

Production in sea ice could fall

New research suggests that climate change-induced sea ice reduction in Antarctica will shift the balance of 'primary production' – photosynthesis by seaweeds, phytoplankton and microalgae – from the sea ice to the sea floor, with consequences all the way up the food chain.

In the Antarctic marine ecosystem, sea ice controls light penetration, scours intertidal zones and ploughs through sediments. Thus, a reduction in sea ice cover as a result of global warming could lead to major alterations to the ecosystem as it adapts to changed seasonal light conditions, reduced abrasion and higher water temperatures.

Through the Institute of Antarctic and Southern Ocean Studies we have been investigating primary production at several coastal Antarctic sites with different annual sea ice distributions. The work is attempting to quantify the effects of sea ice reduction on coastal marine primary production. This is critical to our ability to understand and sustainably manage the coastal marine ecosystem and the resultant changes in animal populations that could occur.

In most temperate and tropical, coastal, aquatic ecosystems, primary production is dominated by two different plant communities – phytoplankton in the water column and seaweeds, sea grasses and benthic (bottom dwelling) microalgae growing on the sea floor. Development of these sea floor communities is dependent on the amount of phytoplankton in the water column, as this can absorb much of the light available for photosynthesis.

In Antarctica, sea ice severely limits production in the benthic and phytoplankton communities for much of the year. Dense micro-algal mats develop on the underside of the sea ice over winter and spring, absorbing virtually all the available light and limiting both phytoplankton and benthic algal growth (there are no Antarctic sea grasses).

When the ice disappears or thins in late spring and summer, phytoplankton and benthic algal blooms occur. A reduction in sea ice through global warming could be expected to lead to an increase in benthic and phytoplankton production, providing more food for krill and fish.

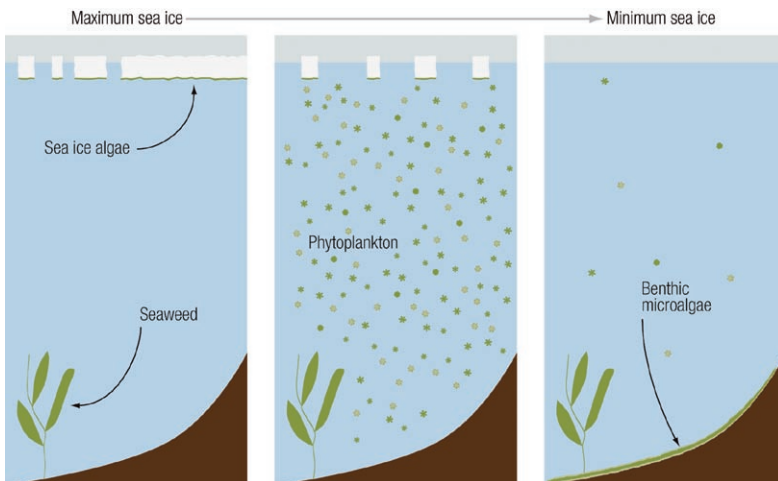
However, melting sea ice also stratifies the water column creating the necessary conditions for the development of large phytoplankton blooms. Accordingly, the absence of sea ice, or a very significant reduction in its extent, could limit the size of these important blooms. If so, we could see a cascading effect all the way up the food chain. The question then is: what is the net effect on primary production of sea ice change?

At Casey we have been measuring photosynthesis and primary production in the sea ice, the water column and on the sea floor, at sites covered by and free of sea ice. Field work commenced in the 2004–05 field season and will continue in 2005–06. *In situ*, custom designed micro-electrode and fibre-optic fluorescent probes are being used to make measurements.

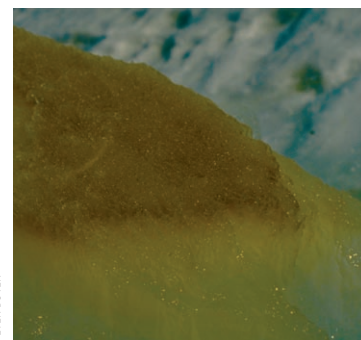
The results show that the contribution to primary production from sea ice algae in areas with less ice was lower than in areas with more ice. The net contribution from phytoplankton was approximately the same in both high ice and low ice areas but the contribution of benthic algae was considerably higher in areas with prolonged open water. It is predicted that in future years there will be an increasing proportion of annual production on the sea floor and this will favour benthic communities over 'pelagic' (open ocean) communities.

Further field seasons are planned to determine how much of the observed change has to do with inter-annual variability and how much is due to long term climate change. The work will also investigate how the changes in primary production are likely to affect other animals and plants.

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In areas of high sea ice cover, primary production (photosynthesis) is dominated by sea ice algae. As sea ice thins and declines, phytoplankton in the water column take over, followed by benthic (sea floor) plant species.



The brown layer in the sea ice is dominated by the diatom species *Entomeneis kjellmannii*.