

Subsistence fishing methylmercury is a global vulnerable-population pattern that regulatory fish-consumption advice does not address

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CORRESPONDENCE

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Abstract

Three independent A-tier studies from the past eighteen months document the same finding from three different methodological vantage points: the methylmercury exposure profile that underlies regulatory fish-consumption advice (FDA-EPA, EFSA, national-level equivalents) is calibrated against typical Western market consumer patterns, while a substantial and identifiable global subpopulation, the consumers of subsistence-fished and locally-caught freshwater and pelagic fish, faces methylmercury exposures that routinely exceed the thresholds the regulatory advice is built against. The pattern is geographically diverse, holds across both marine and freshwater systems, and is being amplified by climate change. The scientific implication is straightforward: an exposure profile calibrated to median-consumer dietary methylmercury intake does not describe the consumers most at risk, because subsistence-fishing populations face exposures the median-consumer calibration does not capture.

1 | Overview

The pattern is not subtle and it is not new in regional documentation. The synthesis here is that three independently-conducted studies in different geographies and methods converge on the same quantitative claim about scale and population, which is the synthesis-page bar this finding now meets. The wiki should treat the finding as established for the populations the three studies document and provisional for jurisdictions where parallel quantitative work has not yet been done.

2 | The global scale (Li 2024)

Li et al. 2024 (PNAS) is the largest global-scale dataset to date on methylmercury extracted from the ocean by fisheries. The study combined high-resolution global fisheries catch data for 1,774 species with an empirically constrained spatial model of seafood methylmercury concentrations validated against a 1,482-measurement yellowfin tuna dataset (R squared 0.80). The central estimate of methylmercury extracted from the ocean annually is 6.1 megagrams (interquartile range 4.2 to 9.5 Mg), about 0.05 percent of the upper 1,000-meter seawater methylmercury reservoir.

The load-bearing numbers for this synthesis are not the global total but the disparity in catch-weighted concentrations: catch-weighted methylmercury concentrations vary over two orders of magnitude (range 0.004 to 1.7 µg per gram wet weight; geometric mean 0.13 µg/g wet weight), with the highest concentrations in tropical and subtropical regions where large pelagic species are harvested. Tropical and subtropical fisheries account for over 70 percent of methylmercury extracted from the ocean. Subpolar and polar exclusive economic zones are the only coastal regions where catch-weighted omega-3 to methylmercury de minimus ratios are met under the US EPA Reference Dose of 0.1 µg/kg body weight per day; in most global fisheries, the omega-3 content of the catch is insufficient to nutritionally offset the methylmercury risk by the EPA's own framing.

The study's most consequential numerical claim for this synthesis is that 84 to 99 percent of subsistence fishing entities globally are likely to exceed methylmercury exposure thresholds based on typical subsistence consumption rates. This is a global modeling estimate, not a population-cohort measurement, and it should be cited with that caveat. But the directional claim, that subsistence fishing populations as a class face exposures the regulatory framework does not accommodate, is robust to the modeling assumptions in the paper.

3 | The freshwater wild fish trajectory (Wu 2025)

Wu et al. 2025 (PNAS) is the parallel finding from a single national dataset. Approximately 13,000 fish mercury samples across 164 sampling sites in China spanning 2005 to 2020 establish a present-day baseline: freshwater wild fish carry methylmercury concentrations 2.9 to 6.2 times higher than freshwater farmed fish across trophic classes, and 1.7 times higher than marine wild fish in the same trophic class. The mean methylmercury concentration in freshwater wild fish of typical adult size (40 plus or minus 5 cm body length) is 30.9 µg/kg wet weight, comparable to US shrimp at 30-40 µg/kg wet weight, a quantity Western consumers and US regulators routinely treat as a meaningful methylmercury exposure source.

The population-share finding from this dataset is that freshwater fish consumption accounted for 51 percent of China's total fish methylmercury intake in 2011, the most recent national consumption-survey year used in the analysis. Subsistence fishing populations within China carry a disproportionate share of this exposure because their dietary share of freshwater wild fish exceeds the national average. The projection finding, discussed in detail at the climate × metals synthesis page, compounds the picture: national average methylmercury concentrations in freshwater wild fish in China are projected to rise by approximately 60 percent by 2031-2060 under SSP2-4.5 and SSP5-8.5, primarily driven by enhanced photochemical methylation under increased solar radiation. The population already most exposed faces the largest projected increase.

4 | The local mining-impacted basin (Auzier-Guimarães 2025)

Auzier-Guimarães et al. 2025 (ACS Environmental Au) is the third anchor: a PRISMA-protocol systematic review of 36 studies published between 1992 and 2022 covering 143 fish species (14,113 individuals, 735 mean Hg values) from the Tapajós River Basin in the Brazilian Amazon. The basin is heavily impacted by artisanal small-scale gold mining (ASGM), which is the proximate driver of mercury contamination across multiple Amazonian sub-basins. Mercury concentrations in fish muscle tissue range from 0.01 to 3.82 mg/kg across

all trophic levels, with piscivorous species at the high end and clear spatial clustering in mining-impacted sub-basins.

The exposure framing in this paper is the most explicit of the three. Using the Target Hazard Quotient at the local average consumption of 116.25 grams per capita per day for the basin's riverside population, 89 percent of the 129 evaluated food-fish species show THQ greater than 1 in at least one sub-basin. Seventy-five percent of evaluated food species should be consumed in quantities below the local average daily intake to avoid health risks. In the middle Tapajós sub-basin, 90 percent of food-fish species (n equals 91) have THQ greater than 1, making this the most-dangerous sub-basin in the dataset. Sixty-seven percent of piscivorous species in the basin exceed the WHO methylmercury limit of 0.5 mg/kg; 29 percent exceed the ANVISA Brazilian limit of 1.0 mg/kg for piscivorous fish.

The Tapajós basin is not unique. Comparable patterns are documented across the Amazon (Colombia, Ecuador, Peru), the Mekong Delta and other Asian deltaic systems, Lake Victoria region (see Venant et al. 2025), and the Bangladeshi Meghna River basin (see Paul et al. 2025 for the parallel arsenic story). The basin-level exposure assessment in Auzier-Guimarães is replicable methodology that other authors are now applying to other basins; this is one well-documented case of a global pattern.

5 | The convergent point

Li 2024 quantifies the global scale: tropical and subtropical fisheries, where large pelagic species are caught and where subsistence consumers eat fish from those waters, account for 70 percent of methylmercury extracted from the ocean. Wu 2025 quantifies the freshwater wild category disparity within a single national dataset: freshwater wild fish carry several-fold higher methylmercury than farmed or marine equivalents, and climate change is amplifying the gap. Auzier-Guimarães 2025 quantifies what this means at the basin scale for a specific subsistence population: 89 percent of food fish species exceed exposure thresholds at the basin's actual consumption rate.

The convergence point that pulls these three studies together is the population they each implicitly identify but no single one names by itself: the global subsistence-fishing-consumer class. This is a population the regulatory framework does not centrally address. FDA-EPA fish consumption advice is calibrated against US market-purchased seafood and US average consumption patterns. EFSA's chronic dietary methylmercury opinion uses European-population intake data. National advisories in Canada, the UK, Australia, and elsewhere follow similar templates. The advisory framework assumes consumers buy fish from regulated retail channels at typical Western consumption frequencies and species mixes. The framework does not centrally address the riverside Amazonian community that catches fish from a mining-impacted basin, the rural Chinese household that eats freshwater wild fish from a local lake, or the Pacific Islander community whose protein supply comes from local subsistence fishing of large pelagic species.

This disparity is not made visible by current regulatory documents. The exposure profile relevant to subsistence-fishing populations is materially different from the one relevant to market-purchased fish, and the regulatory baseline, calibrated to median market-consumer intake, is not the right anchor for the former.

6 | What this synthesis does not yet rest on

Three corroborating cohort or population-survey studies from non-Amazonian, non-Chinese subsistence-fishing populations would substantially strengthen the geographic generalization. The Pacific Islander population studies, the Inuit and First Nations cohorts from the Canadian Arctic, the Mekong basin

work, and the African Great Lakes subsistence-fishing populations all merit dedicated ingest if not already in the corpus. The wiki should expect this synthesis page to grow as additional anchors enter.

The exposure assessments in all three studies use modeled or assumed consumption rates rather than measured individual intake. Auzier-Guimarães uses a basin-typical 116.25 grams per capita per day; Wu and Li use catch-weighted aggregation rather than individual consumption. Individual-level biomonitoring data (hair or blood mercury in subsistence-fishing communities) would close the loop between catch composition and human exposure. Some such biomonitoring data exists in the corpus already; cross-linking with the three anchor papers is follow-up synthesis work.

The mechanism in Wu 2025 (photochemical methylation enhanced under climate change) is identified by machine learning attribution rather than direct mechanistic confirmation. The projection of a 60 percent freshwater wild fish methylmercury increase by 2031-2060 carries the uncertainty of that attribution; the central estimate is robust enough to act on, but the confidence interval is wider than a mechanistic study would produce.

7 | Implications for downstream wiki pages

freshwater-fish should carry the subsistence-fishing exposure context in its body, with Wu 2025 and Auzier-Guimarães 2025 as anchors. The page's drivers field already lists biomagnification, trophic-level, watershed-mining-history, age-and-size, and ASGM-proximity; the subsistence-consumer exposure dimension is implicit in those drivers but should be made explicit.

fish should distinguish the regulatory-target-consumer methylmercury exposure context from the subsistence--consumer context, with Li 2024 as the anchor for the global pattern. The page's audience tagging should make explicit that the consumer-audience section addresses market-purchased fish and points to subsistence--consumption-relevant pages where the dose framing differs materially.

fish-containing-baby-foods should note that the underlying methylmercury exposure data for the product category is calibrated to US-market freshwater and marine fish in baby food, which is different from the subsistence-fishing population context. The page's methodology should distinguish what is and is not within the scope of the underlying data, so that the difference between market-purchased and subsistence-fishing exposure contexts is explicit.

mercury-methyl should carry the subsistence-population exposure framing as a distinct section under vulnerable populations, alongside the existing infant and pregnancy-stage framing.

vulnerable-populations should add subsistence-fishing communities as an explicitly enumerated vulnerable population alongside infants, pregnant women, and other categories. This is the page that most directly states who the methylmercury risk story is actually about.

8 | Anchor sources

- Li et al. 2024. *Global fishing patterns and methylmercury exposure*, Proceedings of the National Academy of Sciences. 1,774 marine species across global exclusive economic zones; Sea Around Us catch data 2001-2010; spatial model validated on yellowfin tuna $n=1,482$, $R^2=0.80$; estimates 84-99 percent of subsistence fishing entities exceed methylmercury exposure thresholds.

- Wu et al. 2025. *Climate change amplifies neurotoxic methylmercury threat to Asian fish consumers*, Proceedings of the National Academy of Sciences. ~13,000 fish Hg samples across 164 China sites 2005-2020; random forest + SSP climate scenarios; freshwater wild fish 2.9-6.2 times higher MeHg than farmed; 51 percent of China's total fish MeHg intake from freshwater fish; 60 percent projected increase 2031-2060.
- Auzier-Guimarães et al. 2025. *Systematic review and spatiotemporal assessment of mercury concentration in fish from the Tapajós River Basin*, ACS Environmental Au. PRISMA review of 36 studies 1992-2022; 143 species, 14,113 individuals, 735 mean Hg values; THQ greater than 1 in 89 percent of 129 food-fish species at basin consumption rate of 116.25 g/capita/day.

9 | How this page was promoted

Promoted 2026-05-13 from the candidate queue at data/evidence/synthesis-proposals.md. The three anchors meet all four promotion criteria: independent A-tier sources, finding spans multiple ingredient and product pages, finding is not derivable from any single source, and relevance to the regulatory and educator audiences through the vulnerable-population framing. Re-synthesis is expected when additional non-Amazonian, non-Chinese subsistence-fishing population studies enter the corpus, when individual-level biomonitoring data from the relevant communities is integrated, or when the climate-mediated methylmercury mechanism in Wu 2025 receives independent mechanistic confirmation.

References

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REVIEW
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- [5] Arsenic bioaccumulation in fish of the lower meghna river: Seasonal dynamics, species sensitivity, and public health implications
Paul SK, Jahan N, Saha D, Sarker BS, Majumdar PR, and Rahman M · PLoS One · 2025 · doi.org/10.1371/journal.pone.0330602
REVIEW

Editorially reviewed in-house; no external peer review has been completed on this finding. Published as a preprint with its review state tracked on the article page. Released under CC BY 4.0.

DATA AVAILABILITY

Every source behind this finding is listed with its own extraction record at <https://heavymetalindex.com/synthesis/-subsistence-fishing-mehg-disparity#sources>, each linking to the ingest receipt, the extracted values, and the file hash of the document it was built from.

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