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Why did the three capelin stock collapses in the Barents Sea during the three last decades affect the ecosystem differently?

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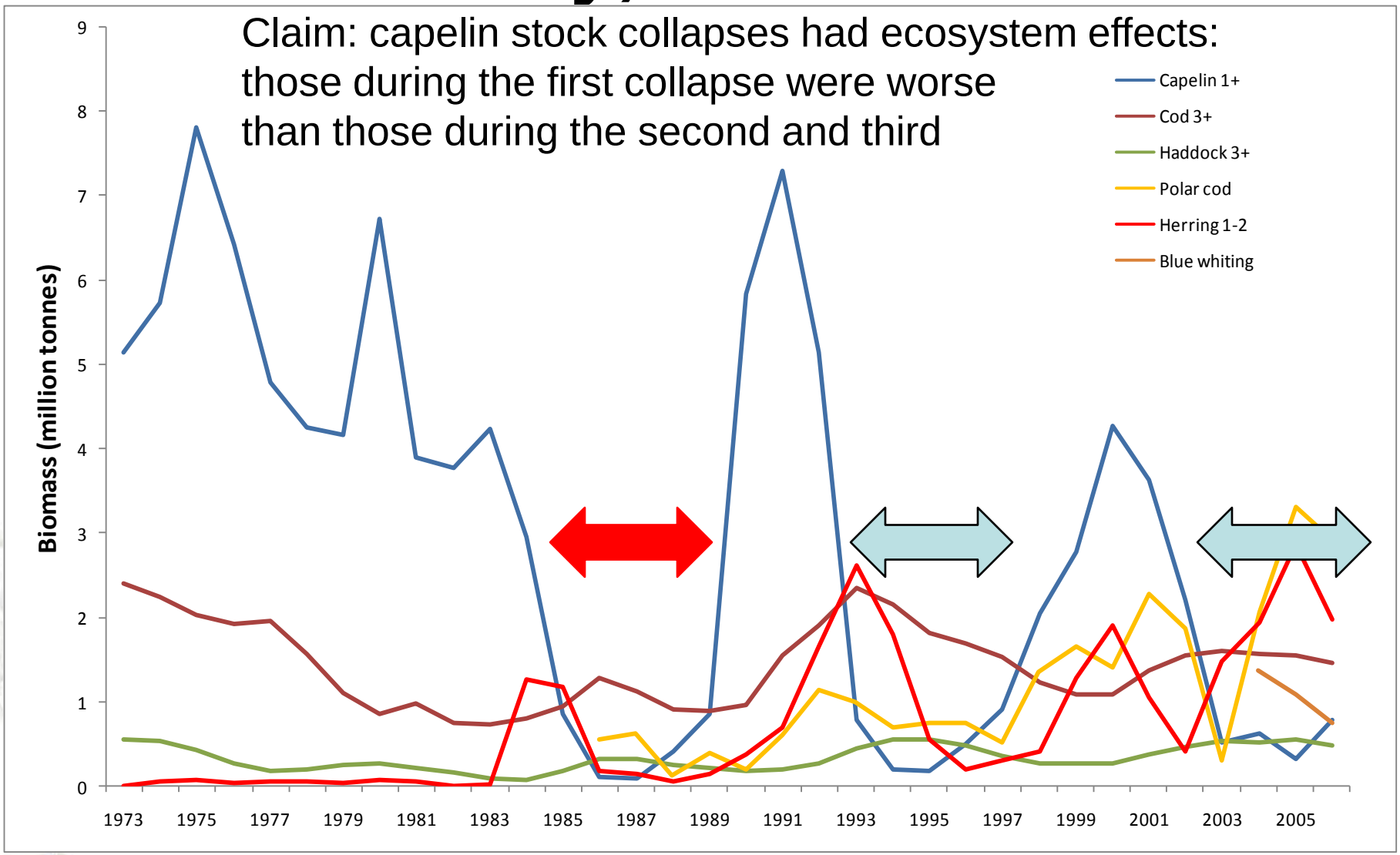
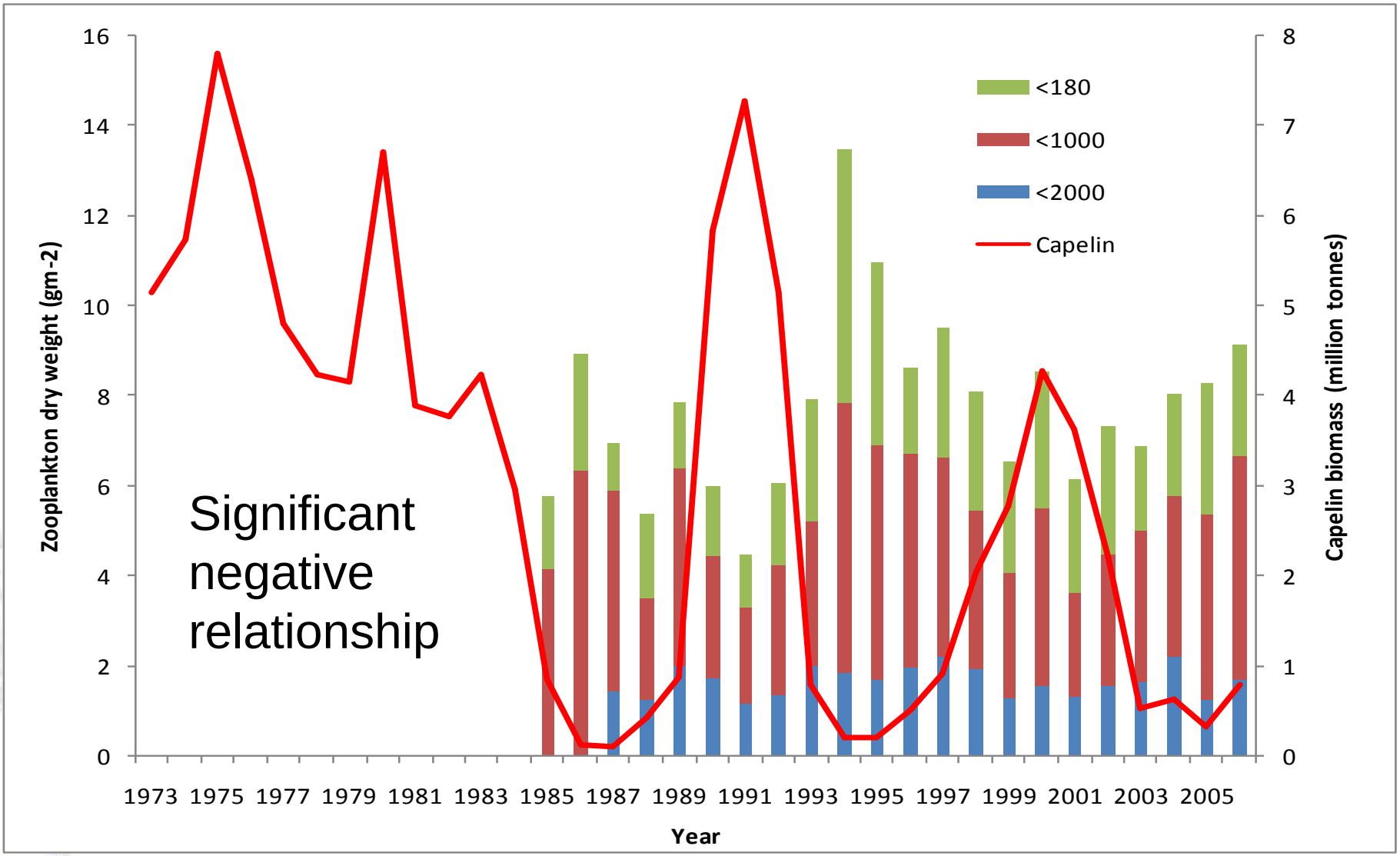
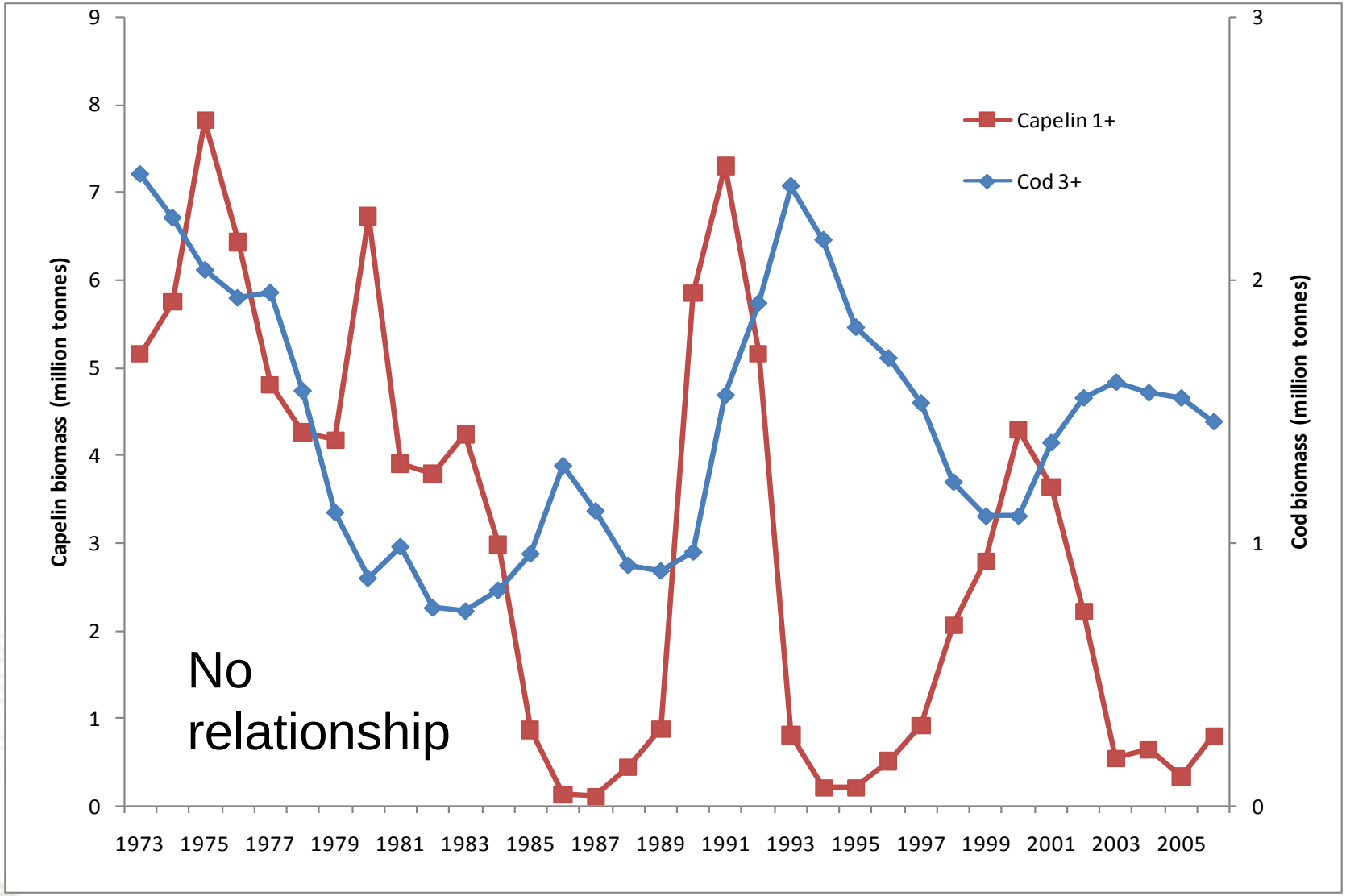
Stock history, main fish stocks



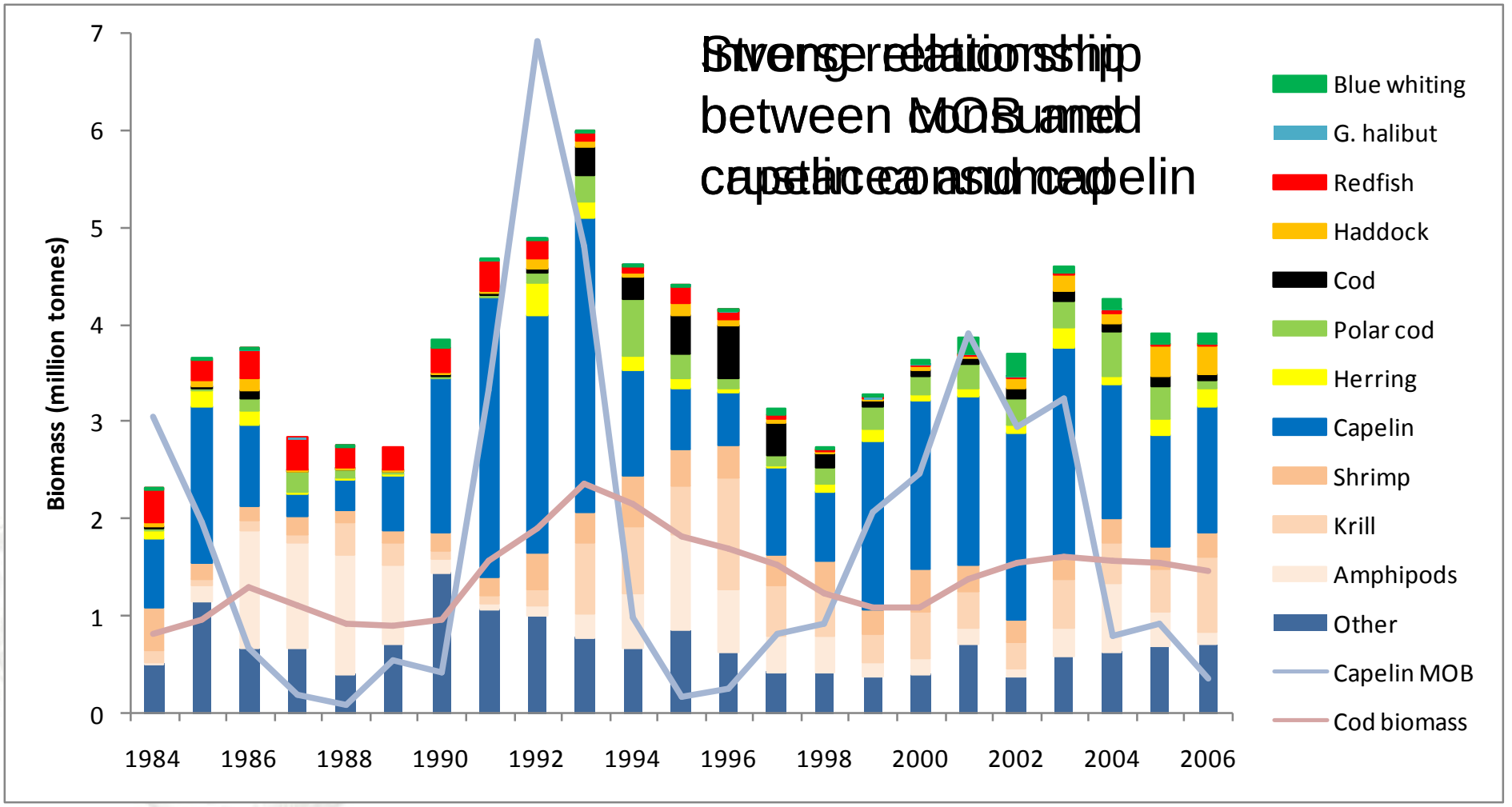
Plankton


Zooplankton dry weight (gm-2)
Capelin biomass (million tonnes)
Year
<180
<1000
<2000
Capelin
Significant negative relationship
0
2
4
6
8
10
12
14
16
0
1
2
3
4
5
6
7
8
1973 1975 1977 1979 1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005

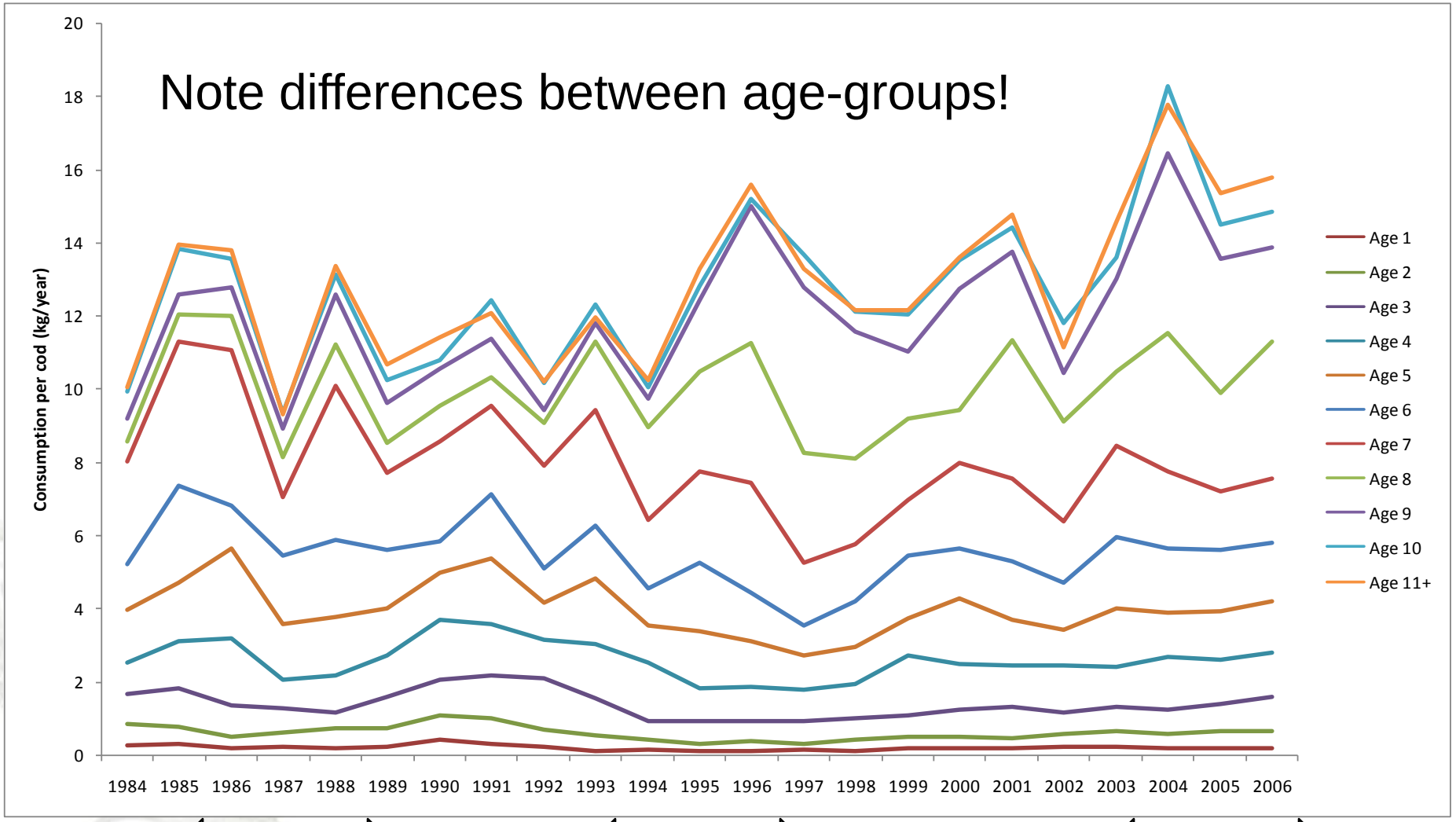
Cod-capelin


Capelin biomass (million tonnes)
Cod biomass (million tonnes)
Capelin 1+
Cod 3+
No relationship
0
1
2
3
4
5
6
7
8
9
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005

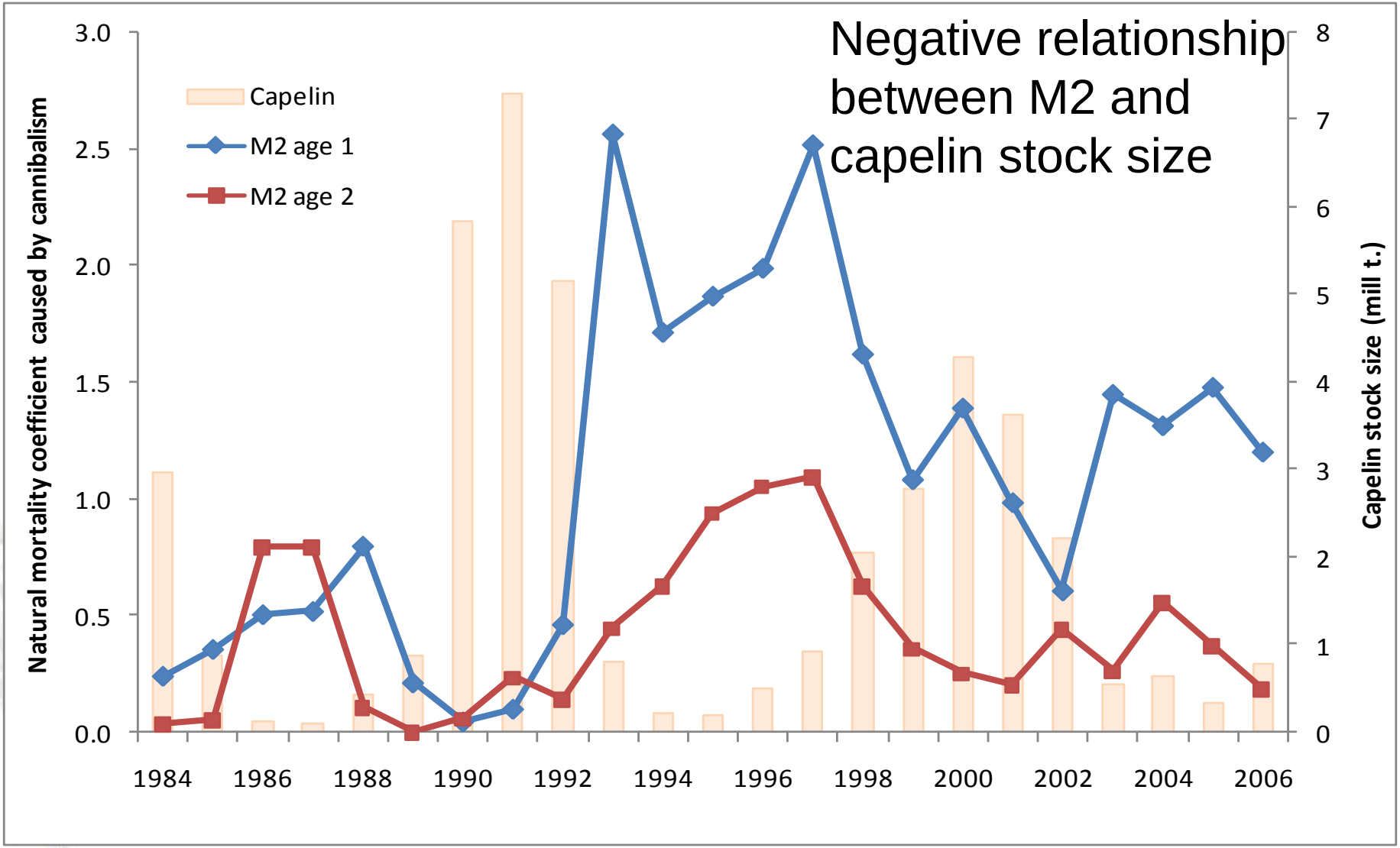
Cod consumption



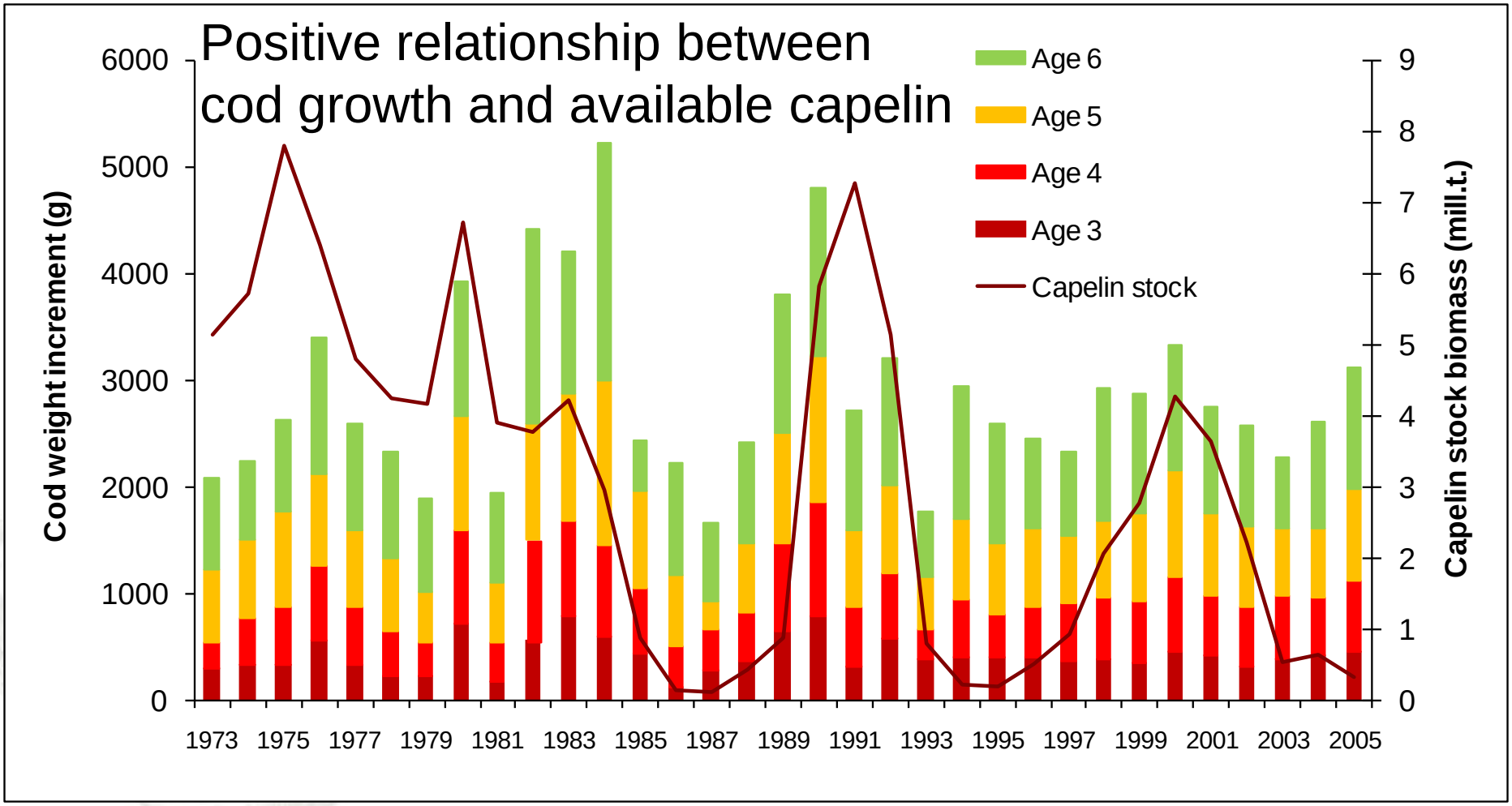
Cod consumption



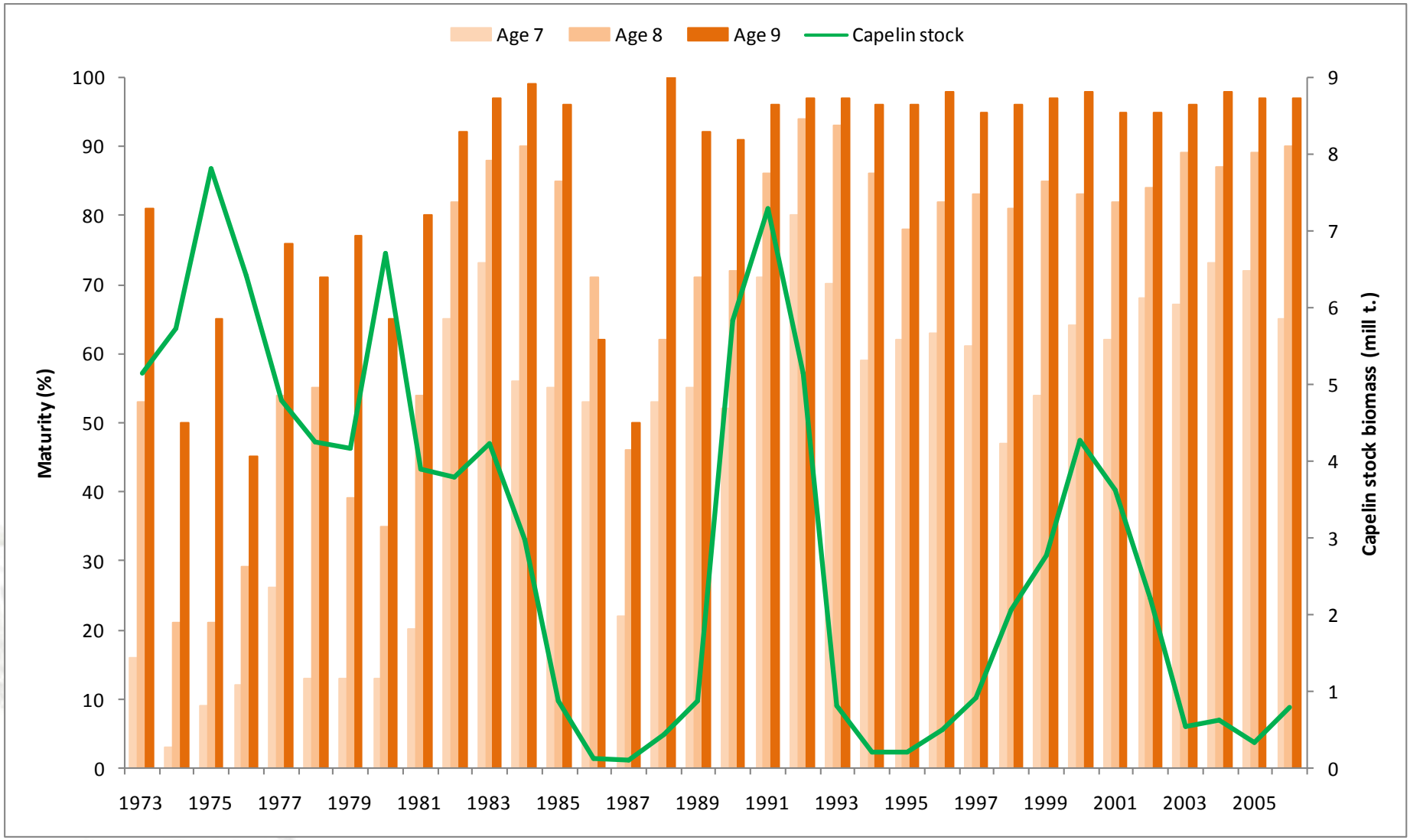
Cod cannibalism



Cod growth

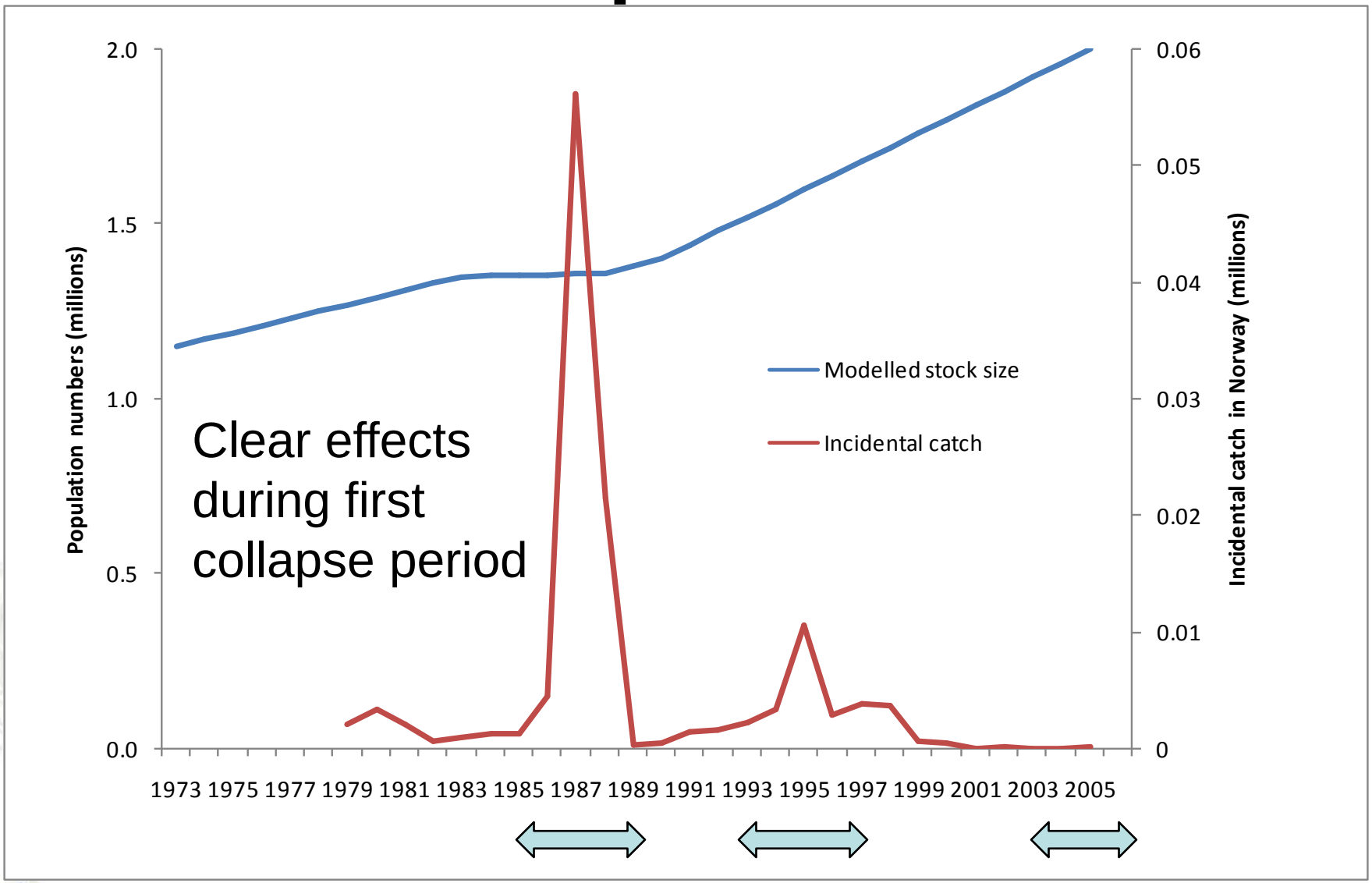

Positive relationship between cod growth and available capelin
Age 6
Age 5
Age 4
Age 3
Capelin stock
Cod weight increment (g)
Capelin stock biomass (mill.t.)
0
1000
2000
3000
4000
5000
6000
0
1
2
3
4
5
6
7
8
9
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005

Cod maturation



Positive relationships exist

Harp seals


2.0
1.5
1.0
0.5
0.0
Population numbers (millions)
0.06
0.05
0.04
0.03
0.02
0.01
0
Incidental catch in Norway (millions)
1973 1975 1977 1979 1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005
Modelled stock size
Incidental catch
Clear effects during first collapse period

Why?

- Two hypotheses:
  - More capelin available for predators during the second and third collapse period
  - A better supply of other food during the second and third collapse period

Hypothesis 1

- There was more capelin available (approximately twice as much) during the two last collapse periods but, only marginally more capelin *per cod*
- Other predators did perhaps also find some more capelin then, but in any case the supply was probably negligible compared to the inter-collapse-periods
- Consequently, hypothesis 1 seems not very satisfactory

Hypothesis 2

- The cod consumption of other prey did increase during the second and third collapse period, but the consumption per cod *was lower*
- The relationship between cod growth and food consumption is not very strong
- Unknown whether other predators were able to compensate better by other food during the two last capelin collapses

Hypothesis 2 cntd.

- The available food base was better during the second and third capelin collapse, because the stocks of plankton, cod juveniles, haddock juveniles, polar cod, herring juveniles and blue whiting juveniles increased from the late 1980s onwards
- Consequently, there is strong circumstantial evidence for this hypothesis

Further research

- There is need for more research concerning:
  - feeding habits of Harp seals during all seasons
  - whether the spatial and temporal coverage of sampling of cod stomachs is adequate for estimation of total consumption
  - the dependence of cod growth on the amount and composition of food