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## The role of fisheries and aquaculture in a circular food system

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Recent studies show that animals fed solely with low-opportunity-cost feeds (LCF), products currently considered unsuitable or undesired for human consumption, can contribute significantly to human nutrient supply. So far, studies on the role of animals in such a circular food system focussed on livestock, while fish can make a valuable contribution through their supply of animal-source food (ASF) rich in essential  $\omega$ -3 fatty acids ( $\omega$ -3EFA). Here we assessed the potential contribution of capture fisheries and aquaculture (i.e. farmed salmon and tilapia) to a circular food system, using the EU-28 as a case study. The contribution of fisheries was assessed through multiple sustainable fisheries scenarios. The contribution of aquaculture was determined by the availability of LCF and their competitive advantage in upcycling them compared to livestock. Such advantages are the supply of  $\omega$ -3EFA in fish, a high feed efficiency and legality to feed processed animal proteins banned as livestock feed. Aquaculture's contribution was assessed with an optimisation model that allocates LCF available in the EU to that combination of animals that maximises human digestible protein (HDP) supply, given that human population requirements regarding vitamin B12 and  $\omega$ -3EFA are met. Results show that in the proposed circular food system, fish consumption (20 g/cap/d), aquaculture production (2.8 million tonne fish meat) and food supply from EU fisheries (4.5 g/cap/d) are higher than currently in the EU. Fish provided all  $\omega$ -3EFA, of which 55% through farmed salmon, which depended on fisheries for  $\omega$ -3EFA containing feed. Overcoming this dependency on fisheries for  $\omega$ -3EFA is essential for nutrition security. While aquaculture is essential to  $\omega$ -3EFA supply and able to upcycle animal based LCF, livestock, especially dairy cattle, is more efficient at protein provision. Under the abundant protein supply in the EU, however, the ability to supply essential nutrients that can only be derived from ASF (e.g.  $\omega$ -3EFA) is more valuable and should be prioritised. Fish, therefore, belongs to balanced diets with respect for our planet, which requires a combination of livestock and fish production systems, that use available LCF efficiently.