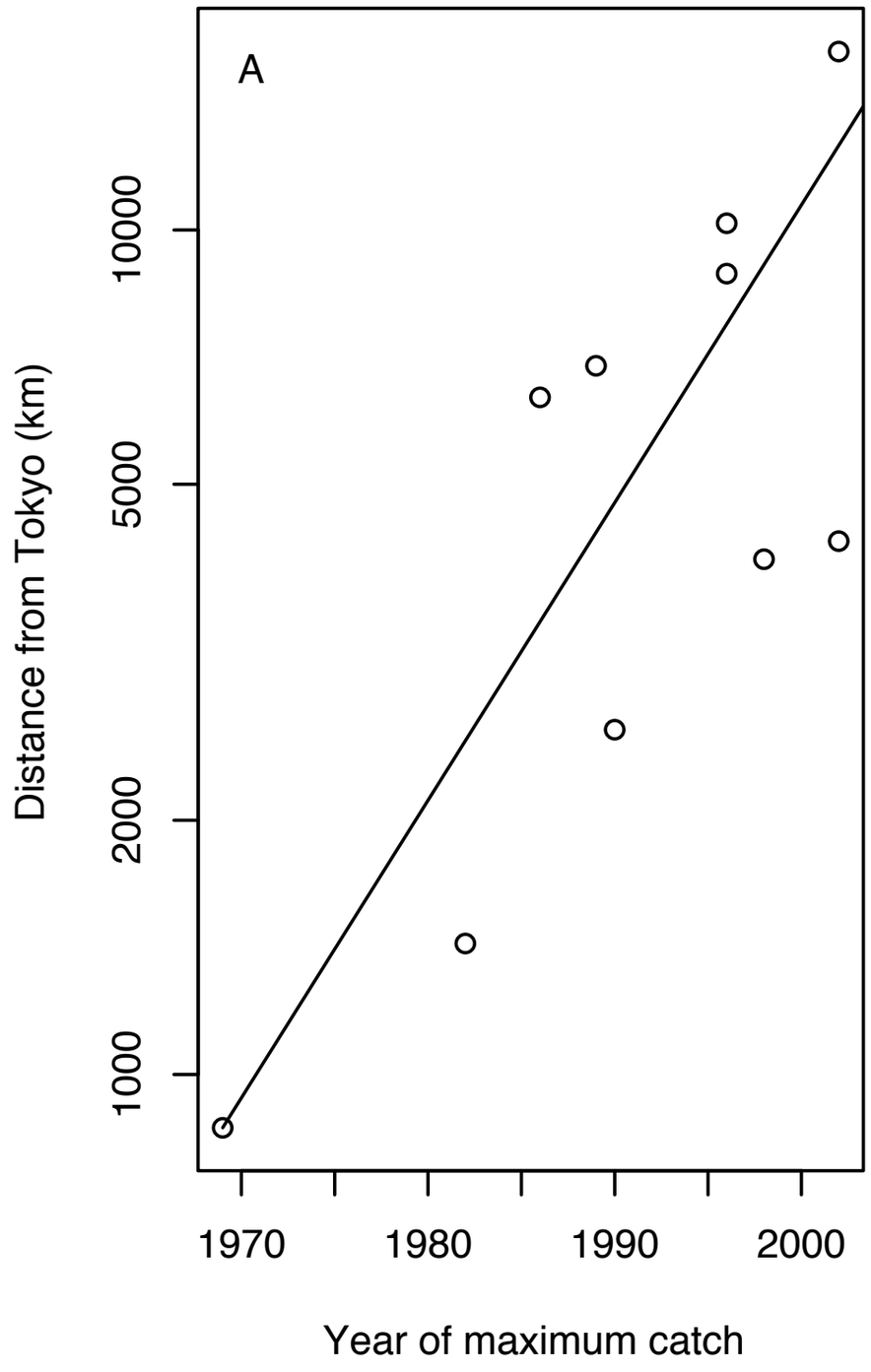
## 2 To what degree might these drivers be causing **detectable patterns of serial depletion**?

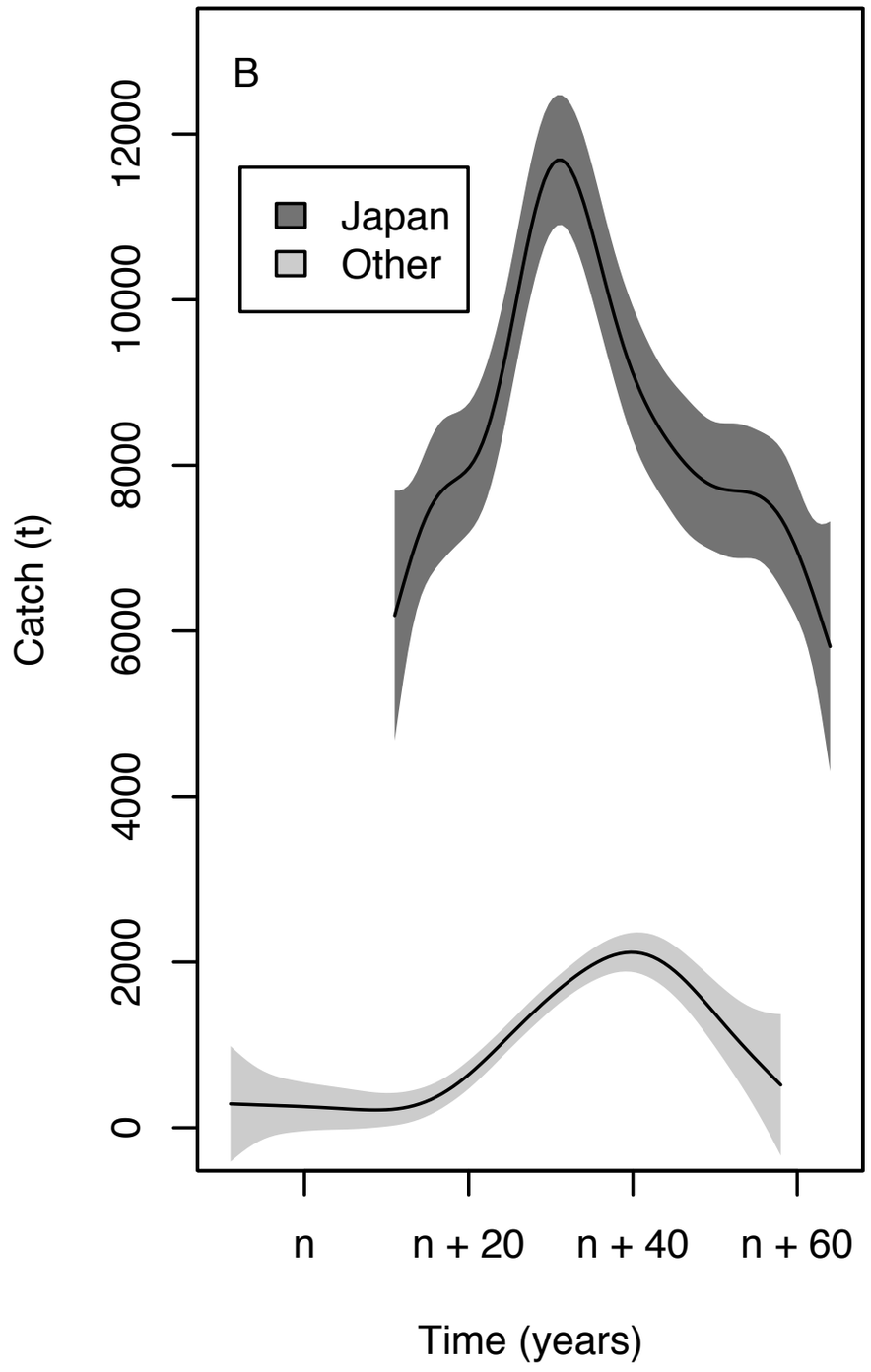
# Shrimps and prawns



# Sea cucumber




A
Distance from Tokyo (km)
1000
2000
5000
10000
1970
1980
1990
2000
Year of maximum catch


B
Catch (t)
0
2000
4000
6000
8000
10000
12000
Japan
Other
n
n + 20
n + 40
n + 60
Time (years)


# Conclusions

Overview lacking

Global forces

Growing issue

## Thanks...

Dr. Heike Lotze

Wade Blanchard

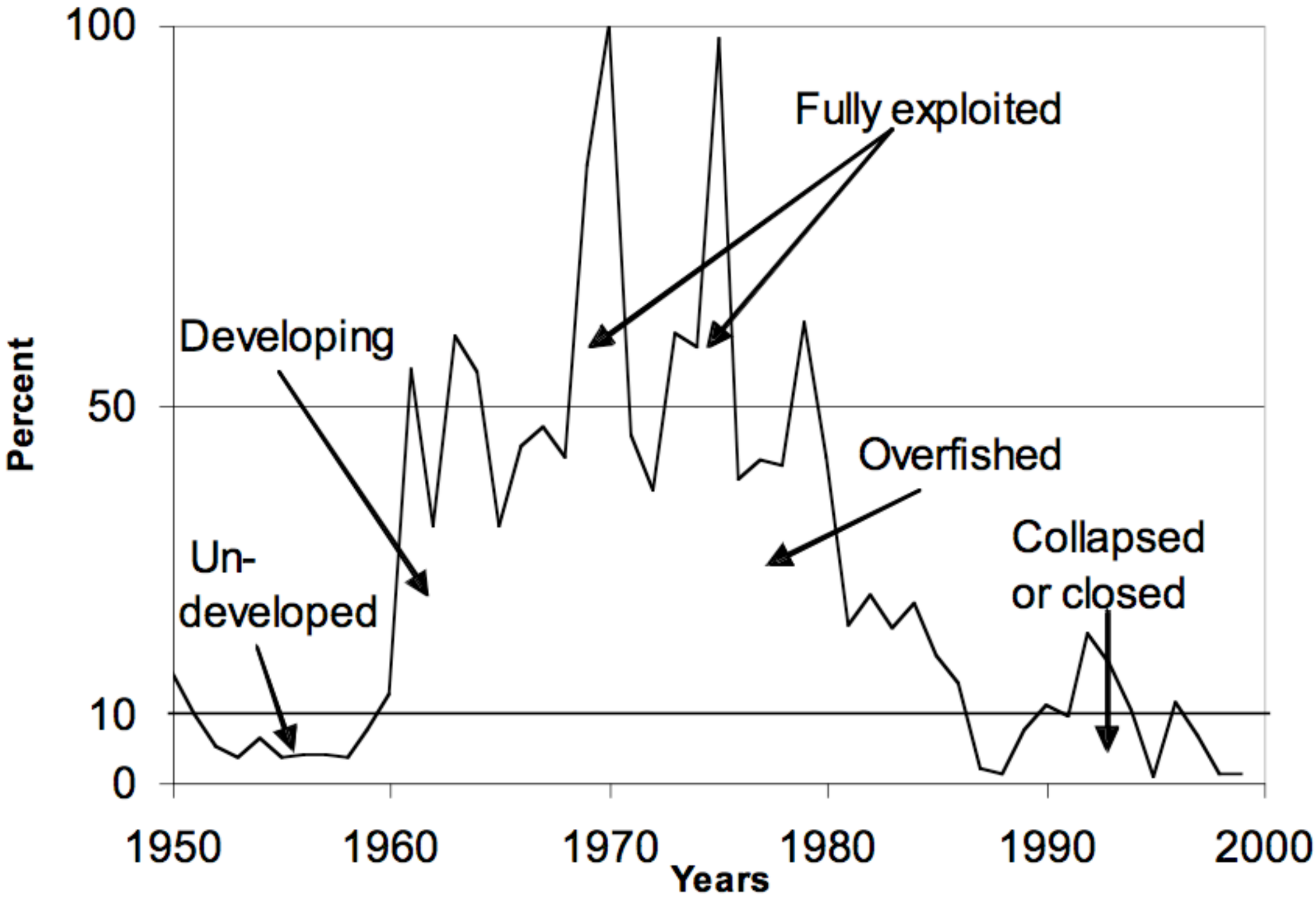
Coilin Minto

Dan Ricard

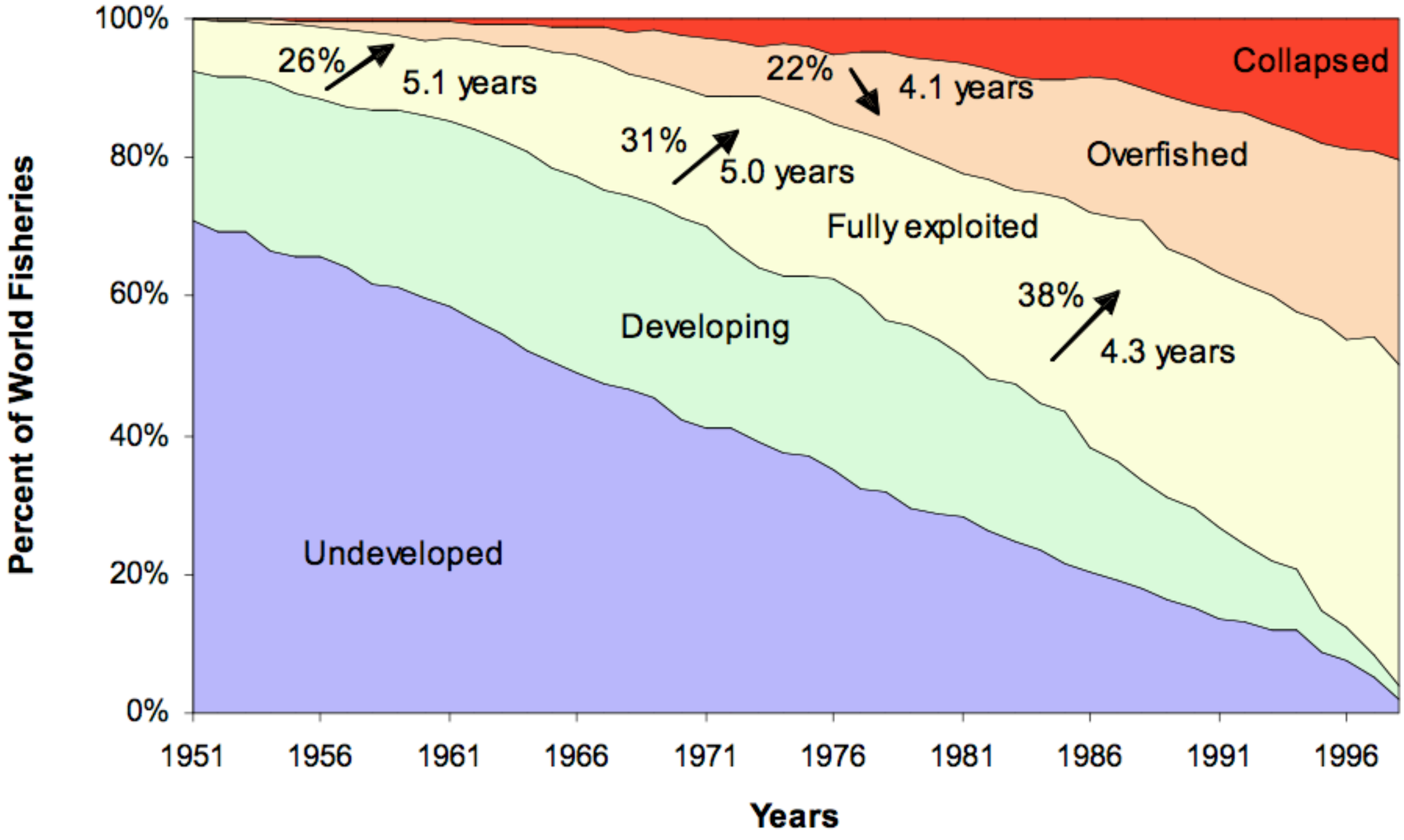
Zoey Zahorodny

FUTURE OF MARINE ANIMAL POPULATIONS

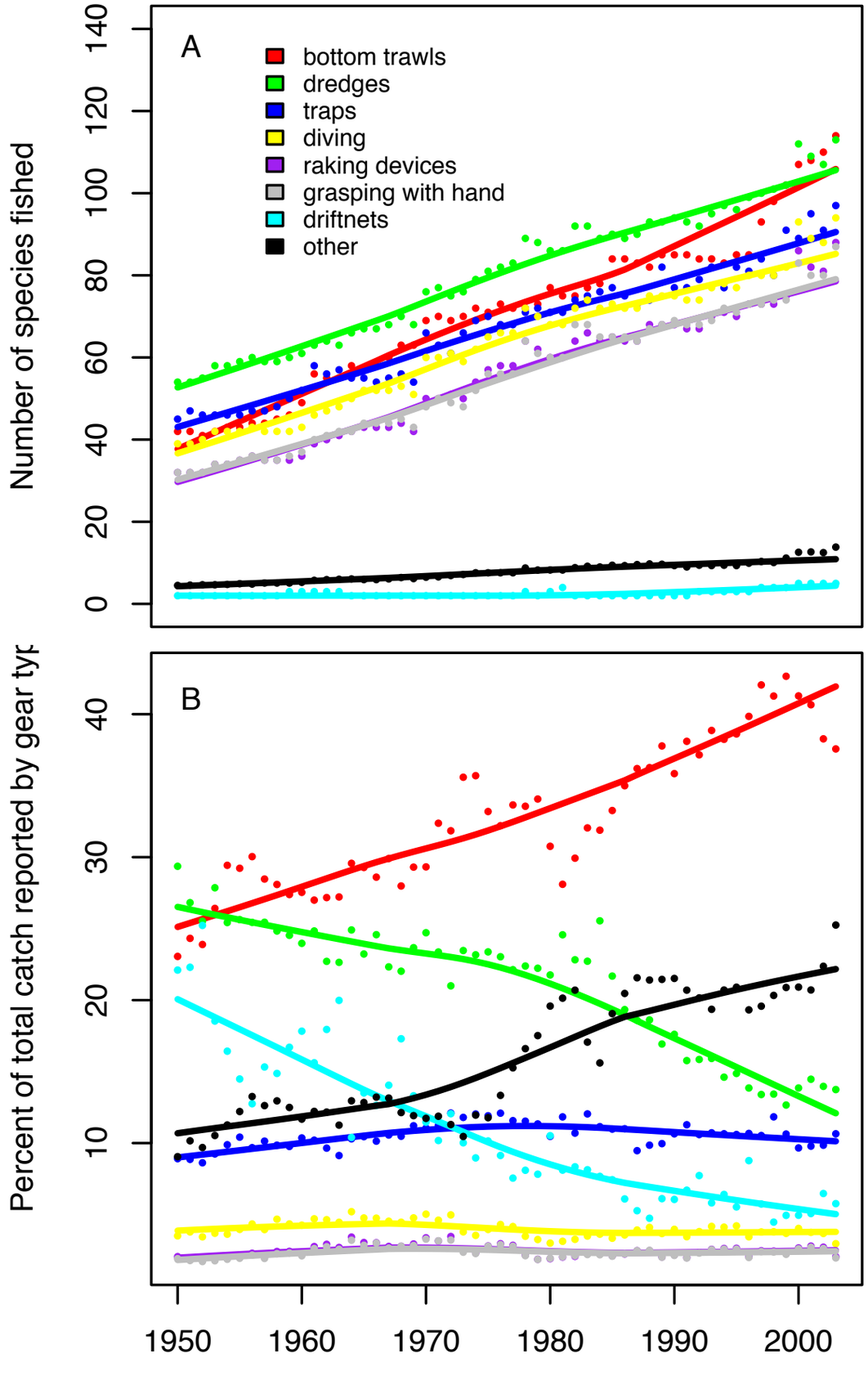
Committee



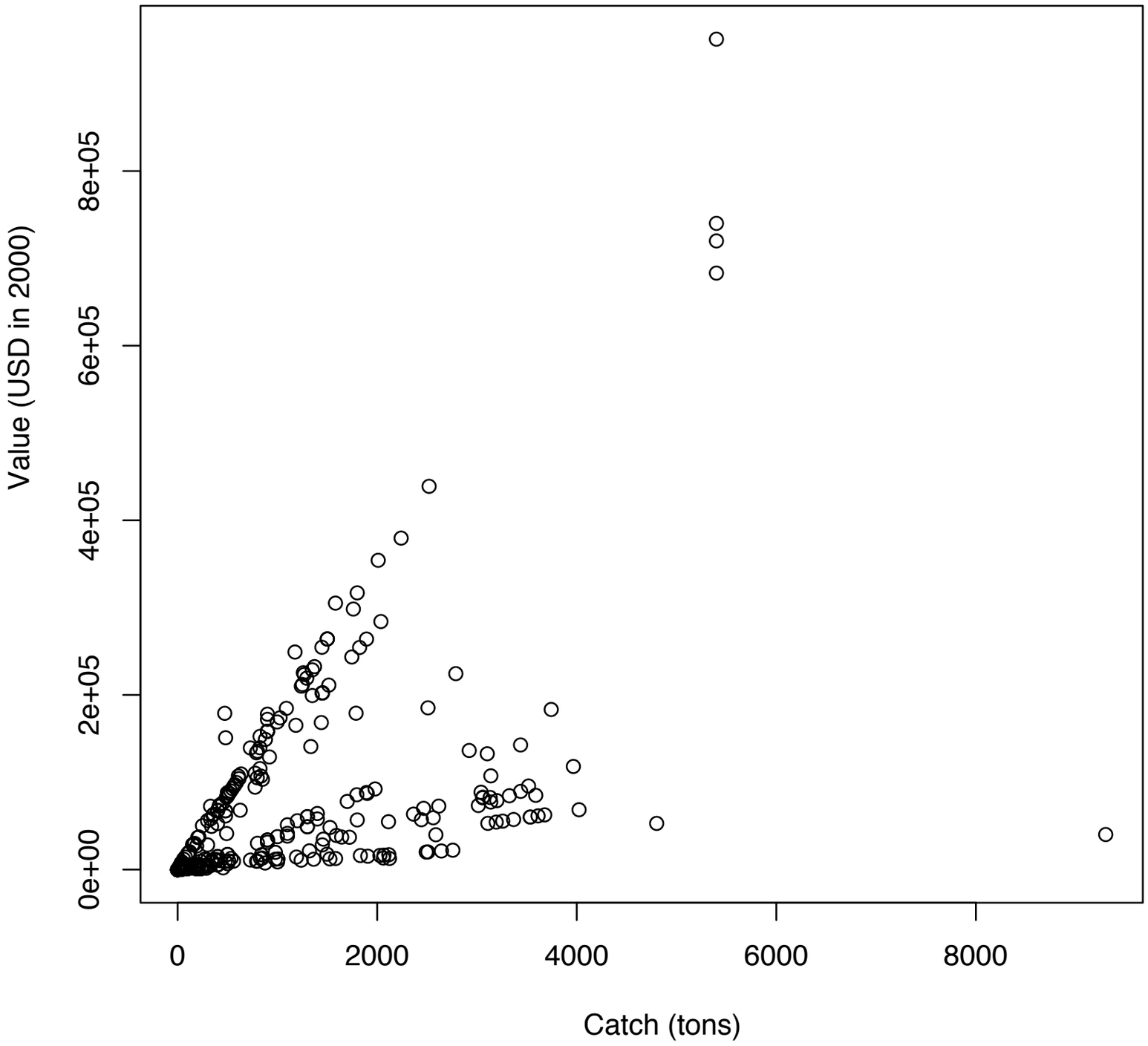

Froese et al. 2002



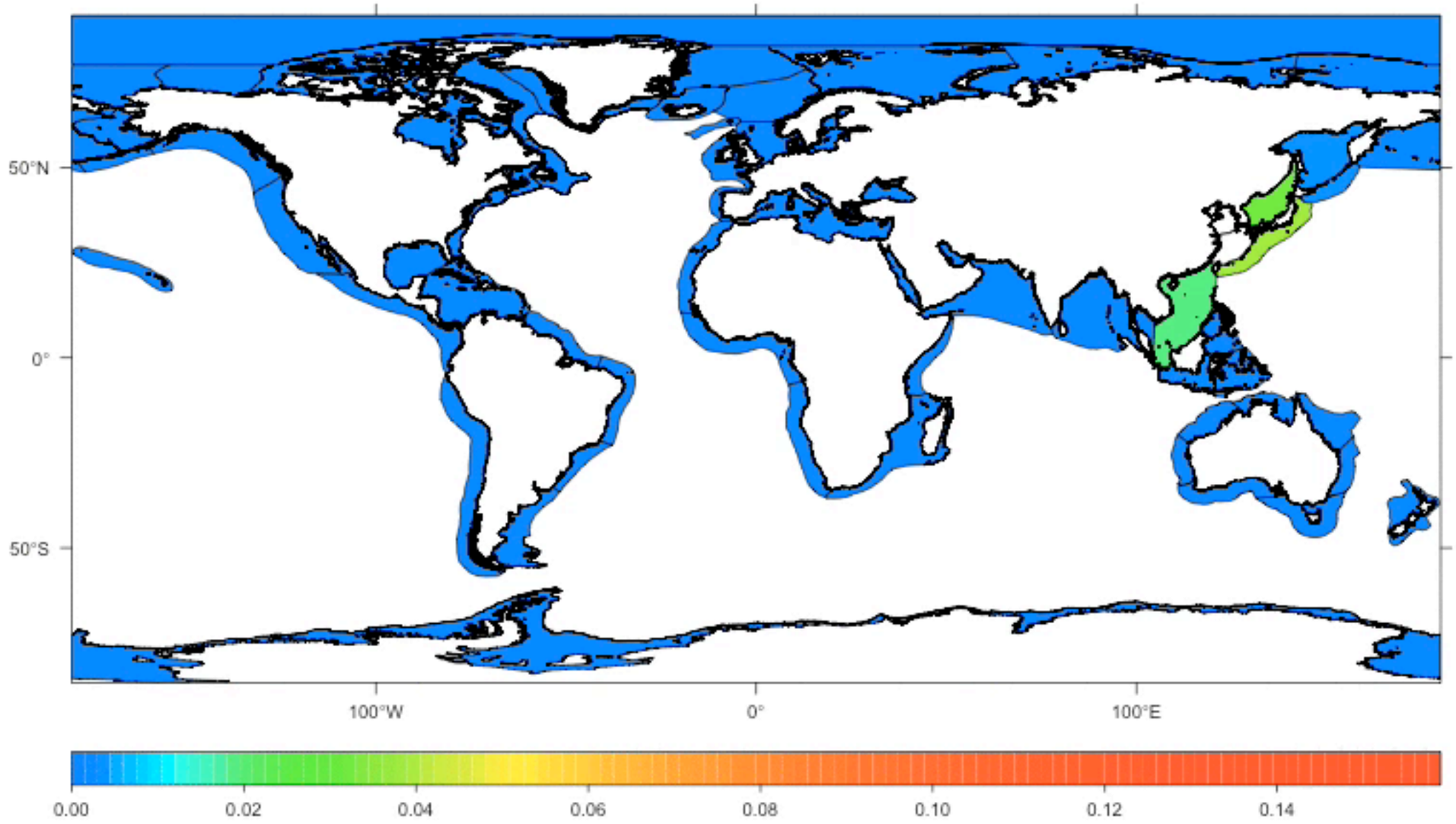

Froese et al. 2002

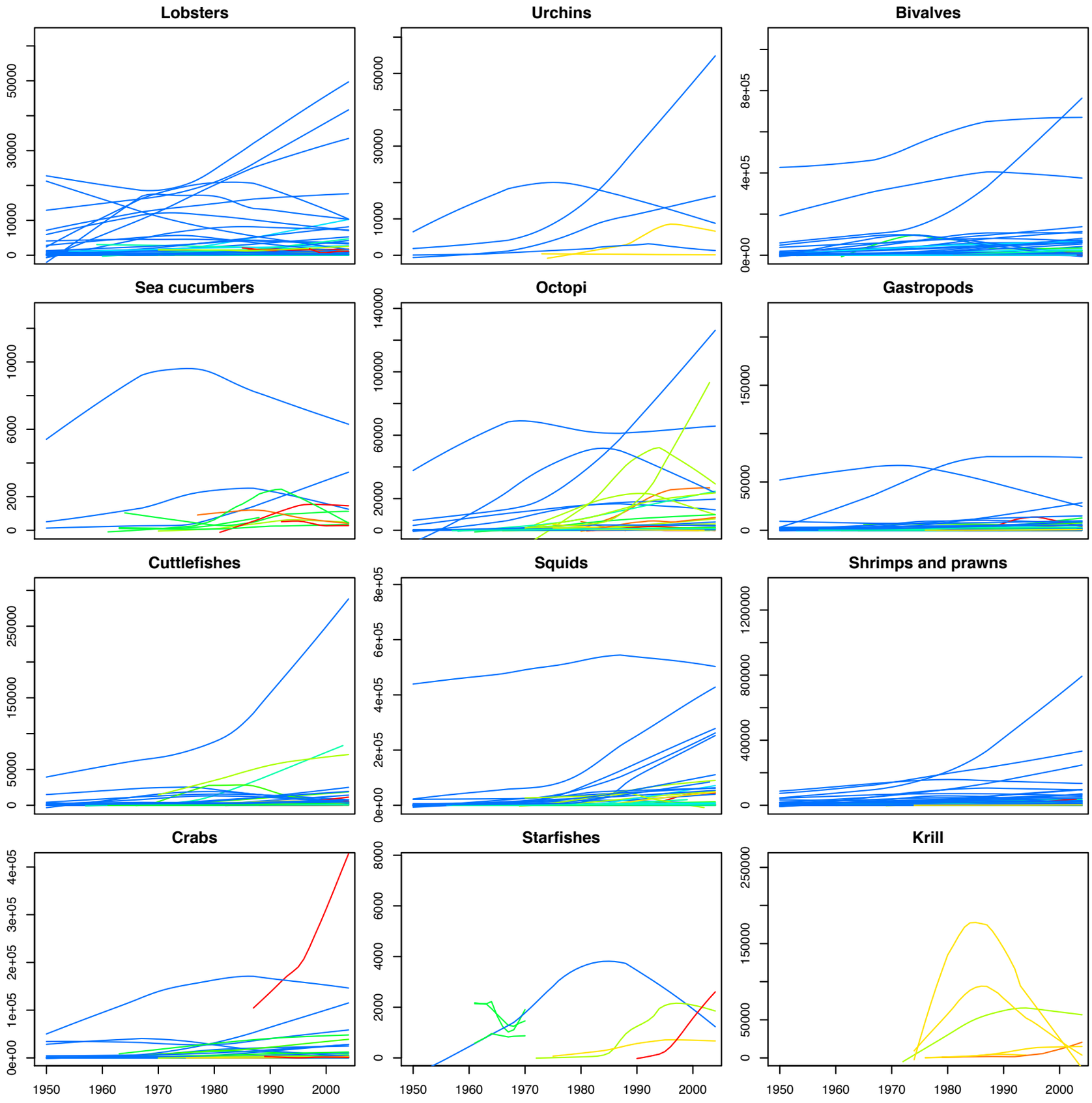

A
bottom trawls
dredges
traps
diving
raking devices
grasping with hand
driftnets
other
Number of species fished
0
20
40
60
80
100
120
140
B
Percent of total catch reported by gear type
10
20
30
40
1950
1960
1970
1980
1990
2000

# Ex-fisher vessel price



Sea cucumber catch (t/100 sq/ km/year): 1950




Lobsters
0
10000
30000
50000
Urchins
0
10000
30000
50000
Bivalves
0e+00
4e+05
8e+05
Sea cucumbers
0
2000
6000
10000
Octopi
0
20000
60000
100000
140000
Gastropods
0
50000
150000
Cuttlefishes
0
50000
150000
250000
Squids
0e+00
2e+05
4e+05
6e+05
8e+05
Shrimps and prawns
0
400000
800000
1200000
Crabs
0e+00
1e+05
2e+05
3e+05
4e+05
Starfishes
0
2000
4000
6000
8000
Krill
0
50000
150000
250000
1950
1960
1970
1980
1990
2000