



## Mariculture: A global analysis of production trends since 1950

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### ABSTRACT

Aquaculture is one of the fastest growing global food animal production industries and, according to the United Nations Food and Agriculture Organization (FAO), now accounts for nearly half of global food fish supply. This proportion is anticipated to grow in the coming decades as global capture fisheries continue to stagnate and global demand for seafood continues to rise. As the significance of aquaculture grows, the marine and brackish ('mariculture') subsector is of particular interest for analysis because of its growing influence on the development of global aquaculture and its known negative impacts on marine biodiversity and coastal health. In this context, and based on known global data limitations and past experience with fisheries and aquaculture statistics reported to the FAO, there is reason to independently verify the FAO's global database of mariculture production statistics. These data were therefore re-estimated and global mariculture production from 1950 to 2010 was GIS-mapped at a higher spatial resolution than available thus far. This new database indicates that, unlike for capture fisheries, the current understanding of historical global mariculture trends is reasonably accurate; however, some uncertainty remains in the accuracy of reported mariculture production statistics at the country level, most notably in China. Thus, mariculture statistics should still be used with caution. Finally, the new database independently confirms global 'farming up the foodweb', and briefly evaluates whether it is really the case that nearly half of all 'fish' consumed nowadays originate from aquaculture.

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### 1. Introduction

The United Nations Food and Agriculture Organization (FAO) defines aquaculture as the farming of individually or corporately-owned aquatic organisms such as fish, molluscs, crustaceans, and aquatic plants with intervention in the rearing process so as to enhance production [1]. Although it is a practice with origins dating back more than 3000 years [2], aquaculture products have only recently been recognized by the United Nations Statistical Commission as distinct global commodities [3]. As the primary warehouse for fisheries<sup>1</sup> and aquaculture information worldwide since 1950 [4], the FAO "Global Aquaculture Production" database indicates that aquaculture's annual global production has increased at an average rate of around 8% in the past three decades (i.e., since 1980) and, despite a recent slowing in global trends, growth remains higher than any other major animal food production sector [5,6]. This rapid global increase in production combined with slowly declining marine fisheries catches [6,7], has

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<sup>1</sup> The term 'fisheries' throughout this contribution refers to the catching of wild fish, and excludes aquaculture; consequently, fisheries catches exclude the products of aquaculture.

led to claims that aquaculture accounts for "around half of the seafood consumed by [developed markets]" [5,8], with the expectation that this fraction will increase further. Indeed, aquaculture is looked to as a vital complement to global capture fisheries and is envisioned to resolve food security issues worldwide [9–11].

However, these optimistic assessments and projections often overlook three key issues. The first issue concerns overall worldwide data accuracy. The current understanding of the status of global aquaculture production relies on historical information provided by the FAO through reports of member countries [12,13]. Many of these FAO member countries have been found to misreport fisheries landings [7,14,15], and the relative newness of global aquaculture statistical collections means that, while improvements to statistics and reporting are ongoing, many of these countries also lag behind in the quality of their reported aquaculture production statistics [3,12,16,17]. The second issue links both data accuracy and the uneven distribution of global aquaculture production. Over two-thirds of aquaculture production (by weight) occurs in marine, brackish, and freshwater environments in China [6]; this means that one country is predominantly responsible for the "blue revolution" of global aquaculture production by quantity [8]. Ongoing uncertainties over the accuracy of Chinese aquaculture statistics, and therefore the status of global aquaculture trends, are of concern to the FAO [13], i.e.:

"There are continued indications that capture fisheries and aquaculture production statistics for China may be too high, as

noted in previous issues of The State of World Fisheries and Aquaculture, and that this problem has existed since the early 1990s. Because of the importance of China and the uncertainty about its production statistics, as in previous issues of this report, China is generally discussed separately from the rest of the world”.

The third issue relates to a shifting emphasis on production practices worldwide. Historically, aquaculture was predominantly carried out in freshwater environments with relatively low-input herbivorous and omnivorous freshwater fishes; herbivorous marine bivalves were later added [2,18]. The bulk of global aquaculture production, mostly in China, still consists of these two major groups. However, China is increasing its use of wild-sourced fishmeals and oils to bolster its considerable aquaculture output [19,20]. Additionally, there is a growing global focus, driven largely by demand from Western countries, on increasing the intensive production of omnivorous and carnivorous species farmed and harvested in maritime and brackish coastal environments (also known as mariculture) which as of 2010 represents a reported third of global aquaculture production [1,6,21]. The farming of these species, such as salmon, groupers, seabasses, and prawns, is typically heavily reliant on inputs such as wild post-larvae and juveniles, fishmeals and oils, and water, land, and energy [22,23]. As such, mariculture has been widely criticized for its often negative impacts on marine and coastal ecosystem health, and negative associations have been drawn to its effects on marine capture fisheries and food security [24–29].

The above issues were considered reason enough to closely scrutinize the FAO “Global Aquaculture Production” dataset (<http://www.fao.org/fishery/statistics/global-aquaculture-production/en>) by comparing it to a new database created by the *Sea Around Us* and specific to global mariculture. Other than a more narrow scope, this new database differs primarily from the FAO dataset in that it retains a higher spatial resolution than that of the FAO dataset between 1950 and 2010, despite significant improvements to the FAO’s 2012 data release and newly available mapping initiatives [30,31]. This analysis was first undertaken when the FAO’s 2010 dataset was the most current; following the newest FAO data release differences in the total number of taxa produced have been resolved between datasets. In the new dataset, global time-series production data for each country are also accompanied for the first time by a spatial Geographic Information System (GIS) component. In keeping with the *Sea Around Us*’ goal of improving public access to global fisheries and aquaculture information [32], this Global Mariculture Database (GMD) is freely available online at [www.seaaroundus.org](http://www.seaaroundus.org).

Using this new database, mariculture’s historical role in global aquaculture production is re-evaluated in the context of the above issues. Its value-added spatial component, which provides additional information for analyses and policies that address broader issues of coastal ecosystem stress and modification, food production, further industry expansion and development, as well as interactions with capture fisheries, are also briefly presented. Finally, the validity of the widespread assertion that aquaculture now provides people with nearly half of the fish they consume is briefly explored.

## 2. Materials and methods

In constructing the GMD, a three-pronged methodology was used for the collection and synthesis of historical production data for each coastal country engaged in mariculture production from 1950 to 2010 (inclusive): (1) raw annual production statistics for marine and brackishwater aquaculture were collected in a primarily electronic format from official statistical sources and published government, academic, and other specialist literature; (2) data gaps were filled using a rule-based systematic estimation

procedure that includes both linear interpolation and extrapolation; and (3) using the same or additional references as above, production data were further taxonomically and geographically disaggregated, i.e., groups such as ‘bivalves’ were split into distinct species where possible and national production figures were split by the (maritime) provinces, states or territories (henceforth ‘provinces’) that subdivide larger countries. For some countries and years where data were difficult to obtain or in countries where 2010 data are not yet published, this estimation procedure could use FAO FishStat data (v.2.31) [30,33] as a starting value for estimation, so as to obtain a complete and consistent dataset starting in 1950. This methodology is similar to that used to reconstruct historical fisheries catches [14,15].

The production data collected for the GMD focuses on commercial data, which in this instance refer to the output of marine and brackish farming activities for profit whose final harvest is used for human consumption [34]. Therefore, subsistence mariculture production, raising juveniles for wild stock enhancement or for sale to aquaculture facilities for on-growing, and the aquarium trade are excluded from the database and this analysis. In addition to excluding freshwater production and aquatic plants, the GMD, in line with the definition of mariculture given above, also excludes euryhaline freshwater cichlid (e.g. tilapias) and cyprinid (e.g. carps) species; however, the important role of these species in global food provisioning is acknowledged.

To add value to the global production time-series trends, the GMD data was also spatialized using a GIS. While countries are increasingly providing some of their own finer-scale (i.e., finer than national level) and spatially-referenced aquaculture information for public analysis (see e.g. [35]) and the FAO has also recently initiated similar efforts [31], this work represents the first global time-series compilation of production data of this kind. Providing a platform for future disaggregation as global aquaculture data continue to improve, the GMD can be used to showcase the geographic history of the production and expansion of taxa across each country’s coastal provinces, as reported in that country’s publically-accessible mariculture statistics and/or supplementary data. With respect to representing the coastal areas from which the production originated, the GMD production figures were not assigned to specific farm-level geographic coordinates at this time, but are instead more generally represented within the Exclusive Economic Zone of the country (or province) in question, within what the *Sea Around Us* has previously referred to as the Inshore Fishing Area (IFA). The IFA corresponds to that part of the continental shelf (i.e., waters not deeper than 200 m) that is within 50 km distance from the shore [36]. As defined, the IFA of countries is under pressure from both industrial and small scale fisheries, and also currently includes the production facilities of all extant mariculture operations in the world.

Collection of data at the provincial scale was undertaken primarily in an effort to avoid the inaccuracies that can arise from aggregated national-scale data reported by member countries to the FAO, while remaining compatible with the FAO aquaculture database; however, this added feature also serves to enhance both the new and pre-existing global mariculture datasets. The overall database product is thus a global time-series of commercial-scale marine and brackish aquaculture production presented spatially by taxa and for each maritime country, by province, in tonnes (1 t = 1000 kg) whole wet weight, for the years 1950 (coinciding with the first year of FAO data) to 2010.

## 3. Results

### 3.1. Assessing the accuracy of global mariculture data

To assess the accuracy of currently reported global mariculture production trends, the compiled *Sea Around Us* provincial-scale

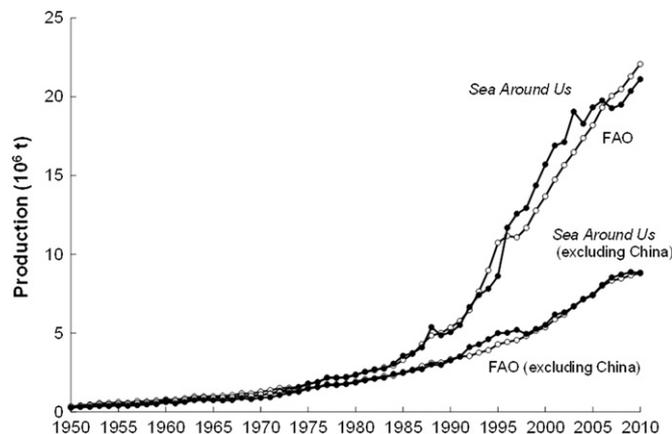
historical mariculture production data were aggregated nationally and then globally and the resulting trend compared to the equivalent FAO Fishstat Plus (v.2.31) Global Aquaculture Production trend [30]. Both datasets indicate a tripling in production between 1950 and 1970, as well as an overall similarity in total annual global production growth from 1970 to 2010 (i.e., just under three quarters of the compared annual production in these years is similar to within 10%). The similarity between compared datasets increases to 80% when China is excluded from the analysis (Fig. 1).

The general resemblance between the compared global mariculture production trends after 1970 similarly extends to all regions of the world except Africa (data not shown). While African datasets are improving in some countries, this region continues to lag noticeably behind in the availability, accessibility, and quality of mariculture production data and this is reflected in discrepancies between historical FAO and *Sea Around Us* datasets and the need for data gap filling. Between 1950 and 2010, the largest and most numerous discrepancies between global datasets were found in the data-poor era prior to 1970 and more than a decade prior to the establishment of the FAO's aquaculture data repository [34]. In these years, the GMD provides the more conservative production estimate.

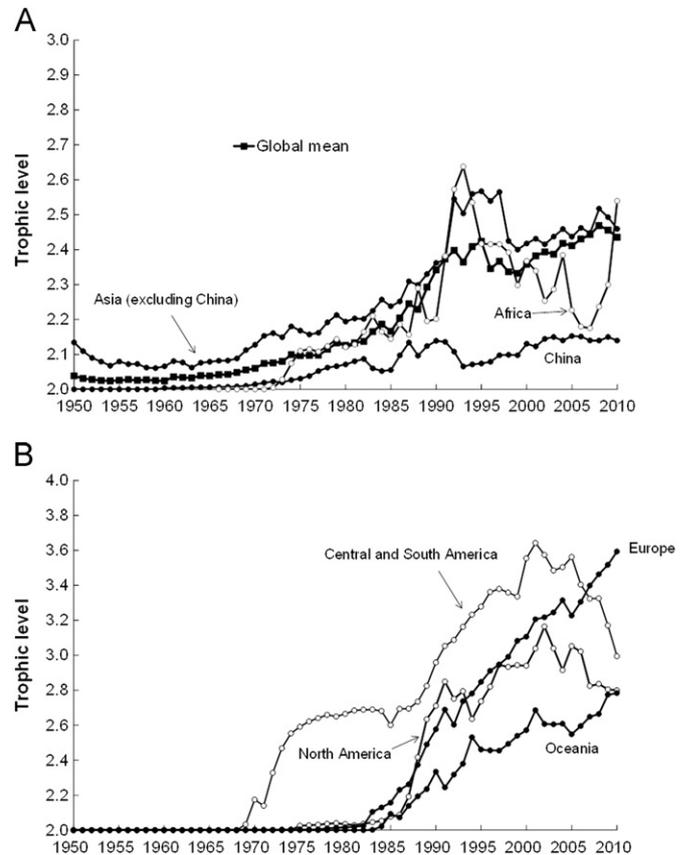
The overall match between the two databases also applies at the major taxonomic group level with respect to overall growth between 1980 and 2010. Mollusks, a grouping composed primarily of bivalves (this analysis excludes a negligible production of cephalopods and gastropods), account for more than 70% of all mariculture production of 'fish' by weight worldwide since 1970. The time-series production trends for mollusks therefore strongly resemble the trends of total global mariculture production. Global marine and brackish finfish trends in both datasets increase more than tenfold between 1980 and 2010 and have comparable annual rates of growth (80% of years have a difference of 5% or less). Reported trends of increase in crustacean production grew about fifty-fold between 1980 and 2010 in each dataset.

### 3.2. A shifting emphasis on global production: farming up the marine food web confirmed

As the total number of taxa reported farmed has increased over time, so too has the weighted mean annual trophic level of the species produced (Fig. 2); i.e., relatively greater quantities of



**Fig. 1.** Comparison of global mariculture dataset trends. Between the FAO and the *Sea Around Us*' GMD datasets, with and without China. Log-linear regression analysis of both datasets for the years 1970 to 2010 yields an  $R^2$  value of 0.993 with China and an  $R^2$  value of 0.990 without China, indicating a strong resemblance between dataset values. A similarity in slopes in this same time period suggests a mean global rate of production increase of 7.7% per year with China and 5.5% per year without China.



**Fig. 2.** Temporal change in the weighted mean trophic level (TL) of mariculture production. Using the GMD, analysis demonstrates "farming up the food web" (A): For the world on average, and for regions where the weighted mean TL is relatively stable or has decreased since the 1990s; (B) For regions with a marked increase in weighted mean TL since 1990.

predator species are being farmed around the world. This phenomenon, previously observed in studies of FAO data which analyzed total global aquaculture [37] as well as mariculture production in the Mediterranean [38], has been described as "farming up the food web" [39]. Trophic levels (TL) describe the relative position of a taxon in the broader aquatic food web in relation to their prey [40]. A trophic level of 2.0 represents an herbivorous species, while intermediate predators begin at around TL 3.1 and top predators have TL values greater than 4.1 [38]. In the absence of an aquaculture-specific trophic index, where the TL of farmed species would be computed based on the trophic level of their feed (which can be computed only given a knowledge of its composition and implies knowledge of a specific origin; see [41]), the analysis below was performed using TL estimates derived from the wild species in question, as given in FishBase ([www.fishbase.org](http://www.fishbase.org)) and SeaLifeBase ([www.sealifebase.org](http://www.sealifebase.org)). Given that farmed higher-TL species are fed diets rich in animal protein and oils, and lower TL species are fed comparatively little or no animal inputs, wild and captive TLs will be correlated [42]; this logic is assumed in this analysis of 284 of the 291 species included in the GMD since 1950.

Fig. 2(A) shows a strong increase in the global weighted mean TL since the 1970s, when the farming of carnivorous marine finfish reached an industrial global scale. "Farming up the food web" is also apparent regionally (Fig. 2A and B); However, since the 1990s, some regions experienced either a levelling off or a decrease in their weighted mean TL. In contrast, China's weighted mean TL, with the majority of its production attributable to bivalves with a TL of 2.0, has remained relatively stable since

the mid-1980s. Although herbivorous and omnivorous species such as the Pacific cup oyster *Crassostrea gigas*, the blue mussel *Mytilus edulis*, and the tiger prawn *Penaeus monodon* are produced in quantities an order of magnitude greater than those of carnivorous species, the constant annual rate of production growth in this trophic class (i.e., TL 2.0–3.0) was only 7% between 1980 and 2010; this is lower than the 23% growth rate in top predators such as amberjack *Seriola dumerili*, bluefin tuna *Thunnus thynnus*, and the Atlantic salmon *Salmo salar* with TLs equal to or greater than 4. Between 1990 and 2010, however, constant annual production rates of growth in top predators have slowed to around 10%.

In analyzing the mean trophic level trends at the country level, a negative absolute change in the weighted mean trophic level of mariculture production occurred between 1980 and 2010 in 10 countries and/or territories (Brazil, Denmark, Finland, Germany, Hong Kong, Nigeria, Norway, Peru, Singapore, and the United Kingdom), which are presently producing greater quantities of lower TL (herbivorous and omnivorous) species than they were in 1980. Nine countries (Colombia, Ecuador, Honduras, the Netherlands, North Korea, Panama, Senegal, South Africa, and Sri Lanka) experienced no overall change in the weighted mean TL of species produced between 1980 and 2010. Seventeen countries increased the weighted mean TL of their farmed species to more than 3.0 (Algeria, Bahrain, Bosnia Herzegovina, Cyprus, Iceland, Israel, Kuwait, Libya, Malta, Martinique, Mayotte, Netherland Antilles, Papua New Guinea, Réunion, Russian Federation, Sweden, and Turkey). All countries with a weighted mean TL increase to 3.0 and above had no reported mariculture production in 1980.

### 3.3. Assessing the accuracy and distribution of global mariculture data: geographic mariculture trends

The historical global mariculture data in the GMD were attributed to more than 600 different ‘provinces’ in 112 coastal countries between 1950 and 2004, with an additional half-dozen

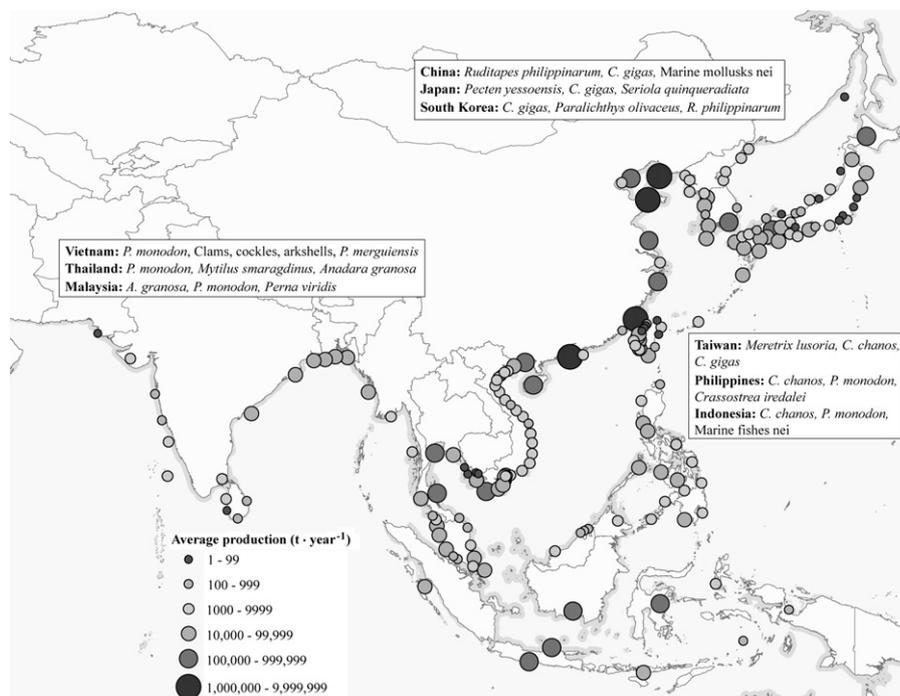
countries beginning commercial production between 2005 and 2010. By comparison, the FAO distributes this historical production across a total of 21 FAO areas [30]. Fig. 3 illustrates the average annual mariculture production in Asia, distributed by province along the coastline of the producing countries between 2000 and 2004. This region, both including and excluding China, has consistently produced the largest quantity of farmed marine and brackish species worldwide since 1950. Note that while finfish and crustacean production is substantial in Asia, particularly with respect to tiger prawn (*Penaeus monodon*) and milkfish (*Chanos chanos*), regional mariculture production has been consistently dominated by bivalves.

In terms of the geographic distribution of this production, while the coastal provinces of many Asian countries experienced an average production in the tens and even hundreds of thousands between 2000 and 2010, China’s top four mariculture-producing coastal provinces (Liaoning, Shandong, Fujian, Guangdong) produced more, individually, than any other maritime country on average in the past eleven years. These provinces reported an annual average production well in excess of million tonnes between 2000 and 2010. Three of these provinces experienced reported production increases of between one-and-a-half and three million tonnes since 1980, of primarily bivalves such as Pacific cup oyster (*Crassostrea gigas*) and Manila clam (*Ruditapes philippinarum*).

## 4. Discussion

### 4.1. Reliability of global mariculture trends

The overall similarity between the FAO and *Sea Around Us* global mariculture production trends—which is in stark contrast to the situation with marine fisheries catches—is encouraging, and might be attributable in part to key characteristics of the industrial mariculture sector. This is a sector predominantly focused on commodity-driven and export-based production, under conditions of private ownership. With limiting economic



**Fig. 3.** Mean annual mariculture production (t) in Asia from 2000 to 2004. Inshore Fishing Area (IFA) is represented as a darker border along the coastline. The text boxes contain the top 3 species produced in the period 2000–2004 for major producing countries. Asia west of Pakistan is not shown here, as their mariculture production is negligible.

and institutional resources, countries with a commercially-viable aquaculture sector may be more amenable to investing in reliable statistical information systems for tracking high-value commodities with the above characteristics than they might be for those with domestically-traded, lower-value, or small-scale aquaculture production, notwithstanding their key roles in rural economies and domestic food security [9]; this has been demonstrated in fisheries [32]. In line with this hypothesis, it was noted that that statistics for commercially higher-value species such as prawns and carnivorous marine finfish were in general much easier to obtain than for other groups, and, unlike lower-value bivalves or finfish, were more often reported at species level.

Unlike in capture fisheries, the vast majority of aquaculture's economically lower-value, domestically-traded, and small-scale production occurs in freshwater inland environments [5]. Indeed, it has been estimated that only one-sixth of such aquaculture production is ever officially reported [43]. This has strong implications for the potential accuracy of the global outlook and status of aquaculture as a whole, i.e., including freshwater aquaculture. Despite aquaculture's obvious historical increase in contributions to the total global food fish supply, when uncertainty over how much fish is produced for food in the freshwater environment is combined with an underrepresentation in reporting from some sectors of capture fisheries, clear conclusions cannot be drawn about the true proportional contribution of either aquaculture or fisheries to global food fish consumption.

While the FAO does not explicitly publish their aquaculture data processing methodology [5,34], another reason for the overall similarities in compared mariculture production trends may be a result of similar global data accessibility and a resemblance between and FAO and *Sea Around Us* data estimation methods. With the GMD dataset, obtaining mariculture production data for some countries, taxa, and years was relatively straightforward; however, approximations were required where it was not. These approximations increase uncertainty in the global, regional, and national production trends outlook. The effects of this uncertainty are most easily illustrated in looking at the strong similarity between compared GMD and FAO regional production trends in Europe, where production data were observed to be reasonably accessible on the whole and required relatively little filling of data gaps.

With respect to the GMD dataset, a strong reliance on electronic media made accessing production statistics challenging when governments did not respond to requests. The FAO reports that compliance from member countries remains moderate at best; as a result, further work or estimation on the part of the FAO staff is often necessary [44]. The FAO estimates that the average annual response rate for countries reporting aquaculture production is around 60%, an improvement from the early 1990s where the average response rate from countries was 40% [12]. Prior to 1985, when FAO aquaculture statistical collections first began [34], aquaculture production statistics were often combined into a more general set of fisheries statistics. It is thus encouraging that the global reconstruction and that of the FAO are generally similar across the time-series, despite discrepancies in the data poor years prior to 1970.

However, it is still possible that both databases may suffer from similar inaccuracies. The main issue here is the ongoing questionable accuracy of Chinese aquaculture production statistics, a subset of a larger issue with the economic statistics that China generates [45,46]. China has been the single largest global mariculture producer for more than two decades and is the world's leading exporter of seafood and fishery products since 2002 [47]. Despite this country's significant role in both fisheries and aquaculture, obtaining reliable production statistics for China is a recognized challenge [48]. A case in point is both the recent and past erroneous reporting in the production of bivalves in

China [16,49]. Bivalves such as clams and oysters comprise a significant proportion of China's national (and therefore global) mariculture production and discrepancies between whole and live weight conversions for three of their major bivalve species [49] have resulted in notable downward revisions to the FAO's reported global mariculture production trends in the past two decades [6].

Thus, despite corrections made to FAO datasets to compensate for these and other reporting errors, a change in Chinese reporting protocols after 1996, and recent improvements in communication between the FAO and the Chinese reporting office [6], it is still uncertain how accurate either the FAO or the GMD dataset is at accurately representing mariculture production in China. These problems with Chinese aquaculture statistics lead to doubts about the accuracy of global mariculture production trends, because of China's enormous contribution to them; indeed, some discrepancies between the analyzed global datasets can be traced back to the availability and accessibility of Chinese data. Given China's dominant global role in both fisheries and aquaculture production and consumption, this also brings into question the accuracy of analyses of global food fish per capita supply which include China. In China, a country with nearly 20% of the global population, the FAO reports that aquaculture supplied 80% of the food fish consumed in the country in 2008, while the rest of the world was supplied with a more modest 26.7% of its total food fish for consumption [5]. Thus, while it has been stated that half the fish people eat is sourced from aquaculture, one must consider that the consumption of aquaculture products is not evenly distributed across the globe. Moreover, fisheries catches around the world have been underestimated in data disseminated by the FAO [14,15,50]; correcting for this underestimation decreases the rest of the world's food fish supply for consumption to about 20% at most.

The second cause for a critical evaluation of the accuracy of mariculture's overall global production trends relates to a lack of clarity in some aspects of the statistical reporting process at both the national and international level. Due in part to aquaculture's rapid rate of worldwide growth and expansion and to the relative newness of commercial-scale industry in many countries, the development and maintenance of statistical systems for aquaculture has not kept pace with a growing and diversifying demand for data [3,12,51]. This lack of clarity arises primarily in the statistical reports of many countries, the contents of which are submitted to the FAO for compilation and analysis. Notably, there is often a lack of clarity and transparency in terms of what is and is not being reported as 'aquaculture', if reported at all. Some of this confusion arises from ambiguities in the statistical definition of aquaculture. Following the FAO's establishment of aquaculture statistics distinct from those of capture fisheries, the FAO has developed a handbook of standardized definitions and concepts to which countries can commonly adhere in their diverse reporting frameworks [52]. However, in practice, the interpretation of these definitions varies between countries. For example, it was observed that the harvest of extensively-reared bivalves is reported as aquaculture in some countries and as capture fisheries in others. This issue is often further compounded by a lack of standardization in the statistical reporting structures at the country level. This issue occurs in developing and developed countries alike, and from low-value, extensively-raised species to among some of the most intensively produced and highest-priced species.

This lack of definitional clarity has also likely contributed to those global and regional discrepancies in mariculture production observable between the *Sea Around Us* and FAO datasets. With respect to the impact of this issue on global production trends, it is possible that trends reported by the FAO prior to 1970 represent an overestimate of actual mariculture production due to the inadvertent inclusion of capture data for bivalves and

brackishwater finfish. Conversely, the difficulty in obtaining a usable estimate of ‘aquaculture’ production prior to 1980 means that the GMD database’s conservative trend of global mariculture production possibly represents an underestimate of actual production during these decades, particularly prior to 1970.

After 1980, however, it is likely that the global and regional production trends reported by the FAO provide a reasonable estimate of historical mariculture production trends (thereby reducing one source of information uncertainty). However, when considering more localized trends, there are indications observed in this analysis, as well as in reported statistics and additional supplemental information, that mariculture production statistics may be variously underreported, reasonably accurate, or over-reported by as-yet unknown amounts depending on the country [17,53]. Thus, the likely accuracy of national mariculture production statistics, and the associated implications to food fish supply and environmental resource use, should continue to be carefully considered for a given country before its reported trends are evaluated.

Although it is prudent to remain aware of uncertainty when examining global, regional, and country-level mariculture production trends, the dramatic worldwide increase in production in a few short decades is indisputable. What is also evident is the temporal trend of global increase in the weighted mean trophic level of mariculture production, indicating “farming up the food web” [37,38]. The weighted (by production) mean trophic level remains low due to the bulk of global mariculture production consisting of bivalves with a TL of 2.0 and omnivorous, brackish finfish and crustaceans with TLs between 2.0 and 3.0. However, there is also a considerable upward ‘pull’ from greater quantities of high-trophic level finfish being farmed worldwide since 1980. Another reason for this result is that the trophic levels used are derived from feeding habits in the wild, and not from artificial feed (which may contain meat or fish meal). Computing the TL of feed, as stated above, is a complicated undertaking, and was not attempted here. It is of note however, that the results yield a mean TL range that overlaps with the TL range obtained (i.e., TL 2.4–2.75) in an analysis of all aquaculture environments up to 2006 [39].

As national aquaculture datasets around the world continue to improve with time and data needs become greater, individual countries, the FAO and the *Sea Around Us* continue to recognize and address ongoing issues of quality and reliability of fisheries and aquaculture data. While the mariculture data compiled for this analysis have shown that reported historical mariculture production provide a reasonably representative outlook in trends, more remains to be done in regards to increasing the quality and the resolution of reported data for use in analysis and policy in some regions and countries. The *Sea Around Us* Global Mariculture Database has taken a crucial step in this regard.

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