Effects of climate change on the survival of larval cod

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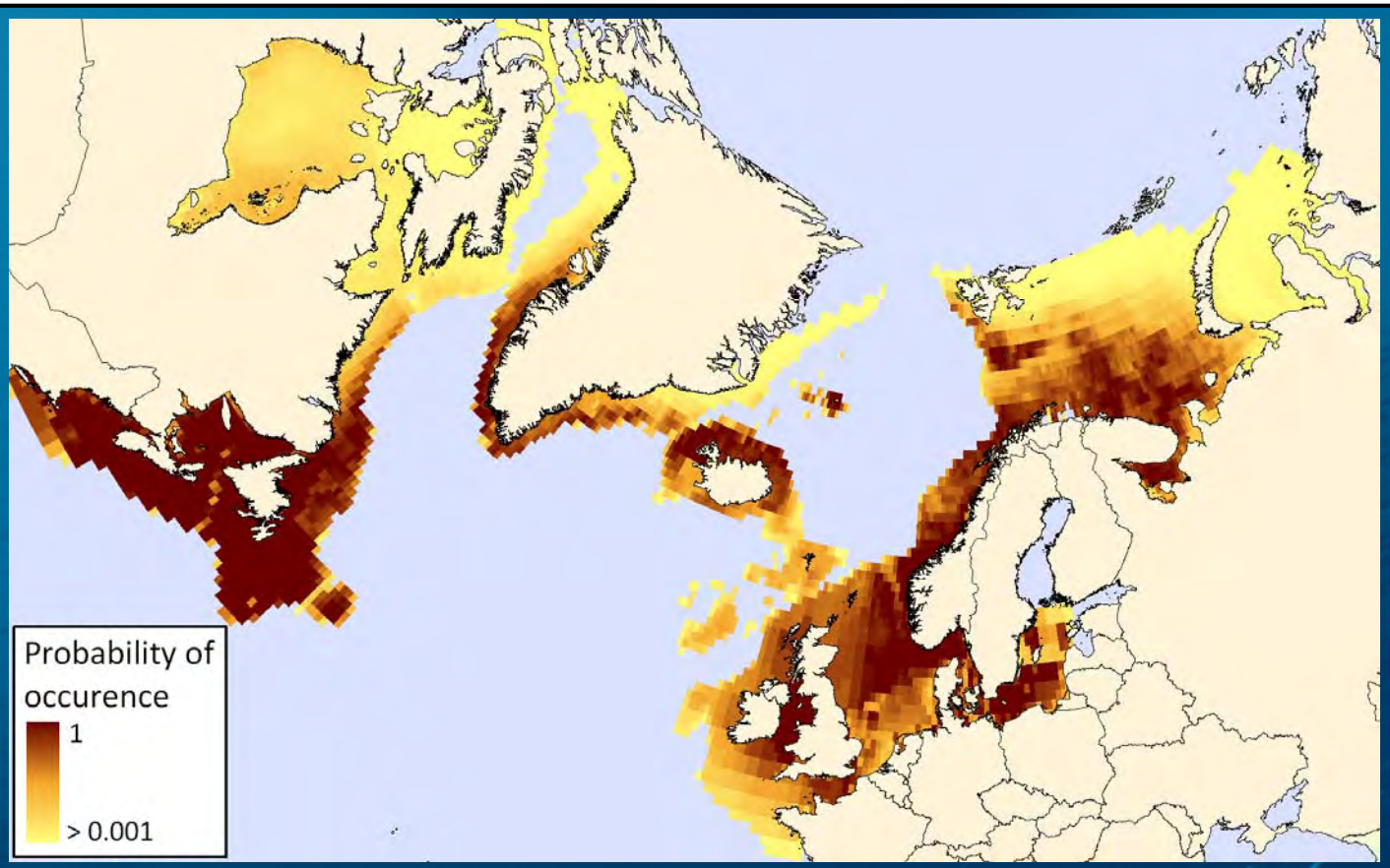
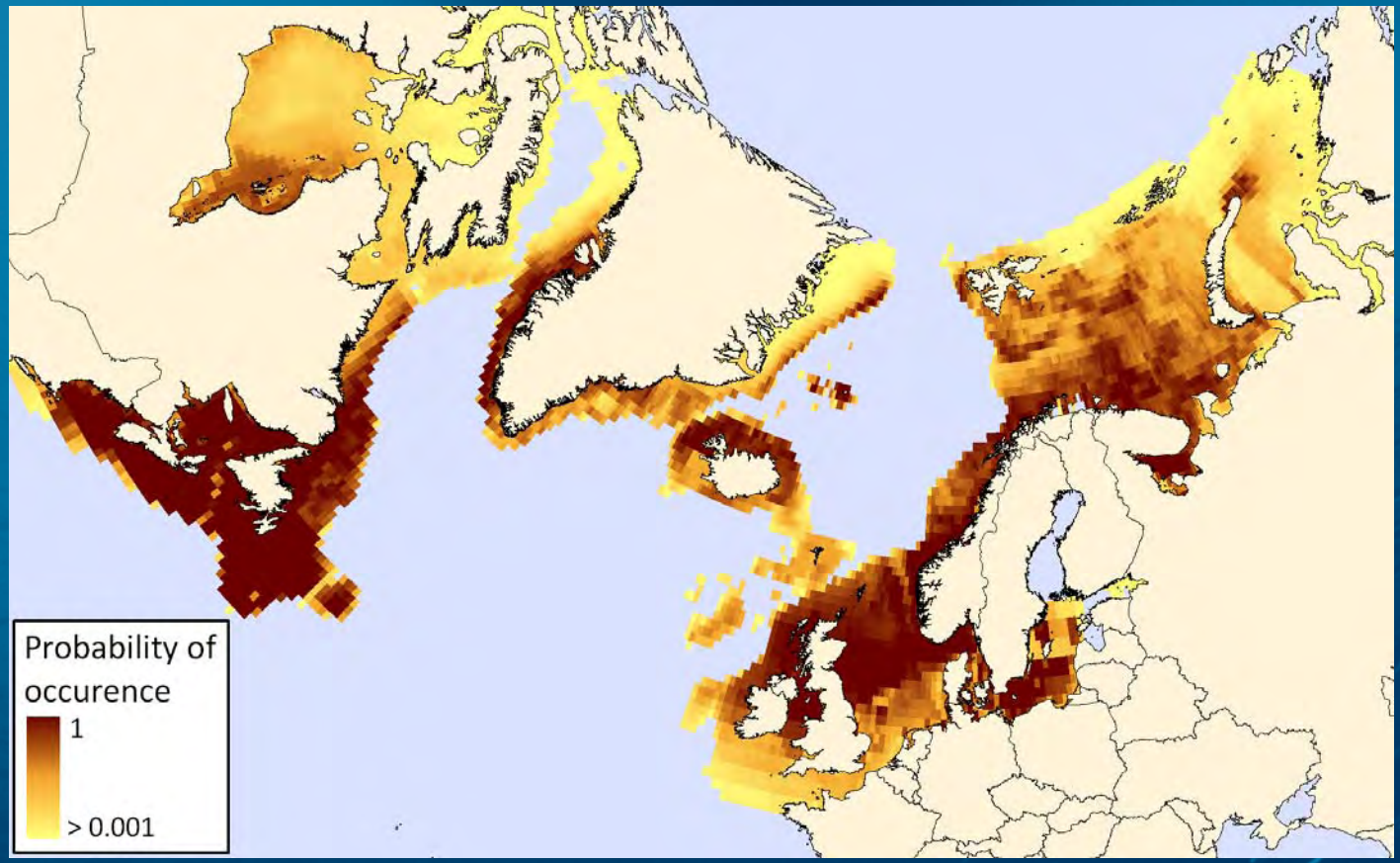
Changes in biogeographical distribution of Atlantic cod



Present

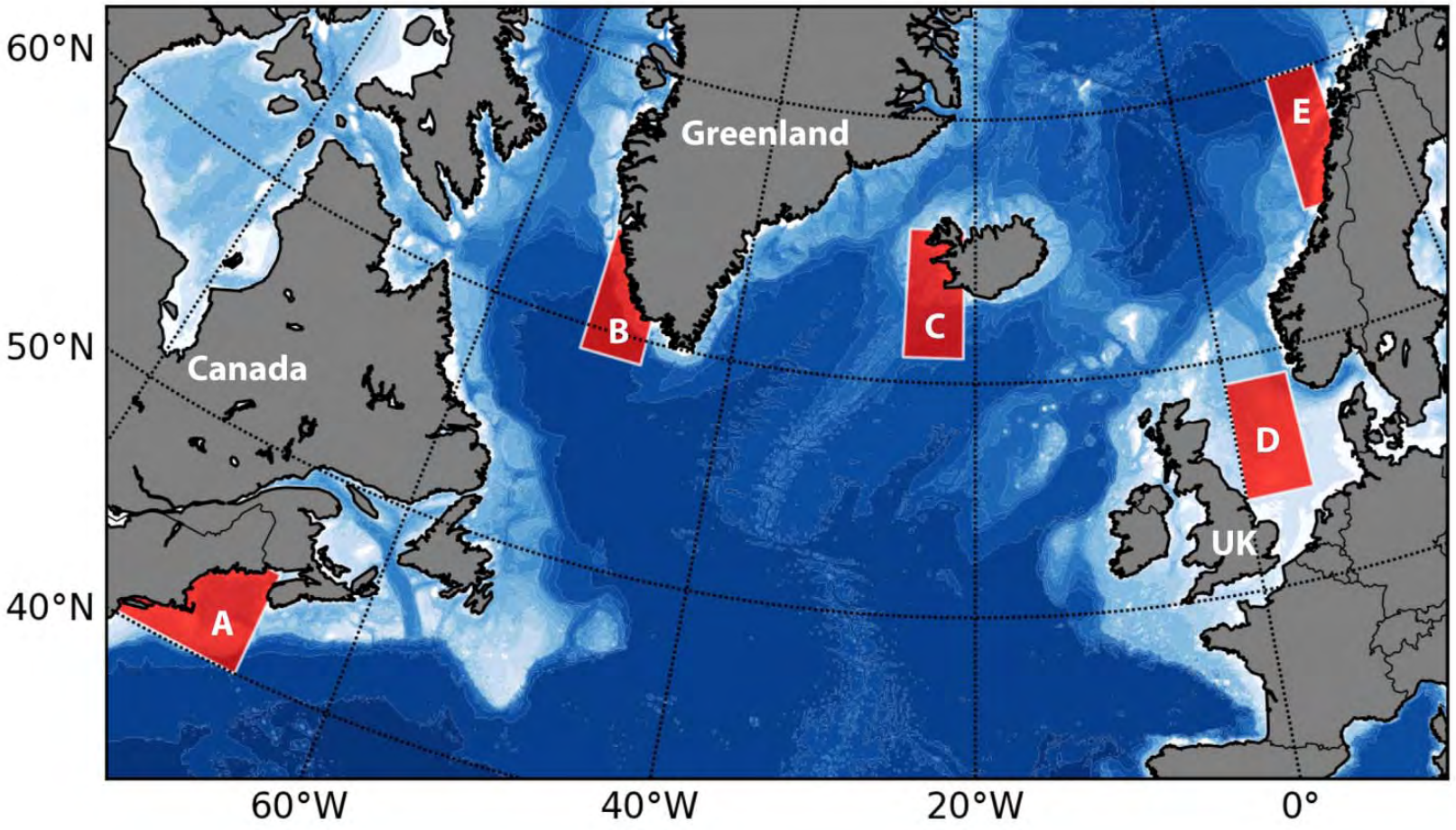
Data from Aquamaps



2050

Data from Aquamaps

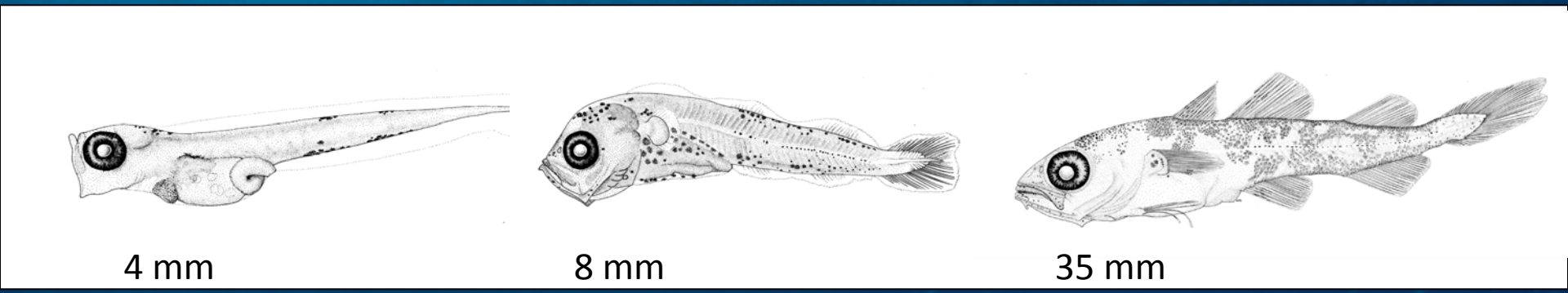
How will current spawning grounds change in the future?



Areas represented as averages over 5x5 degree boxes

Comparative analyses

- Comparative analysis and models may identify what drives changes in ecosystems (e.g. temperature, light, prey)
- How will ecosystems/fish habitats respond to future climate changes?
- How will recruitment be affected?



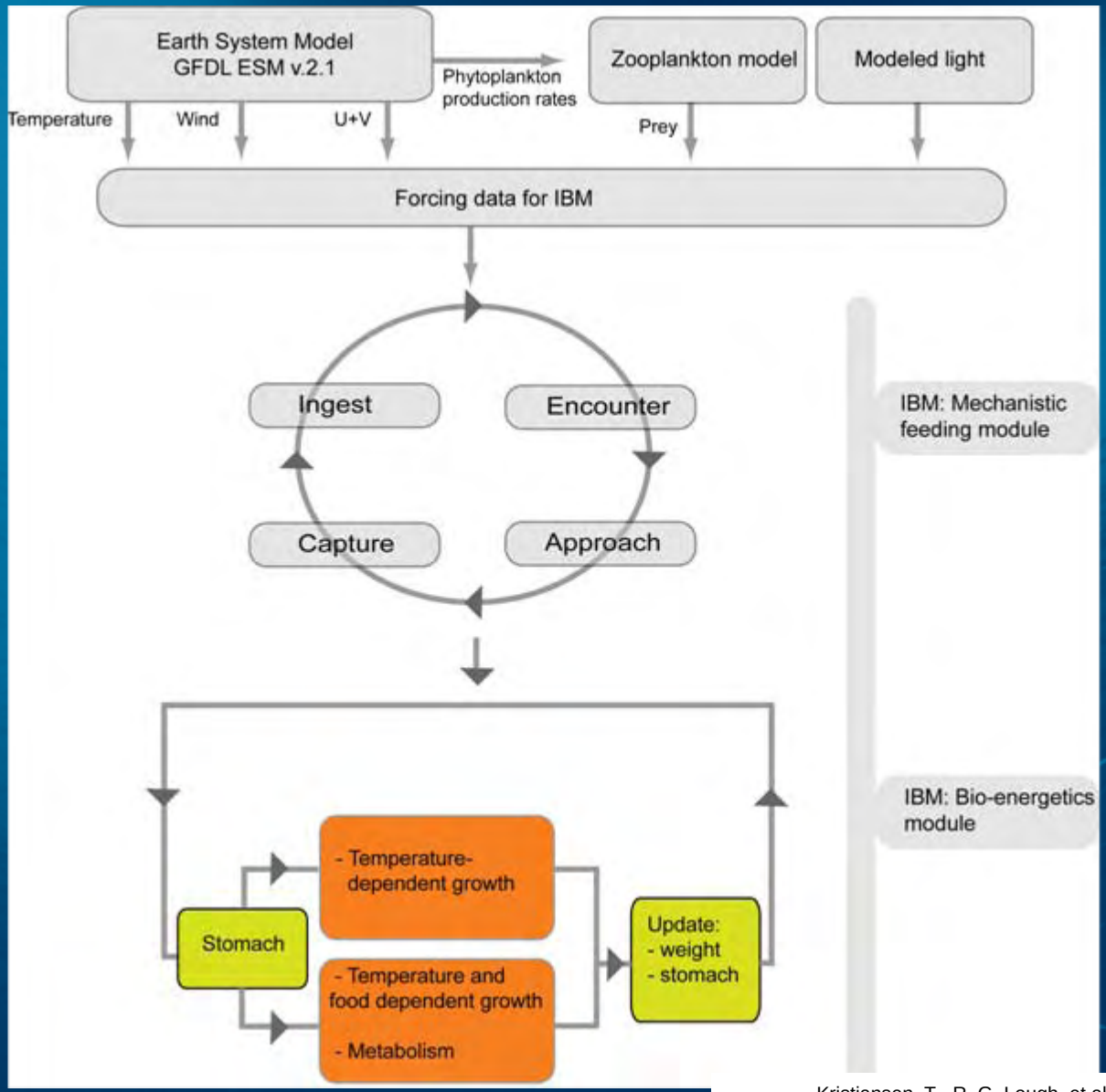
Drawings by Elizabeth Broughton, NOAA, Woods Hole

Modeling future growth and survival with climate change

Objective

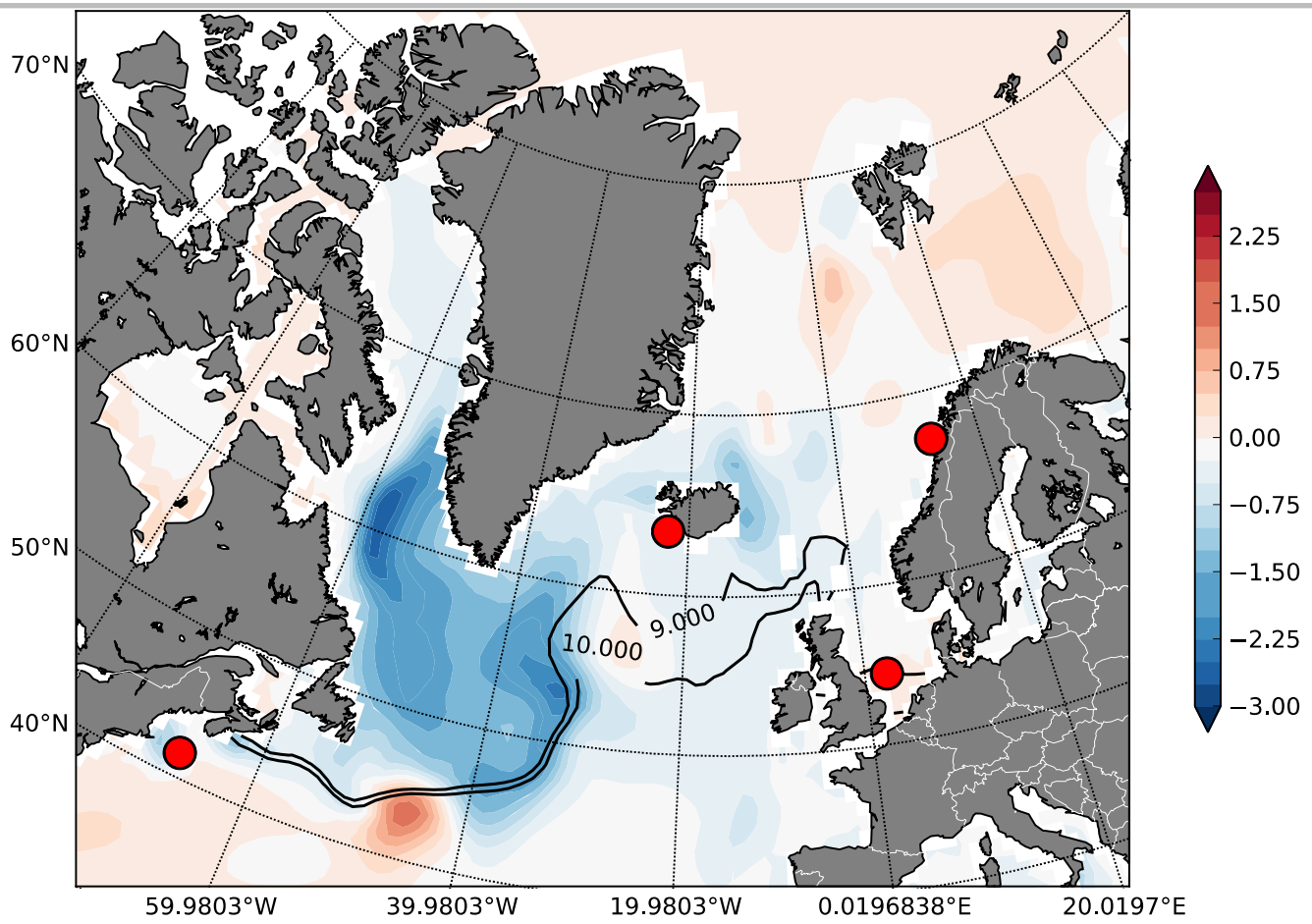
To model future growth and survival until age 30 days for cod at 5 important spawning grounds in the North Atlantic

Coupled model system

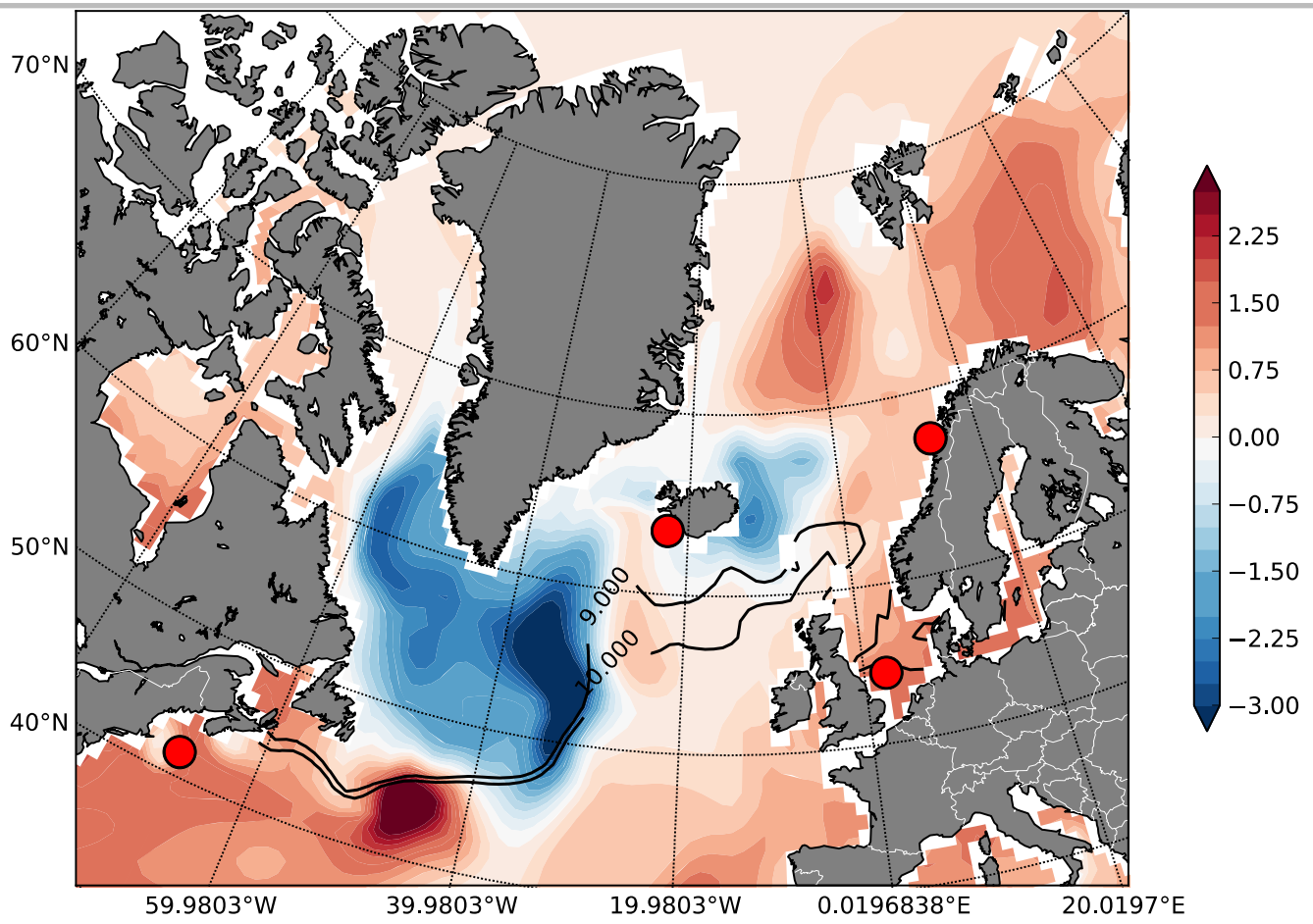


Kristiansen, T., R. G. Lough, et al. (2009). "Individual-based modeling of feeding ecology and prey selection of larval cod on Georges Bank." Marine Ecology Progress Series **376: 227-243.**

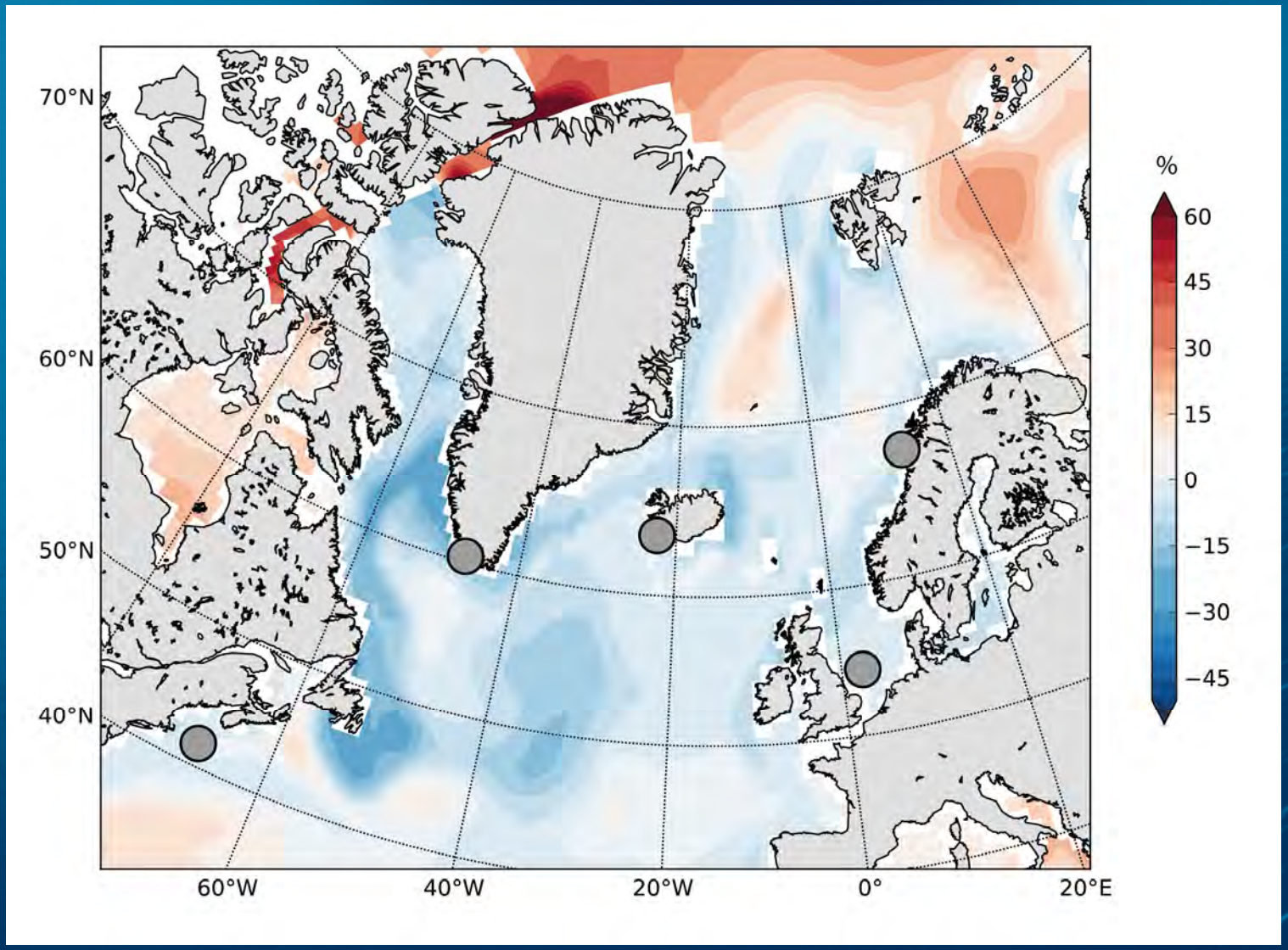
Temperature anomaly
1950-2000 vs 2000-2050

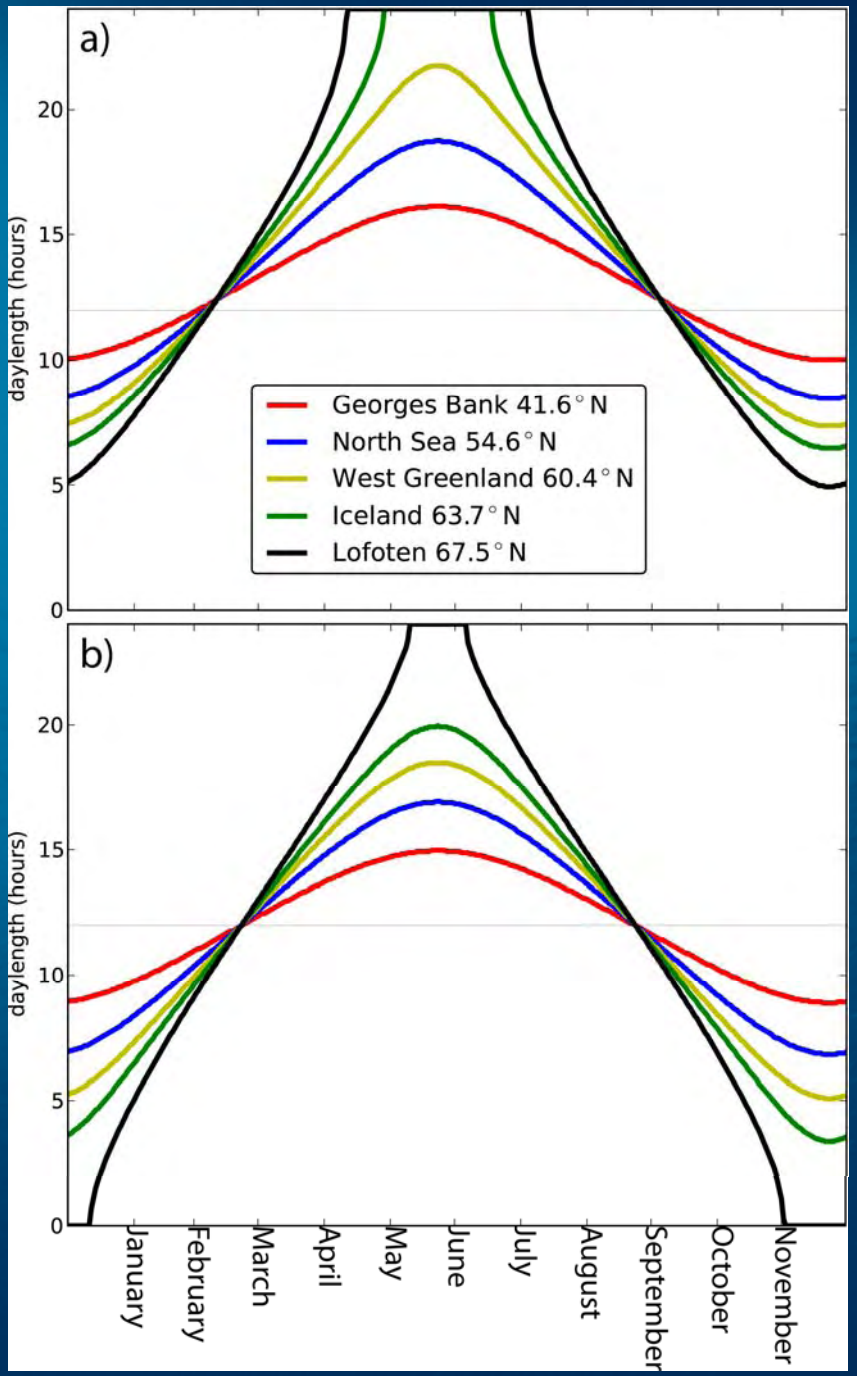


Temperature anomaly
1950-2000 vs 2050-2100



Total percent changes in phytoplankton production 1950-2000 vs 2050-2100



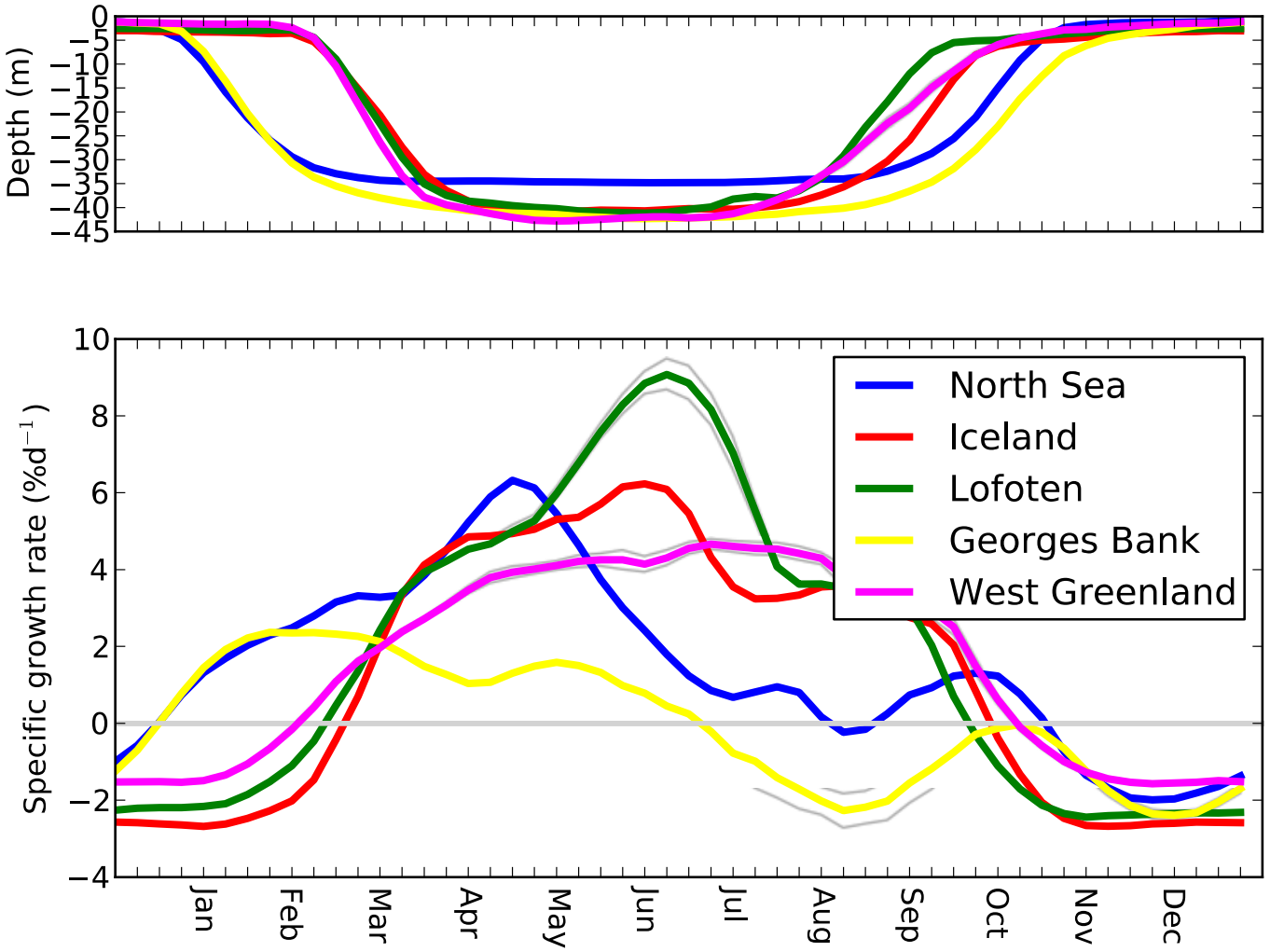


Surface layer

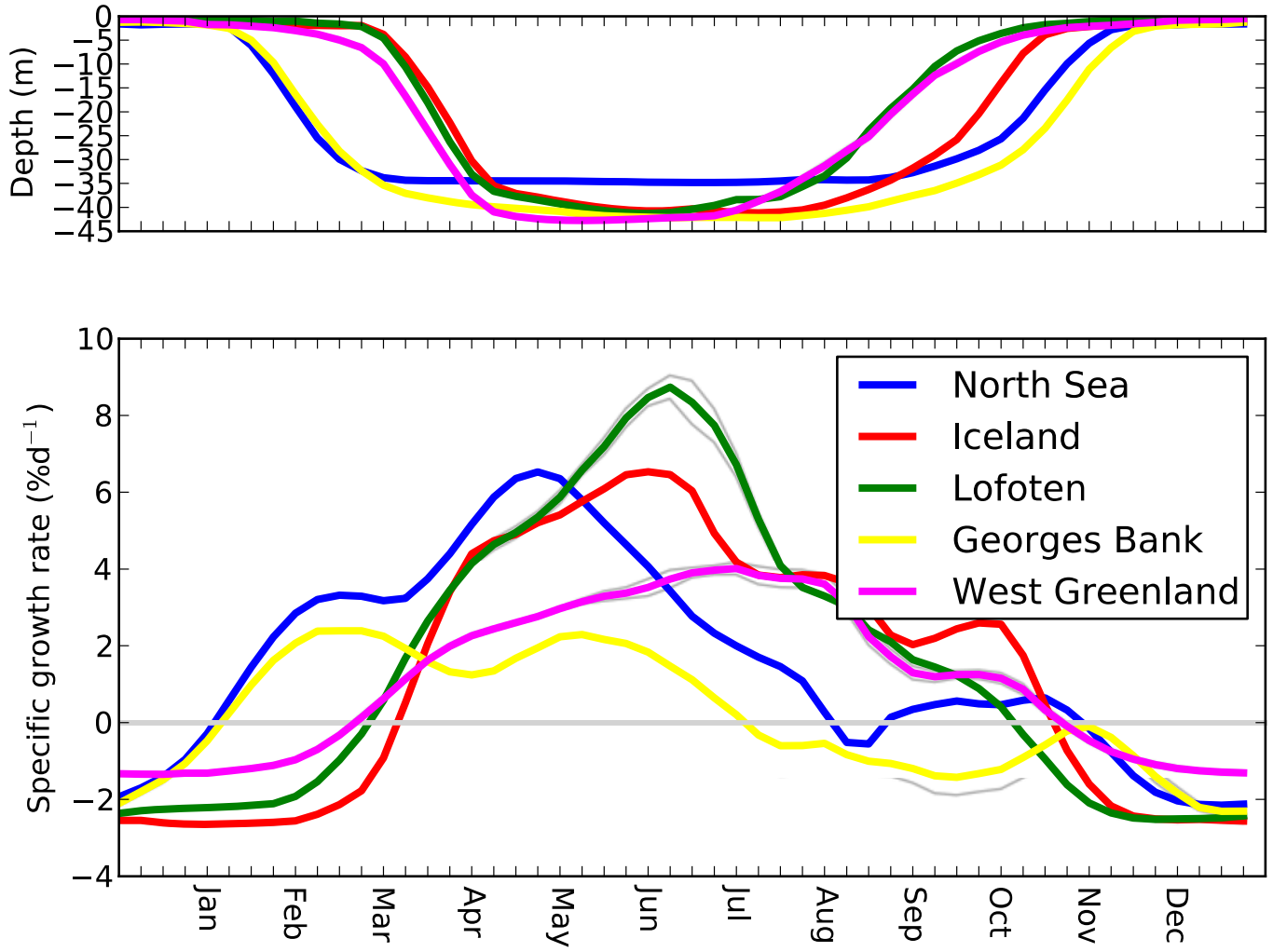
20 meter depth

Growth rate (%/day) and vertical behavour

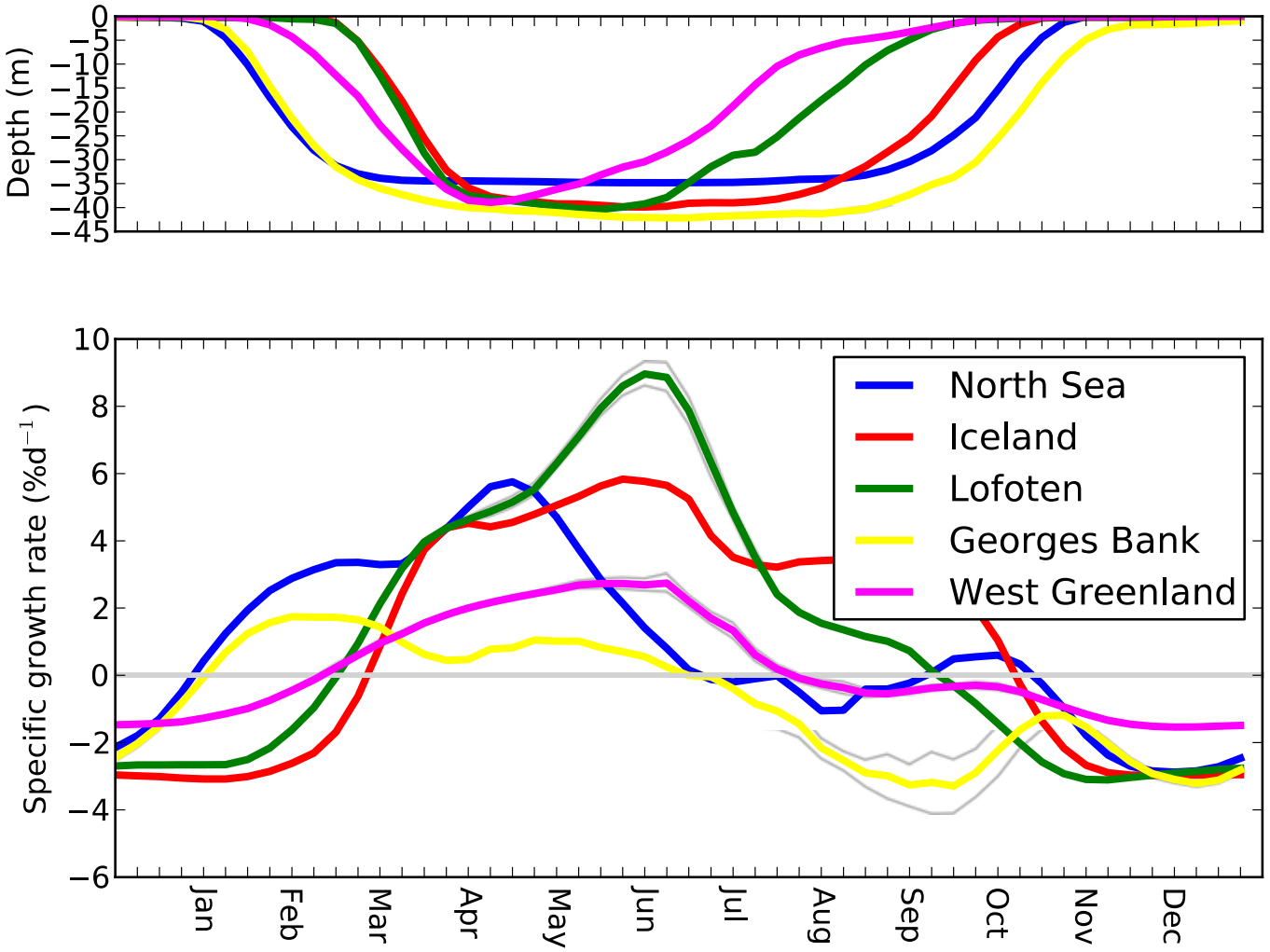
1950-2000



2000-2050


Depth (m)
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
Specific growth rate (%d^{-1})
10
8
6
4
2
0
−2
−4
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
North Sea
Iceland
Lofoten
Georges Bank
West Greenland

2050-2100


Depth (m)
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
Specific growth rate (%d^{-1})
10
8
6
4
2
0
−2
−4
−6
Jan
Feb
Mar
Apr
May
Jun
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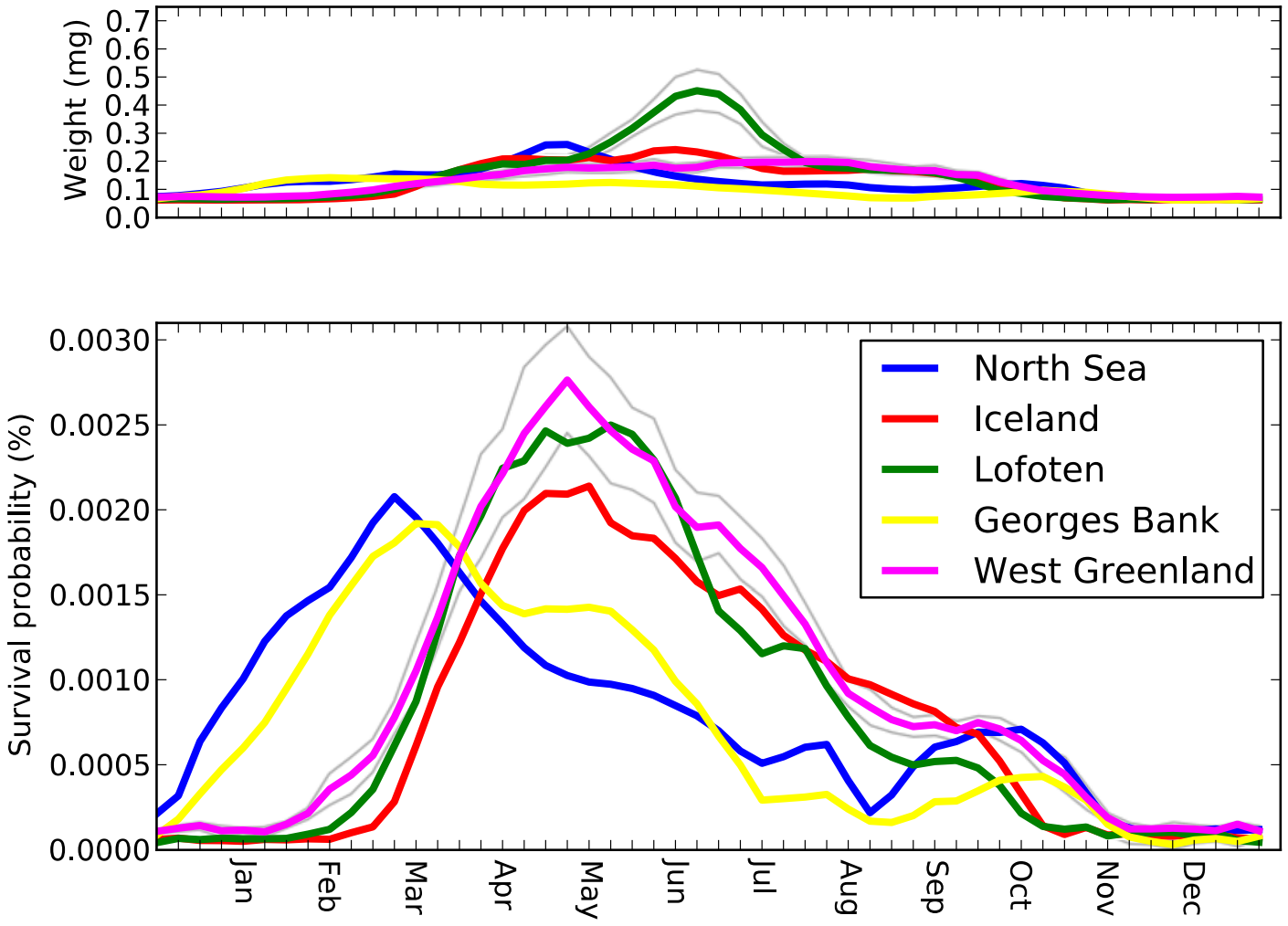
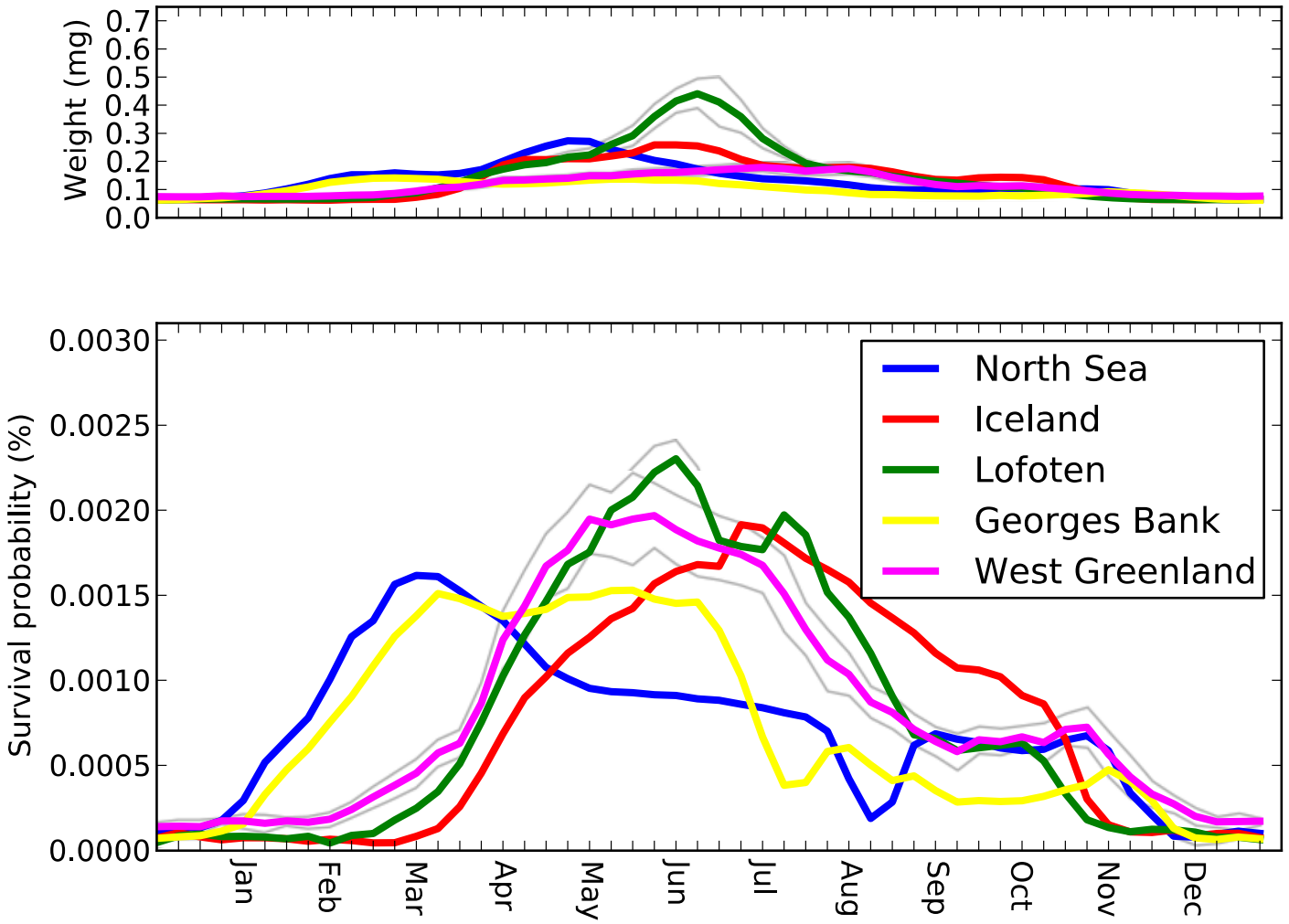
Survival and weight at age 30 days

1950-2000



2000-2050


Weight (mg)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Survival probability (%)
0.0000
0.0005
0.0010
0.0015
0.0020
0.0025
0.0030
North Sea
Iceland
Lofoten
Georges Bank
West Greenland
Jan
Feb
Mar
Apr
May
Jun
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Aug
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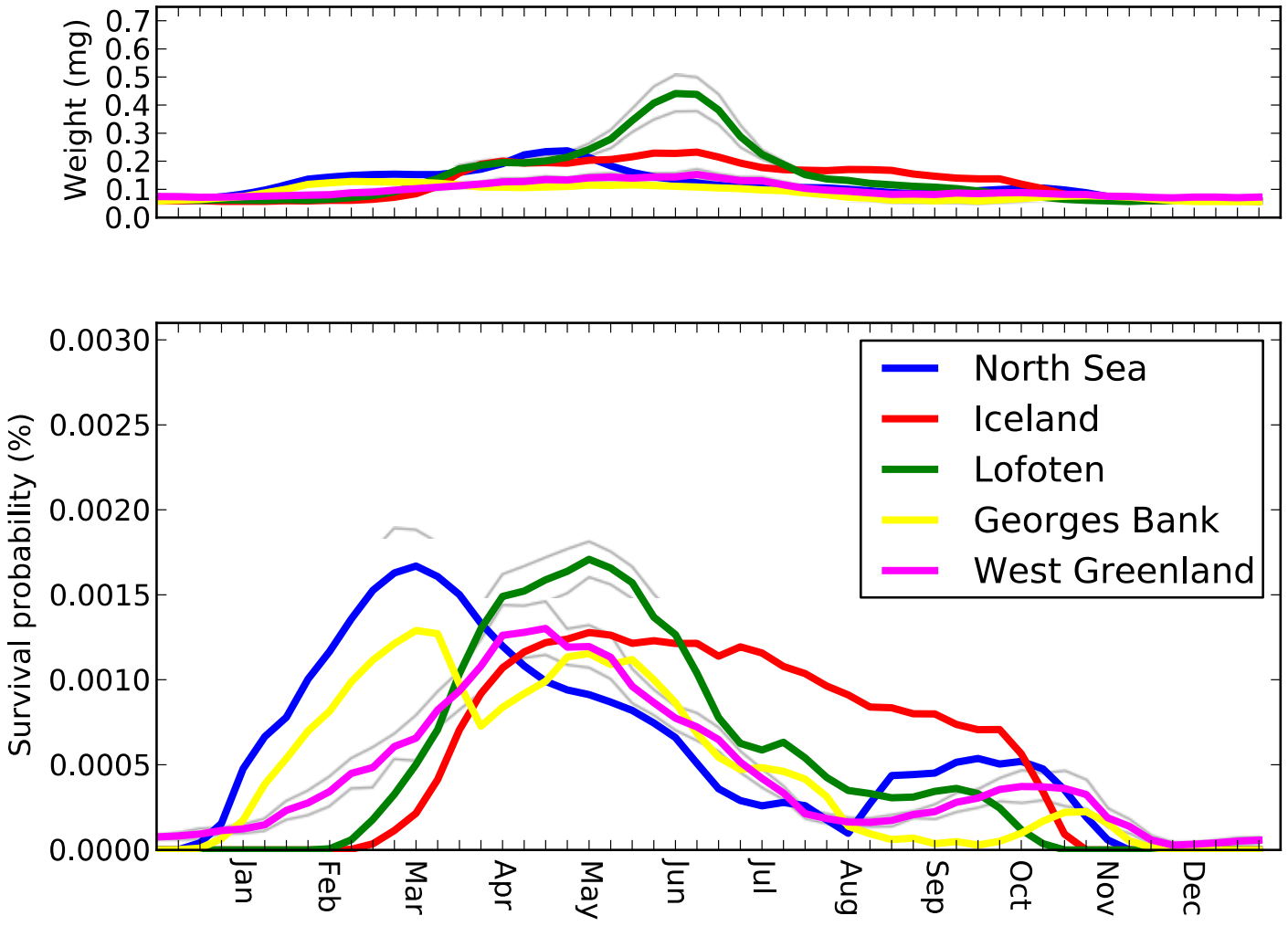
Nov
Dec

2050-2100


Weight (mg)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Survival probability (%)
0.0000
0.0005
0.0010
0.0015
0.0020
0.0025
0.0030
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Conclusions

- Reduced survival at all spawning grounds due to reduced prey conditions
- Growth rates and weight at age remain high
- Complex combinations of prey, temperature, and light conditions determine survival
- Future work: test approach using ESM ensemble models

Acknowledgements

- Thank you to John Dunne and Jasmin John who were responsible for the development of the ESM components we are using and for carrying out the runs (respectively)