

BLEAK FUTURE? The future of the Antarctic ecosystem hangs in the balance, as the krill supply, essential to this part of the world, is under

GETTING SCIENCE RIGHT IS CRITICAL

Antarctic ecosystem under

EVA PLAGÁNYI

ANTARCTICA - the last great wilderness. What have vacuum cleaners got to do with it?

The world's most expensive and sophisticated factory trawler, the *Saga Sea*, operated by the Norwegian multinational corporation Aker ASA, has set to sea for the first time this year. Fitted with revolutionary new technology that allows continuous pumping or "vacuuming" of krill, it is set to change the way krill fisheries operate.

Antarctic krill are truly remarkable animals living in the icy waters off Antarctica. Shrimp-like in appearance with large black eyes and a reddish shell, they can live for up to about seven years. With individual weights of not more than two grams each, it is hard to imagine how they can be effectively the sole food source of the largest animal ever to have lived on Earth - the Blue Whale. Until one considers that they live in huge swarms that can stretch for kilometres.

The lives of these tiny crustaceans are closely tied to the ice that annually forms and retreats in their environment. During the winter months they survive on algae that grow on the underside of pack ice. During the summer they feed on plankton that bloom as the ice melts and they locate their nursery areas close to the ice. But global warming is hitting Antarctica resulting in fewer months of winter sea ice, and krill populations are starting to feel the heat. From the bottom up, global warming is likely to start impacting the multitude of species that have depended on krill for millions of years.

Not everyone likes to eat krill - it has a strong taste - but it is highly nutritious and could be the answer

to feeding growing aquaculture developments. A giant among plankton, with individuals growing to the size of a man's thumb, krill is a popular and vital food source of almost all the whales, seals, penguins, icefish and albatrosses that inhabit Antarctic waters. It is literally the food that makes the world go round in this remote and unique corner of the planet.

The movie *Happy Feet* recently painted a bleak picture of starving penguins at the mercy of trawlers sweeping up their food supplies down south. Could this happen?

To answer this question, I and a team of scientists from around the world, travelled to Santa Cruz, California, and Christchurch, New Zealand, following previous meetings in Japan and Namibia. The answer, it seems, is yes. If other nations start adopting the new krill harvesting technology (currently closely guarded) and the market is there, krill fisheries could conceivably expand rapidly to record new levels.

The main concern of scientists relates to the food needs of land-breeding predators: penguins and seals breed on land, but need to find food at sea to feed and suckle their young respectively. If food around their breeding islands is depleted, the cost to these animals of having to travel long distances to find food may be too great for populations to sustain themselves.

It's thus not just a matter of how much krill the fishery takes and how much is left. It is also important to consider where the krill is caught. In some areas, fishing vessels currently operate both at the same time and in the same place as penguins and seals go fishing to feed their offspring.

Doing the maths is not as easy as



FRAGILE: Ecosystems are being affected by the loss of Antarctic fishing and global warming, says the writer.

splitting catches between the fishery and predators. Ecosystems are complex and hard to quantify. Understanding the biology is only part of the solution.

We need mathematics to answer tough questions such as: how much krill can we let fisheries harvest, and when and where should they be allowed to harvest it? What is the impact on the predators - will populations be able to recover if knocked down through having to share their food resources? Given that Antarctica is a global warming "hot spot", can the ecosystem withstand both the impacts of fishing and global warming?

Applied mathematics seeks to use mathematics as a tool to solve complex problems such as this. We build mathematical models of the population and fishery. This means we put together equations that describe the way in which popula-

tions grow and interact. This understand how the system and what the impact of different catches is.

What happens to the predators South Georgia (an island in the Southern Ocean) if a trawler sums an entire aggregation of near the island? People are predators too and it is recognised that rational use of resources is necessary, so research has to focus on how to protect the ecosystem while simultaneously ensuring that fisheries can operate in an economically efficient manner. We simulate the problems using the mathematical models constructed and come up with answers that are never certain but represent the best available science.

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Ecosystem under threat

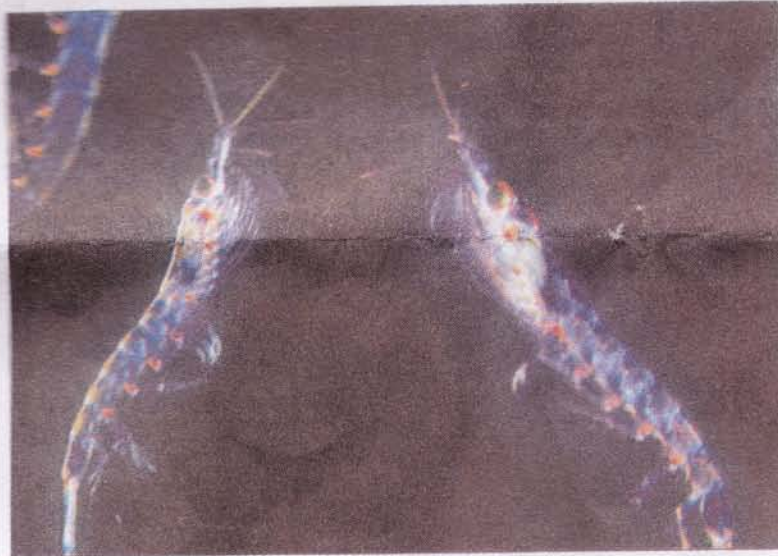
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What happens to the predators on South Georgia (an island in the Southern Ocean) if a trawler vacuums an entire aggregation of krill near the island? People are predators too and it is recognised that rational use of resources is necessary, so research has to focus also on how to protect the ecosystem while simultaneously ensuring that fisheries can operate in an economically efficient manner. We simulate these problems using the mathematical models constructed and come up with answers that are never certain, but represent the best available science.

South Africa is one of 24 voting nations to the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), part of

the Antarctic Treaty System. This body was founded in the late 1970s in response to increasing recognition that Antarctica's living organisms needed protection for the mutual benefit of the ecosystem and humans. South African scientists have played an important role in this organisation from its early days to the present.

CCAMLR was one of the first bodies to adopt a precautionary stance towards fishing, stressing that it is important to simultaneously ensure that dependent species are not adversely affected beyond a reasonable degree. All management decisions by CCAMLR are made by consensus.

The future of the Antarctic ecosystem currently hangs in the balance. Major improvements in fishing technology mean that appreciable impacts can be made on the abundance of krill, despite it being one of the most abundant organisms on earth. Increased pressure for food products from the aquaculture industry as well as increasing recognition of the dietary and medical properties of krill mean that the demand for krill is likely to be on the increase. Global warming seems set to knock krill. Skyrocketing fuel prices may help it by making fishing more expensive.

Getting the science right is critical to achieve an acceptable balance between meeting the practical and economic needs of fisheries and ensuring that enough is left to sustain the whales, seals, penguins and other species that forage in this remarkable habitat.

● *Dr Plagányi teaches in the Department of Maths and Applied Maths at the University of Cape Town and is a member of the executive committee of South African Women in Science and Engineering.*

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