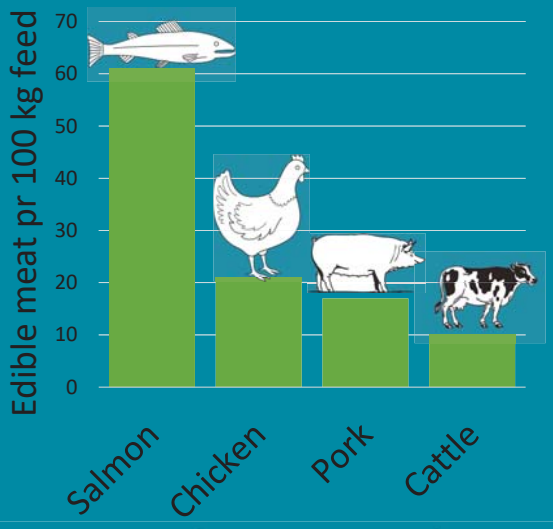
Feeding the world with seafood

Can farmed seafood be a sustainable food source?

Why Aquaculture?

- Preventing overfishing
- Increased animal density
- Less freshwater required
- High energy efficiency



Difficulties with aquaculture

- ***Feed contents***

  Lack of marine resources to prodce fishmeal/oil

- ***Dissolved nutrients***

  Increased growth in seaweed and kelp, which leads to eutrophication

- ***Animal welfare***

  Environmetal conditions, diseases, handling and cleaner fish

- ***Escaped fish***

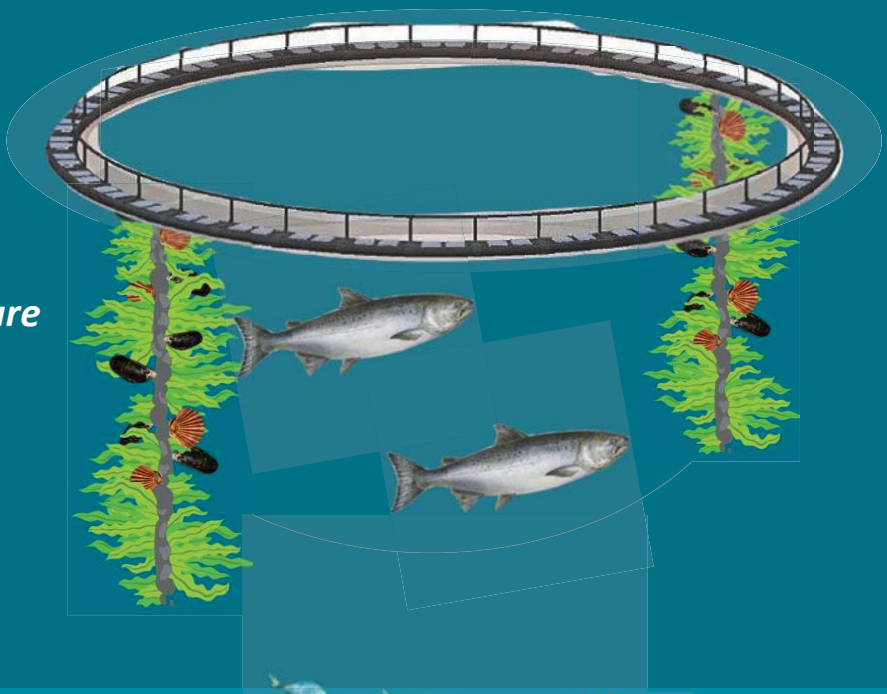
  Genetic influence and can spread diseases

- ***Drugs and foreign substances***

  Effects on non-target organisms

The future of aquaculture

- ***Mariculture of algae***
- ***Aquaculture of filter feeders***
- ***Utilization of seafood waste***
- ***Integrated multi-trophic aquaculture***



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Feeding the world with seafood

In April 2019, the world population reached 7.7 billion (United Nations, 2017). While it keeps increasing, the demand for food rises and it relies heavily on oceans as a protein source. Today, in total, 17 percent of the protein people consume comes from the sea. According to Seafood from Norway in 2019, this is set to rise by 40 percent by 2050. This enormous pressure has led to the development of alternative ways of using marine resources for feed. In 2014, more than half of the seafood came from aquaculture (Belton et al, 2018), and it is estimated that by 2030 almost two thirds will be farm-raised (The World Bank, 2014). About 71% percent (Williams, 2017) of the earth's surface is covered with water, which means that the potential in aquaculture is huge. This essay will thus analyze if **It is possible to feed the growing population by expanding and improving the aquaculture industry?** We will first present the various issues and advantages of such a food production system. Secondly, we will analyze and discuss the feasibility of the expansion of aquaculture.

Today's farmed species include everything from large fish to shellfish and aquatic plants. The advantages of aquaculture, compared to agriculture are many, and include economic growth, greater production per area, and less fresh water required. Furthermore, the increase in aquaculture may prevent overfishing, which is an important factor in SDG 14. Another aspect is that the energy efficiency in aquaculture is substantially higher than land-based animal farming. As an example, the edible meat you get per 100 kg of food is 61 kg for a salmon versus 4-10 kg for cattle (ArcticFish, 2019). In addition, eating seafood is very healthy. Seafood is generally low in saturated fats, carbohydrates and cholesterol. In fact, fish provides 50-60 percent of the daily protein requirements for an adult in a portion of only 150 g (Food and Agriculture Organization of the United Nations, 2014).

However, to expand aquaculture and at the same time provide enough protein for the growing population in a sustainable way, there are problems that need to be solved.
One of the several major challenges is eutrophication. Excess supply of nutrients from fish farming occurs from overfeeding, dead fish and the fish's feces, amongst others. These nutrients are flushed into the surrounding waters and lead to increased algae growth, sedimentation on the bottom and reduced visibility in the water. This can further lead to an increase in decomposition of biological material which makes the surrounding waters lack oxygen (Miljødirektoratet, 2017). The increase in nutrients can also lead to the occurrence of toxic algae. Fish farms are improving their monitoring of the release of nutrients with new technology. However, with an increase in fish farms, the problem will get bigger. It is estimated that a fish farm with 200,000 salmon releases nutrients and fecal matter equivalent to sewage generated by up to 60,000 people (World Watch Institute, 2019).

There is also concerns with the feed used in aquaculture. The pellets given to farmed fish in Norway consists of vegetable commodities, fishmeal and fish oil (Laksefakta, 2018). While in 1990, 90 % of the ingredients in Norwegian salmon feed were of marine origin, in 2013 this was only 30% (Ytrestøyl et al, 2015). The limited access of marine resources to be used in production of fishmeal and fish oil, makes it challenging to expand the farming of carnivorous species.

Finally, there's also problems related to escaping from the farms. Farmed animals are usually part of a breeding program, and thus can have a genetic composition that's not fit for life in the wild. When these breed with the wild population, it can lead to reduced survival of the offspring (Araki et al, 2007). Species that's not natural occurring in this area but farmed there can also escape and do harm to the ecosystem.

We will now present several ways aquaculture could be used for food production in a more sustainable way, to reach not only Goal 14, but also the ones related to hunger (SDG 2), land issues (SDG 15), sustainable consumption (SDG 12) and job creations (SDG 8).

Today's fishing techniques generate an incredible amount of waste: more than 30 million tons per year, including waste during processing and at retail level. The main suggestion would thus be to reduce this waste or/and utilize it. Since most of it comes from by catches, the selectiveness of the current gears is the main point of improvement. With tools which avoid "spatial and temporal overlap of targeted and non-targeted species" (SAPEA, 2017, p. 91), the losses could be drastically reduced.
Then in terms of utilization of the remaining waste, it is likely to be "more suitable as biomass for feed (fishmeal/oil) than direct human consumption" (SAPEA, 2017, p. 91-92). Aquatic biofuels are also part of the options put in the table by the FAO. When mixed up with methanol, the leftover gut can generate biodiesel which can benefit both the local populations and the fish farmers' income (FAO, n.d).

The second solution concerns the mariculture[1] of filter feeders, such as oysters and blue mussels. Many of the shellfish species are already well established as a food source all over the world and can contain nutrients which are good for human health. These organisms do not require artificial nutrition since they feed on nutrients they extract from the water, which deals with the problem of feed production. (SAPEA, 2017). It also responds to the target 14.1 which focuses on reducing nutrients pollution (UN, n.d), as no added feed would reduce the unwanted blooming of algae. One of the complications arising due to the filter feeders extracting the nutrients directly from the environment, is that the nutritional value of the meat varies with the quality of the environment which they are grown.

Another type of mariculture, that would be a more sustainable solution than today's situation, is the farming of macroalgae and microalgae. They do grow on sunlight, water and inorganic nutrients, but unlike terrestrial plants they do not require fertilizers or watering. The protein found in macroalgae is similar to vegetable protein in essential amino acid composition. Microalgae is also high in healthy lipids. Compared to agriculture the use of freshwater is much lower, given that agriculture is currently using 70% of the world's freshwater. The land areas used for food is also pressured, and not expanding the space needed for agriculture could help to reach SDG 15. Algae cultivation can also contribute to global food security, as it is possible to cultivate algae all over the world (SAPEA, 2017). However, inhibiting the further development of the cultivation of algae is the need for developing new technology for harvesting and production, especially low-cost and high efficiency. Another problem is the affinity for heavy metals, which would constrain how much of this food it is safe to eat, and this depends on the production environment (Besada et al, 2009).

It is also possible to reconstruct the marine environment in the farms, through an integrated multi-tropic aquaculture setup, where the aim is to have nutrient cycling and decreasing nutrient outflow.
The different species are chosen according to their "function in the ecosystem, the relationship to each other and their economic value" (SAPEA, 2017). Not only is this production method less harmful than traditional sea farms, but it is also improving the economic stability of the sector (Chopin et al. 2001). Shellfish and seaweed can be utilized by higher trophic levels and reduce the farmers' need to purchase fish feed (Ridler et al. 2007). Some researchers have suggested that IMTA "can increase profits and reduce financial risks due to weather, disease and market fluctuations" (ibid), mainly because farmers can generate income from more variety of marine species.
While IMTA constitutes a promising form of future mariculture, some shadow remains on the licensing system which it will require as well as the skills for multispecies fish farming (SAPEA, 2017).

This analysis has showed that feeding the world with more seafood is a complex enterprise. Although aquaculture diminishes the pressure on a lot of resources such as fresh water and wild fish stocks, it also comes with many issues. Those are primarily linked to the scale of exploitation, which is often intensive. Some of the problems are quite easy to tackle, such as diminishing waste or utilizing it for fuel. However, some require more technological advancements as well as a change of paradigm whereby humans do not

[1] A branch of aquaculture which consists in cultivating sea organisms in sea water directly.

try to mass-produce and focus on the output only anymore. Indeed, the future of seafood production lies in the ability to understand, replicate and make the most of naturally occurring processes as with IMTA or microalgae and macroalgae mariculture. Not only will it allow to reduce eutrophication and improve the production conditions, but it will also contribute to more jobs being created. It will allow unemployed fishermen to stay into the same business but move away from overfishing practices and obtain decent jobs (SDG 8). It will also improve the economic stability of the users of those techniques and contribute to a more circular type of production (SDG 12). And finally, a sustainable exploitation of aquaculture can help achieve zero hunger worldwide (SDG 2) in the long run because of the very low ecological footprint it implies.

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