Baltic Sea Aquaculture

Background study 1/2

21/11/2022

Some key definitions by Eurostat

AQUACULTURE METHODS

Ponds are relatively shallow and usually small bodies of still water or water with a low refreshment rate, most frequently artificially formed, but can also apply to natural pools, tarns, meres or small lakes.

Tanks and raceways are artificial units constructed above or below ground level; they are capable of high rates of water interchange and offer a highly controlled environment, but without water recirculation.

Enclosures and pens are areas of water confined by nets, mesh and other barriers allowing uncontrolled water interchange and distinguished by the fact that enclosures occupy the full water column between substrate and surface; pens and enclosures generally enclose a relatively large volume of water.

Cages mean open or covered enclosed structures constructed with net, mesh or any porous material allowing natural water interchange. These structures may be floating, suspended or fixed to the substrate but still permitting water interchange from below.

Recirculation systems are systems where the water is reused after some form of treatment (e.g., filtering).

WATER TYPES

Freshwater

Applies to waters of rivers, streams, lakes, ponds and other enclosures where the water has a constant negligible salinity.

Sea water

Also referred to as salt water, applies to waters where the salinity is high and not subject to significant variation. The term "sea water" may be inappropriate as the salinity may be of artificial origin.

Brackish water

Applies to waters where the salinity is appreciable but not at a constant high level. The salinity may be subject to considerable variation due to the influx of fresh or sea waters.

Total annual aquaculture production

Figure 1 provides an overview of all aquaculture production in the Baltic Sea region in 2020. This data includes all fishery products, including aquatic animals, freshwater and diadromous fish, shellfish and finfish. No data was available for Russia. We see that Denmark, Germany and Poland have the highest annual aquaculture production, while Estonia, Latvia and Lithuania have the lowest.

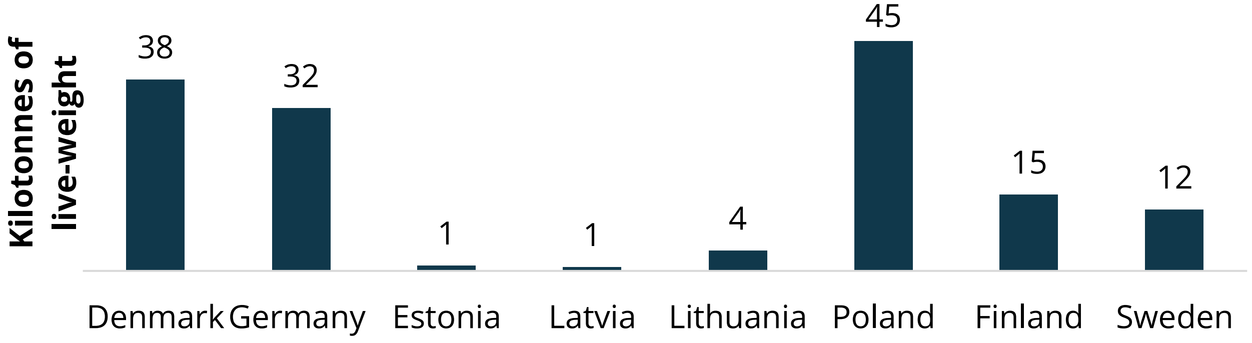


Figure 1. Kilotonnes of live-weight of all fishery products produced via aquaculture (excluding hatcheries and nurseries) by country.

In Figure 2, the aquaculture production in 2020 is broken down by aquaculture method used for each country. Note that the results are not depicted for Germany or Estonia as there was missing information.

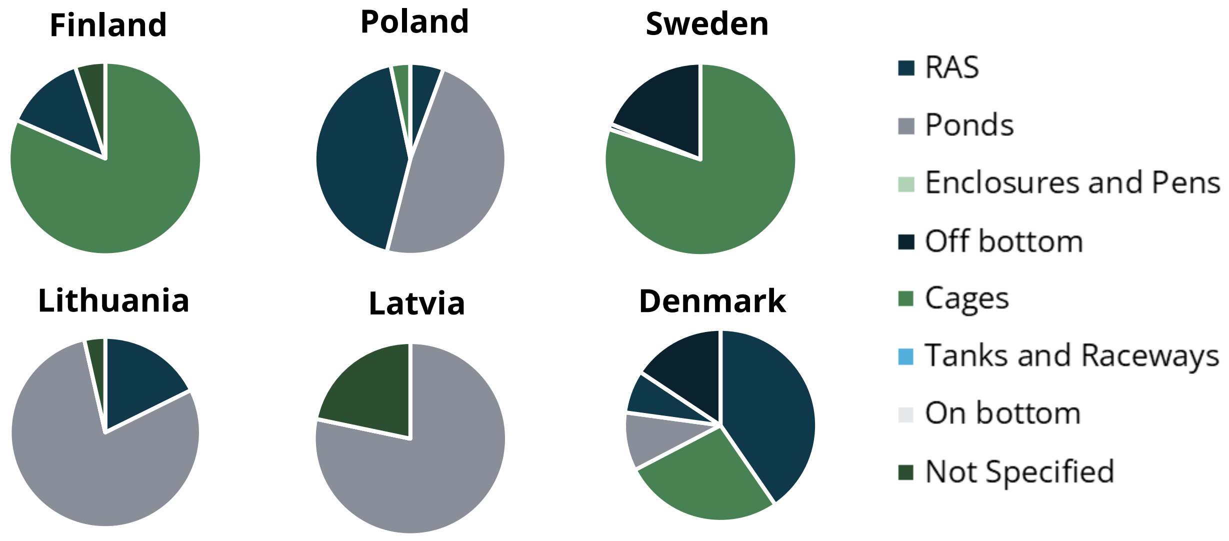
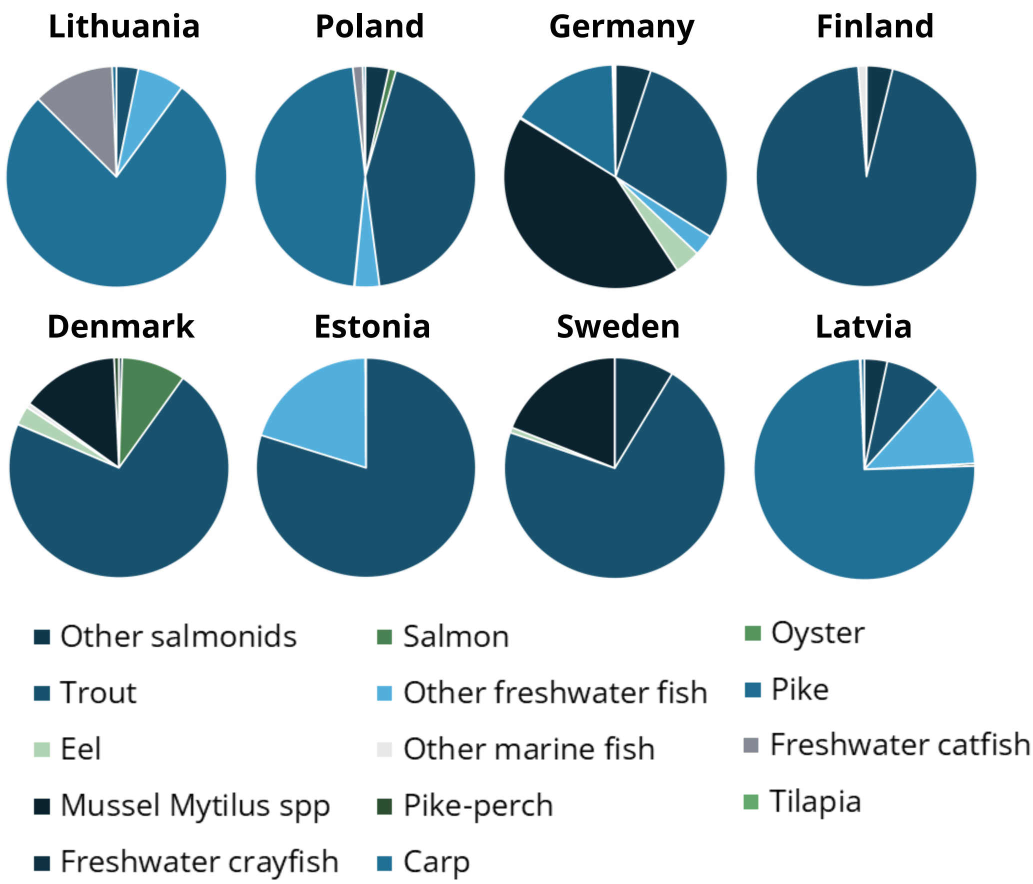


Figure 2. Breakdown of aquaculture production in 2020 by farming method and by country.

Marine cages are the most prevalent in Finland, Sweden and Denmark. Pond aquaculture is primarily used in Latvia, Lithuania and Poland. Tanks and Raceways are used primarily in Poland, but also in Finland, Denmark and Sweden in decreasing order of prevalence. Off-bottom aquaculture is used in Denmark and Sweden. Enclosures and Pens are only used in Poland.

Data on recirculating aquaculture systems was only available for Denmark, Lithuania and Poland. This does not however mean that other countries do not have existing RAS. **Appendix A (see main report)** summarises (to the best of our knowledge) the current status of RAS in the Baltic Sea Region.



Note: There was an in-consistency in total aquaculture production values among the sources. Here, Eurostat was used for the breakdown by farming method and EUMOFA for breakdown by species produced.

Figure 3. Breakdown of aquaculture production in 2020 by species produced and by country.

In 2020, rainbow trout (*Oncorhynchus mykiss*) had the largest share of the aquaculture production in Denmark, Estonia, Finland and Sweden. Common carp (*Cyprinus carpio*) was the dominant aquaculture product in Latvia and Lithuania. In Poland, the majority share was split between rainbow trout and common carp. Germany had the most variable mix with mussels composing the largest share of production, followed by rainbow trout and common carp.

Some other notable fish species in the mix were Atlantic Salmon (*Salmo salar*) in Denmark and other salmonids in countries, such as Finland, Germany, Latvia, Poland and Sweden. European eel (*Anguilla anguilla*) had a minority share of production in Germany, Poland and Sweden. From this data, it can be concluded that there is a mix of both warm and cold-water fish. A summary of some parameter requirements for the species listed above is proved in **Appendix B**.

Nutrient emissions from aquaculture

In 2018, HELCOM assessed the sources of nutrient emissions to the Baltic Sea. The analysis was conducted using data from 2014. The results indicated that in 2014, approximately 826 kilotonnes of nitrogen and 31 kilotonnes of phosphorus were emitted to the Baltic Sea from both water and airborne sources. The nutrient pathways analysed were the following:

Riverine - emissions enter inland surface waters within the Baltic Sea catchment area and are then transported by rivers to the sea

Air - atmospheric deposition directly into the Baltic Sea

Direct discharge into the sea - e.g., point-source or end-of-pipe emission

Emissions from aquaculture fall into the categories of **"Riverine" emissions** in the case of inland farms that emit to the sea via discharges to rivers and **"Direct discharge into the sea"** in the case of sea-based farms. In this report, the focus was solely on direct emissions from existing sea-based farms, i.e., farming using cages and net pens.

In 2014, direct discharges contributed only 4% of total nitrogen emissions (33 kilotonnes) and 5% of total phosphorus emissions (1.5 kilotonnes). These direct discharges included not only emissions from aquaculture, but also municipal wastewater treatment plants and industries. The direct emissions from aquaculture are depicted in **Appendix C**.

From the figures in Appendix C, it is concluded that in 2014, Denmark, Sweden and Finland were the highest contributors of direct nutrient emissions from the aquaculture sector in the region. This aligns with the data presented in Figure 2, which shows that in 2020, these countries had the largest percentage of their production in sea cages.

When the entire Baltic Sea region is considered, the contribution of offshore fish farms to total nutrient emissions is small. In fact, according to Asmala & Saikku (2010), aquaculture is responsible for <0.5% of total nutrient emissions to the Baltic Sea. However, in certain sub-regions of the Baltic sea, aquaculture contributes a higher percentage. For example, according to a figure by Antti Räike, Finnish Environmental Institute (SYKE), fish farming contributed 8% of total phosphorus emissions from 2008-2012 to the Archipelago Sea.

Impacts of nutrient emissions

According to literature, nutrient emissions and organic matter from aquaculture can contribute to algal blooms, eutrophication, hypoxic events, water acidification, increasing concentrations of pathogenic bacteria and spread of water-borne viruses. Furthermore, while dissolved nutrient discharges from fish farms may or may not be measurable in the surrounding waters, secondary impacts such as negative effects on marine biodiversity, are of greater concern.

In particular, areas of intense aquaculture can contribute to local environmental impact. Because of eutrophication in coastal waters, Sweden, for example, has implemented environmental legislation restricting the allowance of permits for traditional open net pen systems. To minimise these impacts, the replacement of current sea-based farms with land-based integrated RAS is explored in our **main report**. The corresponding estimated decrease in nutrient emissions is also calculated.

OTHER METHODS FOR MINIMISING NUTRIENT EMISSIONS

While the focus of this report was to evaluate minimising nutrient emissions by transitioning sea-based farms to land-based integrated RAS, other methods have also been explored. For example, by using locally-sourced fish feed, the nutrients can be kept in a closed loop in the Baltic sea ecosystem.

Better management practices, such as locating the farms in areas with strong current and large depth can also dilute nutrients and therefore minimise their impacts. Integrated multi-trophic aquaculture (IMTA), the culturing of food fish together with other species that filter waste particulates and dissolved nutrients, has also been researched. However, these methods are outside of the scope of this report and are not further detailed.

Reference list

Asmala & Saikku. (2010). Closing a Loop: Substance Flow Analysis of Nitrogen and Phosphorus in the Rainbow Trout Production and Domestic Consumption System in Finland.

Barquet. (2021). A nutrient trading system for the Baltic Sea region examining the possibilities of implementation.

Bergman, Henriksson, Hornborg, Troell, Borthwick, Jonell, Philis, & Ziegler. (2020). Recirculating Aquaculture Is Possible without Major Energy Tradeoff: Life Cycle Assessment of Warmwater Fish Farming in Sweden.

Campanati, Willer, Schubert, & Aldridge. (2021). Sustainable Intensification of Aquaculture through Nutrient Recycling and Circular Economies: More Fish, Less Waste, Blue Growth. *Reviews in Fisheries Science & Aquaculture*.

Eurostat. (2022). Aquaculture production by species (fish_aq). https://ec.europa.eu/eurostat/cache/metadata/en/fish_aq_esms.htm [Retrieved August 2022]

EUMOFA. (2022). https://www.eumofa.eu/aqualculture-yearly-comparison-between-ms [Retrieved August 2022]

Figure by Antti Räike (SYKE) as found on https://www.ymparisto.fi/fi-fi/meri/mika_on_itameren_tila/itameren_fosforikuorma_suomesta

Price, Black, Hargrave, & Morris. (2015). Marine cage culture and the environment: effects on water quality and primary production. *Aquaculture Environment Interactions*.

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