EDITORIAL

Antarctic marine life under pressure

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Next week, the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) convenes in Hobart, Tasmania, to examine the state of marine life in the Southern Ocean. As part of the Antarctic Treaty System, this convention entered into force in 1982, and its focus on the region's environmental integrity has never been more important, given the increasing effects of climate change and commercial fishing. An important focus over the past 40 years has been Antarctic krill, *Euphausia superba* (hereafter krill), a keystone species that helps to hold this marine ecosystem together. Climate and fishing stresses should prompt the CCAMLR to address whether management of krill fishing is at a level that protects the Southern Ocean from losing its overall balance of marine life and the oceanic processes that regulate global climate.

The Antarctic krill is a pelagic crustacean, endemic in the Southern Ocean. It serves as a direct energy link between the ocean's primary producers (phytoplankton) and higher trophic levels such as fish, seabirds, penguins, seals, and whales. Krill comprise 300 to 500 million tonnes of biomass, the largest population of a multicellular wild animal species on Earth. Consequently, this species plays a critical role in marine biogeochemical cycles that affect climate and ocean productivity.

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Unfortunately, krill have declined in parts of the Atlantic sector of the Southern Ocean since the 1920s. This region, where nearly 70% of krill are located, is also home to the largest krill predator colonies and the largest krill fishing industry in the Southern Ocean. Since 2010, the annual krill catch in the southwest Atlantic sector has been increasing steadily. Recently, the time required to reach the krill catch limit in the Antarctic Peninsula has become shorter each year. As a result, krill fishing pressure around the South Orkney Islands has increased. In both of these subareas of the Southern Ocean, krill catches are now more concentrated in space and time than ever before.

The demand for krill will likely grow, driven by at least two industries: the increasing production of fish through aquaculture, resulting in higher demand for fishmeal, and the increasing demand for high-value pharma- and nutraceutical products from krill oil and krill meal. Fishing vessels equipped with new and efficient krill-fishing technology are supporting these demands. At the same time, other pressures challenge the krill population, including the recovery of baleen whales that rely on krill as their main food source. Also, a warming ocean around the Antarctic Peninsula could reduce krill growth and reproduction rates, which would result in a smaller krill biomass. This could in turn affect the survival of predators, including penguins, seals, and whales.

Fisheries in the southwest Atlantic are managed by the CCAMLR. The organization strives to employ an ecosystem-based approach to ensure not only the sustainability of the krill population itself, but also the absence of any long-term adverse effects on krill-dependent predators, by regulating fisheries. The real question is whether the catch limit is set and distributed at the right scale in time and space, currently and into the future. The answer requires more research to better understand krill biology and krill interaction with its predators. Also unclear is how these interactions are affected by climate change. Resolving these unknowns will be fundamental to improving management if the krill fishery is to expand sustainably while conserving the ecosystem. In this context, a krill expert group was initiated under the umbrella of the Scientific Committee on Antarctic Research (SCAR) to support providing biological information critical for CCAMLR's krill management efforts.

The most pressing questions include determining the proportion of female and juvenile krill that are captured by commercial fishing and its effect on the krill population. Research can only answer these questions if there is cooperation with the fishing industry itself. In contrast to research vessels, the new generation of krill fishing vessels operate almost year-round. A collaboration would allow regular scientific krill sampling during data-poor austral autumn and winter to fill knowledge gaps.

It is time for international efforts, from federal funding agencies to nongovernmental organizations and industry, to support this research direction. At the same time, CCAMLR must forge a new krill management strategy that focuses on a spatial and seasonal allocation of catch limits at the Antarctic Peninsula, ensuring the balance of the Southern Ocean ecosystem.

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