Is aquaculture growth putting pressure on feed fish stocks? And is the growth of aquaculture being restricted by finite supplies of fishmeal and fish?

Key points

1. The supply of marine ingredients is likely to be relatively static going forward at about five million tonnes of fishmeal and 1 million tonnes of fish oil per annum – except in El Niño years when production will be less.

2. There is an increasing proportion, 25% and rising, of fisheries by-products in the raw material from which they are produced. There is, therefore, both a lower proportion,75% and falling, and use in tonnage terms, of wild caught feed fish.

3. Usage of fishmeal has switched from mainly pig and poultry feed to mainly aquafeed. Usage of fish oil has moved from , mainly production of hydrogenated fats (for margarine) to use in aquafeed and in direct human consumption (e.g. fish oil capsules).

4. Usage of fishmeal and fish oil in aquaculture has actually been steady or declining slightly in recent years as they are being used more strategically (at critical stages of the life cycle) , more efficiently (the same amount of wild fish yields more farmed fish, via fishmeal and fish oil in feed), and they are being increasingly substituted with vegetable protein and oil ingredients.

5. It seems unlikely there is a 'fishmeal trap', meaning that aquaculture growth will not be limited by the availability of marine ingredients . There is enough fishmeal for aquaculture going forward and alternative ingredients are being used and developed. However fish *oil could* become limiting as there is also rising demand for its healthy long chain (LC) omega-3s for human consumption, pending availability of new sources - *see panel at the end of this article.*

6. Feed fish stocks are now much less vulnerable due to the continuing moves to precautionary fishery management in most part of the world including US, Europe and South America. This continuing trend is likely to see volumes of marine ingredients remaining static, particularly as more pelagic fish are going for direct human consumption.

7. Third-party certification of marine ingredients by producers to reassure the value chain on responsible fisheries management and good manufacturing practices is on the increase. This includes IFFO's ISO65-accredited RS programme for factories which, by autumn 2012, had certified 40% of global production of fishmeal and fish oil as responsibly sourced and manufactured IFFO RS. There are still areas for improvement, especially the use of low value/trash fish fed to aquaculture in Asia, now the focus of international initiatives to develop more responsible practices.

Aquaculture output is growing at 6.6%[i] per cent per annum worldwide. Most farmed seafood diets include fishmeal and fish oil. Some commentators are concerned that, as aquaculture continues to seek to expand:

I. Its growth will be restricted by the limited supplies of fishmeal and fish oil
II. High demand for fishmeal and fish oil will result in increased fishing pressure on wild feed fish stocks.

Q. What are the basic figures on use of fishmeal and fish oil, and how much whole fish is used to produce this?

Diagram 1: Mass balance of marine ingredient production 2010 [ii]

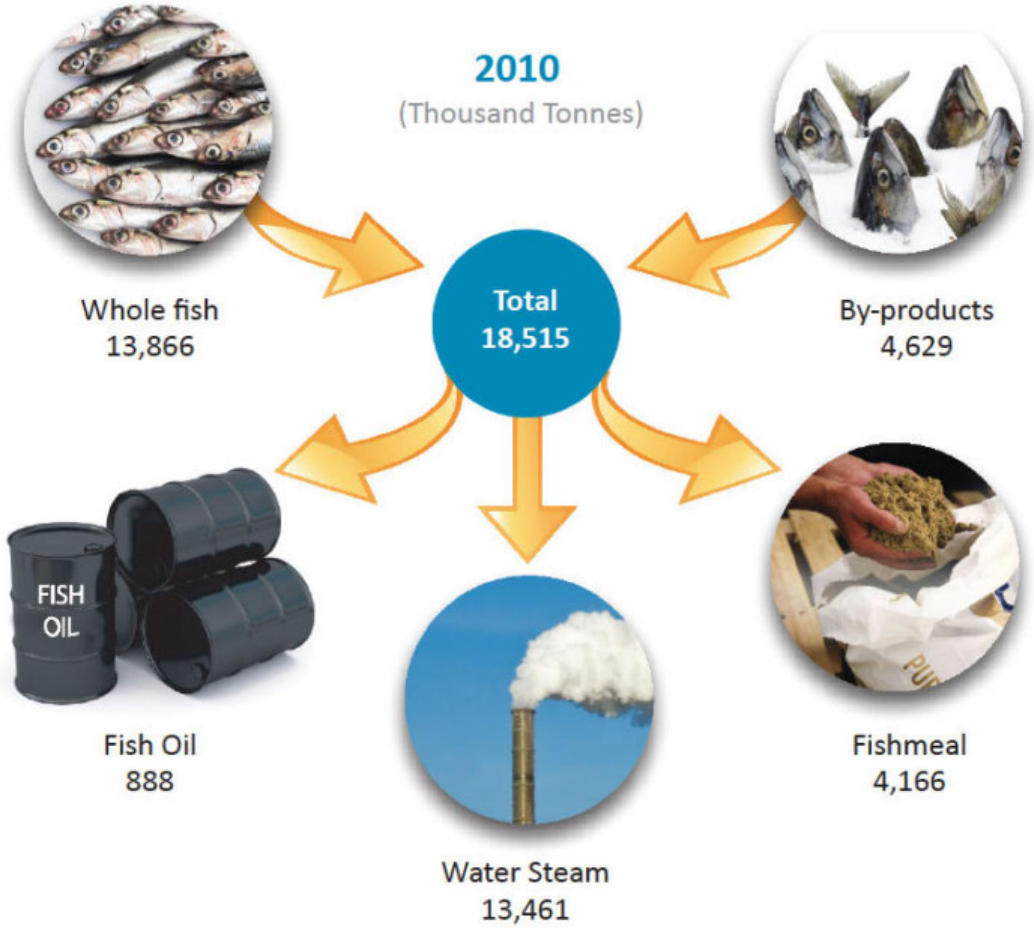


Diagram 1 shows that about 14M tonnes of whole (feed) fish and 4.6 million tonnes of by-products seafood processing (frames, guts, skin etc) were used in 2010 to produce 4.2 million tonnes of fishmeal and 900,000 tonnes of fish oil. Also surveys by IFFO show that the proportion of by-products in the raw material is increasing, from about 12% in 2000 to 25% by 2010. By-product use recycles what was waste into feed.

Q. Are the uses of fishmeal and fish oil changing? Why is aquaculture so important?

Diagram 2: Changing uses of fishmeal from land animal feed to fish feed 1960 to 2010

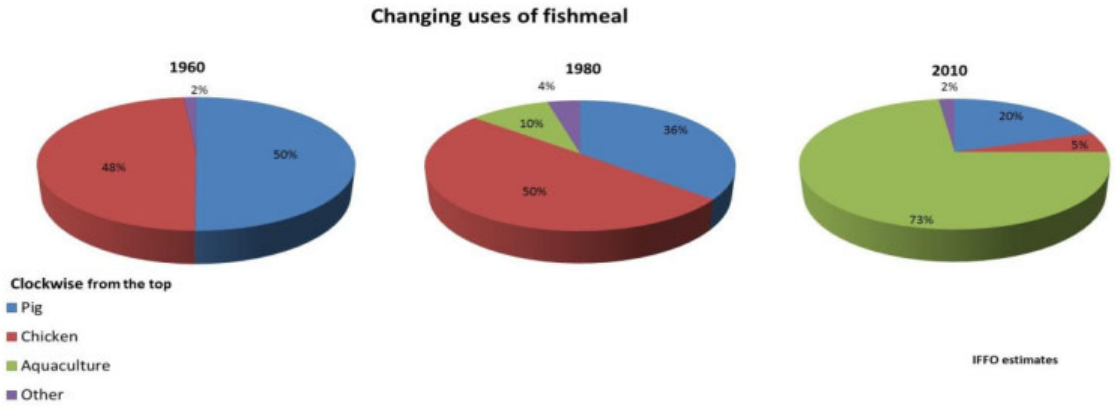
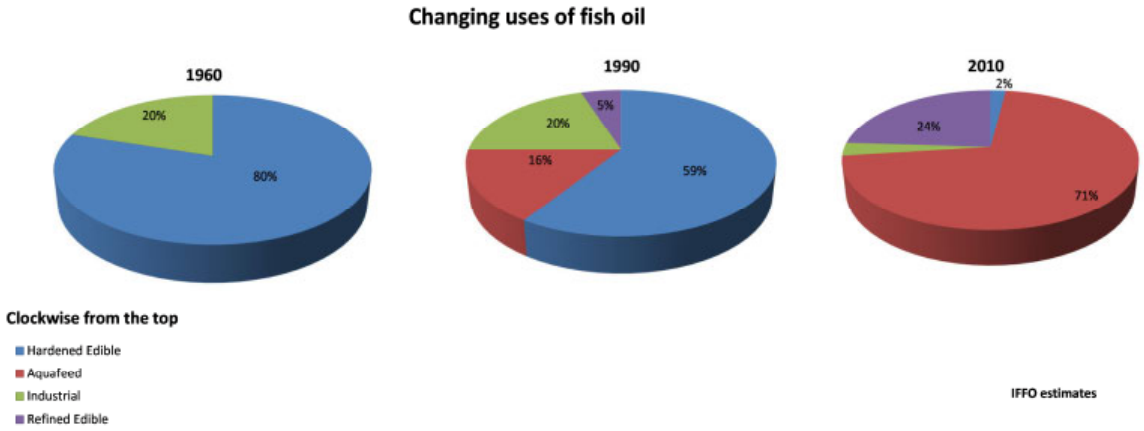


Diagram 3: Changing use of fish oil from hydrogenated fat to aquaculture and direct human consumption 1960 to 2010



There have been massive changes in the use of both fishmeal and fish oil. In 1960 98% of fishmeal was used in pig and chicken diets - diagram 2. By 2010 that had shrunk to 25%, and 73% of fishmeal was being used in aquaculture feed.

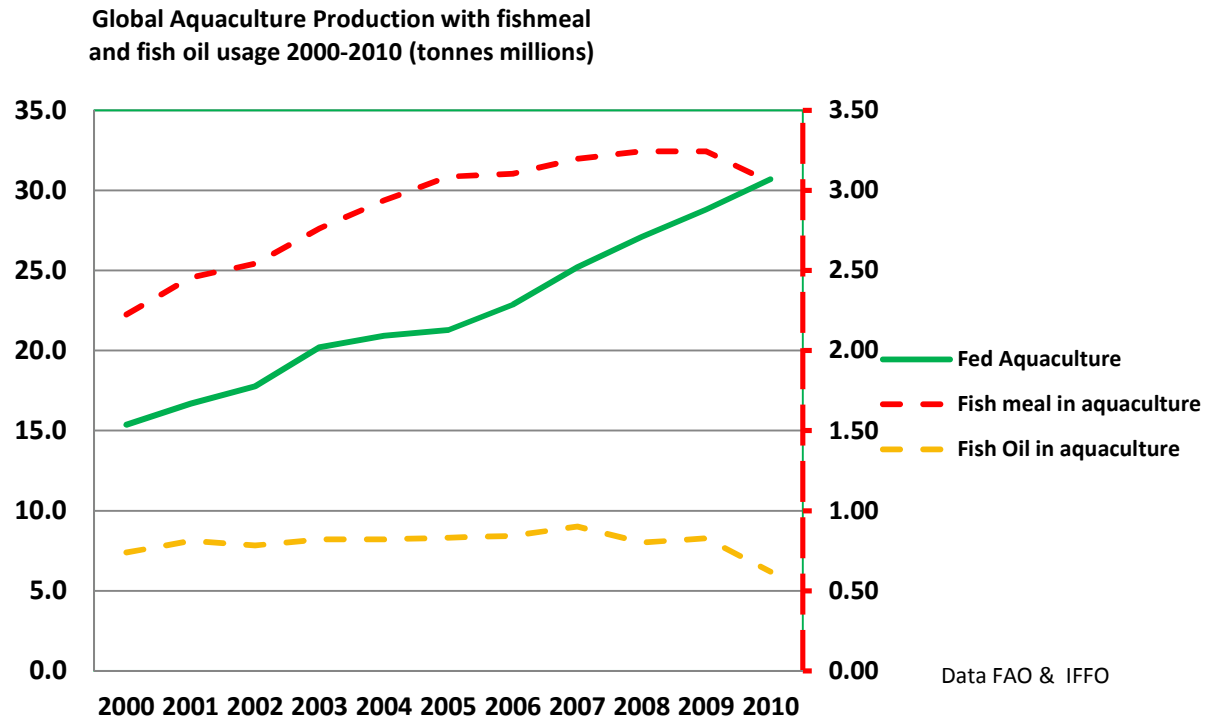
In 1960 80% of the oil was hydrogenated to make hardened edible fat (margarine) and 20% used in industry - diagram 3. The market for fish oil in aquaculture feed or to be refined for direct human consumption such as capsules and additives were virtually non- existent. Yet by 2010 71% was used in aquaculture and 24% was being refined for human consumption

To sum up: aquaculture is important in the context of the usage of fishmeal and fish oil because by 2010 aquaculture was using 73% of global production of fishmeal and 71% of fish oil. The human consumption market for refined fish oil is also expanding rapidly.

Q. But is total use of fishmeal and fish oil in aquaculture diets increasing?

A. Essentially not. The green line on the graph from Jackson and Shepherd [iii] below shows the steady expansion of *fed* aquaculture since 2000. The red and yellow dotted lines show use of fishmeal and fish oil in aquaculture globally over the same period. Use of fishmeal (red) has remained fairly constant at around 3 million tonnes since 2004. Use of fish oil (yellow) has been fairly static since 2000 at around 800,000 tonnes.

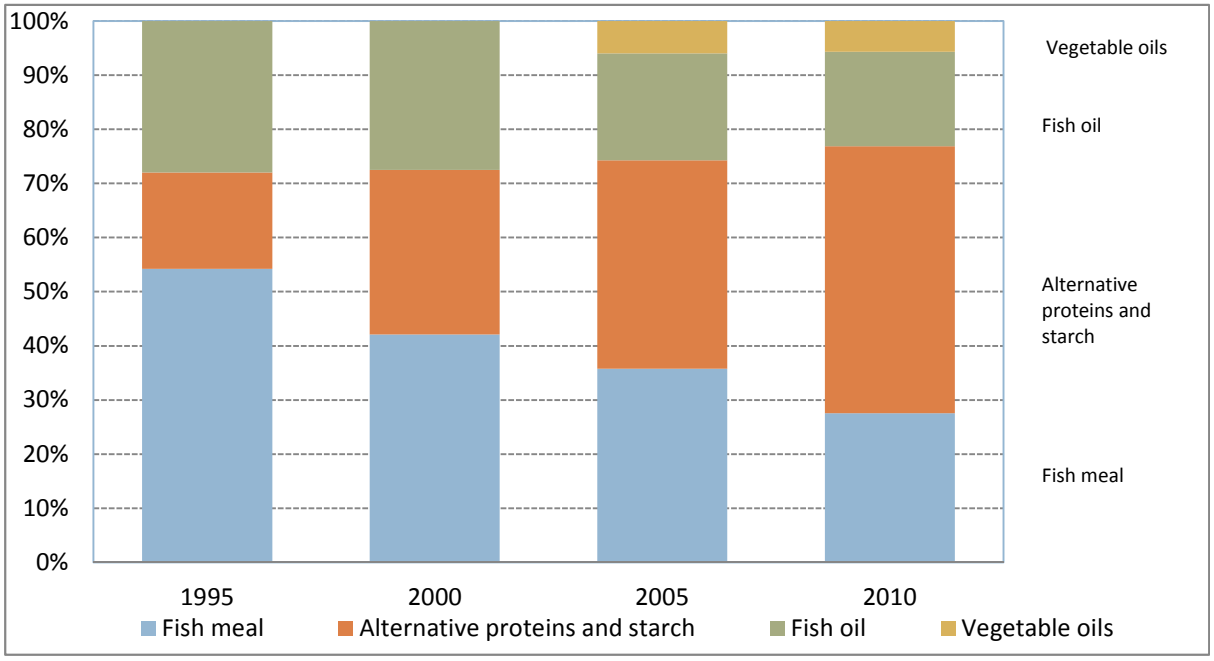
Diagram 4: Fishmeal and fish oil consumption in relation to growth of 'fed' aquaculture



So the concern that expanding aquaculture is currently using more and more fishmeal and fish oil is misplaced. While fishmeal and fish oil's exceptional qualities including high levels of healthy omega-3s, vitamins and trace elements and lack of anti-nutritional factors are highly valued - producers of aquafeeds had recognised by early this century that supplies of these ingredients were finite. Sustainable production from well managed fisheries had a ceiling of about 5 million tonnes of fishmeal and 1 million tonnes of fish oil per annum.

The result is that fishmeal and fish oil are being used more efficiently, more strategically at lower levels (i.e. in fry and brood stock diets) and, in part, substituted by alternative ingredients. The total amount required has levelled off. Diagram 5 shows how fishmeal and fish oil have been substituted with alternative vegetable oils, proteins and starches.

Diagram 5[iv]: Changing composition of salmon feeds over time with substitution of fishmeal and fish oil



(UPDATE: For 2013 inclusion is 15 % fishmeal and the oil content is 1/3 fish oil and 2/3 vegetable oil . Some major producer grower diets are down to 10 % fishmeal.)

Diagram 6 shows the improvements in efficiency of conversion from wild feed fish to farmed seafood. In 2000 2.6 kg of wild fish were used for each kg of farmed salmonid (salmon and trout) produced. By 2010 this had fallen to 1.4kg. On many salmon farms only one kg or less of wild fish is used for each kilogram of salmon produced.[v] Overall fed aquaculture produces three times more fish by weight than it uses in feed, in the form of fishmeal and fish oil.

Diagram 6. Estimated changes in "Whole Fish-In: Whole Fish-Out" (FIFO) ratios based on mass balance.

Farmed Fed Category	2000	2010
Eels	3.0	1.8
Salmonids (including trout)	2.6	1.4
Marine fish	1.5	0.9
Crustacea including shrimps & crabs	0.9	0.4
Tilapia	0.3	0.2
Other fed freshwater fish (e.g. catfish & pangasius)	0.6	0.2
Fed Cyprinids	0.1	0.1
Total for fed Aquaculture	**0.6**	**0.3**

Q. But how well are feed fisheries being managed?

A. UN FAO figures[vi] report that in 2008 32% of global fisheries were overexploited, depleted or recovering stocks. Unregulated, or even illegal, large fishing vessels are one cause of the problem. Feed fisheries have often been referred to as 'industrial' fisheries leading to the mistaken view that it is feed or forage fishing alone that uses such large vessels and industrial methods. Perhaps these points together contribute to concern that feed fisheries are overexploited.

The fact is that the days of unfettered and unregulated fishing are largely behind us. There is a continuing move towards precautionary fisheries management. Controls to protect fish stocks and the wider environment are in place, becoming more sophisticated and are under constant review and development. For example, in relation to feed fisheries:

- ANCHOVY: Peru was rated best country in the management of its fishery resource (mainly anchovy for feed) by a 2008 University of British Columbia[vii] international study. The Peruvian anchovy fishery is the world's largest fishery.
- JACK MACKEREL: In 2012 ratification by Chile of the South Pacific Regional Fisheries Management Organization (SPRFMO) made it legally binding, which means the widely scattered countries of the Pacific can manage stocks for future generations and the depleted jack mackerel stock now stands a strong chance of recovery.
- ALL FEED FISH: The fishmeal industry working with many different stakeholders including environmental NGOs introduced an independently audited ISO65 accredited certification programme in 2009 for fishmeal factories (the IFFO Global Standard for

Responsible Supply or IFFO RS). By summer 2012 more than 60% of fishmeal and fish oil production by IFFO members had achieved certification, encompassing responsible sourcing of the feed fish raw material. These and other fisheries certification programmes, such as those of the Marine Stewardship Council, GAA Best Aquaculture Practice (BAP), Aquaculture Stewardship Council and Global GAP are raising both awareness and implementation of responsible practice.

There are still areas for improvement, especially the use of low value/trash fish fed raw to aquaculture in Asia. Typically mixed fishery trawling in Asian tropical waters is not well controlled and produces a raw material which contains many different species often juveniles of high value fish. This material is either fed directly to farmed fish or increasingly used to produce fishmeal and fish oil which is used in formulated aquaculture feeds. Efforts are being made by many organisations including the UN FAO, Sustainable Fisheries Partnership, International Sustainability Unit and IFFO to encourage improved practices in this critical area.

OMEGA-3 IMPLICATIONS OF HIGH DEMAND FOR FISH OIL

Maintaining omega-3 levels in farmed fish

Fish oil is the main natural source of the healthiest omega-3s, EPA and DHA. Increasing demand for fish oil for direct human consumption (e.g. capsules and additives) will contribute to driving higher fish oil prices and lower inclusion rates in feeds for farmed seafood. This is already resulting in lower LC omega-3 levels in some aquaculture products, such as salmon fillets. Also because the feeds now contain more vegetable oils and proteins, farmed seafood has higher omega-6 levels. Most of us already have sufficient omega-6 in our diets, and too much inhibits uptake of the healthier omega-3s.

Taking salmon as an example, the broad guideline - that a portion of salmon weekly meets international health authority guidelines on human omega-3 intake - may not be achieved by all salmon products because there will be less fish oil in their diets.

It therefore seems likely that some retailers will wish to differentiate their products by insisting that their salmon continues to have high levels of fish oil in the diet so that they can promote their products as “the healthiest farmed salmon”. Meanwhile, other more price sensitive retailers will market their salmon as “value salmon” and reduce the health claims, thereby allowing further reductions in the fish oil content of the diet.

New sources of LC omega-3s.

Genetically modified (GM) plants, krill oil and algal oil seem the most likely alternative sources of high omega-3 oils.

It is unlikely that LC omega-3 demand will be met by GM crop expression in next five years (from 2012). There is no EPA and DHA from land plants available today and unlikely to be significant volumes on the market by 2017. But the potential for production to increase rapidly once techniques have been developed means that in ten years volumes could be considerable.

Algal oil is already entering human nutrition and pharmaceuticals. Production of oil with 30% EPA/DHA equivalence was around 5000 tonnes in 2011 and likely to be around 30,000 tonnes per annum by 2017. The growth of krill harvesting is rapid but total volumes likely to be under 5000 tonnes per annum of oil by 2017.[viii]

Last revised February 2013

References

[i] The State of World Fisheries and Aquaculture, UN FAO 2010

[ii] Production data is based mainly on published information from FAO and from unpublished information from the statistical database of IFFO based in turn on members' data returns. Note that production of 1 kg of fishmeal requires 4 - 5 kg of whole fish, whereas production of 1 kg of fish oil requires 20 – 25 kg of whole fish.

[iii] C.J. Shepherd & A.J. Jackson, Global fishmeal and fish oil supply - inputs, outputs, and markets. 6th World Fisheries Congress, Edinburgh 2012.

[iv] Personal communication from Niels Alsted, Executive Vice President of R&D, Sourcing and Business Development, Biomar

[v] Wild fish in, Farmed Fish Out - FIFO Position Statement

[vi] The State of World Fisheries and Aquaculture, UN FAO 2010

[vii] A Comparative Assessment of Biodiversity, Fisheries and Aquaculture in 53 countries' exclusive economic zones, Edited by Jackie Alder and Daniel Pauly , Fisheries Centre University of British Columbia, Canada Research Reports , 2008 Volume 16 Number 7. ISSN 1198-6727

This Position Statement drew also on the following published paper: C. J. Shepherd, Aquaculture: are the criticisms justified ? Feeding fish to fish. World Agriculture Vol 3 No 2: 11-18