Predicting impacts of climate change in Greenland:
Substituting space for time

Prepared by:
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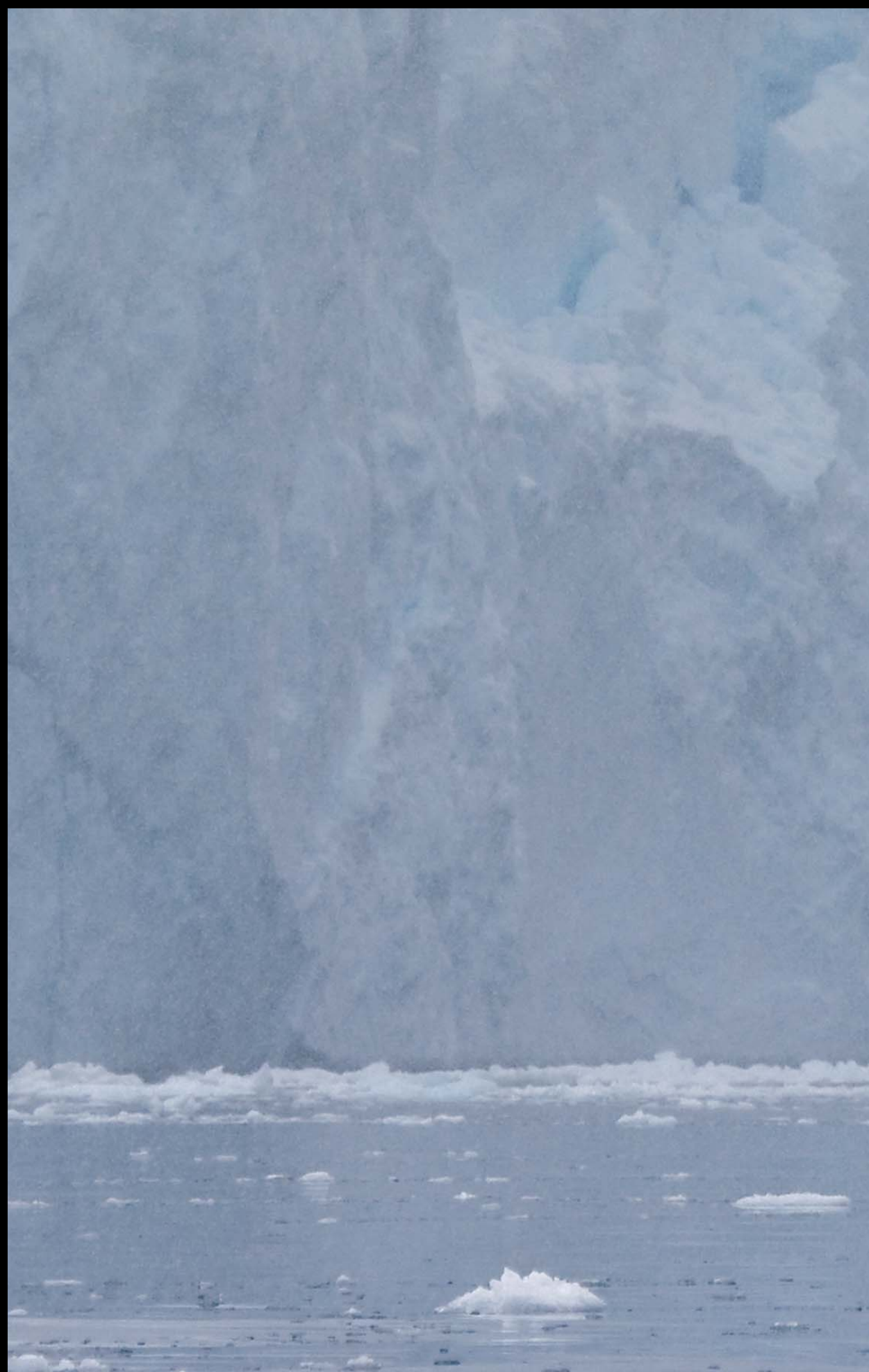
A contribution to the EU project:
Arctic Tipping Points

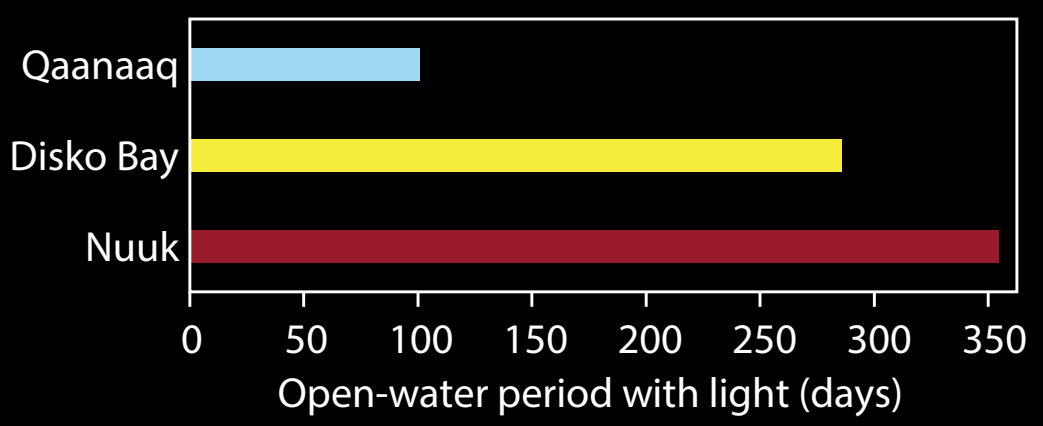
The Arctic is warming twice as fast as the global average. Sea ice is retreating and the Greenland ice cap is melting. Greenlandic society and Inuit culture have always relied on the ocean and its resources, but now the marine ecosystem is changing.

Fishing and hunting is still important for most people in Greenland and the changing climate affects everyday life in Greenland.

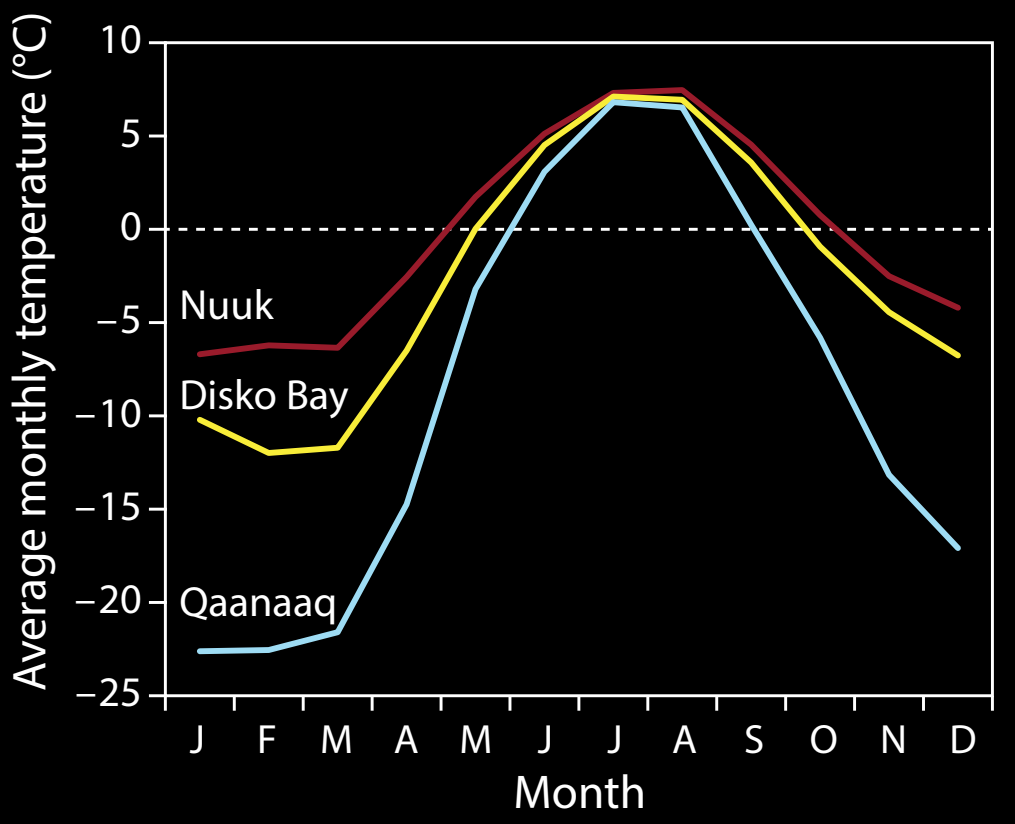
But the warmer climate may also allow for oil and mineral exploitation and new inter-continental shipping routes through Greenland waters where heavy ice cover once prevented these activities.



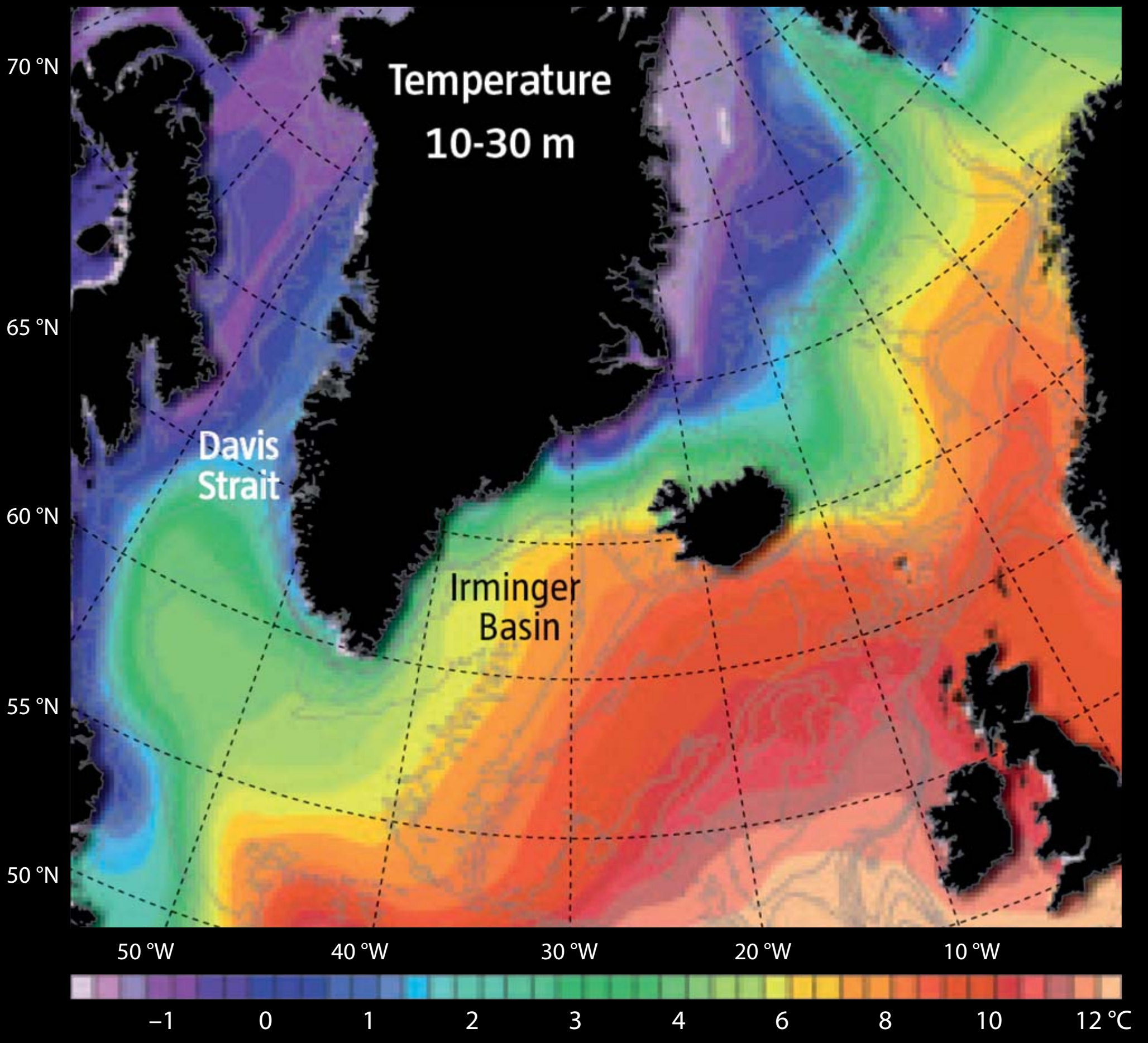
The Greenland coast spans more than 22 degrees of latitude from sub-Arctic to high-Arctic environments. Studying the marine ecosystem along this climatic gradient can give us an indication of what to expect in a warmer future. For example we expect the climate (temperature, ice cover, etc.) in the Disko Bay to resemble the conditions we now find further south in Nuuk by the end of the century.

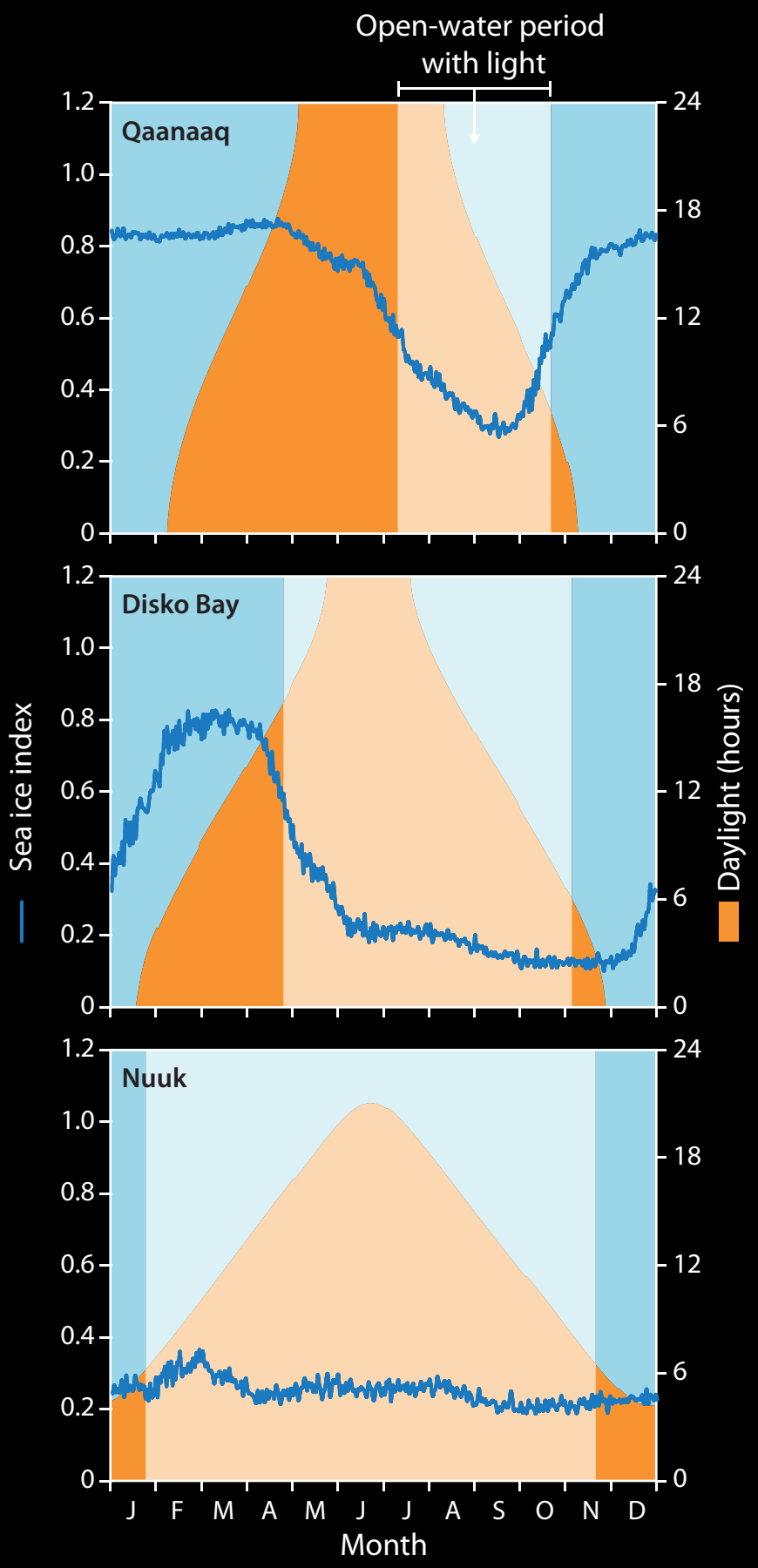

Qaanaaq
Disko Bay
Nuuk
0
50
100
150
200
250
300
350
Open-water period with light (days)


Qaanaaq
Disko Bay
Nuuk

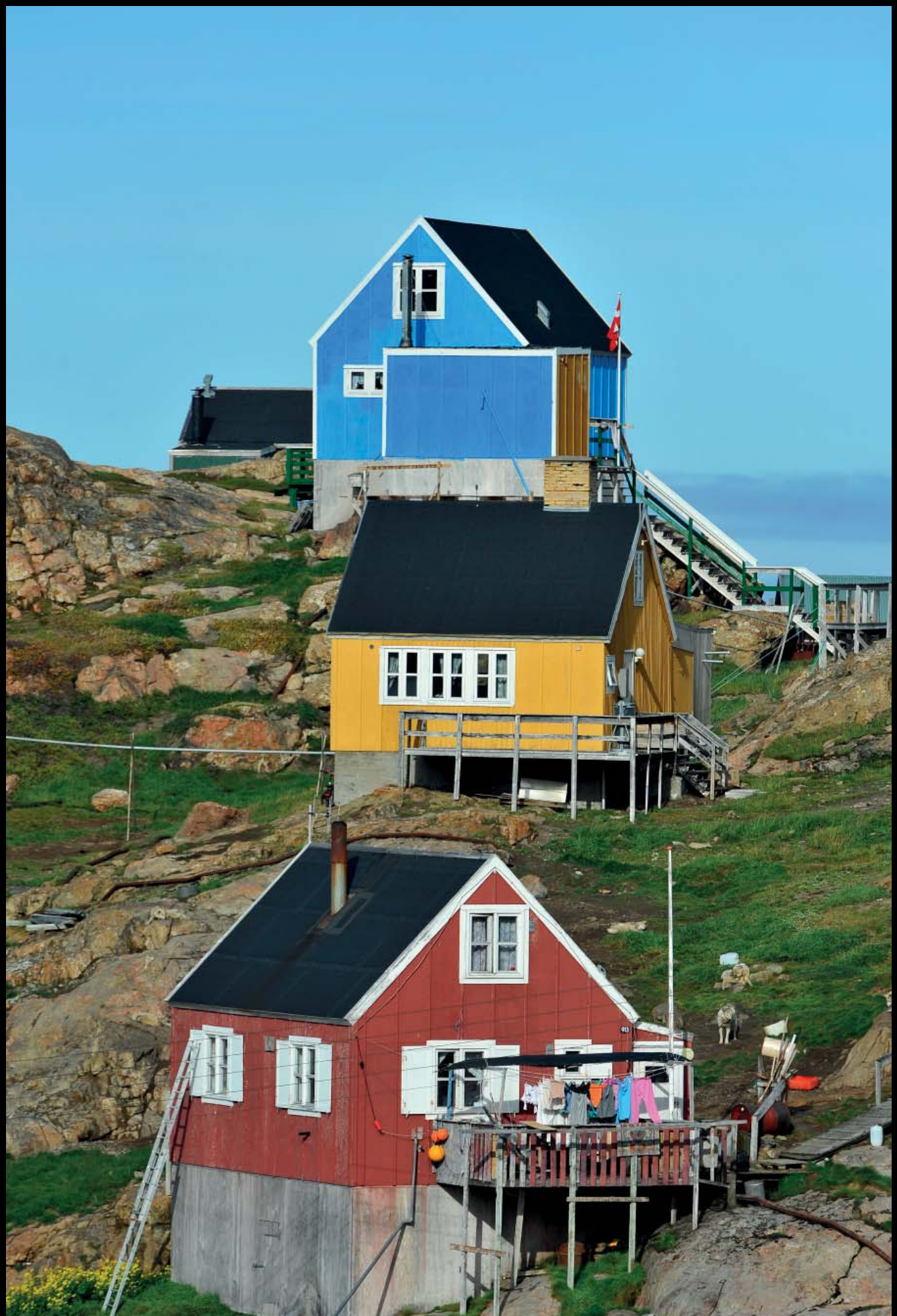

Average monthly temperature (°C)
10
5
0
−5
−10
−15
−20
−25
Nuuk
Disko Bay
Qaanaaq
J
F
M
A
M
J
J
A
S
O
N
D
Month

Ocean currents and air temperature creates different sea-ice regimes and water temperatures along the coast of Greenland. The sub-Arctic conditions with warm water and low sea-ice cover is expected to expand northward in the future due to climate change.

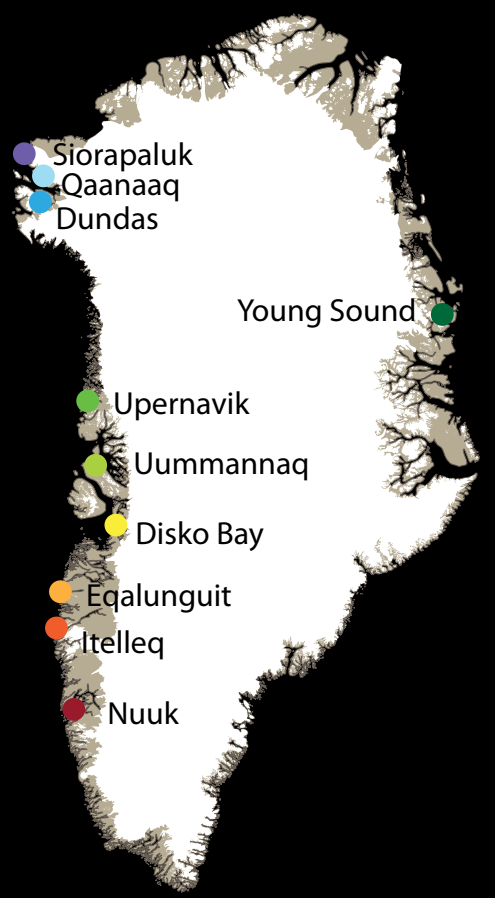

Temperature
10-30 m
Davis
Strait
Irminger
Basin
70 °N
65 °N
60 °N
55 °N
50 °N
50 °W
40 °W
30 °W
20 °W
10 °W
–1
0
1
2
3
4
6
8
10
12 °C

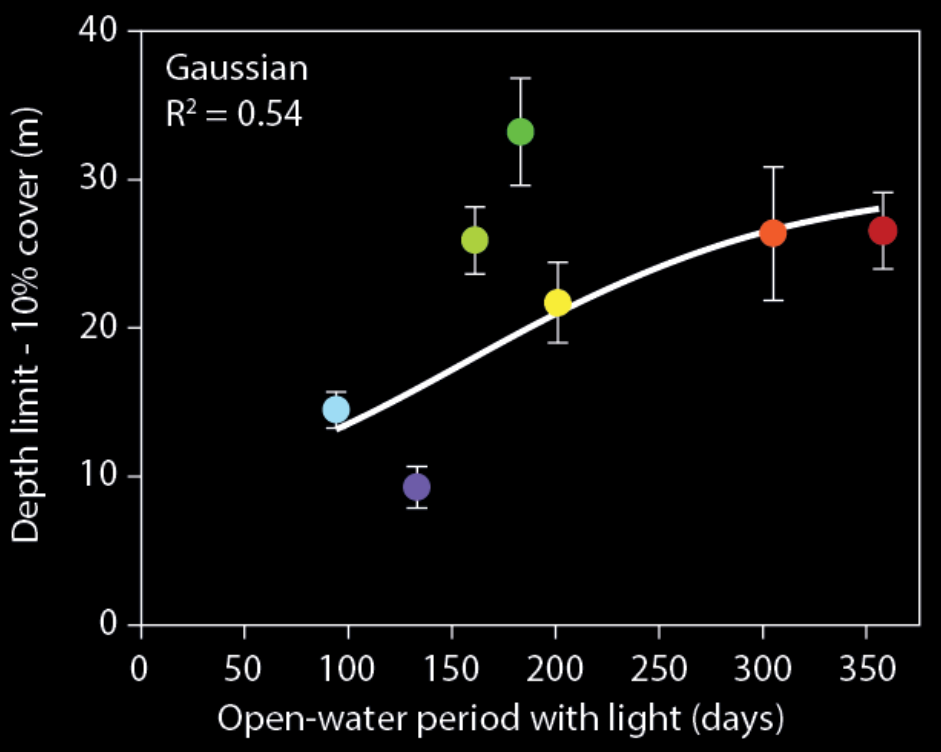


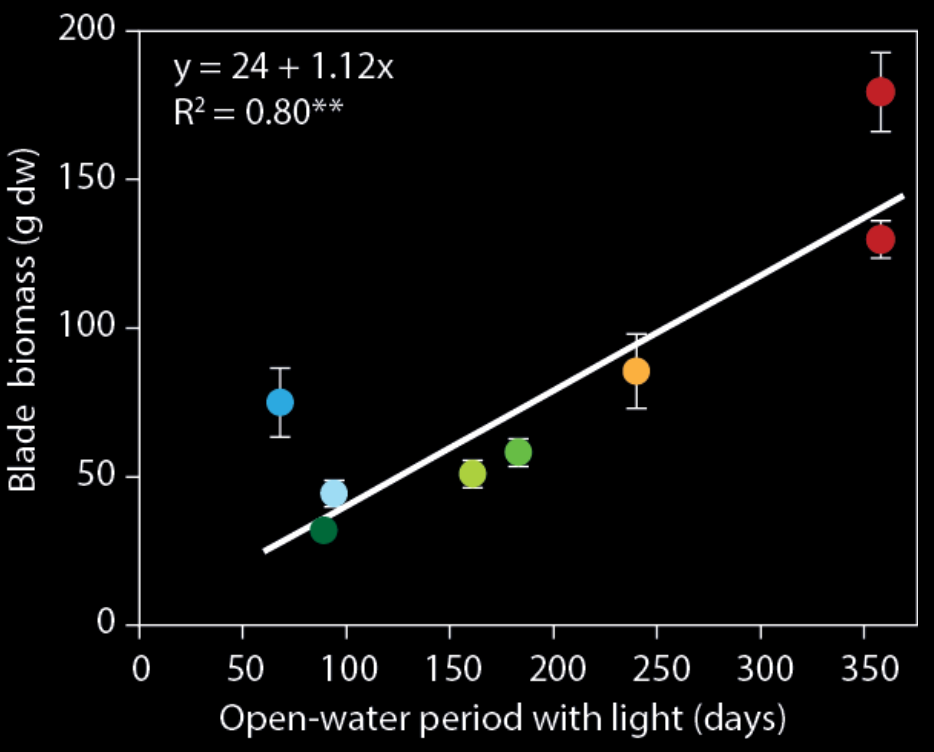
The combination of sea ice cover (blue line) and polar day lengths (yellow area) create latitudinal differences in the duration of the productive period (white area) where sun-light penetrates the sea surface and provides energy for plankton and kelp.



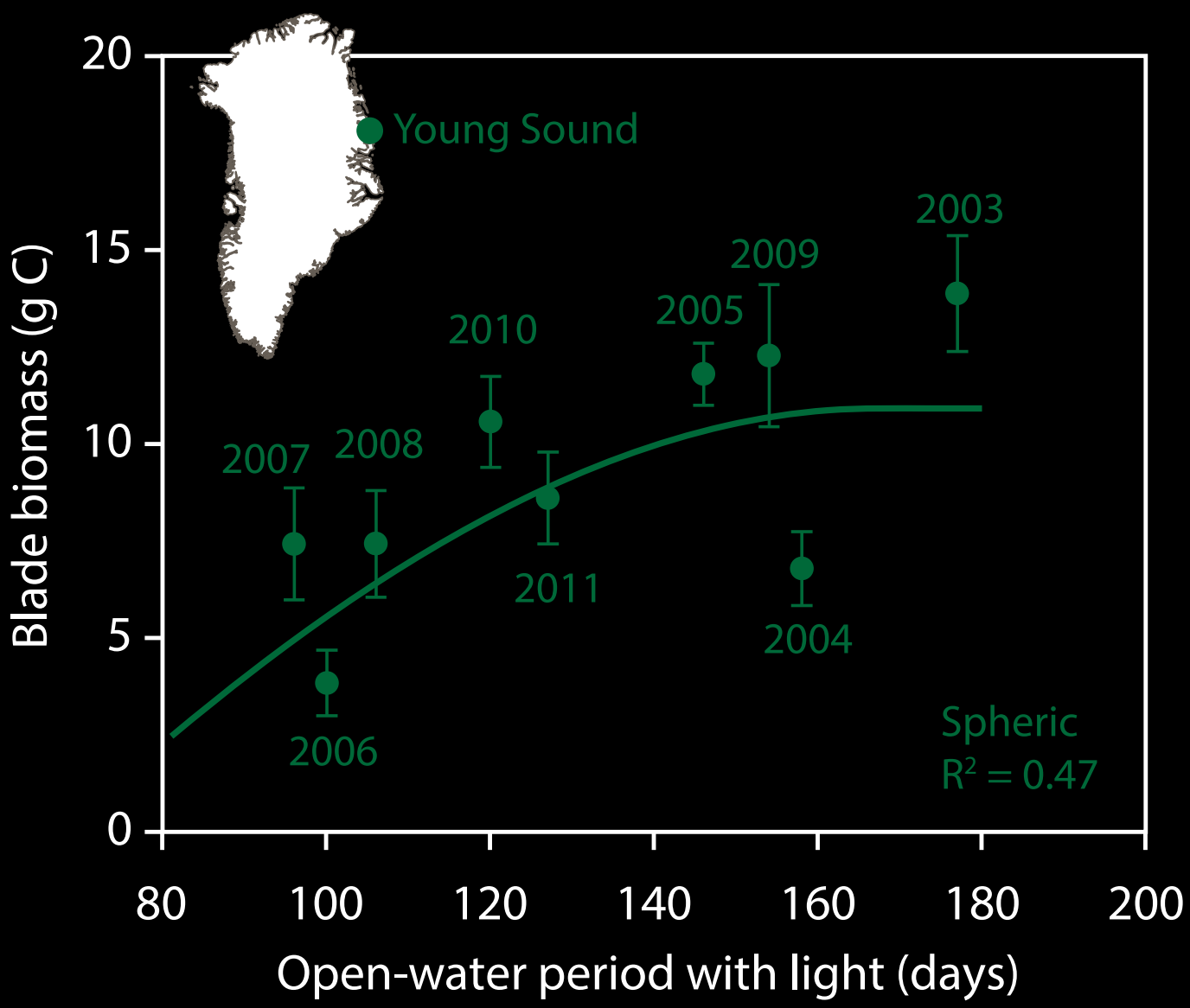
The longer productive period in southern Greenland allows kelp to extend deeper and grow larger.

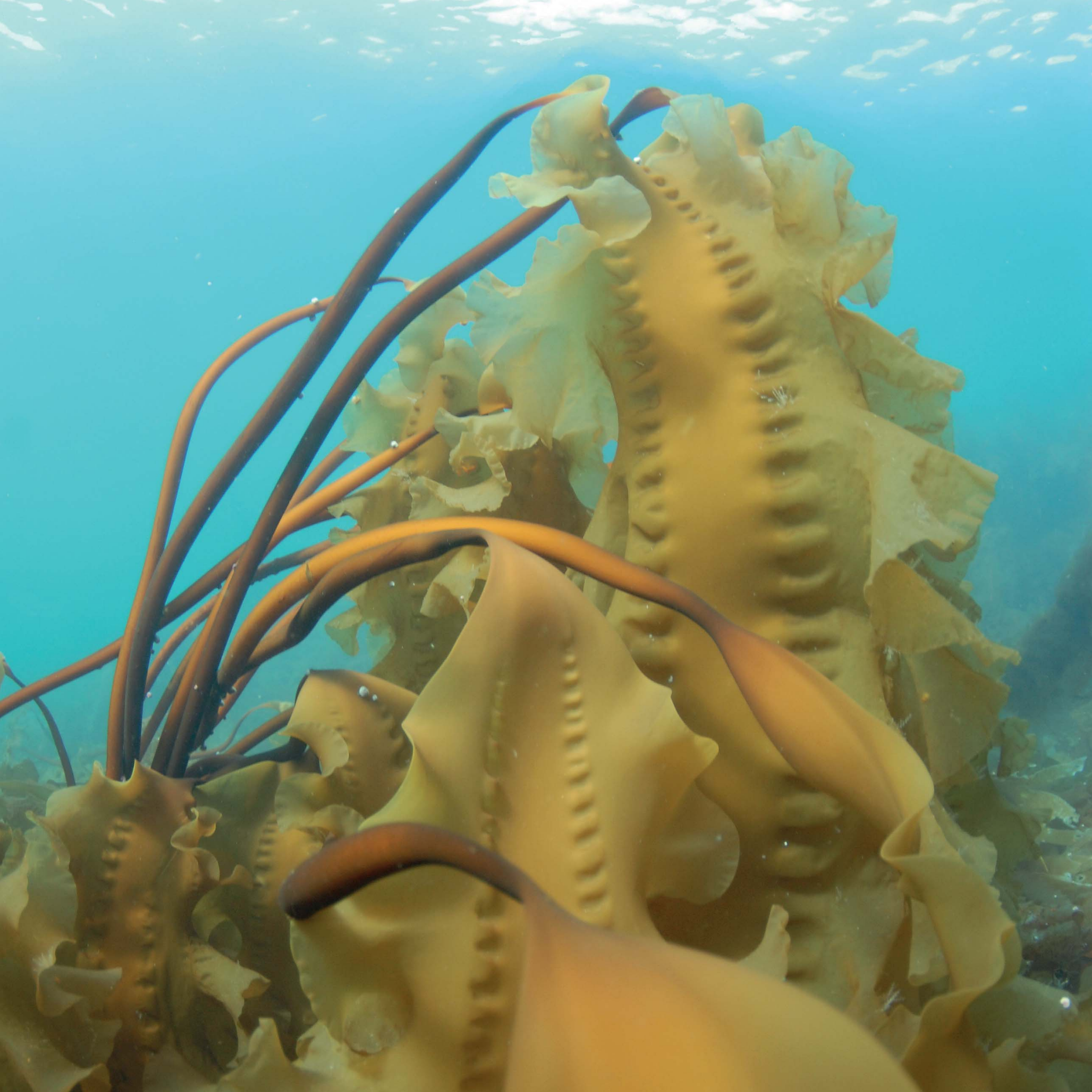




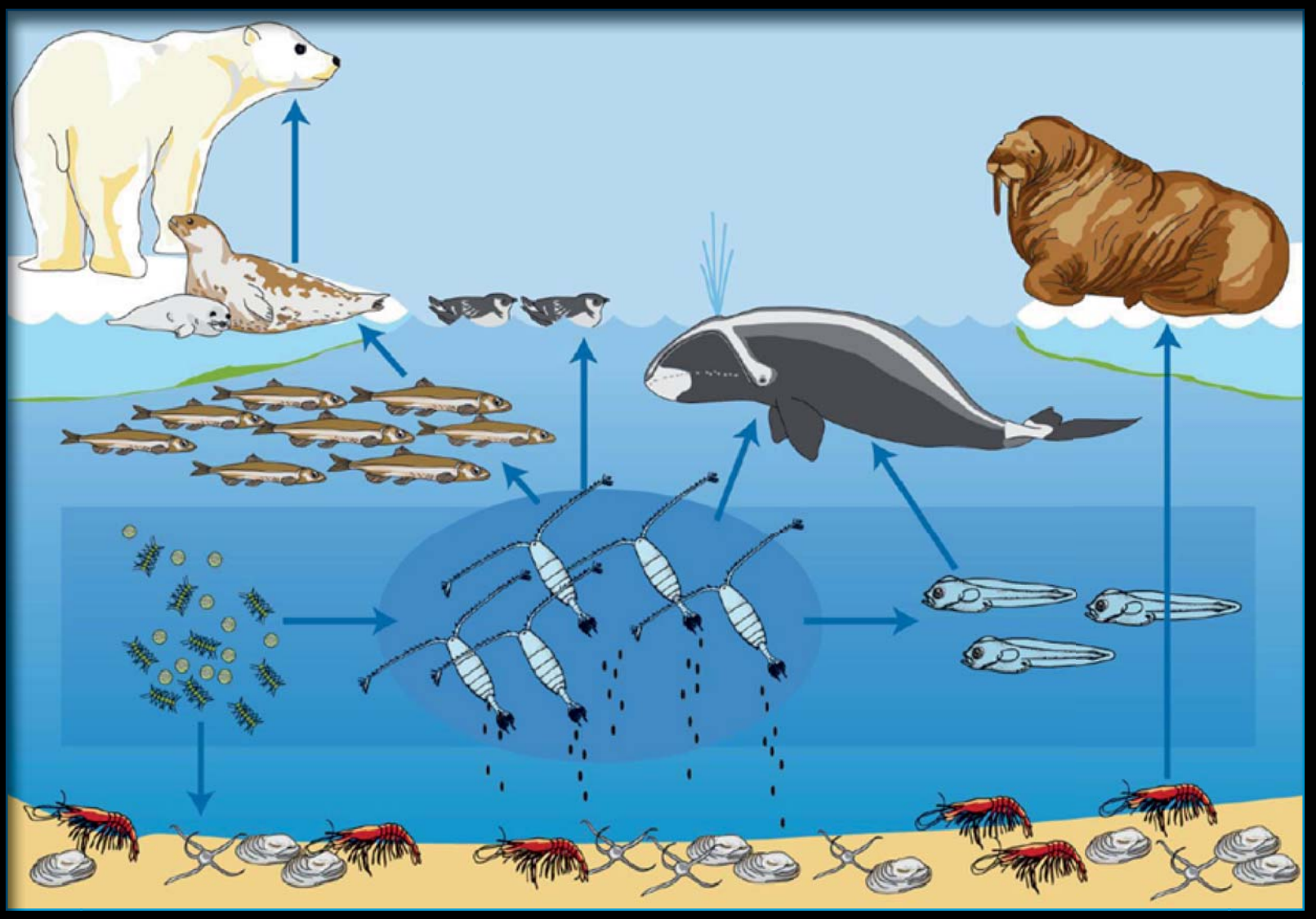


In Young Sound, NE Greenland, where climate monitoring has taken place since 2003 data show that kelp grow more in years with long duration of open water. This confirms the pattern from the latitudinal study.

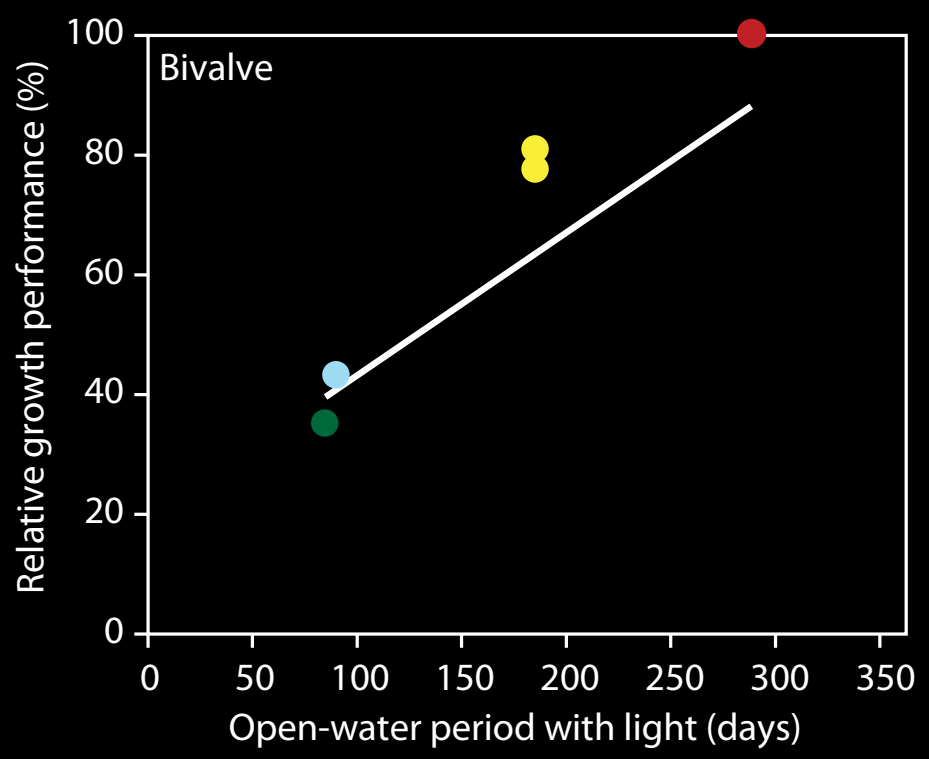


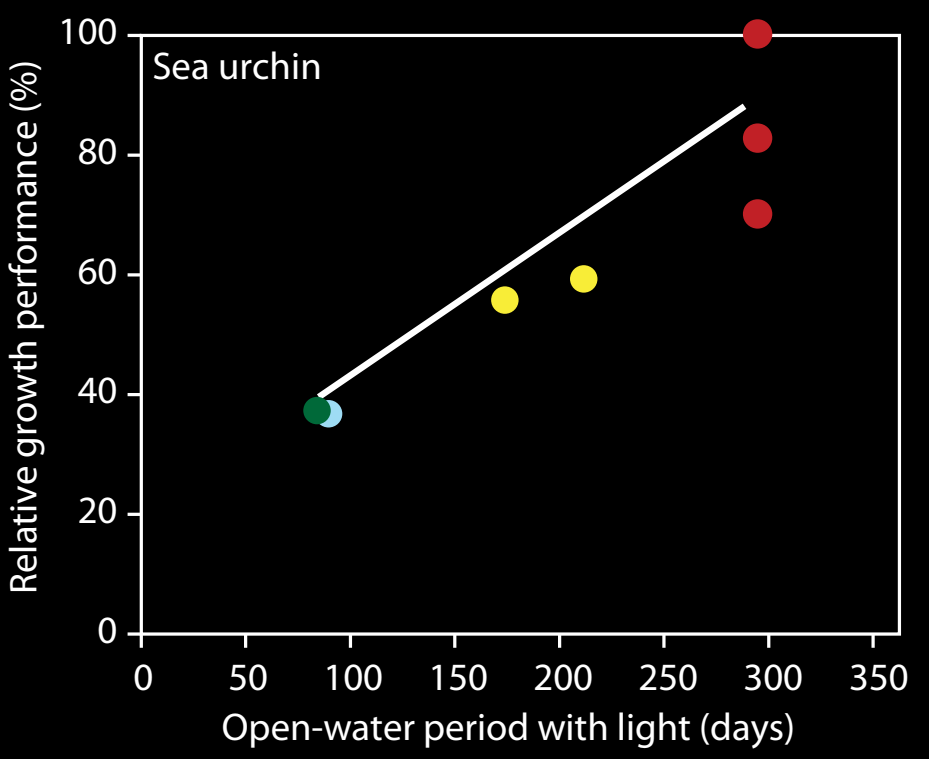


The reduction in sea ice cover has direct impacts on the animals that rely on sea ice as their main habitat such as walruses, polar bears and ice algae. However, the sea ice also modifies the physical environment which can have pronounced impacts throughout the marine ecosystem.



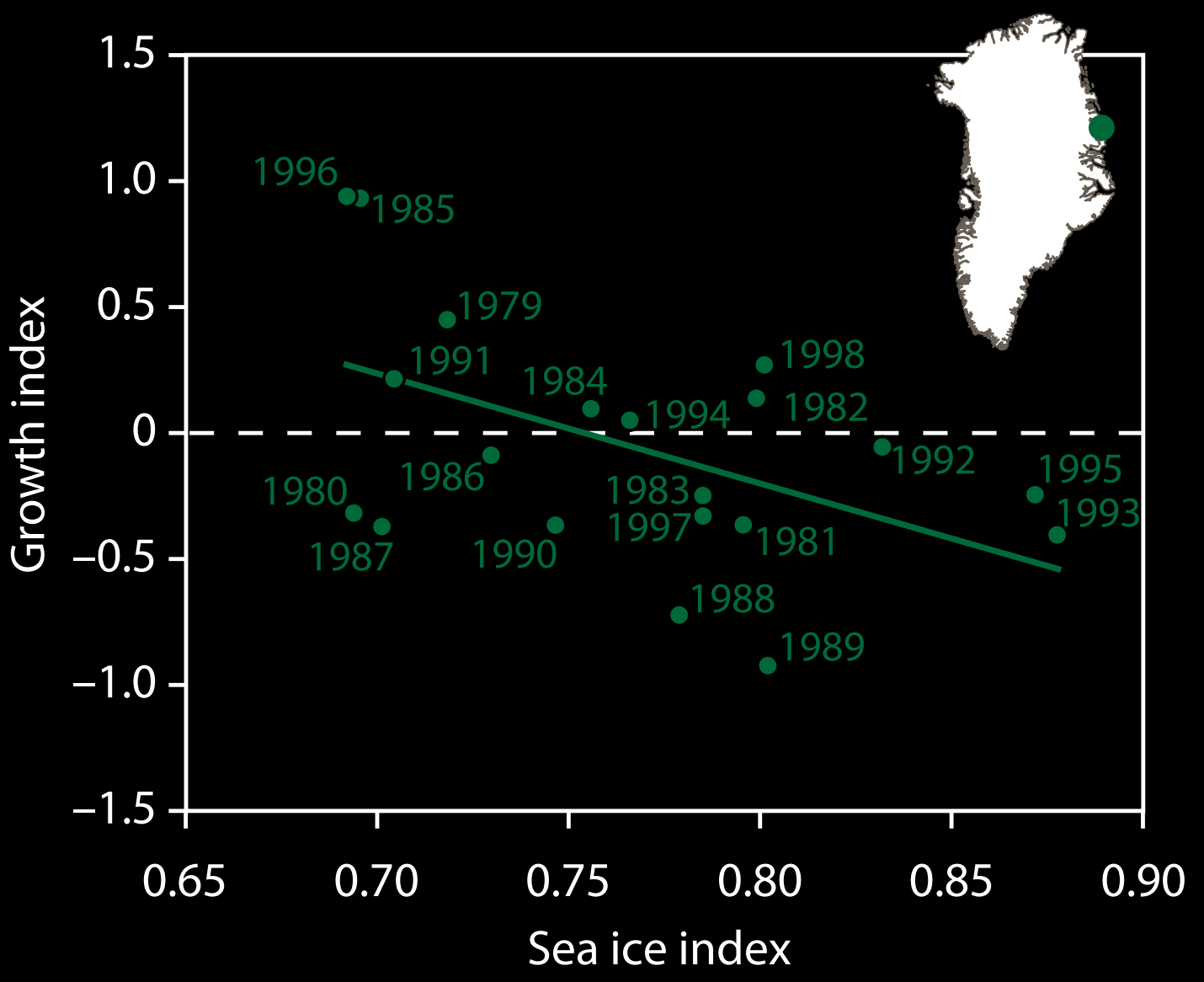
Cockles and sea urchins rely on phytoplankton and kelp for food. In high-Arctic Greenland they are food-limited most of the year and consequently grow slowly. In southern Greenland low sea-ice cover results in an extended productive period, leading to higher growth rates of these organisms.

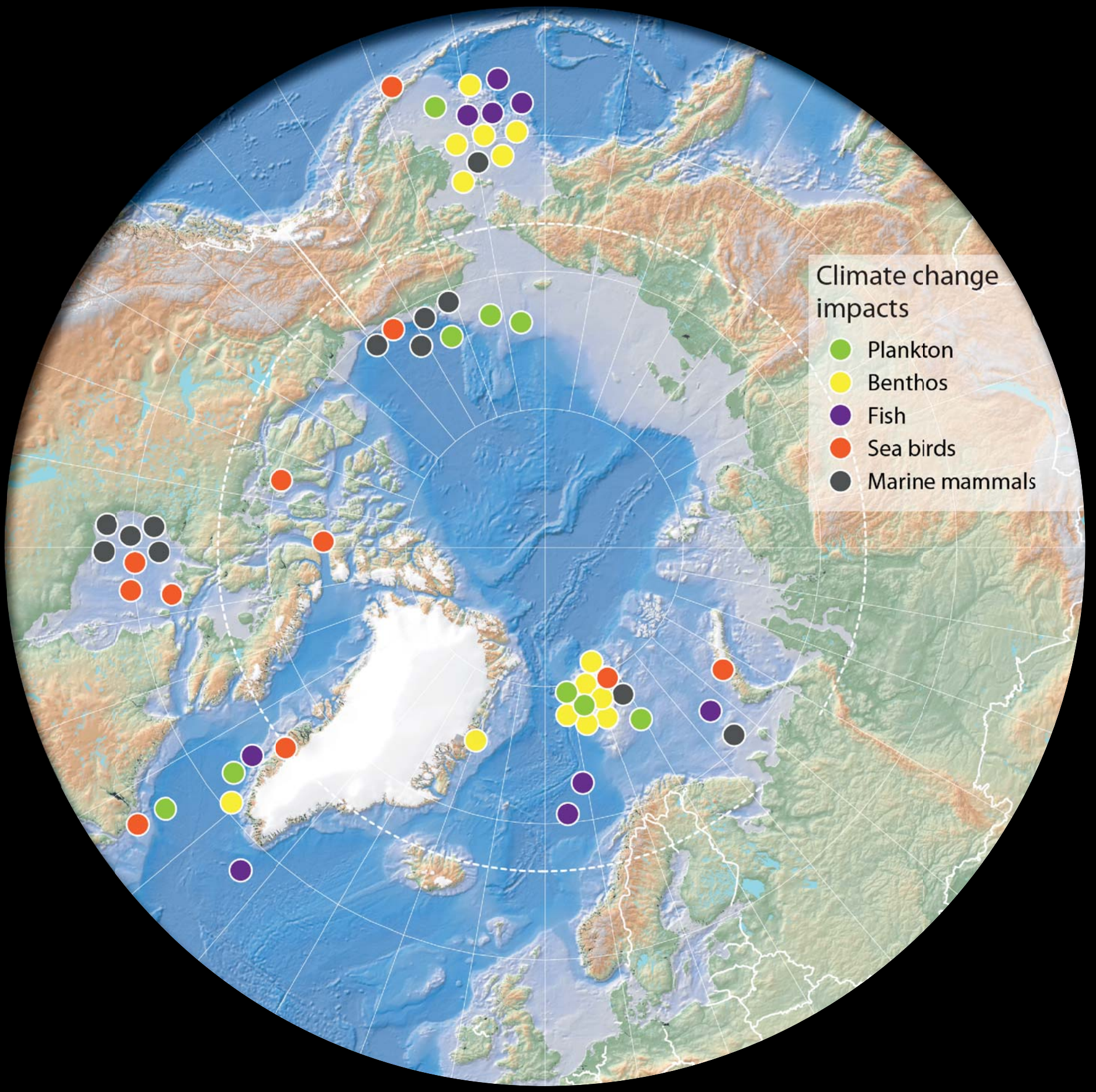




By measuring growth rings in the shell of cockles it is possible to reconstruct past growth rates and show that shell growth is faster in years with less sea ice. As for the kelp, the time series of couples from Young Sound confirms the relationship between sea ice and productivity.

Based on these studies we expect higher productivity of the coastal ecosystem in northern Greenland in a warmer future with less sea ice. However, the loss of sea ice is also a loss of the habitat that characterises the Arctic. With the continued loss of sea ice the high-Arctic marine ecosystem is shrinking and moving further north to smaller and smaller areas near the North Pole.




Climate change impacts
Plankton
Benthos
Fish
Sea birds
Marine mammals

One of the aims of the Arctic Tipping Points project was to collect the available evidence in the scientific literature on how climate change has affected the Arctic marine ecosystem. Although we found numerous examples from all levels of the food chain, it is also evident that almost no examples are found in the central Arctic Ocean and from the Russian part of the Arctic. Large parts of the Arctic are still poorly studied and dramatic changes in the marine ecosystem are mostly likely taking place right now without us knowing it.

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Scientific details can be found in:

Blicher, M.E., Rysgaard, S., Sejr M.K. (2007)
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