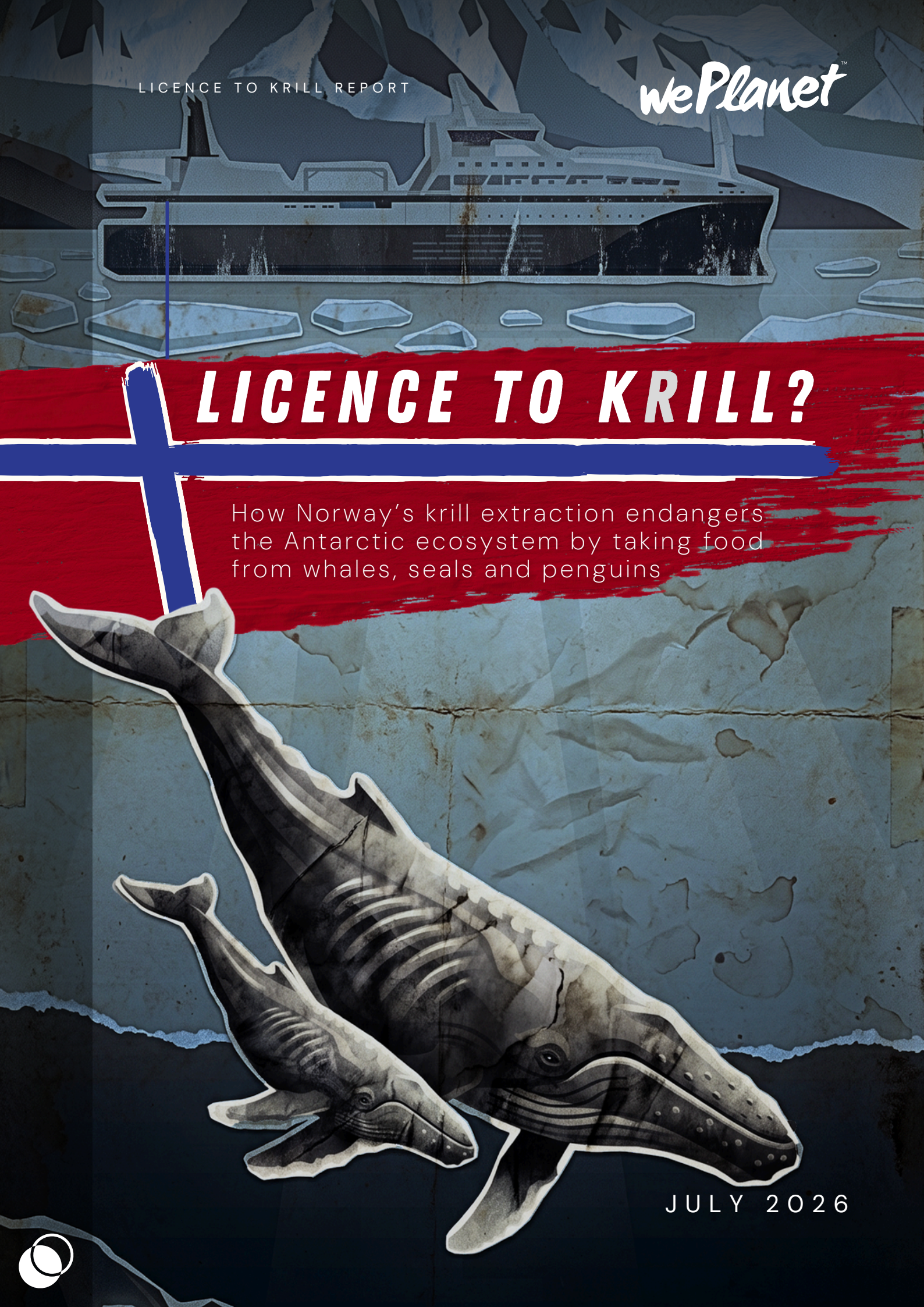
wePlanet™

LICENCE TO KRILL?

How Norway's krill extraction endangers the Antarctic ecosystem by taking food from whales, seals and penguins



JULY 2026

EXECUTIVE SUMMARY

Although it still disgracefully kills hundreds of minke whales in the Arctic, Norway no longer hunts humpback, blue and fin whales in the Antarctic - instead, it just steals their food. Antarctic krill (*Euphausia superba*) are the foundation of the Southern Ocean food web, sustaining whales, seals, penguins, and seabirds [1]. Yet industrial fleets, dominated by Norway's Aker QRILL (formerly Aker BioMarine*) extract hundreds of thousands of tonnes of krill every year — much of it for pet food, salmon feed, and 'wellness' supplements containing omega-3 oils [2]. This is food stolen from wildlife at the base of one of Earth's most fragile ecosystems [1].

This is an unnecessary industry. We don't need to harvest climate-stressed wildlife from the Southern Ocean — **ecologically benign and plant-based alternatives exist for all krill products** [3]. In the past, humans - led by Norwegian whalers - industrially slaughtered over a million whales in these seas, almost driving them to extinction [4]. Norway today likes to pride itself on its international environmental responsibility - to live up to this promise it has to end krill extraction in the Antarctic.

Mark Lynas, WePlanet Head of Policy (lead author)

THE NUMBERS IN BRIEF

• The 620,000 tonnes of krill taken in 2025 could feed over 850 whales for a season.

• The 2025 catch alone could raise up to 31 million Adélie penguin chicks - four times the global population.

• 154,000 crabeater seals could meet their annual food needs from the 2025 catch.

• One krill-oil omega-3 bottle equals the lipids an Adélie chick consumes in four days of growth.

• Each tonne of algal oil can replace ~50 tonnes of krill, preserving food for Antarctic wildlife.

See Appendices 1-3 for methodology and sources used in calculations.

NORWAY'S OUTSIZED IMPACT

Despite sustainability claims, Norway leads krill extraction globally. Its sole krill fishing company, Aker QRILL **hoovered up 63.4% of the entire catch between 2014-2024** [5]. While 2025 data is not yet available, assuming a similar share, its estimated impact means that Norway is responsible for removing:

• Removing enough krill to support over 550 whales for a full feeding season.

• Removing the potential food sufficient to raise 20 million Adélie penguin chicks.

• Taking away krill for the annual food needs for 100,000 crabeater seals.

• Norway's Aker QRILL vessels have been seen trawling through large aggregations of feeding whales [6].

* Aker BioMarine still exists as a separate company but since 2024 focuses exclusively on krill production [7]

EXECUTIVE SUMMARY

MARINE STEWARDSHIP COUNCIL GREENWASHING

The Marine Stewardship Council (MSC), set up to examine and certify 'sustainable' fisheries [8], has previously approved Aker QRILL's operations - an endorsement frequently cited in its marketing [9].

The MSC certification matters because many retailers use it to justify stocking krill products. Unbelievably, at the time of writing the MSC appears poised to recertify Aker QRILL despite strong objections from the Antarctic and Southern Ocean Coalition (ASOC), Sea Shepherd and WWF [10].

This is particularly egregious as krill catches hit a historic high in 2025, increasing pressure on the Antarctic ecosystem [11]. Meanwhile biomass krill surveys are limited and out-dated [12], and climate change is already reducing their reproductive success [13].

Worse still, earlier measures to distribute fishing pressure across areas have also collapsed due to political deadlock at CCAMLR [14]. Without spatial limits, industrial trawlers can now compete directly with wildlife for food at critical times and locations [15].

THE ALGAL ALTERNATIVE

Krill are not the only — or even the best — source of omega-3s [16]. Microalgae, the organisms krill feed on, produce high-purity EPA and DHA at industrial scale without harming ecosystems.

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WEPLANET NORWAY'S DEMANDS

1. **Close the Southern Ocean to krill fishing**
— there is no sustainable way to trawl the base of the Antarctic food web.

2. **The Marine Stewardship Council must not certify krill fishing companies**
— the MSC label means nothing if it continues to endorse ecologically destructive activities.

3. **Designate all proposed marine protected areas in the Southern Ocean**
— prioritising Domain 1 MPA.

4. **Governments must ensure a level playing field so algal-oil companies can compete in the omega-3 market**
— end public financial support that distorts the market in favour of Antarctic krill extraction.

5. **Fast-track algal Omega-3 approvals and investment**
— remove unnecessary barriers to enable innovation and faster market entry for new players.

6. **End the use of Antarctic krill in pet food and aquaculture feed**
— replace with the plant-based alternatives already available.

7. **Declare Southern Ocean as a global wildlife reserve**
— with a 2030 moratorium on all extraction in Antarctic waters.

INTRODUCTION:
THE RISE OF AN INDUSTRIAL KRILL FISHERY

Antarctic krill (*Euphausia superba*) are the small, shrimp-like crustaceans that sustain the greatest oceanic wildlife concentrations on Earth [1]. Measuring up to six centimetres long and weighing up to two grams [2], these semi-transparent creatures form vast swarms — sometimes stretching for kilometres in Antarctic waters [3] — that feed everything from Adélie penguins and crabeater seals to blue whales and albatrosses [4, 5].

Krill are the foundation of the Southern Ocean food web [1]: converting microscopic algae into the dense energy that fuels the region's spectacular biodiversity. Each summer, phytoplankton blooms beneath the retreating sea ice [6], and krill feed on this productivity [2], concentrating the ocean's nutrients into a living reservoir of protein and omega-3 lipids [7]. Virtually every higher predator in the Antarctic depends directly or indirectly on krill [8].

Yet this foundation species is now being exploited on an industrial scale by humans. A modern fleet of highly mechanised trawlers, mainly from Norway, but also from China, Korea, Chile, and Ukraine [9], targets krill in the southwest Atlantic sector of the Southern Ocean — the CCAMLR Area 48 around the Antarctic Peninsula, South Orkneys, South Sandwich Islands and South Georgia [1]. This area is where most of the region's penguin, seal, and whale populations also concentrate, creating an unavoidable overlap between fishing operations and the feeding grounds of dependent predators [1].

The Antarctic krill fishery was once a marginal pursuit, aside from a brief peak in the early 1980s driven by Soviet fleets. For many years before and after, only a handful of vessels operated, constrained by technology and limited markets [10]. But in the past 15 years, technological innovation and new commercial uses have triggered explosive growth. Purpose-built 'super-trawlers' now process krill onboard, using continuous pumping systems that vacuum up live swarms and separate them into different products [11, 12]:

- **Krill oil, rich in phospholipid omega-3s [6], marketed as human supplements for heart and brain health [13].**
- **Krill meal and liquid, used in pet food, aquaculture and livestock feed [14].**
- **Krill protein extracts, a new frontier for functional food ingredients [15].**

2025 saw the highest krill biomass removed from the Antarctic ecosystem ever. Total catches reached around 620,000 tonnes — the precautionary 'trigger level' set by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) [16]. Between 2014 and 2024, Norway — through its sole fishing company Aker QRILL — accounted for nearly two-thirds of global Antarctic krill landings [17], making it likely that it took a comparable share of the 2025 catch.

WHY KRILL MATTER

The ecological role of krill cannot be overstated. A single adult blue whale can consume up to six tonnes of krill per day [18]. Crabeater seals derive over 90% of their diet from krill [19]. For Adélie, gentoo, and chinstrap penguins, krill are the primary source of calories for chick rearing [20, 21, 22]. Even species not feeding directly on krill rely on the cascade of productivity that krill create through the food web [8].

Krill are also critical in the global carbon cycle. By feeding at the surface and defecating at depth, they transport carbon from the atmosphere to the ocean floor — a biological 'carbon pump' that helps slow climate change [4, 23]. Estimates suggest Antarctic krill collectively sequester p to 20 million tonnes of carbon dioxide each year [23].

FISHING MEETS CLIMATE CHANGE

The Antarctic Peninsula, where most krill are caught [24], is one of the fastest-warming areas on Earth [25]. Shrinking sea ice reduces both krill nursery habitat and the winter refuge that allows juveniles to survive. Scientific surveys have shown long-term declines in krill biomass in parts of the Scotia Sea [26] and concurrent shifts in penguin populations in the same region — Adélie penguins declining while gentoo penguins, which have more diets, expand southward [27]. Further research showed that combined effects of fishing pressure and climate change increase the likelihood of negative population growth in gentoo and chinstrap penguins [28].

Industrial fishing compound climate pressure [28]. Krill trawlers concentrate effort in exactly the same zones and months where wildlife feed [1]. Even though the overall catch may seem small relative to the estimated biomass, local depletion at key feeding sites could have severe biological impacts during the short Antarctic summer [7]. Scientists warn that current management does not account for fluctuations in krill populations driven by climate variability [28]. Notably, CCAMLR's 'trigger level' is not a quota but a management threshold pending finer-scale regulation (which has never been implemented).

WHO BENEFITS, WHO PAYS

The largest operator, Aker QRILL (formerly Aker BioMarine) has enjoyed indirect state support from Norway over the years, including export-credit guarantees, innovation grants, and subsidised finance through national banks [29, 30, 31]. Meanwhile, Chinese and Korean fleets benefit from direct subsidies for vessel construction and fuel [31]. In short: public money — and taxpayers in several nations — is underwriting the removal of a keystone species from one of the planet's last intact ecosystems.

WHY THIS BRIEFING

This report brings together the latest science and economics to translate the abstract tonnage of krill into ecological terms — into penguins, seals, and whales. By quantifying how many Adélie penguin chicks could be fed by the krill caught in a single fishing season, and by comparing the krill-oil supplement industry to natural food-web needs, we expose the true scale of this exploitation by Aker QRILL, and others. Our analysis is not just about numbers. It is about what they mean for the Antarctic as a living system — and for the moral and political choices that shape its future.

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KRILL-DEPENDENT SPECIES

ADÉLIE PENGUINS

Adélie penguins are the smallest of the Antarctic penguins and are found only in this region. They are the archetypal 'tuxedo' penguins, with a black face and back, and a white front. They have a highly specialised diet of mainly Antarctic krill, which they store in their bellies and regurgitate later to feed their young. Males build a nest out of stones, and males and females often stay together for multiple years. The chicks form creches to keep warm and safe. Parents take turns caring for their chick and foraging for food. They are vulnerable to the rapidly warming climate, and Adélie colonies on the western Antarctic Peninsula are already in decline [1].

CRABEATER SEALS

Crabeater seals don't actually eat crabs — instead they are highly dependent on Antarctic krill, and have specialised teeth that allow them to filter feed on krill at depth. They are ice-loving seals and tend to migrate seasonally with the pack ice around the whole of the Antarctic continent — sometimes in groups of up to 1,000 individuals. They breed on the sea ice in spring, and females give birth to a single pup — which the males also help raise [2].

ANTARCTIC BLUE WHALES

During commercial whaling, the population of 239,000 Antarctic blue whales was reduced to less than 1% [4]. Today it is recovering, but still critically endangered with an estimated 3000 individuals — barely more than 1% of pre-whaling levels [5]. Moreover, competition with humans for krill and climate change may impact this recovery [6]. Blue whales feed almost entirely on krill throughout their range. They specialise in 'lunge feeding', where they gulp large volumes of water and krill and then filter the water out through their baleen to swallow the krill [3].

Blue whale photo credit: David Stanley

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EATING ANTARCTIC WILDLIFE: QUANTIFYING THE IMPACT OF THE KRILL FISHERY*

What 620,000 tonnes means for Adélie penguins

Each year, industrial fleets remove hundreds of thousands of tonnes of Antarctic krill — the foundation of the Southern Ocean food web. In 2025, the fishery **reached 620,000 tonnes**, its highest-ever recorded catch [1].

Using published bioenergetic data for Adélie penguin chicks, **this catch volume equates to five to eight times the amount of krill required to raise every chick in the global Adélie population** to fledging.

In short: **the krill removed by humans this season could have raised the world's entire Adélie penguin chick population** many times over.

TABLE 1. HOW MANY ADÉLIE CHICKS COULD THIS SEASON'S KRILL CATCH HAVE FED?

Scenario	Krill per chick (kg)	Chicks fed to fledging	Compared with global Adélie chick population (~3.8 M)
Mixed diet (mean)	20 kg	31 million	8× more than all Adélie chicks alive in a season
100% krill diet	32 kg	19 million	5× more
Full range	6–34 kg	15–103 million	4–27× more

* Note that we are not suggesting that the human krill fishery is directly depriving these numbers of wildlife of their food — these calculations are illustrative of a complex situation, and should give cause for concern in a context where climate change and ocean acidification are already impacting krill populations.

TABLE 2. EACH KRILL-OIL BOTTLE EQUALS A PENGUIN'S MEAL

Krill lipid %	Adélie chick-days of food per 30 g bottle
0.5% (upper lipid content)	≈ 16 days
2% (mid-range, realistic)	≈ 4 days
3.6% (low-lipid case)	≈ 2 days

We calculate that every bottle of krill oil consumed as omega-3 supplements represents roughly 2–16 days of food for an Adélie chick — about four days using a central 2% lipid assumption. Promoting krill oil as "healthy" overlooks that it diverts food from a charismatic species already imperilled by climate change. In 2025, global krill-oil production is estimated at 6,000–9,000 tonnes (scaled from ASOC 2021, accounting for market growth) [2], **enough to have supported roughly 23 million Adélie chicks — about six times the current population** — through to fledging if left in the ecosystem.

Every tonne of krill oil requires 28-200 tonnes of krill at the lipid % ratios above (Table 2). For a mid-range 2%, 50 tonnes of krill is required per tonne of oil.

WHAT 620,000 TONNES MEANS FOR BLUE WHALES

The migration patterns and behaviour of Antarctic blue whales (*Balaenoptera musculus intermedia*) is not fully understood. They are generally believed to feed primarily in the high-latitude Southern Ocean during the Austral summer — focusing almost exclusively on krill [3].

Assuming a 4-month feeding season (120 days) and a daily intake of 6 tonnes of krill per whale, this implies that **the 620k tonnes of krill removed by humans in 2025 could have fed over 850 whales for an entire season** around a sixth of the current population.

Note that we are not suggesting that the human krill fishery is directly depriving animals of food and leaving them hungry – these calculations are illustrative. However, because krill are unevenly distributed and fisheries target the same high-density areas favoured by baleen whales, this spatial overlap may already be affecting whale feeding. [4].

WHAT 620,000 TONNES MEANS FOR CRABEATERS

Crabeater seals feed almost exclusively on krill – and concentrate their feeding in hot-spots, which are often the same ones targeted by the krill fishing industry, at the edge of Antarctica's rapidly-diminishing sea ice. We calculate, based on surveys of crabeater seal feeding, that the 620k 2025 catch **could have supported 154,000 crabeater seals for a whole year**.

See the Appendices for the full calculations and citations underlying the above numbers.

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NORWAY'S AKER QRILL — A STATE-SUPPORTED KRILL EMPIRE

Aker QRILL, headquartered in Oslo, is the world's dominant krill-fishing company — controlling around 63.4% of global Antarctic krill catch [1]. The company's expansion and profitability have been underwritten by Norwegian state institutions, which provide financial and political support that few competitors enjoy.

• Norwegian taxpayers effectively underwrite the world's largest Antarctic krill operation, contradicting Norway's stated climate- and ocean-leadership commitments [2].

• Public financing shields Aker QRILL from commercial risk, enabling fleet expansion and market dominance even amid environmental controversy [2].

• This pattern contrasts sharply with other nations: while China and Korea offer direct fuel and vessel subsidies, Norway provides indirect financial and innovation subsidies — equally powerful but less transparent [2, 3].

'Aker BioMarine [sic], Norway's sole Southern Ocean fishing company, has received millions of dollars in subsidies from several government agencies and banking institutions in the form of tax breaks, discounted loans, research and development grants, and infrastructure support. This has facilitated their ability to dominate the krill catch in the Southern Ocean.'
(Chavez-Molina et al. 2025) [4].

Aker QRILL's success is not so much the product of private sector entrepreneurship but of state-enabled extraction. Norway's government has the power — and the responsibility — to redirect this support toward protection, not exploitation, of the Southern Ocean.

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THE SUSTAINABLE ALTERNATIVE: ALGAL OMEGA-3S

Omega-3 fatty acids — especially EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid) — are important for human health, supporting brain, immune, and heart functions [1]. Krill oil supplements are marketed as a 'superior' source of these fats because they contain them in phospholipid form, which may improve absorption under some conditions. However, krill themselves get their omega-3s from algae of course, and human studies show equivalent bio-availability of omega-3s from algal sources [2].

Cultivating microalgae directly bypasses the entire food chain, producing the same nutrients without harming Antarctic ecosystems [1]. Modern fermentation and photobioreactor technologies can produce high-purity algal oils with more options becoming available all the time [3] — at industrial scale and with a mucho lower environmental footprint [4]. All we need now is to increase consumer demand by boycotting fish and krill oil and ensuring the algal alternatives can truly scale.

THERE'S A BETTER WAY TO GET OMEGA-3

• Algal oil delivers the same EPA and DHA as krill — because krill get theirs from algae [1].

• Algal-oil widely available in supplements and fortified foods. It is GRAS approved in the US, and authorised under EFSA in the EU [5, 6].

• Many brands now produce microalgal omega-3s at commercial scale, serving both supplement and aquafeed markets at comparable prices to krill oil.

• Every tonne of algal oil produced can replace the need to harvest roughly 50 tonnes of krill, preserving food for penguins, whales, and seals.

• Transitioning the omega-3 market to algae could end direct exploitation of krill while maintaining human health benefits — a true win-win for climate and biodiversity.

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LATEST NEWS FROM CCAMLR-44

The annual meeting of the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) took place at the end of October 2025 in Hobart, Tasmania, and for many, exemplified an era of inertia in marine conservation in the region.

The meeting failed to make progress on the two most contentious issues: krill fishing restrictions and the establishment of marine protected areas. China and Russia were reported to be responsible for vetoing a proposal for new marine protected areas [1]. This included the Antarctic Peninsula marine protected area (Domain 1), despite years of attempts by the proposal's proponents, Argentina and Chile, to accommodate their concerns. It was also reported Norway attempted to increase the krill catch limit to nearly 1.2 million tonnes per year, from the current 620,000 tonnes [2].

Without a say in the decision-making process are non-CCAMLR states, which are linked to the Southern Ocean by whale populations that migrate from their waters to Antarctica. This includes countries in Latin America, Africa, and the Pacific Islands, where whales have important cultural and economic significance. These countries are reliant on CCAMLR states to protect the krill populations in Antarctica and to act in the interests of conservation.

The lack of progress at this year's CCAMLR meeting demonstrates the mounting commercial interest from some countries to exploit the region further and expand the krill fishing industry, without adequate conservation measures. This undermines the Convention's ability to implement its founding conservation mandate: to protect Antarctic wildlife.

Sarah Locke, Blue Marine Foundation

[1] de Augustinis, F. (2025). Antarctic conservation summit closes with stalemate on MPAs & krill fishing rules. Mongabay.
[2] de Augustinis, F. (2025). Norway's proposal to double krill harvests raises tension at Antarctic conservation summit. Mongabay.

WEPLANET'S DEMANDS

Antarctic krill are the foundation of the Southern Ocean — and the heart of one of Earth's most extraordinary ecosystems. They feed whales, seals, penguins, and countless other species. Yet every year, industrial fleets extract hundreds of thousands of tonnes of krill from these icy waters to turn into pet food, fish feed, and dietary supplements — sustainable alternatives are available on the market for all these uses. This extraction — driven by a handful of companies led by Norway's Aker QRILL — is both ecologically reckless and morally indefensible. It is publicly subsidised, falsely marketed as sustainable, and completely unnecessary. WePlanet calls for an immediate global end to krill fishing, and a transition toward safe, scalable, and truly sustainable algal omega-3 alternatives.

1 **Close the Southern Ocean to krill fishing.**

• The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) must immediately suspend all krill fishing at the next annual meeting.

• All existing krill fishing licences in the Southern Ocean are revoked by CCAMLR.

2 **The Marine Stewardship Council should not certify krill fishing companies.**

• The Marine Stewardship Council (MSC) must refuse to recertify Aker QRILL, and immediately suspend certification of all other Antarctic krill fishing companies.

• Retailers and supplement brands must remove 'sustainable seafood' claims from krill oil marketing.

• The MSC revise its criteria to include ecosystem competition, spatial concentration, and climate vulnerability before evaluating fisheries. A label that certifies the destruction of whales' food as 'sustainable' has lost all meaning. WePlanet calls this what it is: greenwashing on ice.

3 **CCAMLR must designate all proposed marine protected areas (MPAs) in the Southern Ocean.**

• All proposed MPAs in the Southern Ocean must be established, prioritising the Domain 1 proposal covering the Antarctic Peninsula, Western Antarctic Peninsula and the South Scotia Arc, in recognition of its particular climate sensitivity and the area with the highest rate of tourism.

4 **Governments must ensure a level playing field so algal-oil companies can compete in the omega-3 market.**

• Norway and all other nations must end public financial support that distorts the market in favour of Antarctic krill extraction, ending subsidies, export credits, state-backed loans, and publicly funded R&D that artificially lower costs and weaken fair competition.

• These funds should be redirected toward scaling microalgae cultivation and omega-3 biotechnologies, strengthening the competitiveness of sustainable alternatives that can deliver the same nutrients without ecosystem damage.

• Governments should establish or expand dedicated Ocean Innovation Funds to accelerate market readiness and cost competitiveness for regenerative blue industries. Stop funding ocean depletion — start funding ocean innovation.

• Public investment banks, innovation agencies, and pension funds should prioritise algae-based omega-3 production across ocean, food, and climate portfolios, helping build scale and drive down costs.

5 **Fast-track algal Omega-3 approvals and investment.**

• Regulatory approvals should be fast-tracked for proven algal strains, fermentation systems, and production methods to remove unnecessary barriers and enable faster market entry for new players and innovation.

• Strategic public procurement should be used to create predictable demand and support early-stage market competitiveness for algae-based omega-3s in health, nutrition, and institutional settings.

6 **End the use of Antarctic krill in pet food and aquaculture feed.**

• All use of krill in pet food should be phased out. Domestic animals do not need Antarctic wildlife in their diet.

• Aquaculture producers should phase out krill meal and krill oil feed additives by 2027, replacing them with plant-based omega-3s included in plant- or microbial-sourced protein feeds.

• Retailers and feed suppliers must commit to transparent labelling of marine ingredients and adopt 'No Antarctic Krill' sourcing policies.

• Governments and regulators must require that all fish-feed sustainability standards exclude krill ingredients by default.

7 **Declare the Southern Ocean as a global wildlife reserve.**

• The Antarctic Ocean be recognised as a climate-critical ecosystem under international law.

• Nations commit to a 2030 moratorium on all extraction in Antarctic waters under CCAMLR. The health of the Antarctic defines the health of our planet.

WEPLANET'S VISION

WePlanet believes the ocean should be recognised and treated as what it is: the foundation of the system that sustains life on Earth, not the frontier for resource extraction. Krill belong to whales, seals, and penguins — not to profit margins. By ending krill fishing and investing in algae, we can feed the world sustainably while protecting one of Earth's last wild frontiers.

APPENDIX 1. METHODOLOGY

This report translates reported Antarctic krill catch volumes into energetic equivalents for selected krill-dependent species in order to contextualise the ecological scale of industrial extraction. We use the 2025 reported catch of 620,000 tonnes from CCAMLR Area 48 as the baseline biomass removed from the ecosystem. All calculations convert this tonnage into kilograms and apply published bioenergetic intake estimates for Adélie penguins, Antarctic blue whales and crabeater seals. The aim is illustrative: to express krill removal in biologically meaningful terms rather than abstract tonnage.
For Adélie penguins, we use published estimates of mean daily chick consumption (376 g day^{-1}) and a 52-day chick-rearing period, yielding approximately 20 kg of krill required per chick to fledging (with a reported range of 6–34 kg depending on diet composition). Dividing total annual catch biomass by krill requirements per chick gives the number of chicks that could theoretically be raised to fledging on an equivalent mass of krill. Global Adélie breeding population estimates are used for comparison in order to express results as multiples of annual chick production.

For krill oil equivalence calculations, we use published wet-mass lipid fractions of Antarctic krill (0.5–3.6%, with 2% as a central assumption). The quantity of krill required to produce one tonne of oil is calculated as the inverse of the lipid fraction. Chick-day equivalents per 30 g supplement bottle are derived by converting oil mass to required krill biomass and dividing by daily chick consumption. These calculations are simple mass-balance conversions and do not assume additional processing losses beyond lipid fraction.
For Antarctic blue whales and crabeater seals, we apply published mean daily krill intake estimates and assume representative feeding durations (120 days for seasonal whale feeding; 365 days for seals). Total krill required per animal per feeding period is calculated by multiplying daily intake by feeding duration. Dividing total 2025 catch biomass by seasonal or annual per-animal requirements yields the number of whale-seasons or seal-years that correspond energetically to the reported catch.

These calculations are deterministic energetic comparisons and do not model ecological dynamics. They do not assume that the krill fishery directly deprives specific numbers of animals of food, nor do they account for spatial distribution, interannual biomass variability, predator competition, or climate-driven ecosystem change. Rather, they provide mass-equivalent benchmarks to illustrate the ecological scale of extraction relative to the energetic needs of dependent wildlife. Full parameter values and sources are provided in Appendices 2 and 3.

APPENDIX 2. CALCULATION PARAMETERS FOR ADÉLIE PENGUINS

Parameter	Value / Formula	Source
Daily krill intake per chick	376 g day^{-1} (mean); 114–651 g range	Southwell et al. 2015 [1]
Duration of chick feeding	52 days	Southwell et al. 2015
Krill per chick to fledging	376 × 52 = 19.6 kg (mean)	Derived; Southwell et al. 2015 use 20kg (6-34kg range) total
Global Adélie breeding pairs	3.79 million pairs (~7.6 M adults)	Lynch & LaRue 2014 [2]
Average chicks per pair	~1	Multiple field studies
Annual krill catch	620 000 t (= 6.2 × 10^8 kg)	AP 2025 [3]
Chicks = Catch ÷ krill/chick	6.2 × 10^8 ÷ 20 = 31 M; ÷ 32 = 19 M	Derived
Lipid fraction of krill	0.5–3.6% wet mass	Xie et al. 2019 [4]
Bottle content	30 g oil (60 × 500 mg softgels)	Market norm
Chick-days/bottle	30 ÷ (376 × lipid fraction)	Derived
Example (2 %)	30 ÷ 7.52 = 4 days food	Derived
Krill required for oil/t	1 tonne of oil/lipid fraction = 50 t at 2%	Derived

[1] Southwell, D., Emmerson, L., Forcada, J., Southwell, C. (2015). A bioenergetics model for estimating prey consumption by an Adélie penguin population in East Antarctica. Marine Ecology Progress Series 526: 183–197.
[2] Lynch, H. J., LaRue, M. A. (2014). First global census of the Adélie Penguin. The Auk 131(4): 457–466.
[3] Goodman, J., 2005. Krill fishery in Antarctica shut down after record catch triggers unprecedented early closure. The Associated Press.
[4] Xie, D., He, F., Wang, X., Wang, X., Jin, Q., & Jin, J. (2021). Diverse Krill Lipid Fractions Differentially Reduce LPS-Induced Inflammatory Markers in RAW264.7 Macrophages In Vitro. Foods 10(11): 2887–2887.

APPENDIX 3. CALCULATION PARAMETERS FOR BLUE WHALES AND SEALS

Parameter	Value / Formula	Source
Blue whale daily krill intake	6 t day^{-1}	Savoca, pers comm.
Blue whale feeding duration	120 days	Est. seasonal average
Number of blue whale feeding days from krill catch	620,000 t / 6 t = 103,330	Derived
Krill per blue whale per season	6 × 120 = 720 t	Derived
Blue whale seasonal feedings removed by 2025 krill catch	620,000 t /720 t = 861	Derived
Crabeater seal daily krill intake	10.5-12 kg (males-females, mean 11 kg)	Forcada et al. 2012 [6]
Seal feeding duration	365 days	
Seals fed by krill catch for one year	620,000/ (11x365) = 154,000 seals	Derived

[5] Savoca, M. S., Czapanskiy, M. F., Kahane-Rapport, S. R., Gough, W. T., Fahlbusch, J. A., Bierlich, K. C., Segre, P. S., Di Clemente, J., Penry, G. S., Wiley, D. N., Calambokidis, J., Nowacek, D. P., Johnston, D. W., Pyenson, N. D., Friedlaender, A. S., Hazen, E. L., Goldbogen, J. A. (2021). Baleen whale prey consumption based on high-resolution foraging measurements. Nature 599(7883): 85-90.
[6] Forcada, J., Trathan, P. N., Boveng, P. L., Boyd, I. L., Burns, J. M., Costa, D. P., Fedak, M., Rogers, T. L., Southwell, C. J. (2012). Responses of Antarctic pack-ice seals to environmental change and increasing krill fishing. Biological Conservation 149(1): 40-50.