https://doi.org/10.1038/s44183-024-00069-3

Seafood independence is within reach: a multi-scale assessment of seafood self-reliance in the United States

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As a vital source of nutrition, cultural identity, and economic activity, seafood has become one of the most globally traded commodities worldwide. However, increased concerns about food security, coupled with the disruptive effects of climate change, contagious diseases, and geopolitical conflict, are bringing acute attention to the need for food system transformation at multiple scales. Here, we investigate the United States' potential to achieve seafood "independence" and maximize health benefits to the nation by integrating production, utilization, yield, and consumption data across seven regions of the United States and nationally over 50 years (1970–2021). Although the United States is the second largest importer of seafood worldwide, findings from this study show that self-reliance at the national level is achievable, though the ability of different subregions to meet demand is variable. Achieving greater seafood independence would require shifts in consumer behavior, investments in infrastructure, and continual adaptation in the face of climate change.

Food insecurity and poor diet are major contributors to the ongoing health crisis in the United States. Today, 26 million (1 in 10) adults in the country are experiencing some levelfood insecurity[1,2], while at the same time, diet-related diseases associated with obesity, heart disease, and diabetes are significant causes of death[3]. These compounding issues are particularly pronounced in rural communities and among populations of historically marginalized people who often have limited access to healthy foods and inadequate health care services as evident by the fact that an estimated 46% of Native Americans and Alaska Natives face food insecurity and are also 50% more likely to experience obesity than their white counterparts[4]. Such diet-related inequity is not new, but it has been exacerbated by the COVID-19 pandemic[5], spurring calls for transformative change in food systems at local, regional, national, and global scales.

To achieve meaningful food system transformation in the United States, change is required within all sectors of the food system, including those associated with marine and aquatic foods (increasingly referred to as "blue foods"). Blue foods have received notable attention in recent years for their high nutritional value and potential contributions to global health[6]. These endorsements squarely align with the 2020–2025 Dietary Guidelines for Americans, which recommends that people consume eight or more ounces of seafood per week to reduce diet-related diseases[7]. However, even as blue foods are being recognized for their nutritional benefits, their potential contributions to food system transformation and their role in addressing health in the United States are often overlooked. This blind spot is reflected, for example, in the White House National Strategy on Hunger, Nutrition, and Health, which fails to even mention seafood[8].

One reason why blue foods are not well integrated into discussions about food system transformation in the United States may be because of the perception that blue foods are not a significant part of the nation's food system. Today, seafood is among the most traded food commodities in the world[9], obscuring the link between blue food harvest and consumption[10]. Indeed, an estimated 80% of the total seafood consumed in the United States, by volume, comes from imported sources (6.1 billion pounds)[11]. However, despite the United States' dependence on imported sources[12], the nation produced 8.4 billion pounds of seafood in 2020 alone and is among the largest producers of blue foods in the world[11].

Recognizing the disconnect between consumption and production, and in response to calls for food system transformation, we evaluate the potential for blue food production in the United States to meet consumer demand and contribute to the dietary needs of its population. We accomplish this by using a self-reliance analysis to evaluate the extent to which the United States could achieve seafood "independence" under the current consumption scenario as well as one in which consumption reflects recommendations for a healthy diet. By seafood independence, we mean the capacity of a region or country to meet its seafood needs through its own production by reducing reliance on imports. Increasing food system self-

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reliance can help to ensure food and nutrition security by reducing dependence on trade[13,14]. Further, self-reliance buffers places from systemic shocks, which have become more prevalent over the last 50 years[15]. Here, our approach considers production, utilization, yield, and consumption data across seven regions of the United States and nationally over 50 years (1970–2021). Using these results, we also investigate the extent to which blue food production aligns with the dietary recommendations for seafood consumption in an effort to triangulate the possible contributions that blue foods could make toward meeting dietary needs for the country if seafood self-reliance were prioritized as part of future efforts to transform and strengthen regional and national food systems.

While any major change in the distribution and availability of blue foods in the United States would require a substantial shift away from global trade, we assert that this pivot is not beyond imagination. The recent COVID-19 pandemic has brought acute attention to the shortcomings of overreliance on global trade in the seafood sector, leading to numerous calls to strengthen supply chains and bolster local, regional, and domestic seafood systems[16–18]. In order to act on these recommendations, realistic estimates of the potential contributions that blue foods can make to the nation's food system are needed. While previous studies have investigated the proportion of consumed seafood that is imported into the United States[12]—a number which is often the focus point of debate about seafood—no analysis has yet to systematically evaluate the potential for the United States to achieve seafood independence or meet the dietary needs of its population. By filling this gap, this paper has the potential to bring attention to the role of blue foods in the nation's fight against food and nutrition insecurity and inform efforts to implement activities associated with the 2023 National Seafood Strategy released by the National Marine Fisheries Service.

Results and discussion

Results

Blue food production in the United States. Seafood production has varied across regions and through time over the past 50 years (1970–2021) (Fig. 1). Overall, the estimated edible proportion of all species, including fish, shellfish, and other types of seafood, reported by weight (Eq. (3), "Methods") has increased after removing species used as bait/non-human food. The nation's overall seafood production profile is disproportionately driven by North Pacific (Alaska) (Fig. 1B$_2$), which

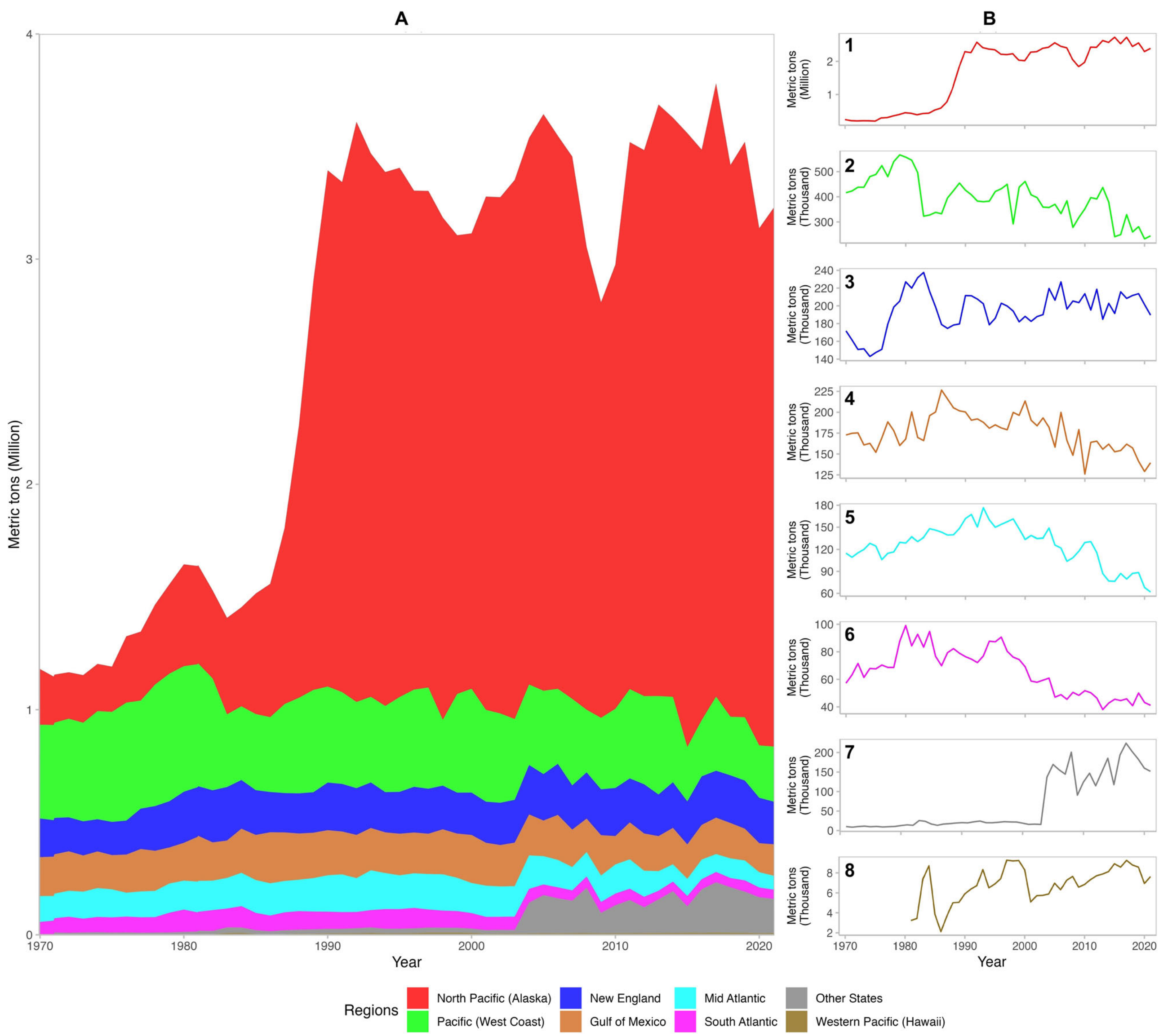

Fig. 1 | Production profile of edible seafood in the United States. A Stacked area plot of seven regions plus other inland states with reported landings (national production). **B** 1–8 Production trend of each region in descending order of magnitude (North Pacific [Alaska], Pacific[West Coast], New England. Gulf of Mexico, Mid Atlantic, South Atlantic, Other States, Western Pacific [Hawaii]).

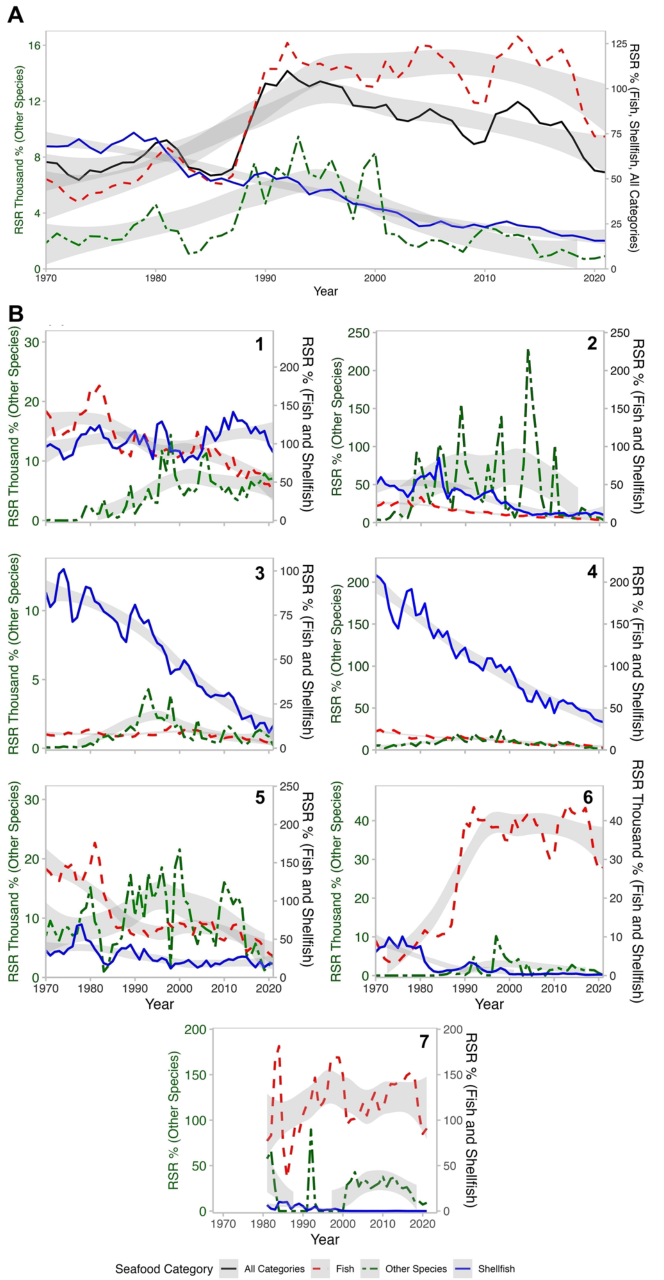

Fig. 2 | Annual self-reliance of seafood in the United States separated by fish, shellfish, and other species (1970–2021). **A** National self-reliance. **B** Self-reliance by region (1—New England, 2—South Atlantic, 3—Mid-Atlantic, 4—Gulf of Mexico, 5—Pacific (West Coast), 6—North Pacific (Alaska), 7—Western Pacific (Hawaii)). Red dashed line denotes fish with labels on the right *y*-axis; blue solid line represents shellfish with labels on the right *y*-axis; and green dashed line denotes other species with labels on the left *y*-axis; black solid line represents the sum of all categories (shellfish, fish and other species).

accounts for the highest seafood production by weight in the United States, reaching an annual production peak of 2.7 million metric tons (mmt) recorded in 2015. Total production by region is followed by the Pacific (West Coast), which recorded an annual production peak of 566 thousand metric tons (tmt) in 1979. New England recorded its peak in 1983, with a production volume of 237 tmt, while the Gulf of Mexico recorded an annual production peak of 226 tmt in 1986. The Mid-Atlantic, South Atlantic and Western Pacific (Hawaii), which recorded the least volume, had mean annual production peaks of 176 tmt, 99 tmt, and 9 tmt recorded in 1993,1980 and 1997 respectively. Since 1970, there has been a progressive increase in the decadal volume of edible seafood production at a national level, with a sharp increase in the mid-1980s due to the massive expansion of the pollock fishery in Alaska. However, this growth slowed down in the 2000s and 2010s, stabilizing at a mean volume of 3.4 mmt. Among the seven defined regions, only North Pacific (Alaska), New England, and Western Pacific (Hawaii) experienced increased or stable production volume in the last two decades, while the other regions exhibited a downward trend in production volume.

Self-reliance across regions. Seafood self-reliance is a function of blue food production, species yield, human population, and consumption. Regional self-reliance (RSR) was calculated at a regional level ($n = 7$) in alignment with federal management areas (see Supplementary Figs. 1 and 2) and by product category (fish, shellfish, and other species). The analysis of RSR for the three categories of seafood revealed variations across the seven regions (Fig. 2B). For the fish category, North Pacific (Alaska) recorded the highest RSR with an annual mean (1970–2021) of 27,000%, followed by Western Pacific (Hawaii) (119%), New England (99%), Pacific (West Coast) (80%), South Atlantic (14%), and Gulf of Mexico (11%), with the Mid-Atlantic region recording the lowest at 7%. The Pacific (West Coast) started with a high RSR of 142% in 1970, peaking at 176% in 1981, but it sharply dropped to 55% in 1990, remaining relatively stable until 2021, when it further declined to 27%. Although North Pacific (Alaska) was the most self-sufficient region in the United States for fish, with RSR in thousands, it gradually increased from an average of 6000% in the 1970s to a sharp rise of 40,000% in 1995, maintaining relative stability until 2017, and then dropping to 27,000% in 2021. Western Pacific (Hawaii) maintained an RSR above 100% between 1990 and 2019, recording a low of 36% in 1986 and a peak of 181% in 1986. New England's fish RSR reached its highest in 1982 (175%), but has steadily declined since then to 36% in 2021. The other regions (South Atlantic, Mid-Atlantic, and Gulf of Mexico) showed relatively stable and low fish RSR from 1970 to 2021.

RSR for shellfish across five regions (South Atlantic, Mid-Atlantic, Gulf of Mexico, Pacific (West Coast), Western Pacific (Hawaii) and North Pacific (Alaska)) exhibited an observed downward trend from 1972. The Western Pacific (Hawaii) region recorded the lowest shellfish RSR in 2021. These downward trends are largely a function of an overall decrease in production relative to a growing number of population that is consuming more. There was a steady decline in shellfish RSR observed in the Mid-Atlantic and Gulf of Mexico regions, both recording their lowest in 2020 and 2021 respectively. However, New England maintained a relatively stable and high RSR with an annual mean (1970–2021) of 105%.

For the "other species" category, which includes products like squid, the Pacific (West Coast), North Pacific (Alaska), Mid-Atlantic, and New England recorded the highest RSR with annual means (1970–2021) of 9533%, 4148%, 1899%, and 1059% respectively. The Gulf of Mexico, South Atlantic and Western Pacific (Hawaii) regions recorded the lowest RSR for other species with mean values of 105%, 44% and 30%, respectively. There was a general upward trend in RSR for other species across all regions from 1996 to the year 2000, except for the South Atlantic region, which experienced a peak of 229% in the year 2005. This trend was driven by squid production, which recorded the highest landings between 1970 and 2021.

Self-reliance at the national level. National self-reliance (NSR) for shellfish exhibited a steady decline from 68% in 1970 to 15% in 2021, with an annual mean of 42% (Fig. 2A). In contrast, fish NSR showed an upward trend from 49% in 1970 to a peak of 125% in 1992, followed by annual means (1993–2013) of 110% and a peak of 128% in 2013, and then a dip to 73% in 2021. For other species, the NSR was observed to be higher than either fish or shellfish categories, measured in thousands. This varied annually, reaching a peak of 9465% in 1993, and then steadily declined to 713% in 2019, with a slight increase to 918% in 2021. While there was a general downward trend in NSR for all categories from 2013 to 2021 after an initial increase recorded in previous years, mean overall

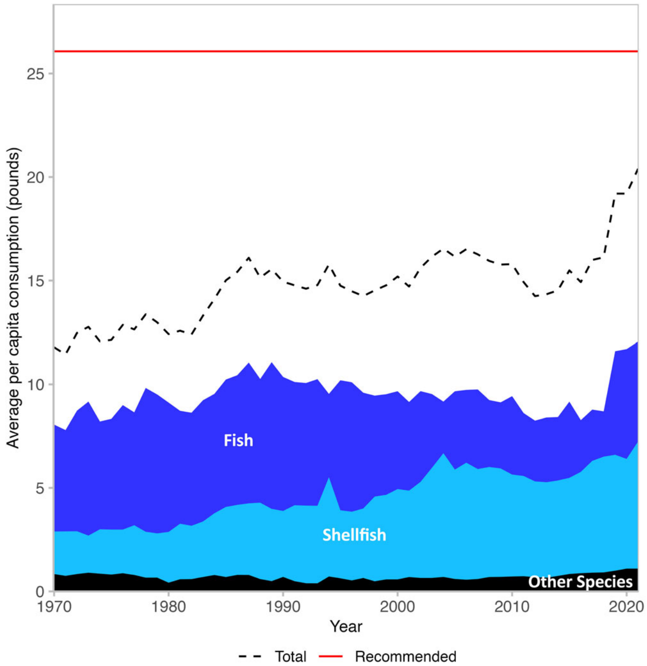

Fig. 3 | Per capita consumption of fish, shellfish, and other species in the United States. The dashed black line represents the total per capita consumption of all categories; the solid red line denotes the recommended per capita consumption (as recommended by U.S. Department of Health and Human Services).

national self-reliance for the past decades was 59%, 70%, 98%, 81%, and 76% between years 1972–1981, 1982–1991, 1992–2001, 2002–2011, 2012–2021 respectively. As noted above, the national trend is driven by the North Pacific (Alaska), which makes a critically important contribution to seafood production overall.

Seafood consumption recommendations to support healthy living. Per capita consumption of fish in the United States is higher than either shellfish or other species, reaching an all-time high of 12 pounds per capita in 2021, after declining from 11 pounds per capita in 1989 to 8.7 pounds per capita in 2018 (Fig. 3). In contrast, the shellfish category experienced a steady rise, from 2.9 pounds per capita since 1970 and peaked at 7.2 pounds per capita in 2021. The "other species" category remained relatively stable until 2014, with a slight increase from 0.74 pounds per capita to 1.1 pounds per capita in 2021.

Overall, seafood consumption in the United States has increased over the last 50 years, with the total per capita consumption of seafood showing a steady increase from 11.7 pounds per capita in 1970 to 20.3 pounds per capita in 2021. Increases in shellfish consumption have been the primary driver of this trend, which is a point we return to in the discussion. Although per capita consumption of seafood remains below the recommended 26.07 pounds per capita recommended by the U.S. Department of Health and Human Services and U.S. Department of Agriculture[7], per capita consumption appears to be nearing the recommended level (currently at 78%).

Discussion

This study provides estimates of seafood self-reliance across seven regions managed by the U.S Regional Fishery Management Councils (as created by the Magnuson-Stevens Act)[19] of the United States and nationally over a 50-year period from 1970 to 2021. We find that NSR for fish is above 70% self-reliance, surpassing other seafood categories since 1990. In contrast, NSR for shellfish exhibited a declining trend from 1970 to as low as 15% in 2021. These disparities can be attributed to the per capita consumption of shellfish, which has exceeded production capacity since 1988, whereas per capita consumption of fish trended downward until 2018, when it increased, leading to a decrease in NSR. In all categories combined; NSR has ranged from 49% to 110% over the past 50 years, with a decadal peak of 98% recorded between 1992 and 2001. Importantly, despite major population growth during the study period from 201 to 350 million[20], and an overall increase in per capita seafood consumption from 11.7 pounds to 20.3 pounds, the United States is not far from meeting current demand for blue foods, suggesting that seafood independence is within reach (i.e., >100% self-reliance). Indeed, in the last 10-year period of this study, seafood self-reliance at the national level for all categories was 76% and has been as high as 93% (Fig. 2A). This finding stands in juxtaposition to the current reality that 80% to 90% of the seafood consumed in the United States is imported and highlights the potential contributions that domestic blue foods could make to the nation's food system.

The results of this study are driven by the outsized effect that North Pacific (Alaska) has on blue food production and NSR. North Pacific (Alaska) accounts for two-thirds of the nation's annual seafood harvest, which has remained consistent in the last three decades, with Alaska pollock, cod, and salmon accounting for the largest volume of catch. Western Pacific (Hawaii) boasts the second highest RSR, while the Pacific (West Coast) ranks third despite its large population (averaging 50 million people). New England, the Gulf of Mexico, and the mid-Atlantic regions rank fourth, fifth, and sixth, respectively, among the seven regions. This ranking can be attributed, in part, to some species, which are primary contributors to commercial landings in these regions, but were removed from our analysis[21] because they are predominantly used as bait for other highly valued species such as lobsters, tuna, and striped bass[22]. Further, while the Gulf of Mexico has the most diverse suite of species caught, with 343 unique species with an average landing volume of 175 tmt (see Supplementary Table 1), it has a relatively large human population (average of 50 million in the past 10 years) and high seafood consumption, which drives down RSR. New England experienced a peak in RSR at 179% in 1979[23], which has subsequently declined to as low as 36% in 2021. This decline could have been due to historic overfishing, catch regulations, and the increasing total per capita consumption. We note that our analysis of the northeast region's RSR for fish and shellfish between 2001 and 2009 mirrors the findings of Griffin et al.[24], demonstrating a higher RSR for shellfish (44%) compared to fish (24%).

When we consider dietary recommendations, we find that people in the United States are falling short of meeting recommended dietary intake of seafood, which should average 26.07 pounds per year[7]. However, per capita consumption of blue foods appears to be increasing in the United States with average consumption reaching 20.3 pounds in 2021. This represents 78% of the recommended consumption level.

Overall, our study shows that the United States has the potential to significantly increase self-reliance based on current production and consumption levels, though it falls short of producing enough blue foods to support a scenario in which people eat enough seafood to meet dietary recommendations. To move toward self-reliance and better dietary outcomes, multiple considerations will need to be considered. First, consumer preferences ultimately play key roles in mediating seafood consumption in the United States[25,26]. Therefore, we suggest that any meaningful transformation will require changing consumers' dietary preferences so that their purchasing decisions align with what is available regionally or nationally[27] Necessarily, this will include a shift toward species that are currently being utilized as bait or exported to other countries due to limited demand. Initiatives that lower the barriers to seafood access for historically marginalized people will be equally important[28]. Second, any meaningful transformation will require investments in infrastructure—from boat to plate—that enables local and regional distribution of blue foods. This includes investments in working waterfront access, cold storage and processing, and distribution networks that are intentionally designed to serve local and regional markets. Currently, much of the infrastructure that is in place exists to promote global trade, making access to locally sourced seafood challenging. Third, addressing the growing demand for shellfish among consumers necessitates an increase in production, which can be achieved with strategic investments in local, small-scale, and community-based mariculture. Finally, all actions must consider the impacts that climate change is having on seafood production. Although the United States is the second largest importer of seafood worldwide, findings from this study show that self-reliance at the national level is achievable.

Methods

Production data

Using publicly available data from NOAA Fisheries, a dataset was created that contained annual commercial landings (except territorial landings) values in dollars and weight in pounds of round (live) weight for all species or groups in each state where species were landed[29]. The annual dataset considered for this study included all species and states and spanned from 1970 to 2021. Landing statistics summaries were reported as both confidential and non-confidential. Mollusks, including clams, mussels, oysters, and scallops, were reported in pounds of meat which excludes the weight of their shells.

Consumption data

Data on food availability from 1970 to 2018, specifically the per capita consumption of seafood, was acquired from the USDA Economic Research Service data system[30]. Per capita consumption data on seafood for the years 2019 to 2021 was obtained from the NOAA Fisheries Office of Science and Technology[31].

According to Economic Research Service (ERS) data system[30], the total annual seafood supply is calculated by subtracting nonfood use from available commodity supplies. The U.S. supply of seafood (imports and landings) is converted to edible weight, and any decreases in supply (exports and industrial uses) are also converted to edible weight and are subtracted from the U.S. supply[11,26]. To calculate per capita seafood availability, the annual total seafood supply during a specific time period is divided by the U.S. resident population in a given year:

$$\text{per capita availability} = \frac{\text{Total annual seafood supply of a commodity}}{\text{U.S.population for that year}} \tag{1}$$

The total U.S. resident population considered for food availability by USDA includes the population of 50 states and the District of Columbia, but it does not include the U.S. territories[32]. The annual population data was obtained from the Census Bureau[20]. Regional population was determined by aggregating the population of states constituting each region.

Data cleaning and preparation

NOAA fisheries production data for all states with reported commercial landings from 1970 to 2021 were selected, encompassing both confidential and non-confidential data. The confidential data was divided into categories, considering species with undisclosed weights for a specific year in a given state. For instance, due to federal statutes prohibiting public disclosure of landings for certain species like Atlantic salmon, reported landings became confidential after 2010. To estimate subsequent years' data, the states that were into Atlantic salmon production were identified, and their historical landings were averaged. This information was further correlated and adjusted with reported weights from annual reports on the fisheries of the United States[33]. A similar approach was adopted for other species with confidential weights, and in some cases, state-specific data were utilized.

The ERS data from 1970 to 2018, focusing on food availability, specifically the total and per capita availability of fishery products like canned, fresh/frozen fish, and shellfish, were analyzed by categorizing them into fish, shellfish, and other species. Also, the pounds of other species that do not belong to either fish or shellfish were subtracted from the total per capita consumption to account for the consumption of these other species. NOAA Fisheries per capita consumption data on seafood was reported as fresh/frozen, canned, and cured. For consistency with ERS data, NOAA fisheries per capita pounds data was separated into fish, shellfish, and other species using the historical average percentage they constituted in past ERS data. Data analysis was carried out using R (v 4.2.2) programming[34] in R.Studio (v. 1.4).

Regional classification of states

To assess the regional self-reliance of the United States, the classification of states into regions was required. Although there is no standardized and widely accepted division of states into regions in the United States[24,35], this study adopted the regional classification used by the U.S Regional Fishery Management Council[36]. According to this classification, the United States was categorized into seven regions, with Hawaii as a standalone region in the Western Pacific being one of the only 50 states considered in the national food availability estimate by USDA in the region (see Supplementary Figs. 1 and 2). Unlike other states with reported landings, Hawaii started reporting its annual commercial landings in 1981. All the states included in these regions are considered seafood-producing states (reported commercial landings)[29], except Idaho in the Pacific/Pacific (West Coast) region.

Regional production estimation

In this study, the analysis focused on NOAA fisheries commercial landings for all 30 states where data was available (data does not include landings by U.S. flag vessels at ports outside the 50 States). However, out of these 30 states (Alabama, Alaska, California, Connecticut, Delaware, Florida (Florida-east, Florida-west), Georgia, Hawaii, Illinois, Indiana, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oregon, Pennsylvania, Rhode Island, South Carolina, Texas, Virginia, Washington, Wisconsin), only 24 of them could be properly classified into regions. The remaining 6 states were grouped together and classified as "Other States" (Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin). Since the commercial landings data was reported on a state level, a regional analysis was conducted by aggregating data from states in the same region.

The species-level data was taken into consideration, and the names were adjusted to their acceptable market or species group names[37]. To account for the diverse seafood preferences across different regions of the United States, this study included seafood species that are consumed as food in each region (see Supplementary Tables 1 and 2). For instance, certain regions have historically regarded specific species as bait for catching other high-value species, whereas the same species are considered a food source for humans in other regions[38,39]. To ensure the accuracy of the findings, only species consumed as food for humans were selected from the dataset. The total output (average pounds) F for each species (i) for a given year (j) was estimated as:

$$F_i = \frac{1}{n_i} \times \sum_{j=1}^{n_i} Pounds_{ij} \tag{2}$$

where n_i is the number of years for which data is available for a given species (i)

The edible weight (V) of species (i) calculated based on the edible proportion K[40,41] of a given species consumed as food was estimated as:

$$V_i = F_i \times K_i \tag{3}$$

The total weight of all species (W) consumed as food for a given year was approximated as:

$$W_j = \sum_{i=1}^{n} V_i \tag{4}$$

To integrate with consumption data, species were classified into fish and shellfish[42]. Any species that did not fall into these categories were collectively grouped as "other species". The total weight (TW) for each category was calculated as:

$$TW_{lj} = \sum_{i} \omega_{ilj} \tag{5}$$

Where ω_{ilj} is the weight (ω) of species (i) in a category (l) [fish, shellfish or other species] for a given year (j).

The national production estimate was calculated by aggregating seafood production from all seafood-producing states (states with reported commercial landings). The species were filtered based on a list of collectively consumed species across all 50 states, including the District of Columbia. This approach was taken because it was assumed that while some states might be selective in the choice of seafood species they consumed, this might not be the case for other states (both seafood-producing and inland states). Additionally, it is important to consider that when species are landed in a state, they are quickly transferred and redistributed to other coastal and inland states for consumption, further processing, or exported to other countries. The production data was also grouped into seafood categories to estimate national self-reliance, and a national production estimate of W_j was made for national production of consumable seafood in the United States.

Regional consumption estimation

The research utilized total and per capita availability data of fishery products obtained from the United States Department of Agriculture[30] which is an essential indicator to estimate regional consumption[43,44]. The seafood availability data encompassed fresh and frozen fish, fresh and frozen shellfish, canned and cured products, such as salmon, tuna, sardines, and other species. The data was regrouped into three main categories: fish (fresh and frozen fish, canned salmon, canned sardines, and canned tuna), shellfish (fresh and frozen shellfish, and canned shellfish), and other species.

For each category, the annual per capita consumption (in pounds) was calculated based on the national population for their respective year[30]. However, to estimate the regional consumption (RC) of category (l) for a given year (j), the regional population (RP) and national per capita consumption (N) were used. This was expressed as:

$$RC_{lj} = \sum N_{lj} \times RP_j \tag{6}$$

Similarly, national consumption was estimated using national population for a given year:

$$NC_{lj} = \sum N_{lj} \times NP_j \tag{7}$$

where (NC) was expressed as national consumption of category (l) for a given year (j) with the national population (N) and national per capita consumption (NP) for the year.

Self-reliance

The regional and national self-reliance was calculated based on the total seafood production and consumption of a given seafood category (fish, shellfish, and other species). The regional self-reliance estimates considered several factors, including the variation in seafood species consumed in each region (Appendix 1, also see Supplementary Material). Species used as bait or those not intended for human consumption were excluded from the analysis at a regional level, while the edible proportion of each species was considered (Eq. (3)). Moreover, the confidentiality of the landings' weight for certain species was also taken into account.

The regional self-reliance (RSR) of category (l) for a given year (j), was calculated for each region as:

$$RSR_{lj} = \frac{TW_{lj}}{RC_{lj}} \times 100 \tag{8}$$

For National self-reliance (NSR), National population was used for national consumption:

$$NSR_{lj} = \frac{TW_{lj}}{NC_{lj}} \times 100 \tag{9}$$

Where TW_{lj} represent the national total weight TW, expressed as a percentage of the total consumption for each category in a given year (see Supplementary Fig. 3 for data linkages flowchart).

Data availability

Source data for this analysis are open-access. All seafood production data can be found at https://www.fisheries.noaa.gov/foss/f?p=215:27:15220583455865. Food availability data were sourced from the USDA Economic Research System at https://www.ers.usda.gov/data-products/food-availability-per-capita-data-system/.

Received: 9 November 2023; Accepted: 27 May 2024;
Published online: 07 June 2024

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Acknowledgements
The authors are grateful to the National Marine Fisheries Service Office of Science and Technology and the U.S. Department of Agriculture for making the data used for this study publicly available. The authors also extend their appreciation to two anonymous reviewers for their input on the paper. This research was funded by National Marine Fisheries Service (Grant # NA22NMF4690289). The funder had no role in the design, implementation, analysis, or interpretation of the results.

Author contributions
T.O. and J.S. conceived and planned the study. T.O. processed the data, performed the analysis and designed the figures. T.O. and J.S. drafted the manuscript. T.O., S.A., and J.S. contributed to the interpretation of the results. S.A. and J.S. provided critical feedback and helped shape the research, analysis, and manuscript. All authors discussed the results and commented on the manuscript.

Competing interests
The authors declare no competing interests.

Additional information
Supplementary information The online version contains supplementary material available at https://doi.org/10.1038/s44183-024-00069-3.

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