Marine Pollution Bulletin 89 (2014) 5–11

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Viewpoint

The past and future of fish consumption: Can supplies meet healthy eating recommendations?

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ARTICLE INFO

Article history:
Available online 26 September 2014

Keywords:
Aquaculture
Healthy eating
Historical ecology
Omega-3
Sustainability
UK fisheries

ABSTRACT

In many developed countries fish and shellfish are increasingly promoted as healthy alternatives to other animal protein. We analysed how much fish was available to UK and global populations after accounting for processing losses, and compared this to recommended levels of fish consumption. In 2012, UK domestic fish landings per capita fell 81% below the recommended intake, although declines were masked by increased imports and aquaculture from the 1970s onwards. Global wild fish supply per capita declined by 32% from its peak in 1970. However, overall fish supplies per capita increased by 10% over the same period due to rapidly expanding aquaculture production. Whilst aquaculture has so far prevented a downturn in global fish supplies, many developed nations continue to aspire to consume more fish than they produce. Until demand is balanced with sustainable methods of production governments should consider carefully the social and environmental implications of greater fish consumption.

1. Introduction

Fish constitute a major source of animal protein in many nations, with some countries, for example Bangladesh, the Solomon Islands and Indonesia, relying on fish for over half their animal protein intake (Kawarazuka, 2010). However, in recent years a crisis has developed in global fish supply (Watson et al., 2013). Commercial fish stocks are experiencing widespread collapses and the rate is accelerating (Worm et al., 2006). Predator species are particularly vulnerable to the effects of fishing, with estimates of more than 90% decline in predator biomass in coastal areas of the North Atlantic and North Pacific in the last 50 years (Tremblay-Boyer et al., 2011). The last 50 years have also seen expansion of fisheries across the Southern Hemisphere and further offshore (Swartz et al., 2010), whilst demersal fisheries have expanded to targeting species at greater depths, for example, deep water species such as orange roughy (*Hoplostethus atlanticus*) and blue ling (*Molva dypterygia*) (Morato et al., 2006). These patterns demonstrate that current exploitation rates are unsustainable. In addition, as marine biodiversity declines the quality of ecosystem services we receive are reduced and future recovery of marine communities becomes less likely (Sala and Knowlton, 2006).

In recent decades the health benefits of eating fish have also become better appreciated. Fish protein (including shellfish) is typically lower in saturated fats than red meat, whilst oily fish is high in essential fatty acids (Calder, 2004). Research suggests that a diet rich in fish protein lowers the risk of cardiovascular disease, whilst omega-3 fatty acids are critical for neurological development and health (Daviglus et al., 2002). Fish is also high in dietary nutrients such as calcium, selenium and zinc (Sheeshka and Murkin, 2002). These properties have led to recommendations by various national and international bodies on how much fish we should eat to benefit health, with examples we found ranging from 97 to 550 g capita^{-1} week^{-1} (Table 1).

In this paper we explore historical patterns of fish supply to ask whether there are enough fish to go around to meet health aspirations, both now and into the future. In the United Kingdom, records of domestic fish landings and imports were recorded annually from 1888, presenting a useful case study to illustrate broader patterns in developed nations' fish consumption. These records allow us to determine patterns in fish availability (i.e. quantity of fish per capita) over a period of 124 years as national landings have declined and the UK's population has increased. We examine these patterns in the context of national recommendations on how much fish people should consume for good health. We then use fish production data published by the World Food and Agriculture Organisation and other literature to quantify global fish supply from 1950 to 2012. Using these global data alongside detailed historical

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http://dx.doi.org/10.1016/j.marpolbul.2014.09.016
0025-326X/

records from the UK, we consider the global implications of fish-importing nations recommending higher levels of fish consumption than they can meet from domestic supplies.

2. Methods

2.1. UK fisheries supply

To quantify UK (including Ireland until 1921, and Northern Ireland thereafter) fish supplies for the period 1888 to 2012, we obtained figures for domestic landings of finfish and shellfish by UK vessels from annual fisheries statistical tables (Table 2). Landings of finfish were reported as the weight of head on, gutted fish. Prior to 1965 many shellfish landings were provided in numbers of individuals rather than weight. We converted these to metric tonnes either using guidelines present in the statistical tables or by estimating the average weight per specimen based on the results of literature searches. We gathered figures on UK aquaculture production from the FAO FishStat Plus database (FishStat, 2013); these included marine, freshwater and brackish aquaculture production. To adjust UK fish supply for imports and exports, we gathered import and export data for the whole of the UK from the Ministry of Agriculture, Fisheries and Food (MAFF) statistical tables. We did not include fish products such as fish meals and oils as the vast majority are used for livestock and aquaculture feeds rather than direct human consumption (Naylor et al., 2009).

Fish supply is usually quoted as gross tonnage (FAO, 2012), but such figures overstate what is available for consumption. To determine the overall weight of fish actually available for human consumption, we converted landed weight of fish to processed weight using conversion weight ratios produced by HM Revenue and Customs (2010) (HMRC) in consultation with the National Federation of Fishmongers. We used HMRC estimations of the proportion of usable whitefish (cod, codling, haddock, hake, ling, whiting, lemon sole and plaice) and herring after conversion to fillets as a proxy conversion factor for all finfish. The conversion factor from whole fish (head on, gutted except for herring which is usually landed whole) to fillets with skin averaged 0.49 (S.E. 0.02) edible proportion by weight. Shellfish conversion weights were an average of the different conversion rates for all shellfish provided (lobster, prawn, langoustine, shrimp, cockle, mussel, oyster, scallop, whelk and winkle). The average conversion factor for shellfish was 0.28 (S.E. 0.05) edible proportion by weight. Whilst some imports include whole fish, many are already prepared in some measure (e.g. frozen fish fillets, processed fish cakes, shelled prawns, etc.), so no conversions were applied to imported weight (Agriculture and Agri-Food Canada, 2011; Seafish Industry Authority, 1991; United Nations, 2010).

To calculate UK annual fish supply per capita we acquired British human population data from censuses produced by Histpop (2010) and the Office of National Statistics (2014) for the period 1881–2011. Histpop provided census data every 10 years from 1881 to 1931 and the Office of National Statistics provided census data every 10 years from 1971 onwards. We interpolated between data points to provide yearly population estimates of adults and numbers of children under 15 years old. The Central Statistics Office (2014) provided annual Irish and Northern Irish population data for the period 1891–2008 (until 1921 the population of the UK included all of Ireland, from 1922 just Northern Ireland).

2.2. Global fish supply

To quantify global fish supplies, we obtained data on global capture fisheries and aquaculture (freshwater, brackish and marine) production from the United Nations Food and Agriculture Organisation (FAO, 2009, 2012) and FAO FishStat Plus (FishStat, 2013). We disregarded landings of aquatic plants, marine mammals and inedible species (e.g. corals, sponges) from the analysis, as these are not sources of fish protein and thus were assumed not to contribute to fish intake recommendations. Fish production was separated into finfish and invertebrates and corrected for processing losses using the formula from HMRC. Whilst we recognise that processing losses will vary around the world as a result of the different species landed, cultures, markets and processing techniques, we used these conversion rates to account for the fact that some degree (however variable) of processing loss will occur. To calculate fish supply per capita we obtained annual world population estimates from 1950 to 2012 from the Population Reference Bureau (PRB, 2013). The global population was also adjusted to account for the assumption that children under 15 need to consume half the quantity of fish.

2.3. Quantifying fish production needs based on health recommendations

The UK Food Standards Agency recommends that people eat 280 g of fish/shellfish per week (Food Standards Agency, 2010). To determine whether the UK's fish supplies are sufficient to meet

Table 1
National dietary guidelines for fish consumption.

Country	National guidelines	Recommended amount (g wk^{-1})	Source
United Kingdom	2 portions (140 g each) per week, one of which should be oily	280	Food Standards Agency (2010)
United States	2 average meals (6 oz each) per week, not including species high in mercury	340	U.S. Food and Drug Administration (2014)
Australia	2–3 servings per week (150 g each) not including species high in mercury	375	Food Standards Australia New Zealand (2013)
New Zealand	2–3 servings per week (150 g each) not including species high in mercury	375	Food Standards Australia New Zealand (2013)
Canada	At least 150 g each week	150	Health Canada (2011)
Denmark	200–300 g fish per week	250	WHO (2003)
Iceland	300 g fish per week	300	Gunnarsdottir et al. (2009)
Austria	1–2 portions per week (total 150 g)	150	WHO (2003)
Germany[a]	1 portion of seafood per week	100	WHO (2003)
Greece[a]	5–6 servings per week	550	WHO (2003)
Georgia	12.8–15 g fish per day	97	WHO (2003)
Ukraine	20 g fish per day	140	WHO (2003)
Estonia	2–3 servings per week (50 g each)	125	WHO (2003)
Armenia	30 g fish per day	210	WHO (2003)

[a] Specific portion size not provided, assumed that one portion equals 100 g.