



Fig. 2. The percentage of US consumption from imports (see *SI Appendix* for details). (A) Illustrates trade flows, highlighting the imports of US origin and re-imports/re-exports. (B) Estimated percentage of consumption from imports for NOAA and FAO data (none of which accounts for US seafood processed abroad). (C) Estimated percentage of consumption from imports depends on assumptions of average conversion factors (CF) from product form back to capture weights and the percent of imports of US origin. The yellow dashed lines represent the apparent average conversion factors for NOAA and FAO, and the red dashed line represents the upper limit of the percentage of imports of US origin.

with more than 60 news articles quoting it annually since 2014 (*SI Appendix, Fig. S1*), and it is increasingly used to support proposed policy changes. In recent years, the former US Secretary of State, current US Secretary of Commerce, and members of Congress have all cited the number to call for new policy measures addressing seafood sustainability and dependence on foreign seafood (Fig. 1).

However, we argue that far more than 10%, likely 35–38%, of seafood consumed in the United States is of domestic origin. Precise estimates are difficult because of complex supply chains: for instance, some seafood caught in the United States is exported for processing and imported again under a different trade code for consumption in the United States. Such globalized supply chains are commonplace with many products relying on numerous foreign inputs and crossing international borders multiple times. For example, beef production between the United States and Mexico can involve multiple exchanges of calves, adults, and final products (3). These counterintuitive patterns are created by low tariffs and transportation costs that allow producers to optimize for favorable interest rates and low production costs across supply chains, keeping prices low for US consumers of beef, seafood, and countless other products.

Unfortunately, a dark cloud looms over seafood trade as tariffs recently imposed by the United States

and retaliatory tariffs imposed by China and other countries hit US seafood exporters and importers, resulting in higher seafood prices for US consumers. Accounting for the realities of globalized supply chains is not only needed for better statistics that support evidence-based policy but is also key to supporting the US seafood industry, achieving sustainable production, and meeting consumer demand.

Better Statistics

The statistic that 90% of seafood is imported feeds into a narrative about US reliance on foreign seafood. It's being used to justify proposed changes to capture fisheries, aquaculture (aquatic farming), and trade policies (4, 5). In May 2018 at the National Press Club, Secretary of Commerce Wilbur Ross stated:

... more than 80% of our seafood consumed in the US is imported, and that seems a little bit silly to me given the coastlines we have and given everything else. So, one of my objectives is to try to change that trade deficit into a trade surplus.

But this statistic and the underlying data overestimate reliance on foreign seafood and fail to capture the complexity of modern seafood production, thus inhibiting evidence-based policy that would otherwise support sustainable seafood and US seafood producers and consumers.

for new policies to increase development and production of domestic farmed seafood (4, 5). Despite the uncertain future of the AQUAA bill, the Department of Commerce is working to grow US aquaculture production, announcing \$11 million of funding for 22 projects to expand sustainable US ocean, coastal, and Great Lakes aquaculture. However, increasing aquaculture production will not necessarily reduce apparent US reliance on imports. Under the current trade statistics, the portion of farmed seafood exported for processing will appear destined for foreign consumption, whereas the imported processed form will still appear to be a foreign product.

The global growth of aquaculture and globalization of supply chains complicate policies aimed at improving the sustainability of seafood consumed in the United States and are key drivers of US seafood imports. As aquaculture has grown rapidly worldwide, US imports from major aquaculture-producing countries have also increased (1). Today, three of the top four most consumed seafood products in the United States (shrimp, salmon, and tilapia) are among the most intensively farmed species (2) and are typically available at lower prices than wild-caught seafood (11). Imports of farmed seafood help meet US demand for inexpensive seafood, but the increasingly globalized seafood supply chains for both wild-capture and aquaculture products complicate efforts to track a single product and its sustainability.

Ultimately, consumer preferences for cheap seafood and traceability lie at the heart of questions concerning the overall sustainability of seafood consumed in the United States. Improving traceability to connect consumer demand to sustainable production requires improved monitoring along the supply chain and finer detail in international commodity code systems, which currently group many species and do not differentiate between farmed and wild products. Conversely, proposed policy changes that fail to acknowledge the underlying drivers of seafood imports or lack support for the development of foreign markets will do little to reduce the trade deficit, promote sustainable seafood, or expand domestic production.

Seafood Trade Policy

Trade policy is another tool for addressing US reliance on foreign seafood. However, to support US fisheries, tariffs and trade agreements should be structured to account for seafood's global supply chain and to promote the development of foreign markets for US products. The current trade war between the United States and China highlights these two issues. China is the United States' largest seafood trading partner because of its role as a prominent seafood processor and its growing market for US seafood. This makes the US seafood sector vulnerable to trade barriers. Since January 2018, back-and-forth escalation of tariffs has led to US tariffs on more than \$200 billion of Chinese goods, including 10–25% on Chinese seafood imports and China has imposed retaliatory tariffs in kind. With the current uncertainty over the US–China trade war, it is important to take stock of its impact on US industries.

Although it has received less attention and relief efforts than agriculture, US seafood is front and center in the trade war. US companies have slowly worked to build a market for US seafood in China, but now a combination of tariffs and exclusion from tariff cuts on 300 seafood products announced by China in January 2019 threaten US seafood investments in the Chinese market. For example, around \$130 million of Maine lobster was exported to China in 2017, a close second to Canadian lobster exports to China. But the combination of exclusion from a rollback of Chinese tariffs and the addition of new tariffs places US lobster at a 45% price disadvantage (12). In fact, in August 2018, Maine-based lobster companies announced layoffs because of the drying up of the Chinese market for US-produced lobster (13). Dealers are now reportedly exploring opportunities to shift operations to Canada to take advantage of more favorable tariffs (14).

Even more vexing are the large quantities of seafood the United States sends to China for processing (currently purported to be exempt from Chinese tariffs) that are exported back to the United States (and potentially subject to US tariffs). As Alaska Senator Lisa Murkowski has pointed out, the United States is effectively taxing its own seafood. NOAA has stated that imports from China of processed seafood with US origin will be exempt from the tariffs, but there is uncertainty around whether this will occur or indeed how processed seafood of US origin will be identified to allow this exemption. Although China is not currently imposing tariffs on seafood intended for processing, it is imposing tariffs on seafood destined for Chinese consumption, putting at risk the US seafood industry's efforts to become established in the Chinese market.

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The above policies focus on reducing the seafood deficit. But it is worth asking whether reducing reliance on foreign seafood is worthwhile to promote US industry, support sustainable fisheries, and supply affordable seafood to US consumers. Many seafood industry representatives are advocating for open-trade policies that allow US seafood to participate in global markets. Meanwhile, improved certification, traceability, and import standards are more promising solutions to support sustainable seafood production, ensure imports are of sustainable origin, and avoid foreign seafood “dumping.” NOAA's recent Seafood Import Monitoring Program (81 FR 88975) is a good start, and sustainability commitments by major seafood industry representatives and new technologies on the horizon, such as blockchain, provide promising opportunities to verify sustainable and humane seafood supply chains.

US seafood consumption has grown modestly in recent decades, but still more than 80% of consumers fall below US Department of Agriculture (USDA)

seafood consumption recommendations (15). Sustained growth in seafood demand or an increase to meet the USDA guidelines provides opportunity for the US seafood sector. But policies supporting US seafood cannot ignore the central position the sector occupies in an increasingly global industry.

Data and Materials Availability

All data are publicly available through Google Trends, the NOAA statistical office, and the FAO FishStatJ database.

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- 1 Gephart JA, Pace ML (2015) Structure and evolution of the global seafood trade network. *Environ Res Lett* 10:125014.
- 2 FAO (2018) *The State of World Fisheries and Aquaculture 2018: Meeting the Sustainable Development Goals* (United Nations, Rome).
- 3 Gonzalez S, Beaubien J (November 9, 2018) Planet Money Episode 875: Why did the cow cross the border? Available at <https://www.npr.org/sections/money/2018/11/09/666372072/episode-875-why-did-the-cow-cross-the-border>. Accessed April 3, 2019.
- 4 Montañez JL (2014) Offshore aquaculture regulations under the Magnuson-Stevens Fishery Conservation and Management Act. *Fisheries* 39:562–563.
- 5 Lester SE, Gentry RR, Kappel CV, White C, Gaines SD (2018) Opinion: Offshore aquaculture in the United States: Untapped potential in need of smart policy. *Proc Natl Acad Sci USA* 115:7162–7165.
- 6 Pauly D, Zeller D (2016) Catch reconstructions reveal that global marine fisheries catches are higher than reported and declining. *Nat Commun* 7:10244.
- 7 Macpherson M (2017) In pursuit of optimum: Forty years of federal fisheries management under the Magnuson-Stevens Fishery Conservation and Management Act. *Tulane Environ Law J* 31:209.
- 8 NOAA (2017) Report to Congress on the status of U.S. fisheries. Available at <https://www.fisheries.noaa.gov/national/2017-report-congress-status-us-fisheries>. Accessed April 3, 2019.
- 9 Costello C, et al. (2016) Global fishery prospects under contrasting management regimes. *Proc Natl Acad Sci USA* 113:5125–5129.
- 10 D'Angelo C (July 5, 2018) Ocean agency suggests opening marine monuments to commercial fishing. *Huffington Post*. Available at https://www.huffingtonpost.com/entry/marine-monuments-commercial-fishing_us_5b3e945be4b05127ccf05a35. Accessed April 3, 2019.
- 11 Asche F, Dahl RE, Steen M (2015) Price volatility in seafood markets: Farmed vs. wild fish. *Aquac Econ Manage* 19:316.
- 12 Overton P (June 19, 2018) China's threatened tariff on lobster from U.S. has Maine's industry on edge. *Press Herald*. Available at <https://www.pressherald.com/2018/06/19/chinas-proposed-tariff-on-u-s-lobster-has-maine-industry-on-edge/>. Accessed April 3, 2019.
- 13 Whittle P (September 14, 2018) Layoffs hit, prices lag as lobster biz feels tariff pinch. *Business Insider*. Available at <https://www.businessinsider.com/ap-layoffs-hit-prices-lag-as-lobster-biz-feels-tariff-pinch-2018-9>. Accessed May 17, 2019.
- 14 Donnan S (November 7, 2018) Even lobsters can't escape Trump's trade war. *Bloomberg Businessweek*. Available at <https://www.bloomberg.com/news/features/2018-11-07/even-lobsters-can-t-escape-trump-s-trade-war>. Accessed April 3, 2019.
- 15 Jahns L, et al. (2014) Intake of seafood in the US varies by age, income, and education level but not by race-ethnicity. *Nutrients* 6:6060–6075.