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Aquafeeds

Study re-evaluates the wild fish required for global aquaculture feed

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Research concludes that considerations for aquaculture inputs should be widened

A recent study argues that aquaculture's impact on wild fish is greater than commonly cited, requiring a broader and ecologically oriented approach to calculate the fish biomass used in aquafeeds. Photo of Peruvian anchoveta (*Engraulis ringens*) by ignacio_diaz05 (CC BY 4.0 https://creativecommons.org/licenses/by/4.0, via Wikimedia Commons).

A recent study offers additional insight into the argument that fed aquaculture is sustainable because wild fish use is low and has improved over time.

Including trimmings and byproducts from wild fish in aquafeeds and using four different sources of industry-reported feed composition data, research recently published in *Science Advances* shows ratios of fish inputs to farmed outputs of 0.36 to 1.15, or 27 to 307 percent higher than a previous estimate of 0.28. These estimates challenge the sustainability of fed aquaculture and its role in food security.

The **study** (https://doi.org/10.1126/sciadv.adn9698) – authored by Spencer Roberts and Jennifer Jacquet (University of Miami, Miami, Florida USA), Patricia Majluf (Science and Strategy Team, Oceana, Washington, DC, USA) and Matthew N. Hayek (New York University, New York, NY USA) – aims to account for previous omissions and trade-offs to provide a more comprehensive environmental evaluation of the feed requirements for global aquaculture. These methods can be used to inform future research for more comprehensive life cycle assessments.

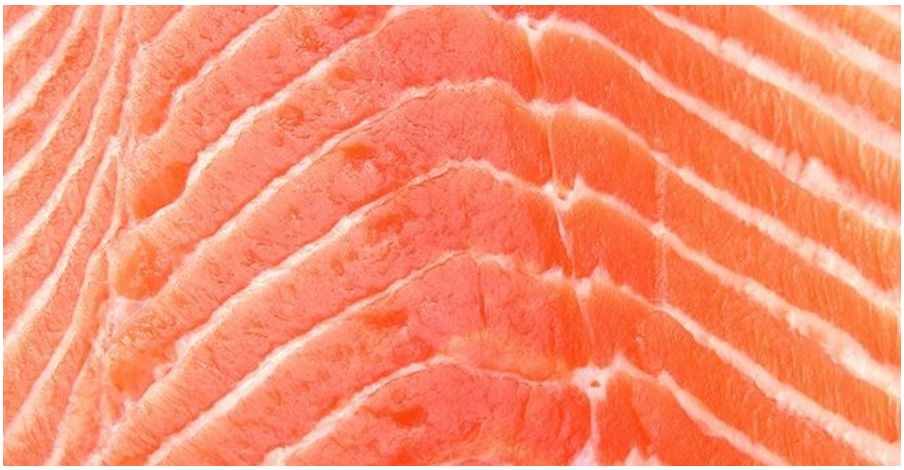
"Fish farming is growing at a fast rate and is attracting interest from investors and governments as a potentially efficient form of protein production. However, its feed sources still come from a combination of farming crops on land and catching fish from the oceans," Dr. Hayek, assistant professor at the Department of Environmental Studies at New York University and corresponding author of the study, told the *Advocate*.

Reduction fisheries, or industrial seine fleets targeting small pelagic fish such as anchoveta, whiting, and sardines, account for an estimated average of **one-sixth of the mass of the global marine catch** (https://dx.doi.org/10.14288/1.0354481)and can comprise nearly one-third in some years. Approximately 70 percent of this biomass is **processed into aquaculture feed** (https://doi.org/10.3390/microorganisms11020439), with the remaining 30 percent being used for other animal feed, supplements and cosmetics.

The fish-in:fish-out (FI:FO) metric was developed to quantify the reliance of aquaculture on captured fish. FI:FO reconstructs a "live weight equivalent" from reported feed use, which approximates the biomass of wild fish consumed, then divides it by farmed output to estimate the **ratio** (https://doi.org/10.1016/j.aquaculture.2008.08.015) of fished biomass inputs to farmed fish biomass outputs for a given farm, farmed species group, or the aquaculture sector as a whole. FI:FO quantities should therefore reflect integrated average wild fish utilization across all stages of the farmed fishes' life cycles.

However, translating processed feed inputs into a live weight equivalent of wild fish requires making approximations for proportions of wild fish incorporated in aquaculture feeds and assumptions regarding how they are reduced and processed. **Naylor et al.** (https://doi.org/10.1038/s41586-021-03308-6)compiled a comprehensive estimation of these feed reduction parameters, concluding that aquaculture feed, on aggregate, consisted of approximately 7 percent wild fish in 2017.

Yet the proprietary status of feed manufacturing requires taking these data from voluntary industry disclosures, which are difficult to validate. In this study, authors compiled additional feed composition datasets obtained using survey, projection, or metastudy for similar time frames from other sources, including the U.N.'s **Food and Agriculture Organization (https://www.fao.org/4/ba0002e/ba0002e.pdf)**, Monterey Bay Aquarium's **Seafood Watch** (https://seafoodwatch.org/globalassets/sfw-data-blocks/reports/T/MBA_SeafoodWatch_TilapiaChinaReport.pdf)program, and **Pahlow et al.** (https://doi.org/10.1016/j.scitotenv.2015.07.124) A wider range of source-independent estimates may help gauge uncertainty, as well as risk.



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"Past research has looked into the marine feed requirements for aquaculture at a large scale, but when we noticed how sparse some of the reporting was, we asked ourselves if there was any more information out there," Dr. Hayek said. "We discovered three additional independent sources with feed ingredients and processing data. All three of these new sources showed higher wild-caught fish use than the original study. When we analyzed all four sources together, the whole range confirmed that fish farms likely use much more wild-caught fish in their feed than the earlier research had suggested. This is particularly concerning for carnivorous fish like sea bass and salmon, which require more wild-caught fish as feed than we get in return from farming them."

Considering marine and terrestrial inputs combined, these findings reiterate that fish and crustacean farming does not, on net, produce calories or protein. Retention of dietary nutrients in feed is less studied and more variable, but also a net loss. While some analyses have examined nutrient retention in a FI:FO framework, nutrient availability in terrestrial feed inputs must also be considered to make congruent comparisons with other food sectors. Future efforts should analyze the net micronutrient benefits and losses across various aquaculture species groups globally. Although aquaculture can provide concentrated sources of **deficient nutrients** (https://doi.org/10.1016/j.energy.2022.123723) in some contexts, it can diminish nutritional quality in others, and reduction fisheries remain a notable **driver of malnutrition** (https://doi.org/10.1038/s41586-019-1592-6).

While FI:FO is informative in some contexts, it compares a small fraction of inputs to total outputs and **omits the impacts of shifting to terrestrial feeds** (https://aquafeed.com/newsroom/news/low-cost-aquafeed-reduces-operational-costs-in-fish-farms/). The methods provided in this study do not equate

to a full life cycle assessment (LCA) but provide a more accurate quantification of fish extraction and crop cultivation impacts, which is a prerequisite to more accurate LCAs in future research.

“The expanded view of feeding global aquaculture offered here suggests that common sustainability accounting methods have been too narrow, overconfident in their precision, and overly optimistic,” concluded the study authors. “Both marine and terrestrial impacts are still highly uncertain, but these revised estimates suggest that the environmental impacts of this sector, in its current form and structure, are sufficiently large that directives to expand this sector on sustainability grounds should be reconsidered.”

Read the full study. (https://doi.org/10.1126/sciadv.adn9698)

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