

IT'S A FISH-EAT-FISH WORLD. SCIENTISTS WANT TO CHANGE THAT.

Farm-raised fish and shrimp eat other wild fish, which is leading to overfishing and damage to marine ecosystems. Insect- and bacteria-based alternatives just might turn the tide.

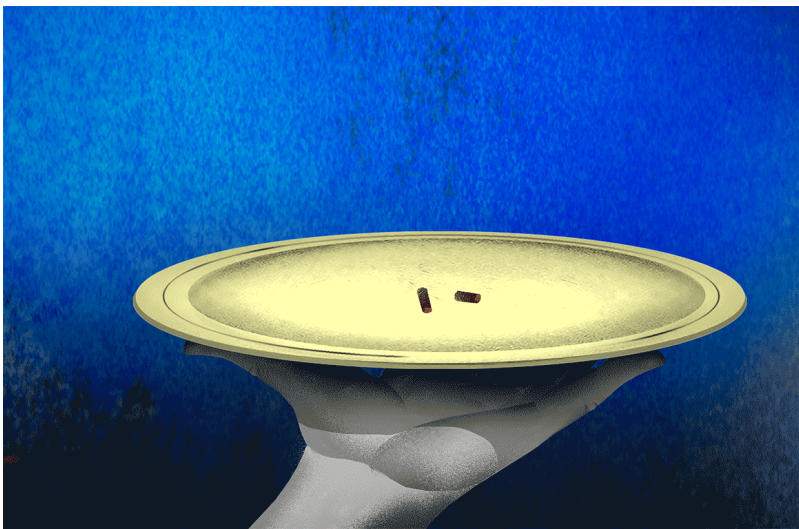


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For the first time in history, humans are poised to harvest more fish and seafood from farms than they catch in the wild.

This milestone, expected within two years, would help keep the oceans from being overfished except for one issue: Those farmed fish eat wild fish.

Around 12% of the world's wild whole-fish catch goes to feed fish and aquatic creatures like shrimp raised on farms, according to The Marine Ingredients Organization, a trade group for the international fish feed industry. Captive salmon and shrimp are fed fishmeal composed of smaller

fish like sardines and anchovies, which themselves are being overfished in some parts of the world, damaging marine ecosystems and reducing an important food source for locals.

As aquaculture has expanded over the past few decades, scientists have tried to replace fishmeal with plant-based feeds, including soy. But these efforts have had only limited success for carnivorous fish like salmon, which rely on protein-dense fishmeal to reach market weight quickly. Salmon and other species also rely on fish oil—a crucial feed ingredient derived from wild-caught fish—to absorb the omega-3 fatty acids that consumers want. The result is a fish-feed bottleneck that could slow the expansion of global aquaculture.

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To solve the problem, teams of scientists and entrepreneurs are developing fish-free fish food from bacteria and insects, along with replacements to fish oil derived from algae and genetically modified canola. They are attracting funding from major investors like BP PLC and Temasek, Singapore's national investment vehicle.

“If we take any more fish out of the ocean—what we call wild-caught—then literally the ecosystem could collapse,” said Alan Shaw, the chief executive of Calysta, a Menlo Park, Calif.-based startup that is among the first companies to use bacteria to convert natural gas into protein that can be used as an alternative fish feed. Calysta operates a factory in northeast England where its bacteria feed on methane producing single-cell proteins that are dried and packaged into pellets it calls FeedKind.

The company announced a \$30 million investment from BP in June, which gave the British energy giant the right of first refusal to supply natural gas to Calysta's future factories. It already had a partnership with Thai Union, an Asian seafood giant, which says trial shrimp grown on Calysta's bacterial protein taste the same as those fed traditional diets that include fish.

FeedKind is one of many alternative proteins soon to hit the feed market. Skretting, one of the world's largest fish and shrimp food producers, began including insect meal from black soldier fly larvae in the feed it delivered to salmon farms in Norway last year. Cargill, the U.S. agriculture giant, has developed a GMO-enhanced canola crop with omega-3 fatty acids that it is planting in Montana, which it says could begin replacing fish oils required to feed salmon by next year.



Many of these approaches will struggle with scale—whether it's generating tons of black soldier fly larvae or harvesting protein derived from natural gas. There are issues about cost of production, “especially with methane, which is explosive,” said Sunil Kadri, a salmon behaviorist.

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But companies are ramping up. Calysta says it will be able to scale up rapidly with prices for natural gas so low. Skretting says it hopes to secure 100,000 tons of novel feed ingredients, including insect meal, annually by 2022. One of its suppliers, a French start-up called Innovafeed, breeds black soldier fly larvae at an industrial site in northern France, feeding batches of larvae with agricultural industrial waste before harvesting and processing it into insect meal and insect oil. “In nature the role of insects is to accelerate the conversion of waste, to extract nutrients from waste to feed fish” and other creatures, said Clement Ray, Innovafeed's co-founder. “That's what we try to replicate.”

Another strategy is to reduce how much food farmed salmon need to eat. The AquAdvantage salmon is a genetically modified fish that reaches market weight quickly, so it requires 25% less feed than the typical farmed salmon, according to AquaBounty, the company that farms them, reducing the reliance on fishmeal. It has its origins in university experiments in 1989, when researchers injected genetic material composed of a Chinook salmon growth hormone gene and a DNA fragment from an ocean pout, an eel-shaped fish, into fertilized Atlantic salmon eggs.

The U.S Food and Drug Administration approved the first imports of the AquAdvantage Salmon into the U.S. in March. A batch of AquAdvantage salmon are now being raised in Indiana, with the first harvest expected for next year.

If efforts like these become successful at scale, it could relieve pressure on ocean sardine fisheries. Kerala state, a coastal area in southwest India, is famous for its sardine curries. But Kerala's oil sardine catch declined by around 80% from 2012 to 2015 and remains depleted, due in

part to overfishing linked to the rapid rise of the local fishmeal industry, according to Kolliyil Sunil Mohamed, principal scientist at the Central Marine Fisheries Research Institute, an autonomous research institute under India's Ministry of Agriculture.

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India's fishmeal exports increased nearly 10 times in the span of a single year leading up to the collapse, according to statistics posted on the website of the Indian Fishmeal and Fish Oil Exporters' Association.

"The demand was there, so the fishermen were catching even very small sardines and they were all taken by the fishmeal factories," said Mr. Mohamed. For local consumers, the price of the oil sardine, once considered a "poor man's fish," has quadrupled since the sardine collapse, Mr. Mohamed said.

Mahesh Raj Malpe, the fishmeal export association's chief executive, denies that the fishmeal industry played a significant role in the sardine population's drop, saying it was mainly due to El Nino climatic factors. He predicted that the sardine population, which has experienced boom and bust cycles in the past, would recover shortly.

Problems like these have convinced investors that sustainable fish feed is a growth industry. Tesco, a leading U.K. grocer, announced in August that it is updating its farmed salmon standards to reduce the amount of wild fish fed to them. It is exploring replacing the omega-3 rich fish oils that are a key ingredient in fish diets with a new strain that is derived from algae.

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Representatives of Skretting, the Norwegian company whose feed supplies a third of the world's farmed salmon, says its ambition is to use ingredients that humans don't consume directly. In 2017, the company achieved a breakthrough by growing healthy salmon without using any fishmeal or fish oil, instead relying on vegetable proteins and algal oils, though it's been challenging to do this at scale. Fish food ingredients composed of insects are currently more than twice as expensive as fishmeal, said Sophie Noonan, a Skretting communications manager.

But the new wave of fish-food startups insist that now is the time. Calysta, the company that uses bacteria to convert methane into protein pellets, purchased the technology five years ago from Equinor, the Norwegian energy giant formerly known as Statoil. The technology had been developed in the 1990s, but high natural gas prices at the start of the millennium made converting natural gas into fish food seem like a bad bargain. That changed with the shale oil and gas boom in the U.S. Dominic Emery, vice president of group strategic planning at BP, said his company's investment in Calysta gave BP an additional sales stream and a chance to "turn our gas into a higher value product."

Corrections & Amplifications

Sophie Noonan is a communications manager at Skretting. An earlier version of this article incorrectly spelled her last name. (09/12/2019)

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