Socioeconomic Impact of Mussel Farming in Coastal Areas of Baltic Sea

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Kurzeme planning region

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About

Baltic Blue Growth is a three-year project financed by the European Regional Development Fund. The objective of the project is to remove nutrients from the Baltic Sea by farming and harvesting blue mussels. The farmed mussels will be used for the production of mussel meal, to be used in the feed industry. 18 partners from 7 countries are participating, with representatives from regional and national authorities, research institutions and private companies. The project is coordinated by Region Östergötland (Sweden) and has a total budget of 4,7 M€.

Partners

- *Region Östergötland (SE)*
- *County Administrative Board of Kalmar County (SE)*
- *East regional Aquaculture Centre VCO (SE)*
- *Kalmar municipality (SE)*
- *Kurzeme Planning Region (LV)*
- *Latvian Institute of Aquatic Ecology (LV)*
- *Maritime Institute in Gdańsk (PL)*
- *Ministry of Energy, Agriculture, Environment, Nature and Digitalization of Schleswig-Holstein (DE)*
- *Municipality of Borgholm (DK)*
- *SUBMARINER Network for Blue Growth EEIG (DE)*
- *Swedish University of Agricultural Sciences (SE)*
- *County Administrative Board of Östergötland (SE)*
- *University of Tartu Tartu (EE)*
- *Coastal Research and Management (DE)*
- *Orbicon Ltd. (DK)*
- *Musholm Inc (DK)*
- *Coastal Union Germany EUCC (DE)*
- *RISE Research institutes of Sweden (SE)*

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Cover: Staff working at St. Anna mussel farm in Sweden. Photo: Lena Tasse, Region Östergötland.

Abbreviations

CSB – Central Statistical Bureau

DE – Germany

DK – Denmark

ECB – European Central Bank

EE – Estonia

EMFF – European Maritime and Fisheries Fund

EU – European Union

EUR – euro

EUR/h – euro per hour

EUR/kg – euro per kilogram

Eurostat – European Statistical Office

FAO – Food and Agriculture Organization of the United Nations

GDP – gross domestic product

IT – information technology

LT – Lithuania

LV – Latvia

m. – municipality

N – nitrogen

OECD – Organisation for Economic Co-operation and Development

P – phosphorus

PL – Poland

thous. – thousand

UN – United Nations

VAT – value added tax

Summary

There are numerous papers explaining the impact of regional development, while the impact of mussel farming in coastal areas is described in the present paper.

Mussel farming could potentially develop in coastal areas, thereby creating new jobs and increasing national budget revenue.

The economy of the Baltic Sea region has high potential; the real GDP growth rate was 2.3 per cent per year in the last five years. Agriculture, forestry and fishing sectors provide a low gross value added if compared to other activities. However, when analysing the amount of revenue in the fishery sector and comparing it to other sectors in Pāvilosta municipality, fishery ensures 18 per cent of the total turnover of all companies and ensures work to 6 per cent of working men that is significant for one coastal municipality.

Current (existing) long-term interest rate is low and therefore it might seem attractive for potential stakeholders to make investments and to develop industries.

Due to the current fleeting fishing quotas, fishing could require major restructuring process to transform the way the existing products are sold and allow other forms of development to be introduced; however, the conversion process would require both political and supportive mechanisms.

Targeted funding shifts have helped promote shellfish farming, for instance, in Denmark and Sweden.

In 2015, fishing provided employment to 7359 people and 1033 people were employed in marine aquaculture, while wages in the fisheries sector are lower than the national average wage; the pay gap is considerable, which can be a contributing factor to the development of mussel farming in the eastern Baltic Sea countries where average wages are significantly lower. It should be noted, however, that wages have increased significantly in these countries over the last three years, e.g., the average wage in Latvia increased by 8 per cent in 2017 and 9 per cent in 2018. This increase has also affected the fishing industry.

The rapid growth of wages is also influenced by economic growth which is reflected in the GDP growth rate. Changes in remuneration can be analysed together with changes in the population and working population.

In order to understand the potential importance of shellfish farming in the coastal area, the financial indicators of Pāvilosta municipality, where a mussel farm was established, were analysed.

Payroll workers in the fishing industry pay taxes in the range between 3 per cent and 15 per cent compared to total sales or EUR 0.03–0.15 per value of the product sold.

The income tax paid by fishing enterprises is 2–3 per cent of the turnover of the company which goes to Pāvilosta municipality and is included in the local government budget.

Considering that various sectors affect each other, the creation of additional workplaces and payment of taxes can facilitate further creation of additional workplaces in other areas.

The expert survey showed that governmental support, financing and end-use market are the most important factors to develop mussel farming in the Baltic Sea region. Expert answers revealed that mussel farming would reach the growth stage in 6–10 years.

Experts revealed that the industry might develop faster in countries where development of the industry has already started.

Based on analysed economic and social factors scenarios for potential development for mussel farming were created:

Scenario and timeline/Prognosed Development		Economic Benefits	Social Benefits
Slow growth – pessimistic scenario	0-5 years	➢ 80-300 t per year harvested mussel amount in the Baltic Sea ➢ compensation to mussel farmers for removed P and N, if available	➢ 0.4-2 full time employees per year ➢ 3900-15000 EUR tax payments per year
	6-10 years	➢ 90-340 t per year harvested mussel amount in the Baltic Sea ➢ compensation to mussel farmers for removed P and N, if available	➢ 0.5-2.3full time employees per year ➢ 4200-17000 EUR tax payments per year
	11-15 years	➢ 97-365 t per year harvested mussel amount in the Baltic Sea ➢ compensation to mussel farmers for removed P and N, if available	➢ 0.4-2.5 full time employees per year ➢ 4600-18000 EUR tax payments per year
Average growth – realistic scenario	0-5 years	➢ 800-3000 t per year harvested mussel amount in the Baltic Sea ➢ compensation to mussel farmers for removed P and N, if available	➢ 4-20 full time employees per year ➢ 40-150 T EUR tax payments per year
	6-10 years	➢ 2200-8000 t per year harvested mussel amount in the Baltic Sea ➢ compensation to mussel farmers for removed P and N, if available	➢ 15-53 full time employees per year ➢ 106-400 T EUR tax payments per year
	11-15 years	➢ 3500-13000 t per year harvested mussel amount in the Baltic Sea ➢ compensation to mussel farmers for removed P and N, if available	➢ 23-87 full time employees per year ➢ 172-642 T EUR tax payments per year
Rapid growth – optimistic scenario	0-5 years	➢ 1500-5600 per year harvested mussel amount in the Baltic Sea ➢ compensation to mussel farmers for removed P and N, if available	➢ 14-65 full time employees per year ➢ 65-245 T EUR tax payments per year
	6-10 years	➢ 5400-20000 t per year harvested mussel amount in the Baltic Sea ➢ compensation to mussel farmers for removed P and N, if available	➢ 225-1000 full time employees per year ➢ 237-900 T EUR tax payments per year
	11-15 years	➢ 8700-33000 t per year harvested mussel amount in the Baltic Sea ➢ compensation to mussel farmers	➢ 360-1800 full time employees per year ➢ 382-1400 382-1400 T

Scenario and timeline/Prognosed Development		Economic Benefits	Social Benefits
		for removed P and N, if available	EUR tax payments per year

Developed scenarios are different, but historically analysed information has shown that harvested shellfish volumes can vary by up to a half from year to year.

According to the precautionary scenario, the harvested mussel amount in 6–10 years varies from 90 up to 340 tonnes per year, whereas if developing mussel farming up to a commercially viable amount, the shellfish amount should reach from 2200 up to 8000 tonnes which would require employment of 15–53 people. Due to a lack of data, it is not possible to compare the employment outlook in marine aquaculture in 2018, but shellfish farming can account for up to 5 per cent of the total number of employed in marine aquaculture.

Scenario analysis has helped to shape the concept of new industry development and economic contribution to the Baltic Sea region. Scenario analysis shows that a seemingly insignificant and possibly underestimated sector can contribute to the environment by reducing water pollution and also to the economy and the social sector by creating new jobs, increasing business turnover and payment of taxes into the state budget.

Introduction

One of the aims of the project Baltic Blue Growth is to remove nutrients from the Baltic Sea by farming and harvesting blue mussels. In order to demonstrate the impact of the development of this area in the region, socioeconomic data analysis, including environmental and economic data, as well as data from farms established within the scope of the project in the Baltic Sea, has been carried out.

In this paper, several data acquisition and analysis methods have been used, i.e., scientific publication studies regarding mussel farming development; case studies; probabilistic projection method; survey of different stakeholders in mussel farming – public administrators, entrepreneurs and researchers (from 2017 to 2018); expert interviews (from 2016 to 2018).

The information contained in this paper will help public authorities, entrepreneurs and other stakeholders understand the contribution of shellfish farming to the coastal area in the Baltic Sea region.

The main population in coastal areas, their habits, life cycle changes, employment and other conditions have had an impact on the Baltic Sea. In recent years, focus on the condition of the Baltic Sea has made it possible to change public opinion by focusing on the importance of the environment.

Several centuries ago, people were redirected to places where they were provided with work and fishing was one of the jobs. Over time, fishing has lost its importance, and some of the inhabitants leave fishing villages to move to more economically active settlements.

Today more than 600 million people (around 10 per cent of the world's population) live in coastal areas that are less than 10 metres above sea level. Nearly 2.4 billion people (about 40 per cent of the world's population) live within 100 km of the coast (United Nations, 2017). The growing population in coastal areas has left a load on water bodies, which is why active involvement is now needed to reduce eutrophication.

In water bodies where water exchange is less frequent, the condition is more noticeable. The research carried out on the development of shellfish farming in the Baltic Sea has shown that bivalve molluscs absorb phosphorus and nitrogen, but it is also possible to assess socioeconomic factors to understand the economic and social contribution to the coastal area.

Socioeconomic factors are also known as certain components of macroeconomic factors, therefore, social and economic factors were explored in the first chapter, while certain scenarios have been developed in the second chapter to analyse shellfish farming, based on the information gathered while developing this paper and other papers.

Mussel farming offers great development possibilities in our open waters for enhancing food and livelihood security of the stakeholders in our coastal regions. In order to understand the possible impact of mussel farming on the coastal regions, several indicators have been selected in this paper that portray the economic and social situation and enable to compare the conditions in the countries around the Baltic Sea.

The geographical scope of this document – the Baltic Sea region.

Mussel farming is included in such sectors as agriculture, forestry and fishing. Therefore, a statistical data analysis was carried out on the basis of data available in various sources, e.g., the Food and Agriculture Organization of the United Nations (FAO), European Statistical Office (EUROSTAT), the Organisation for Economic Co-operation and Development (OECD), etc.

1. Assessment of the impact of mussel farming in coastal areas

1.1. Assessment of the economic and social situation in coastal areas based on indicators

1.1.1. Economic indicators

Gross domestic product growth rate and gross value added

Gross domestic product (hereinafter – GDP) is one of the primary indicators to assess the health of an economy (Bureau of Economic Analysis, 2007), "the GDP growth rate is the most important indicator of economic health" (Henderson *et al.*, 2012) and "GDP aims to best capture the true monetary value of our economy" (Khan, 2014).

The economy of the Baltic Sea region countries has developed, and the increase in the real GDP growth rate demonstrates changes in the economy in the last nine years.

Table 1. Real GPD growth rate % in 2009–2017 (OECD, 2019)

	2009	2010	2011	2012	2013	2014	2015	2016	2017
Denmark	-4.9	1.9	1.3	0.2	0.9	1.7	1.6	1.7	2.3
Germany	-5.6	4.1	3.7	0.5	0.5	1.9	1.7	1.9	2.2
Estonia	-14.7	2.3	7.6	4.3	1.9	2.9	1.7	2.1	4.9
Finland	-8.3	3.0	2.6	-1.4	-0.8	-0.6	-0.0	1.9	2.8
Latvia	-14.3	-3.8	6.4	4.0	2.6	2.1	2.7	2.0	4.6
Lithuania	-14.8	1.6	6.0	3.8	3.5	3.5	1.8	2.3	4.1
Poland	2.6	3.7	5.0	1.6	1.4	3.3	3.9	2.6	4.8
Sweden	-5.2	6.0	2.7	-0.3	1.2	2.6	4.5	3.3	2.1

Due to the financial crisis in 2007–2008 (in Latvia until 2010), which led to the Geat Recession, the real GDP growth rate was negative in 2009.

The real GDP growth rate was high in Sweden in 2010 and in 2015, and the rate returned to normal levels in 2017 and 2018 (Statistics of Sweden, 2019).

The average real GDP growth rate in Finland was 0 per cent in the last nine years.For the last three years the real GDP growth rate of Poland has been high.

The average annual growth rate of real GDP in the Baltic Sea region countries has been 2.3 per cent per year in the last five years.

The Baltic Sea region countries play an important role in the EU economy by providing 31 per cent of the total EU gross value added through all activities.

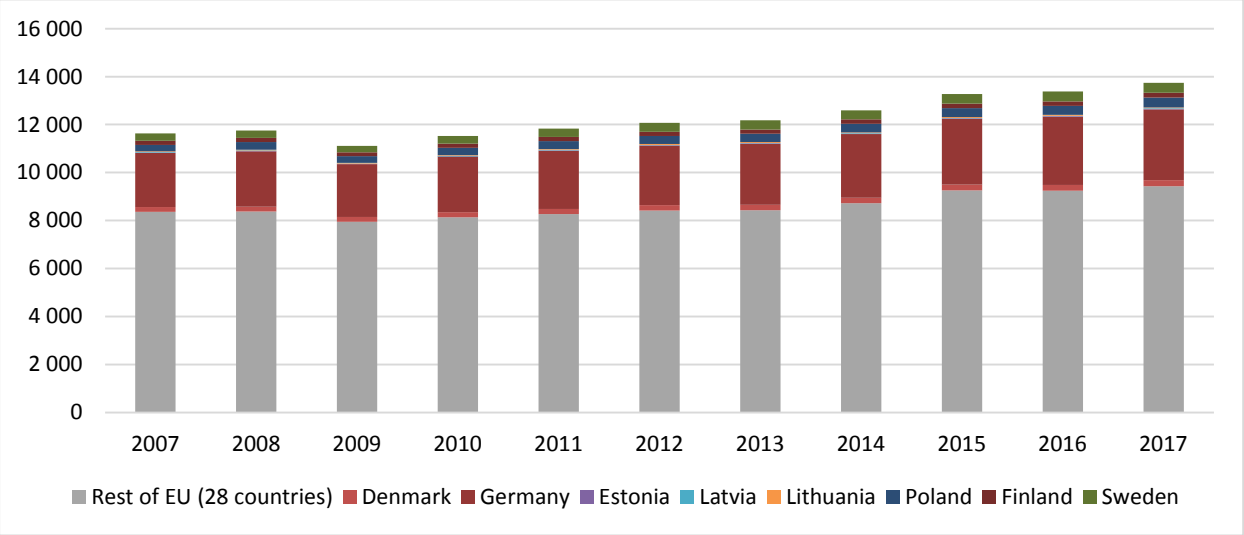


Figure 1. Gross value added in current price, billion EUR, 2007–2017 (Eurostat, 2019)

Gross value added is defined as output (at basic prices) minus intermediate consumption (at purchaser prices); it is the balancing item of the national accounts' production account (Eurostat, 2019).

Gross value added measures the contribution to an economy by valuing the goods and services produced in an area.

Germany provided more than 21.5 per cent in total amount of gross value added in 2017, but Poland and Sweden each provided 3 per cent. The Baltic Sea region countries have increased their importance in the EU economy from 28 per cent in 2007 to 31 per cent in 2017.

In order to evaluate the industry importance in overall economy, the total amount was used, split by the Statistical Classification of Economic Activities in the European Community, commonly referred to as NACE, activities where agriculture, forestry, and fishery were included.

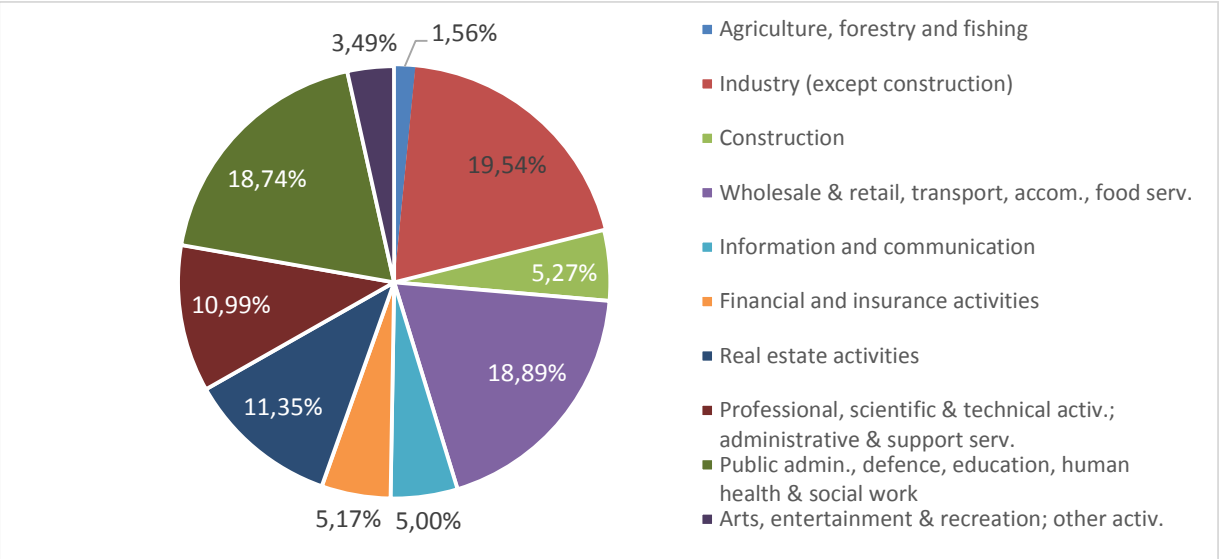


Figure 2. Share of gross value-added split by NACE activities in 2016 in the EU (Eurostat, 2019)

Wholesale and retail trade and real estate activities are taking the leading position among other activities.

Agriculture, forestry, and fishing altogether provide 1.56 per cent of the share of gross value added, compared to other NACE activities.

In 2017, the share of the gross value added in agriculture, forestry, and fishery by NACE activities increased up to 1.7 per cent in the EU (28 countries).

Importance of agriculture, forestry, and fishery in economy

Agriculture, forestry, and fishery are playing an important role in the whole economy in the EU.

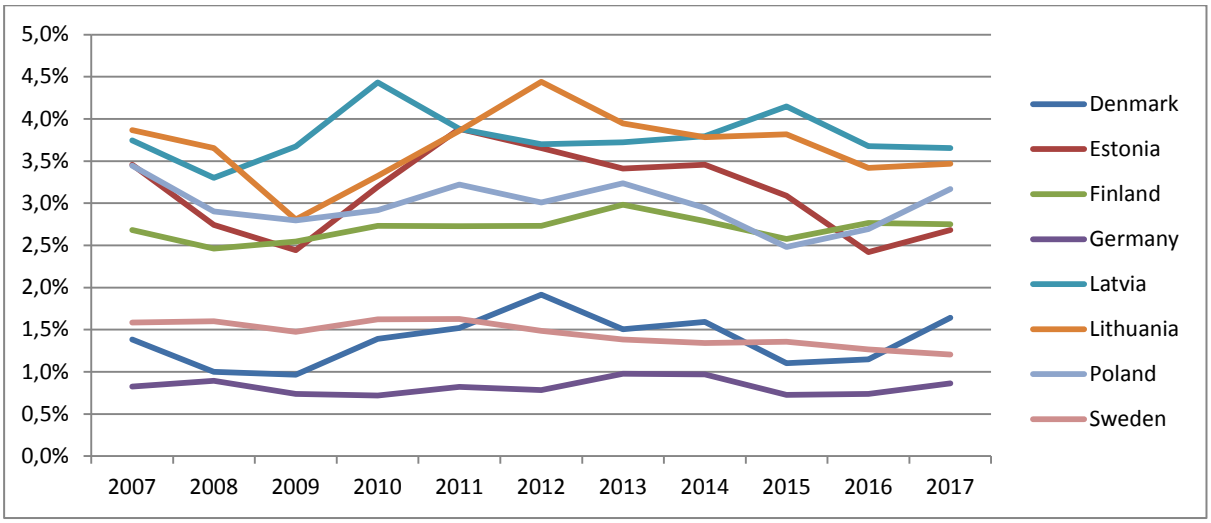


Figure 3. Share (%) of agriculture, forestry, fishery fishing gross value added within national economy 2009–2017 (Eurostat, 2019)

The gross value added in agriculture, forestry, and fishery is above 2 per cent in Estonia, Finland, Poland, Latvia, and Lithuania. In 2016, compared to 2015, the share of agriculture, forestry, and fishery by NACE activities decreased in Estonia, Latvia, Lithuania, and Sweden. In 2017, the share of agriculture, forestry, and fishery compared by NACE activities increased in Denmark, Estonia, Germany, Lithuania, and Poland.

Analysing the changes over a longer period of time (i.e., 2009–2016), the numbers show that the share of agriculture, forestry, and fishery in comparison with other NACE activities fluctuated, the share thereof increased in 2011–2013 and over the next three years the share decreased.

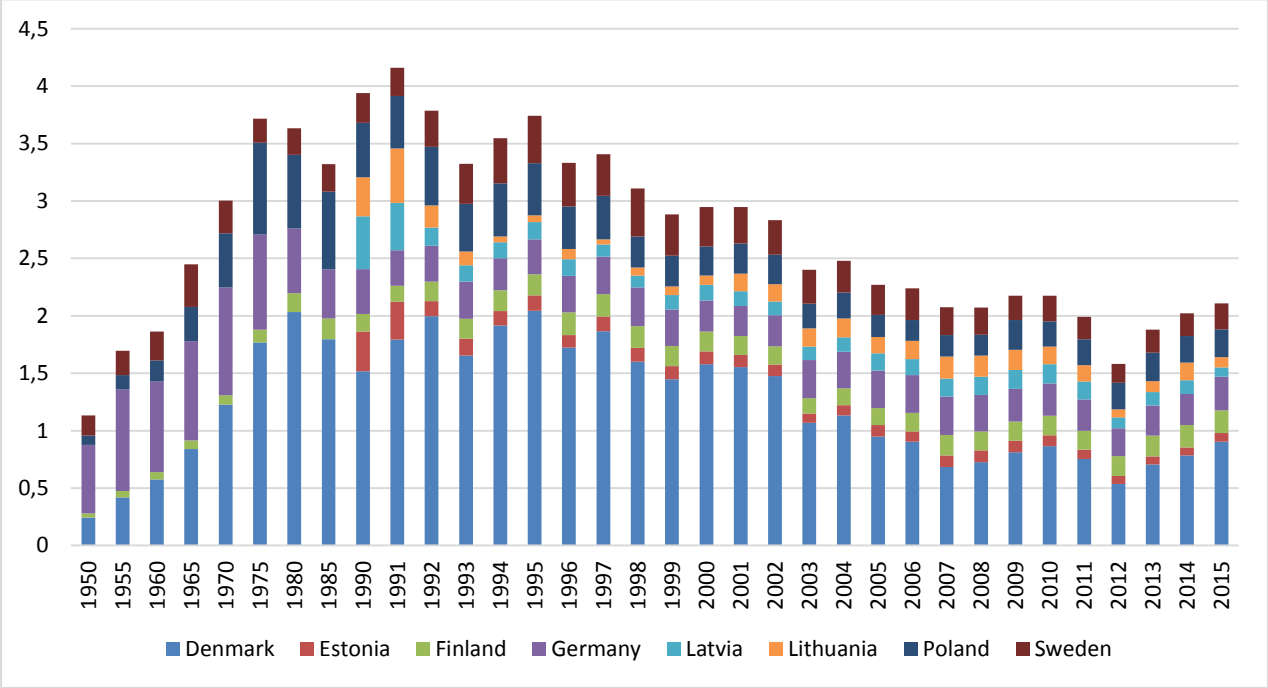


Figure 4. Fishery production amount 1950–2015, million tonnes (FAO, 2018)*

** Fishery production amount in the Baltic States available since 1990.*

The total amount of fishery has decreased in the last 30 years. Meanwhile, in the last 25 years the fishery production amount has decreased by 13 per cent in Sweden and by 25 per cent in Germany, by 40 per cent in Denmark and by 49 per cent in Poland, and by more than 70 per cent in Estonia, Lithuania, and Latvia. In the Baltic States, it has decreased by more than five times.

Only in Finland it has increased by 30 per cent in comparison with the situation 25 years ago.

The analysis of financial indicators revealed that the growth rate is higher in Latvia, Lithuania, and Poland; however, global fishery production has increased in Finland, Germany, Poland, and Sweden, but in other countries the production amount has decreased.

Interest rates of loans

"Long-term interest rates refer to government bonds maturing in ten years. Rates are mainly determined by the price charged by the lender, the risk from the borrower and the fall in the capital value. Long-term interest rates are generally average of daily rates, measured as a percentage. These interest rates are implied by the prices at which the government bonds are traded on financial markets, not the interest rates at which the loans were issued. In all cases, they refer to bonds whose capital repayment is guaranteed by governments. Long-term interest rates are one of the determinants of business investment. Low long-term interest rates encourage investment in new equipment and high interest rates discourage it. Investment is, in turn, a major source of economic growth" (OECD, 2017).

Table 2. Long term interest rates %, 2009–2017 and in the 4rd quarter of 2018 (OECD, 2019)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018Q4
Denmark	3.59	2.93	2.73	1.40	1.75	1.33	0.69	0.32	0.48	0.33
Germany	3.22	2.74	2.61	1.50	1.57	1.16	0.50	0.09	0.32	0.30
Estonia*	-	-	-	-	-	-	-	-	-	-
Finland	3.74	3.01	3.01	1.88	1.86	1.45	0.72	0.37	0.55	0.65
Latvia	12.36	10.34	5.91	4.57	3.34	2.51	0.96	0.53	0.83	1.04
Lithuania	14.00	5.57	5.16	4.83	3.83	2.79	1.38	0.90	0.31	0.31
Poland	6.12	5.78	5.96	5.00	4.03	3.52	2.70	3.04	3.42	3.12
Sweden	3.25	2.89	2.61	1.59	2.12	1.72	0.72	0.52	0.66	0.58

** There are no Estonian sovereign debt securities that comply with the definition of long-term interest rates for convergence purposes. No suitable proxy indicator has been identified (ECB, 2018).*

Long-term interest rate has decreased in the last eight years. Before the financial crisis in 2008 and up to 2010, the interest rates in Lithuania and Latvia were high. In 2016 and in 2017, long-term interest rates were low – less than 1 per cent, except for Poland. The interest rate in the 4th quarter of 2018, compared to 2017, decreased in Denmark, Germany, Poland, Sweden, but in Latvia and Finland the rate increased.

The interest rate for enterprises is higher than government long-term interest rate, but still it is at a low level.

Low interest rates increase the interest of investors to invest in their business or to develop new businesses. Governmental bonds pose a lower risk and therefore their interest rate is lower than in the business sector.

The long-term interest rate usually is applied for the assessment of the risks.

Employment in fishery, aquaculture and in processing

Fishery plays an important role in European coastal communities, such as Åland (Finland), Saaremaa, Hiiumaa, Läänemaa, Pärnu (Estonia), Kurzeme (Latvia), Bornholm (Denmark) (Kouvelis, 2017).

The EU Blue Economy provides over five million jobs and approximately 4 per cent of Europe's GDP (Vandevyver, 2016).

Approximately 350000 people were employed in 2012 in the fisheries, aquaculture and processing sectors or 0.16 per cent of the persons employed in the EU in total.

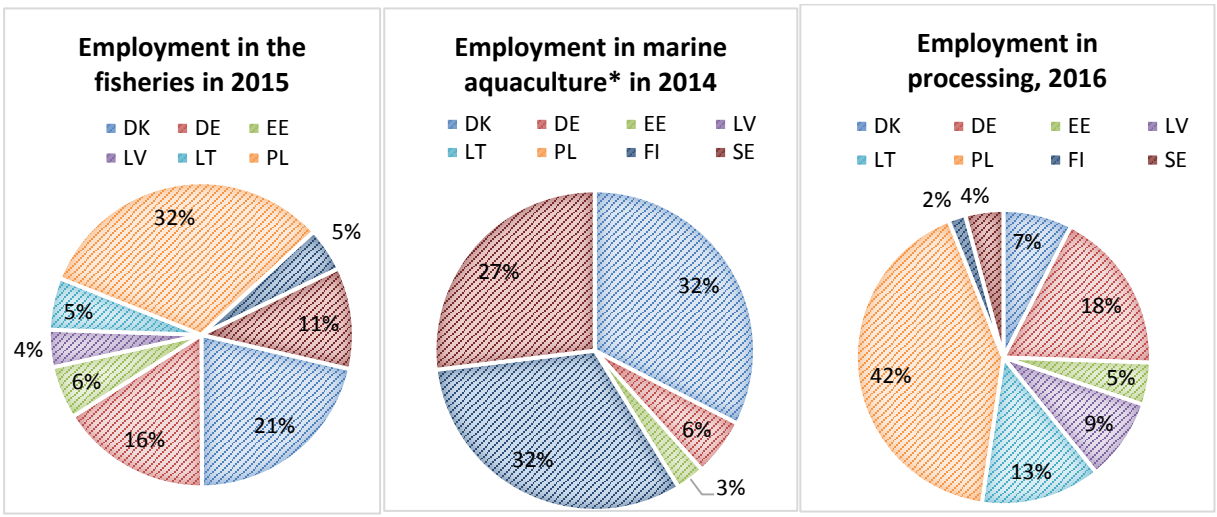


Figure 5. Employment in the fisheries, aquaculture and processing sectors (measured in full-time equivalents) in the Baltic Sea region (Kouvelis, 2017)

** No data from LT, LV, PL.*

In 2015, 7359 employees were employed in the fishery sector in the Baltic Sea region. In total, 2364 people were employed in Poland and 1570 people were employed in Denmark.

In marine aquaculture, 1033 people were employed in the Baltic Sea region in 2014.

In processing industry, 39829 people were employed in 2016. Overall, 42 per cent of the people employed in the fishery processing sector were employed in Poland. In 2012, approximately 50 per cent of the total employed persons were women.

The unemployment rate is the share of the labour force that is jobless. Unemployment exists even in a healthy economy because employees are always coming and going, looking for better jobs (Amadeo, 2018).

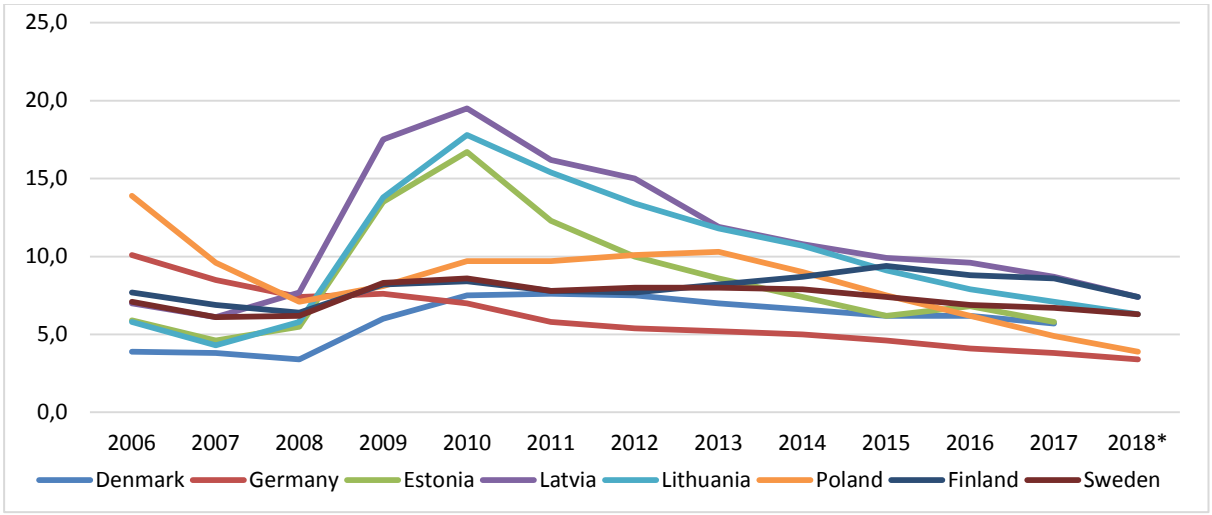


Figure 6. Unemployment rate of active population in the Baltic Sea region countries, 2006–2018 (Eurostat, 2019)

** No data available on Denmark and Estonia in 2018.*

The unemployment rate of active population has decreased in the last eight years. In 2009, the unemployment rate was the highest in Latvia among other Baltic Sea countries and even in 2017 the unemployment rate was the highest in Latvia – 8.7 per cent.

In 2006, 2007, 2008, and 2009, the lowest unemployment rate of active population was in Denmark, but in 2010 the lowest unemployment rate of active population was in Germany – 7 per cent. In 2018, the lowest unemployment rate was recorded in Germany 3.4 per cent.

Inflation

Inflation is a sustained increase in the general price level of goods and services in an economy over a period of time (Blanchard, 2000; Barro, 1997).

Table 3. Annual inflation rate (%) in the Baltic Sea countries, 2009–2018 (OECD, 2019)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Denmark	1.3	2.3	2.8	2.4	0.8	0.6	0.5	0.3	1.1	0.8
Estonia	-0.1	3.0	5.0	3.9	2.8	-0.1	-0.5	0.1	3.4	3.4
Finland	-0.0	1.2	3.4	2.8	1.5	1.0	-0.2	0.4	0.8	1.1
Germany	0.3	1.1	2.1	2.0	1.5	0.9	0.2	0.5	1.5	1.7
Latvia	3.5	-1.1	4.4	2.3	-0.0	0.6	0.2	0.1	2.9	2.5
Lithuania	4.5	1.3	4.1	3.1	1.0	0.1	-0.9	0.9	3.7	2.7
Poland	3.8	2.6	4.2	3.6	1.0	0.1	-0.9	-0.6	2.0	1.7
Sweden	-0.5	1.2	3.0	0.9	-0.0	-0.2	-0.0	1.0	1.8	2.0

In recent years the annual inflation rate in the Baltic Sea region countries was low, and in some years it was negative; however, the annual inflation rate increased in 2017 and 2018.

The total impact of external supply factors on the inflation was rather neutral in Latvia. There are several factors, such as fuel price or energy price, etc. that either increase or reduce the inflation rate (Paula, 2013) in several countries.

The main cause of inflation in Estonia and in the euro area as a whole was the rise in the price of crude oil, as the price of a barrel of oil on world markets rose from 69 dollars at the start of the year to over 80 dollars by October (Pert, 2019).

The slow price growth in the external environment of the Polish economy results mainly from a previous sharp fall in commodity, which led to lower energy prices and a deceleration in food price growth in many countries. The national currency depreciation in the Russian Federation led to price decrease, too (National Bank of Poland, 2016).

The energy (electricity, fuel) price increase affects both direct and indirect mussel farming costs. By determining the price of a given energy supply makes it possible not to expose the company to the

rise of production costs, while at the same time the price (selling price of the blue mussel) can change significantly.

Financing

"The OECD predicts that looking to 2030, many ocean-based industries have the potential to outperform the global economy as a whole, both in terms of value added and employment. The output of the global ocean economy is estimated at EUR 1.3 trillion today and this could more than double by 2030" (OECD, 2016).

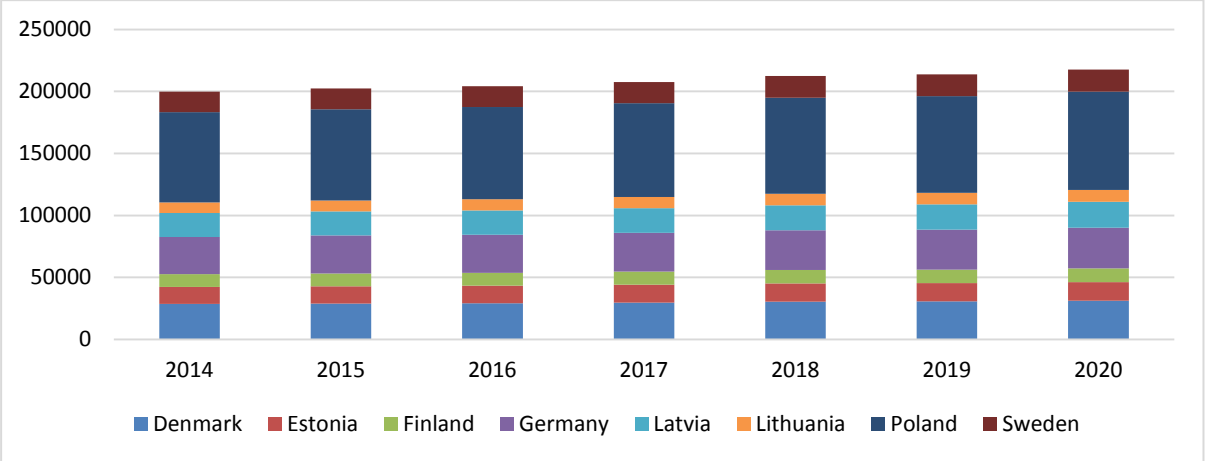


Figure 7. European Maritime and Fisheries Fund 2014–2020, thous. EUR (EU, 2017)

Each year the Baltic Sea countries are planning to use EUR 200 million from the EMFF.

Poland will receive one of the largest funding sums from the EMFF – EUR 531 million, which is the fourth largest in the EU.

Denmark is planning to acquire EUR 208 million from the EMFF, Germany – EUR 220 million, Sweden – EUR 120 million, Latvia – EUR 140 million, Lithuania – EUR 63 million, Finland – EUR 75 million, and Estonia – EUR 101 million.

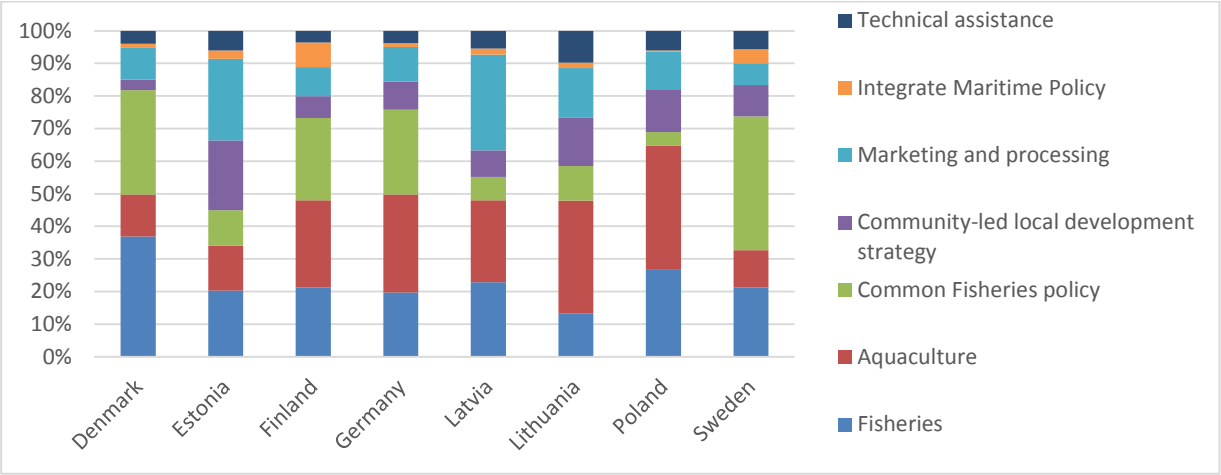


Figure 8. Total EMFF budget split by priorities in the Baltic Sea countries (2014–2020) (EU, 2017)

In Denmark, the protection of marine biodiversity and restoration of rivers to protect biodiversity and facilitate fish migration is one of the aims; the investment amount is 37 per cent and it is the main investment position under priority “Fisheries”.

Mussel farming has been mentioned as one of the four aquaculture industries that is important for further development.

In Estonia, fisheries, local development strategy, marketing, and processing are of similar importance. By means of marketing and processing activities it is planned to support fisheries and aquaculture products.

Finland intends to attract the largest financing amount under the first three activities:

- to achieve sustainable fishing resulting in profitable operations;
- diversification of production in aquaculture to achieve Finland’s self-sufficiency in fish products;
- co-operation.

Germany invests most of funds in aquaculture and its aim is to support aqua-environmental measures and productive investments in aquaculture and innovation. The second largest investment is planned under priority “Common Fisheries Policy”.

In Latvia, the main activities are planned under such priorities as fisheries (23 per cent), aquaculture (25 per cent), marketing and processing (29 per cent). Traditional pond fish farming is the main method used, and carp account for 80 per cent of total production in volume. Support is planned also for aquaculture providing environmental services.

Poland is going to receive 36 per cent of the total investment amount in the Baltic Sea countries.
Fisheries are focusing on maintaining the balance between fishing capacity and available fishing opportunities, making innovative use of unwanted catches, enhancing the competitiveness of enterprises, and improving fishing port, auction or landing site infrastructures. Moreover, measures for protecting and restoring marine biodiversity and boosting technological development will also receive support.
Aquaculture is focusing on promotion and the farming of salmonids and other species (eel, pikeperch, sturgeon, catfish, and turbot) with significant market potential, and also on increasing the share of species other than carp in aquaculture overall. This position is the largest in total budget (EUR 202 million from the EMFF fund and EUR 67 million from national budget).

Sweden has set the priority “Common Fishery Policy” as the most important one. Moreover, blue mussel farming is viewed as a market potential (priority “Aquaculture”).

Mussel farming is considered to be an important field in Denmark and Sweden. Governments of both countries are planning to support activities to promote this field.

Almost every country has admitted to support measures related to the protection and restoration of marine biodiversity.

Direct economic calculations of profitability may not be able to fully account for employment or educational values, and indirect benefits, including the development of the ‘social capital’ which is equally important for long-term sustainability (Joyce, Rubio, Winberg, 2010).

The proposed budget for the new EMFF for the period 2021–2027 amounts to EUR 6.14 billion in current prices (EU, 2019).

1.1.2. Social indicators

Education and salary are among the socioeconomic indicators. Employment is an indicator of access to a certain salary, which is positively related to health (Smith *et.al.* 1998; Marmot, Wilkinson, 2003).

Salary and taxes

In 2017, *Institut Économique Molinari* published a paper on tax burden (Roger, Philippe, 2017).

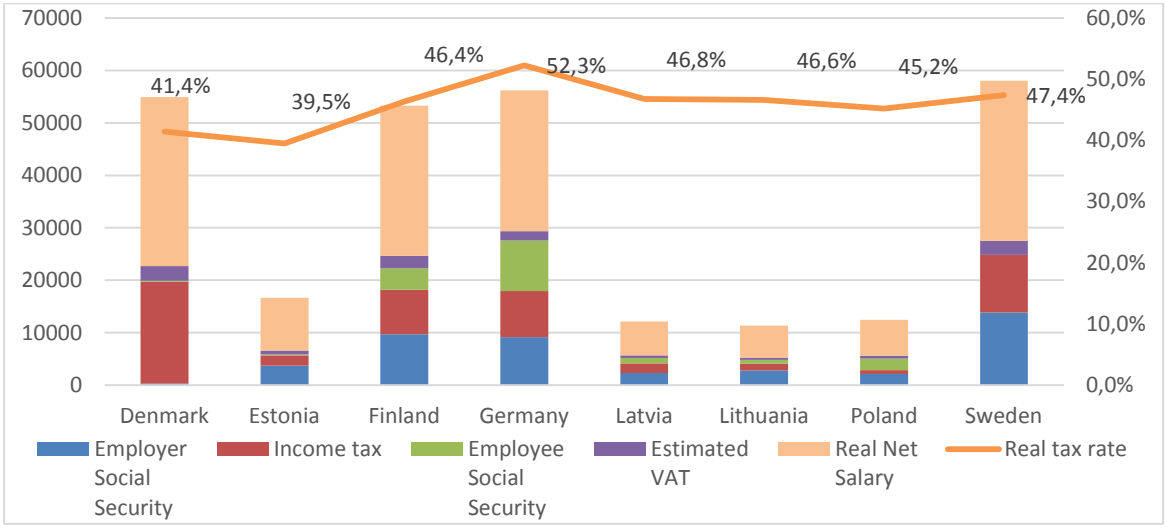


Figure 9. Taxes and income annually in the Baltic Sea countries in 2017 (Roger, Philippe, 2017; Eurostat, 2017; created by authors)

In 2017, the highest real tax rates were in Germany, Sweden, and Latvia. The smallest income rates were in Lithuania, Latvia, and Poland.

The highest social tax (employee and employer social security) was recorded in Germany, Poland, and Lithuania.

In Estonia, Latvia, Lithuania, and Poland real net salary is three up to five times smaller than in other Baltic Sea region countries.

Average annual wages and salaries of people employed in fisheries in Latvia

Remuneration in the Latvian fisheries sector has traditionally been lower than the average wage in Latvia. For example, in 2016, the average gross monthly salary was EUR 859, while in the fisheries sector (fishery and aquaculture) it was only EUR 682. In recent years wages in fisheries and aquaculture have increased by an average of 1–6 per cent annually, with an exception in 2013, when it decreased by 2 per cent (see Figure 3). The fishing fleet balancing measures have contributed positively to this process, which, under circumstances, when available fishing resources decrease

allows the remaining fishermen to work more efficiently. However, this increase in remuneration is lower than the average wage increase in the country (EMFF, 2016).

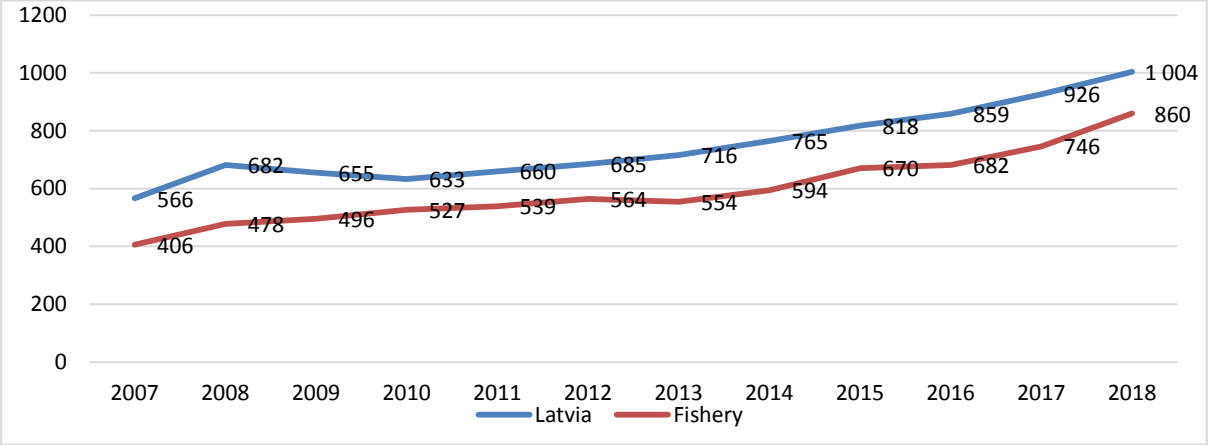


Figure 10. Monthly average gross wages and salaries of the employed in Latvia and in fisheries, 2007–2018, EUR (CSB of Latvia, 2019)*

** No data available on salaries by sector at NACE Rev. 2. at three-digit code level – (03.1) Fishing.*

Changes in the average wage affect not only the wage increase for employees, but also structural changes in labour market – enterprises that have started and stopped their operational activities during the year, changes in the number of employees and loads in various sectors, as well as state administrative measures in fighting against the shadow economy. The impact of these factors is generally reflected in changes in the wage fund and the employed full-time staff used in the calculation of average wages.

Compared to 2016, in 2017, when the average wage in the country amounted to EUR 926, the average wage increased in all areas, including by 8.8 per cent in agricultural, forestry, and fisheries sectors (at a higher rate in fisheries, amounting to EUR 746).

In higher-ranked sectors of economic activity, increase in the average wage was influenced both by the increase in the wage fund and the decrease in the number of full-time employees. In turn, the wage fund in agricultural, forestry, and fisheries sectors grew faster than the number of employees (CSB of Latvia, 2018).

Table 4. Hourly rate in fishery sector in Latvia (a workplace where more than 10 employees are employed) (State Revenue Service of Latvia, 2019)

Hourly rate in fishery sector in Latvia (by classification of occupation)	Hourly rate in December 2018, EUR/h	Hourly rate in June 2017, EUR/h
Managers of aquaculture and fisheries production	7.68	5.52
Aquaculture workers	4.30	3.36
Inland and coastal fishermen	4.64	3.69
Marine fishermen	6.56	5.63
Butchers, fish processors and related trades workers	4.98	3.80
Fisheries and aquaculture workers	3.52	2.98

In recent years the salary has increased in Latvia and in the 3rd quarter of 2018 the average salary was EUR 992 in the private sector (hourly rate approx. 5.9 EUR/h). The hourly rate for coastal fishermen is 4.64 EUR/h which is by 21 per cent less than the average salary in the country.

Population changes in the Baltic Sea region

Population fluctuation affects economic development. Population growth has effect on economic growth (Heady, Hodge, 2009; Fox, Dyson 2018).

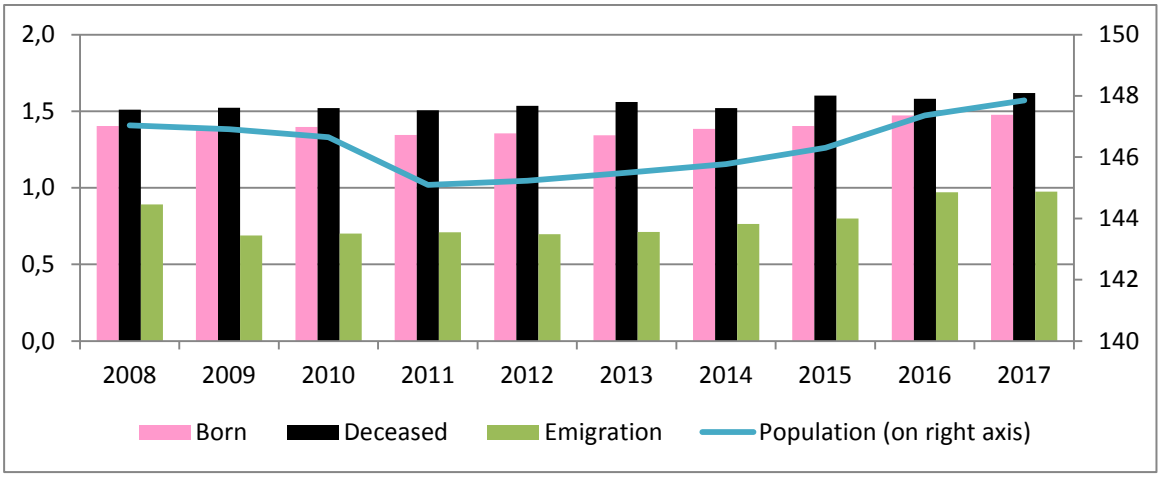


Figure 11. Demography 2008–2017 in the Baltic Sea region in millions (Eurostat, 2019)

The population has changed during the last nine years. In 2011, it decreased by almost 1.6 million inhabitants and the next year it started to increase. In 2008, 0.9 million people emigrated from the Baltic Sea region countries.

If comparing the birth and death rates in Sweden, Denmark, Finland, and Poland, the birth rate was higher than the death rate. Meanwhile in other countries this indicator is negative.

In addition, emigration has a significant effect on demography in the Baltic Sea region. In 2008, a large number of people emigrated from Germany, i.e., 0.7 million people; however in upcoming years emigration rates decreased – in Germany to 0.24 million in 2012 and in Poland to 0.28 million in 2012. The highest number of people having emigrated from Germany, i.e., 0.56 million was recorded in 2017.

Taking into consideration that mortality and emigration in Latvia were among the highest in the Baltic Sea region, the situation in this country has been examined in detail.

Changes in population in Latvia

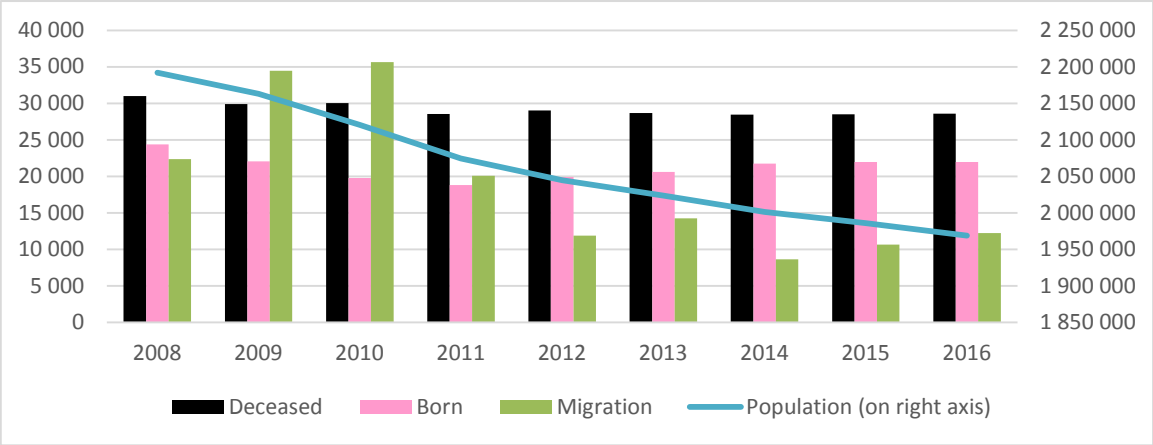


Figure 12. Demography in Latvia, 2008–2016 (CSB of Latvia, 2017)

Latvia has lost more than 0.2 million inhabitants in the period of the last eight years. More than 30000 inhabitants left Latvia in 2009 and 2010. Such negative changes in population will have effect on economic development.

Social culture

With boats, fish houses, ship yards, crafts, traditions and other fishing-related elements, over centuries commercial fishermen have not only intervened in the natural environment of coastal areas, but also have established an identity and place attachment. Fishermen and their material culture are a part of a maritime cultural landscape and traditional working waterfront. However, due to the changes in the use of resources and land / sea use regulations and policies, along with development and climate change, fishing towns are in decline; in many places development has taken over and gentrification has occurred. This has resulted in the loss of maritime cultural heritage such as the fishing material culture, traditional waterfronts, and maritime cultural landscape (Khakzad, Griffith, 2016).

The countries around the Baltic Sea have well-developed fishing and fish processing traditions. Inhabitants of the coastal regions have traditionally been involved in coastal fishing. After cessation of vessel scrapping measure funded by the European Union Fisheries Fund, it can be concluded that there are very few fishermen left in the coastal area and the measure in general has destroyed the coastal fishing fleet in Latvia, and not all coastal fishermen have found new jobs. Over the last 10 years, the fishing industry has been affected by many factors, such as decrease in fish resources, catch quotas and fishing tackle. Nowadays, the fishermen way of life seems to be going extinct.

Knowledge and traditions of coastal fishing are an important cultural resource for the population of coastal regions and portrays important non-monetary benefits. The extinction of fishing may lead to the loss of this important knowledge in future. Mussel farming, similar as coastal fishing, is about understanding conditions in the sea and living in coastal communities. Development of new marine uses is a possibility to save the traditions and to transfer knowledge to the new generations.

1.2. Case study in Pāvilosta

One local municipality where a shellfish farm is located has been analysed in order to be able to assess the sea-related importance of the coastal area.

Pāvilosta municipality is located on the west coast of the Baltic Sea, in Kurzeme region, with the total area of 515 km². Pāvilosta is the administrative centre of the municipality, situated in the bank at the mouth of the River Saka. Historically, Pāvilosta has been a fishermen town and the ancient fishermen traditions are still alive there. Nowadays tourists come during the season to enjoy the white sandy beaches, stately pine forests, and the old fishermen houses, which are still surrounded by the smell of the smoked fish. The main industries in the municipality are fishing and fish processing, forestry and agriculture.

The experimental mussel farming site in Latvia has been established near Pāvilosta municipality and therefore a more detailed case study was conducted about this municipality.

According to statistical information on enterprises at the disposal of Lursoft Ltd., a national database on enterprises in Latvia, in total there are 92 enterprises with turnover above EUR 200 which had submitted the annual report of the company for 2016 and whose legal address has been indicated in Pāvilosta municipality. Five of these enterprises operate in fishery sector.

Table 5. Turnover of enterprises registered in Pāvilosta 2014–2016 (Lursoft, 2018–2019; created by Z. Ozolina)

	Unit	2014	2015	2016
Total enterprise turnover in Pāvilosta	EUR	11 586 589	11 475 145	11 370 144
Turnover of enterprises operating in fishery sector in Pāvilosta	EUR	1 800 110	2 001 152	2 013 381
Fishery share in total sales	per cent	16%	17%	18%

The fishery industry is an important field in Pāvilosta municipality because 16 per cent up to 18 per cent of total enterprise turnover was obtained in fishery sector.

The data revealed that the share of turnover of enterprises working in fishery has increased within the analysed period, i.e., from 2014 to 2016.

Pāvilosta is a small municipality with 2658 inhabitants. In 2016, considering that only men were working in fishery, the statistical data revealed that 1264 men were registered in this municipality.

Table 6. Inhabitants and economically active men in 2014–2016 (CSB of Latvia, 2019; Lursoft, 2018; created by Z. Ozolina)

	2014	2015	2016
Pāvilosta population in total	2742	2701	2658
Men in Pāvilosta	1304	1294	1264
Economically active persons in Kurzeme region	72.7%	72.1%	74.3%
Economically active men in Pāvilosta	948	933	939
Fishery employers in Pāvilosta	57	50	55
Share of fishery employed men, working in Pāvilosta	6.0%	5.4%	5.9%

Statistical data on the number of economically active men in Kurzeme region were used to determine the number of economically active men in Pāvilosta municipality. The ratio used for regional calculations was applied also to Pāvilosta municipality due to the reason that there were no municipality-related calculations.

According to the results of the analysis, six per cent of economically active men in Pāvilosta are employed in fishery sector and this is a good indicator, taking into account that this is a rather small coastal municipality.

The ratio of revenue per employee allows evaluating productivity per employee in fishery sector in coastal municipalities.

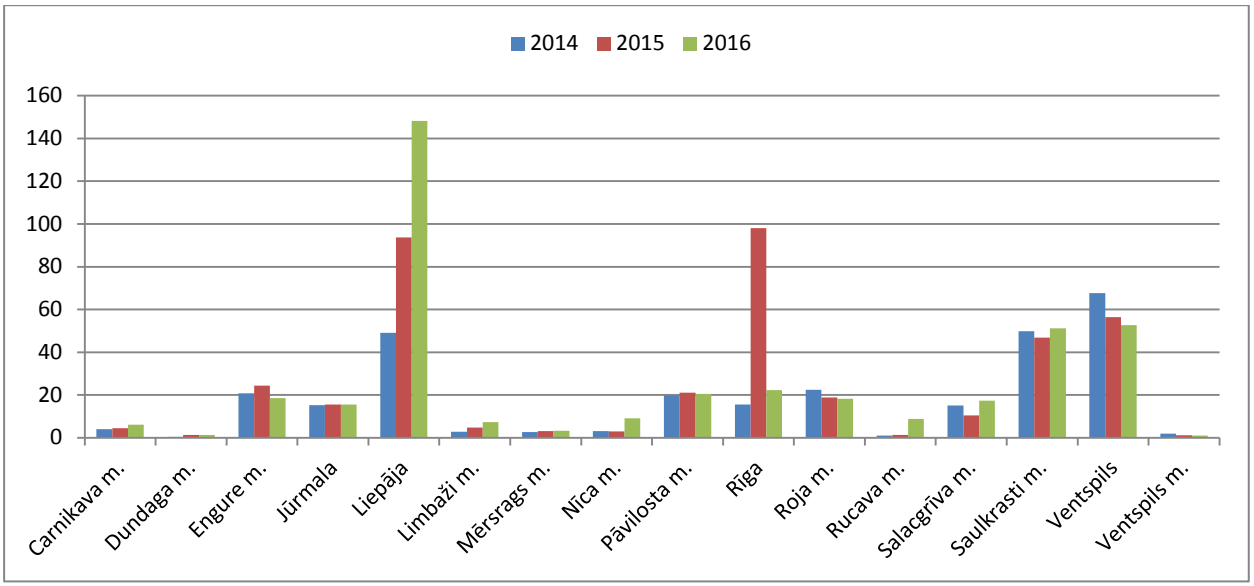


Figure 13 Revenue per employee in fishery sector, thous. EUR, 2014–2016 (Lursoft, 2018; created by Z. Ozolina)

The results revealed that enterprises operating in Liepāja city and in Riga (in 2015) earned the highest revenue per employee in fishery sector. In Saulkrasti municipality companies working in fishery sector earned EUR 51 thousand revenue per employee, Ventspils - EUR 53 thousand, Rīga – EUR 22 thousand, Roja m. – EUR 18 thousand, Pāvilosta m. – EUR 21 thousand.

In Latvia, a certain amount of tax payments such as personal income tax, property tax, etc. is transferred to municipalities.

In Latvia, municipal income is comprised of payments to local governments or national budget, as well as from the equalisation fund.

For example, personal income tax and real estate tax are paid into the local government budget, so local governments are interested in business development, as it will produce higher tax revenues.

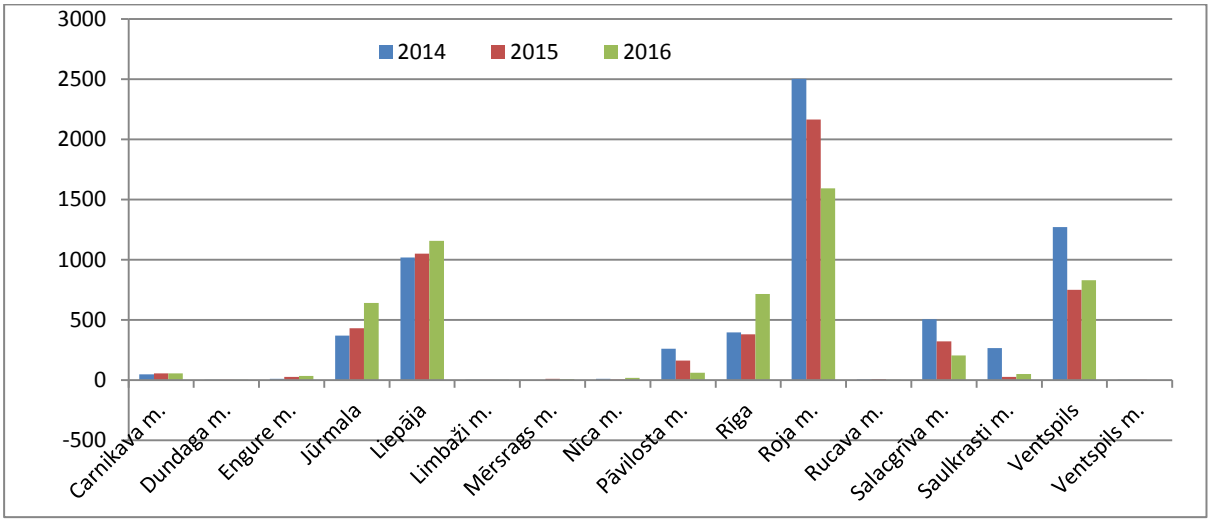


Figure 14. Total tax payments of enterprises operating in fishery sector, thous. EUR, 2014–2016 (Lursoft, 2018; created by Z. Ozolina)

The largest amount of tax payments is recorded in Roja municipality, Liepāja and Ventspils; however, the total tax payment in this sector has decreased. Companies in Pāvilosta municipality paid in total EUR 62 thousand in 2016. Compared to 2014, companies operating in the field of fishery have paid EUR 261 thousand as tax payments.

In order to pay EUR 1 as tax payments, fishery companies had to sell the product on average for EUR 12 in 2014, but in 2016 for EUR 14, but in 2016 the companies registered in Pāvilosta region had to earn EUR 32, but in 2014 – EUR 7 to pay EUR 1 in taxes.

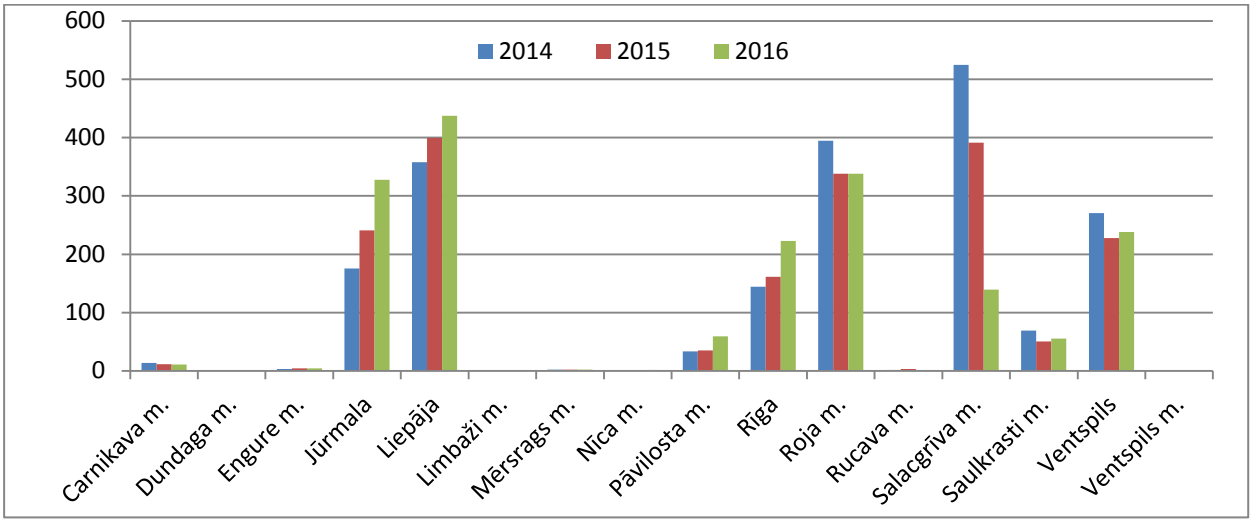


Figure 15. Personal income tax payments from employees working in fishery sector, thous. EUR, 2014–2016 (Lursoft, 2018; created by Z. Ozolina)

The largest personal income tax payments were withheld from employees working at companies registered in Liepāja, Jūrmala, Roja municipality, Salacgrīva municipality, and Ventspils.

Based on expert interviews, it was revealed that small mussels are sold for EUR 100 per tonne in Denmark; however, the calculation made within the scope of the project Baltic Blue Growth revealed that the lowest mussel farming cost is EUR 500–540 per tonne (Ozolina, 2018).

According to information obtained within the framework of the Baltic Blue Growth project, it was discovered that 320 man-hours were spent for the maintenance of the farm and to harvest 40 tonnes of mussels a year.

When working at sea it is necessary to comply with certain safety requirements and in further calculations it was established that two persons would be the minimum to achieve such safety requirements. According the national legal acts 1–2 months were calculated as a vacation period and 1 month was calculated as a period of unexpected leave; therefore two persons should be working in a farm where it could be possible to grow 360 tonnes of mussels per year.

Mussel farming sales could be analysed in conjunction with nutrient removal aim. In the area of the Baltic Proper, there are roughly 12 Swedish municipalities that could qualify as the 'archipelago archetype'. The size of the population in these coastal communities varies between 5000–44000, but is on average close to the archetype of 20000. From the rough estimate summarised in the report, 60 per cent of phosphorous outlet in this municipality type comes from private wastewater units that would need a higher treatment level. The estimated cost to fix such units is more than 1000 EUR/kg P. Today these municipalities altogether discharge by 36 tonnes more P per year than the system can take, directly into our most economically valuable coastal areas. Even if all thinkable measures that cost less than 200 EUR/kg P were implemented in these archipelago regions, there would still remain a yearly outlet of 22 tonnes excess P per year (Minnhagen *et.al.* 2018/2019).

Table 7. Turnover of companies operating in fishery sector in Pāvilosta, EUR, 360 tonnes of the harvested amount of blue mussels

	% in fresh whole	**Weight, kg**	**EUR/kg**	**Revenue, EUR**
Nitrogen	0.8	2880	30*	86400
Phosphorus	0.05	180	360*	64800
Mussel shell			0.08	28800
Turnover of companies operating in fishery sector in Pāvilosta, EUR Harvested amount 360 tonnes				**180000**

** (Minnhagen et.al. 2018/2019)*

In fishery sector the company could earn EUR 180 thousand for harvesting 360 tonnes of mussels.

Table 8. Analysis of sales, payment and income payment volume in Pāvilosta and financial indicator forecast for mussel farming (created by Z. Ozolina)

	2014	2016	Mussel farm per year	Share 2014	Share 2016
	1	*2*	*3*	*3/1*	*3/2*
Turnover of companies operating in fishery sector in Pāvilosta, EUR	1800110	2013381	180000	10%	9%
Total tax payments of companies operating in fishery sector in Pāvilosta, EUR	260900	62460	30000	11%	48%
Personnel income tax received from companies operating in fishery sector in Pāvilosta, EUR	33570	59460	3000	9%	5%
Share of total tax payments in sales	15%	3%	15%		
Share of personnel income tax payments in sales	2%	3%	3%		

Total tax payments of companies operating in fishery sector were EUR 261 thousand in 2014, whereas in 2016 tax payments totalled EUR 62 thousand.

A mussel farm which harvests 360 tonnes per year could pay EUR 30000 in tax payments per year.

It is important for Pāvilosta region to develop a new area, especially in fisheries. Such a large farm will increase the turnover of companies working in the region by an average of 10 per cent and an average of 11 per cent of tax payments.

Mussel farming as a new area would be an essential part of the fishing industry, which has long been experiencing an economic downturn. By developing this sector and investing purposefully into the development of the industry, the municipality would have more prospects for development.

This case can be attributed to other municipalities, where the development of one new sector could contribute to the development of the entire region.

In addition to the development of a new business, also other areas can develop, e.g.:

- transport and logistics, moving production;
- provision of additional materials;
- processing, production;
- packing;
- trade.

1.4. Situation assessment based on a questionnaire

An expert questionnaire (Annex 1) was developed in order to gather information on stakeholders' views on the key issues of mussel farming in the Baltic Sea.

In total, 467 experts from governments, regional stakeholders, researchers, and fishermen from countries around the Baltic Sea region received the questionnaire in 2018. Overall, 110 experts responded and completed questionnaires were received from Denmark, Estonia, Finland, Germany, Latvia, and Sweden. Experts could state whether they had no opinion on the respective analysed aspect, and, if so, such answers were not included in further analysis.

Expert survey was organised to analyse the development aspects of mussel farming in the Baltic Sea region (Denmark, Estonia, Finland, Germany, Latvia, Sweden). Experts were selected according to their working experience and were asked to answer questions on the main factors affecting the development of mussel farming.

Field importance in the national economy of the specific country

In your opinion, how important are the fields mentioned below in the national economy of your country?

Table 9. Expert opinion on importance of aquaculture sectors in national economy. Evaluation scale: 1 – highly unimportant to 10 – highly important. Expert survey results in 2018 (survey conducted by Z. Ozolina)

Evaluation 1–10; 1	Fishery	Marine aquaculture	Mussel farming
1	1%	17%	30%
2	4%	15%	15%
3	5%	8%	10%
4	5%	13%	6%
5	18%	10%	2%
6	8%	5%	5%
7	16%	15%	1%
8	17%	6%	2%
9	8%	5%	1%
10	16%	2%	0%
Total	100%	100%	100%

Experts have admitted that fishery is above an average important field in the national economy; however, mussel farming is an unimportant field in the national economy of the specific country by assigning the rate 1–4 in 61 per cent of responses.

Experts have different viewpoints regarding the development of mussel farming in the next 10 years in their country, i.e., experts in Sweden, Germany, Denmark, Estonia consider that mussel farming will develop (median 7), while the evaluation of experts from Finland and Latvia was on average low.

It is possible to analyse these answers in conjunction with the current situation in this field. The answers are more positive in countries where mussel farming has been already started, compared to countries where the development is still in the early stage.

Factors affecting the development of mussel farming

Table 10. Factors affecting the development of mussel farming in the Baltic Sea region, main statistical indicators (survey conducted by Z. Ozolina). Evaluation scale 1–10, where 1 – unimportant, 10 – highly important, total answers – 52

	Labour force/ Human resource	Financing (subsidies, loans)	Formal, also informal education	Climate change	Marketing activities	Taxes	End-use market	Government support	Environmental pollution
Mean	5.29	8.00	6.31	6.19	6.83	6.25	7.96	8.13	6.58
Std. error of mean	0.364	0.312	0.348	0.352	0.294	0.353	0.324	0.266	0.343
Median	5	8	7	6	7	6	8	8	7
Mode	4	10	7	7	6	4, 6, 8, 10	10	10	7 and 8
Std. deviation	2.622	2.249	2.509	2.536	2.121	2.543	2.334	1.920	2.476
Range	9	8	9	9	8	9	9	6	8
Minimum	1	2	1	1	2	1	1	4	2

Experts have admitted that the most important factors to develop mussel farming are government support (mean 8.13), financing (mean 8) and end-use market (mean 7.96). Labour force as the developing factor for mussel farming obtained the lowest rate. Climate change was evaluated as the second lowest one.

The tax aspects and labour force / human resource aspects were analysed between age groups. For experts at the age of 35–44 and 55–64 the tax aspect as a factor affecting the development of mussel farming in the Baltic Sea region is more important (mean 7.2) than for experts at the age of 25–34 and 45–54 (mean 5.4). Experts at the age of 25–34 and 45–54 indicated labour force / human resource as the least affecting factor (mean 4.6) than experts at the age of 35–44 (mean 5.9) and 55–64 (mean 5.4).

Mussel farming and mussel processing development stage

Experts were asked to answer which stage **of mussel farming / mussel processing development** can be reached in the specified period in their country.

Table 11. Expert survey results evaluating the mussel farming development stage by periods in the Baltic Sea region (survey conducted by Z. Ozolina)

Share (per cent)	Today	In 5 years	In 6–10 years	In 11–15 years	In 16 years and over a longer period of time
Introduction stage (Sales are low, although they will be increasing. The costs for market launch are high.)	43–44%	24–32%	22–27%	2–3%	2%
Growth stage (Sales volume is growing, and the company has a profit from the sale of products. The company plans to invest in development.)	5%	23–27%	35–44%	18–23%	10%
Maturity stage (The company plans to maintain the existing market share; the company considers investing in product upgrading activities.)	2–5%	2–5%	25–27%	34–35%	32–33%
Decline stage (The sales volume starts to decrease, probably the market is saturated, probably the product brings profit.)	0–2%	02%	2–5%	13–18%	76–81%
Not started / will not be launched	70–71%	10–13%	5%	0–3%	11–13%

Experts in Sweden, Denmark, Germany, and Finland have revealed that mussel farming / mussel processing might reach the growth stage 5–10 years earlier than in Estonia and Latvia. The developing stage depends on the current situation in the mussel farming industry. The field of mussel farming might develop faster if the industry is supported.

According to estimates of mussel farming experts, 20 years are required for the mussel farming industry to develop. In addition, supportive activities could promote the development of the industry, as, for example, in 2013, the Government of Newfoundland and Labrador supported marketing activities to facilitate the development of the industry (Newfoundland Aquaculture Industry Association, 2013).

Environmental aspects

In total, 53 per cent of experts have admitted that if the aim of mussel farming is to reduce contamination of nutrients in the Baltic Sea, **mussel farming should receive subsidies**. Overall, 26 per cent of experts have rejected the idea of subsidies and 21 per cent of experts did not want to answer this question.

Experts have a common opinion on some measures to improve the condition of the Baltic Sea environment:

Table 12. Expert survey results evaluating the measures to improve the conditions of the Baltic Sea environment in the Baltic Sea region in 2018 (survey conducted by Z. Ozolina). Total answers – 88

	Frequency		
	Answer: Yes	***Percentage***	**Answer: No**
Support for measures to reduce pollution	56	*63.6%*	32
Limitation of shipping	5	*5.7%*	83
Payments for causing pollution	50	*56.8%*	38
Limitation of oil extraction and transportation at sea	20	*22.7%*	68
Control of hydrotechnical building and use them in a sea	11	*12.5%*	77
Stricter pollution control	55	*62.5%*	33
Controlling / limiting tourist flow in coastal areas and at sea	2	*2.3%*	86
Limitation of fishing activities at sea	10	*11.4%*	78

Experts have admitted that the following measures should be introduced to improve the condition of the Baltic Sea environment: support for measures to reduce pollution, payments for causing pollution, and stricter pollution control.

Market price of blue mussels used as food

Experts revealed that they would be ready to pay on average 4–5 EUR/kg for frozen mussels and on average 6–10 EUR/kg for fresh mussels. This question needs further research in order to find out public opinion in this matter.

Insect meal potential

In the project, part of blue mussels were used to obtain insect meal and such question was included in the questionnaire, taking into considetation that this industry has development potential in the near future.

Experts were asked to **answer the question about insect meal**. **Experts from Germany, Denmark, and Sweden would consume food** in which one of the ingredients is of insect origin and **would feed animals** with a product in which one of the ingredients is of insect origin.

Experts from Latvia, however, **would not consume food** in which one of the ingredients is of insect origin, but main part of experts **would feed animals** with a product in which one of the ingredients is of insect origin in Latvia.

Conclusions

The development of mussel farming depends on the current economy and cultural particularities in each country. Experts revealed that the industry might develop faster in countries where development of the industry has already started. Governmental support, financing and end-use market are the main factors to encourage industry development.

1.5. Socioeconomic aspects in mussel farming and their assessment, Latvia case

Over the last 10 years fishing industry has been affected by many factors such as decrease in fish resources, catch quotas and fishing tackle and therefore the demand for alternative sources of income in the coastal regions of the Baltic Sea and also development of new business areas would be important for regional growth. For example, the establishment of mussel farms could help increase turnover of coastal companies and create new jobs, thus, stabilising the economic environment of the coastal regions of the Baltic Sea. By establishing mussel farms, quality improvement of coastal waters and the ability to deliver nutrients from the sea back to land would be a parallel positive benefit.

Synergy with other areas would promote the development of entrepreneurship. Although employment opportunities on a single mussel farm are limited, if several farms in one region are combined, a synergy can be created. The establishment of such co-operation will enable the involvement of other related industries and introduction of innovations in mussel farming. The socioeconomic impact of mussel farms on the Baltic Sea region should be also assessed on a wider scale, including the impact on creating new jobs in related industries and the impact on the supply chain of mussel farms. Upon development of mussel farms, there will be demand for farm equipment, transportation services, specialised mussel gathering works, as well as there would be benefits of supplying mussel feed to related industries such as local farms for salmon, poultry and pigs. In addition, mussel farming as an additional activity can provide benefits to existing fish farmers.

OECD studies have proven that the development of transport and logistics has an impact on the development of the branch trends.

In determining the socioeconomic impact of this sector, final consumption of mussels is a relevant aspect as this will affect the necessary processing equipment and the number of jobs regardless of whether mussels are used in food, feed or elsewhere.

One of the most important non-monetary benefits of mussel farming development may include diversification of the local sustainable food production, at a time when consumers are increasingly seeking for positive environmental attributes in their consumption patterns.

Due to the small size of mussels farmed in the Baltic Sea, their use in food is limited, although it is possible as it would be one of the most profitable sales opportunities. Regardless of the size of mussels, they can be used in food industry or in the production of fish and poultry feed, thus, generating higher profits than using mussels in other industrial sectors such as production of fertilisers or bioenergy.

Factors that would attract the interest of the Latvian coastal population to farm mussels might be long-term work, economic sustainability, and profit. Production profitability would be therefore the most important aspect in establishing a mussel farm.

Wage level of mussel farm employees would vary depending on the education, previous work experience, etc. of a particular person. If the wage is lower than the person has presumed, people will stop working. The higher the real wage, the more coastal residents will be ready to engage in mussel farming and therefore in the process of industry formation it is necessary to crystallise the costs that can be diverted into wage increases to attract potentially more qualified specialists, thus, attracting knowledgeable specialists and providing a competitive salary.

Nowadays in related fisheries sectors mostly part-time working hours are registered, and the average hourly rate in most cases is low.

Local authorities would have the opportunity to save on not installing more efficient water treatment plants, because mussels will be able to partially clean water. This will improve water quality and the attractiveness of the nearby coast, thus, promoting the attraction of tourists. In addition, tourism service providers would be able to organise trips to mussel farms to catch and taste mussels in combination with other tourism and entertainment options offered. It would be possible to combine tourism with local catering services, giving restaurants the opportunity to get fish products, including mussels, from fishermen, if the farm has prepared / obtained all the necessary permits for mussel farming for human consumption. It would create an additional tourist flow by visiting the farm, getting general understanding on their cultivation and the opportunity to taste the local product.

Initial investments in the establishment of mussel farms could be obtained through EU assistance, e.g., by attracting financing as part of the European Fisheries Fund measures, including LEADER, and through credit financing provided by the Latvian Development Finance Institution Altum for various EU environmental measures. Financing of environmental measures in Latvia would be a new field, the development whereof would require further research.

The state and municipalities would earn additional revenue from taxes (i.e., income tax, VAT, natural resources or corporate income tax or environmental service income), whereas coastal residents would obtain new jobs and additional income sources.

Currently mussel farming as a sector does not have a significant economic impact, both as a promotion of employment and activity in the sector itself (direct impact) and as an effect on the supply chain (indirect effect) and on the wider scope of the Latvian economy (intermediate effect).

It is not expected that mussel farming would promote employment along the coast of the Baltic Sea in the near future, since mussel farms are still to be established and, in the first years of their operation, they do not require more than one to two employees, depending on the size of the farm.

By developing the industry at least two to four new direct jobs in each mussel farm can be created, but this can happen in conjunction with industry experts, teaching staff and experienced colleagues from other countries. In addition, a modern and profitable mussel farm should be established on the basis of effective work organisation, as well as working and social conditions that meet EU requirements.

Foreign experts with experience not only in mussel farming, but also in other areas of aquaculture could be attracted for the establishment of a mussel farm. The attraction of such experts would contribute to the development of aquaculture in general.

As the industry evolves, it will have a direct and indirect impact on tourism industry. The direct impact on tourism industry will be the expenses of coastal travellers who will visit seaside regions and modern mussel farms, whereas the indirect impact – additional economic activity related to tourist expenses.

Mussel farms would have an impact on the provision of environmental services, as mussels significantly increase water transparency. Considering the unused Baltic Sea area, spatial planning, it would be possible to create several mussel farms, providing environmental services in the Baltic Sea.

Mussel farms could attract tourists who could either visit them on the boats of mussel farmers or explore the farms by diving, which could potentially become one of the objects of underwater survey.

A mussel farm could become a sightseeing object in the region, thus, attracting additional funds for tourism, as tourists would choose local restaurants and they may also use accommodation services.

Technical experts, diving experts, as well as people with metalworking and construction skills would be required when establishing a farm. Furthermore, services of ports, freight carriers, fishing equipment providers would be also necessary.

People from wholesale, retail sale, frozen product storage, biogas plants, feed processors, developers of insect industry, environmental activists, representatives of the biotechnology sector, processing or processing of products, etc. could be involved in the harvesting stage. The emergence of new products would increase the range of products or services mentioned above.

2. Mussel farming development scenarios

To reflect uncertainty, it is necessary to create at least two scenarios (Heijden, 1996, Amer *et al.*, 2012; Finne, 2017).

Comparisons with analytical designs are the intuitive approaches. These primarily depend on the development of stories. There are a number of basic steps in an intuitive scenario process: a) identification of subject or problem area; b) description of relevant factors; c) prioritisation and selection of relevant factors; d) the creation of scenarios. A subsequent step might be scenario evaluation as pre-policy research (Van Notten, 2005).

Considering the information gathered on mussel farming in the Baltic Sea and the harvested volumes, growth changes over time, based on information provided by experts on possible development stages, the development scenarios for mussel breeding will be reviewed in three stages: pessimistic, realistic, and optimistic.

For development of the scenario, the following factors were used: industry-specific growth indicators, GDP, the number of molluscs produced, viewed as a whole with developmental and limiting factors, as well as biological parameters, economic and social factors affecting shellfish farm (the results were obtained within the scope of the project).

The authors would like to point out the following global and national factors enhancing the development of mussel farming:

- ✓ a limit to the expansion of capture fisheries – capture fisheries will stagnate over the next 10 years (Black, Hughes 2017);
- ✓ climate change – ocean acidification, extreme weather conditions, disease and harmful algae species;
- ✓ considerable social benefits – support for jobs and knowledge accumulation in coastal areas;
- ✓ cost of energy – if it increases, those aquaculture products which require no feed, such as shellfish (Muir, 2015), would be expected to be advantageous;
- ✓ development of technology that will reduce the environmental impact and increase the social acceptance of aquaculture (Black, Hughes 2017);
- ✓ EU and governmental supports for expansion of aquaculture and mariculture industry;
- ✓ increasing demand for high-value protein products (Henchion, Hayes, Mullen, Fenelon & Tiwari, 2017);
- ✓ increasing demand for seafood (FAO, 2019).

Increasing demand for seafood and high-value protein products increases the potential for the development of mussel farming in the Baltic Sea that would allow to retain the local society in the coastal areas by providing them with jobs and sea knowledge accumulation, though certain internal and external circumstances should be considered, such as:

- political document exchange time (national or EU level);
- projects, experience and knowledge accumulation;
- development of new areas, incl. artificial intelligence;
- a turning point if a new product with high added value occurs;

- changes in environmental conditions;
- promotion of circular economy.

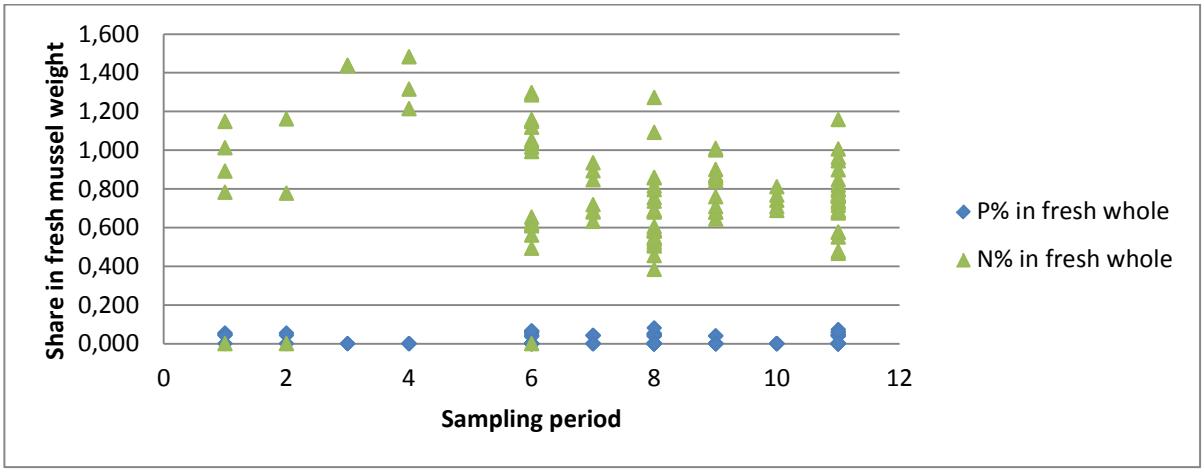
Prerequisites for development:

- published project results;
- gained knowledge;
- accumulated experience;
- society attitude and habits.

Main economic data for development scenarios

- In 2016, 91953 tonnes of the blue mussel were farmed in the Baltic Sea region (FAO, 2019).
- As part of the project Baltic Blue Growth, mussel farms harvested 125 tonnes of the blue mussel in the Baltic Sea, some of the mussel lines are still in water, and there are mussel farms in Germany, Denmark, Finland, and Sweden that have been established by commercial companies and other research projects.
- The results of St. Anna shellfish farm were compared to the results of commercial farms. The number of man-hours spent did not exceed the man-hours spent on commercial farms, so these man-hours will be used for future calculations (two employees are required to harvest 360 tonnes per year (Ozolina, Fricsons, Kļaviņa 2013; Ozolina 2018).
- No scenario was developed after the 15th year as it involves too many unforeseen circumstances.
- Tax rates for fishery companies were obtained by analysing the financial statements of fishing enterprises in Denmark (www.proff.dk), Sweden (www.proff.se), and Latvia, as well as by calculating wages, including the amount of taxes in Sweden (https: //statsskuld.se), Denmark (https://skat.dk), and Latvia. The tax rate is calculated according to the forecast amount of human resources, salary, applying tax rate and supplementing with corporate income tax.
- Harvested blue mussels within the Baltic Blue Growth project were analysed (on their chemical composition) and the results revealed the following information:
    - nitrogen content in fresh mussel on average amounts to 0.8 per cent;
    - phosphorus content in fresh mussel on average amounts to 0.05 per cent.

Table 13. Nitrogen and phosphorus share in fresh wet blue mussel whole weight collected in different harvesting months (University of Tartu; created by Z. Ozolina)



2.1. Slow mussel farming development scenario in the Baltic Sea region

The precautionary scenario is based on the presumption that the growth of shellfish production is slow in the Baltic Sea region, based on the following assumptions:

- Economic data assumptions:
  - harvested blue mussel sales growth is slower (~1.5 per cent per year applying adjusted data) than GDP growth rate (~2.5 per cent);
  - governmental support is at the same level as in previous periods in mussel farming;
  - mussel farming receives support from the EMFF, regional, national structural funds at the same level as in previous periods;
  - mussel farmers are looking for processing sites;
  - lower meat and fish consumption per capita (Ceres project, 2016);
  - ecolabel certification schemes (Ceres project, 2016).
- Social factors data assumption:
  - population change remains at the same level as in previous periods;
  - there are difficulties to attract personnel, especially qualified;
  - educational events remain at the same level;
  - loss of knowledge about the sea continues.
- Environmental factors: there are no changes in environmental conditions in the Baltic Sea having a significant impact on mussel farming within the time period of 0–15 years estimated.

Industry drivers

- support from governmental and regional institutions;
- financing;
- research;
- mussel farmers initiatives.

Table 14. Slow mussel farming development in the Baltic Sea region in upcoming years (created by Z. Ozolina)

	0–5 years	After the 5th year, 6–10 years	*Increase yearly*	After the 10th year, 11–15 years	*Increase yearly*
Forecast harvested mussel amount per year in the Baltic Sea (tonnes per year)	80–300	90–340	*1.5%*	97–365	*1.5%*
Prospective full-time employees per year	0.4–2	0.5–2.3	*1.5%*	0.4–2.5	*1.5%*
Prospective tax payments per year, EUR	3900–15000	4200–17000		4600–18000	
Prospective amount of nitrogen (N averagely 0.8 per cent in fresh mussel) tonnes per year, based on harvested mussel amount	0.6–2.4	0.7–2.7		0.8–2.9	

A total of five mussel farming sites established within the scope of the Baltic Blue Growth project could harvest 130 tonnes of mussels every second year. In interviews, it was established that some mussel farming sites plan to expand mussel production in the upcoming years. Apart from the Baltic Blue Growth project, there are other mussel farming sites in the Baltic Sea (Sweden, Finland).

Historically the harvested mussel amount fluctuates year-over-year, therefore the estimated harvested mussel amount is set in adjusted data.

Part-time employees are hired at St. Anna mussel farm. Based on the data of this farm, it is possible to calculate that two persons could handle up to 300 tonnes; however, using other mussel farming methods and techniques, the number of the persons involved changes.

The estimated tax payment is calculated based on the salary of the involved personnel and estimated corporate tax.

The estimated nitrogen removal is calculated based on the obtained laboratory test results, analysing the nitrogen content in harvested mussels from the project mussel farms. It was 0.8 per cent for fresh mussels.

2.2. Average mussel farming development scenario in the Baltic Sea region

Realistic scenario is developed on the assumption that shellfish farming reaches commercial scale in the Baltic Sea

- Economic data assumption:
    - harvested blue mussels achieve their development phase in 6–10 years and mussel farms in the Baltic Sea can provide one processing site with mussels and therefore the harvested mussel volume within 10 years would increase more rapidly and afterwards it would increase by 10–13 per cent per year which is above the industry growth rate, i.e., 1–3 per cent per year;
    - governmental and regional support has increased, compared to previous periods;
    - increased interest to attract alternative financing;
    - mussel farming receives greater support from the EMFF, regional, national structural funds than in previous periods;
    - mussel farmers have one processing site in the Baltic Sea region;
    - marketing events increase the interest of stakeholders;
    - research in mussel farming in the Baltic Sea continues;
    - educational events increase the knowledge on mussel farming;
    - fresh mussel sales price is 6–10 EUR/kg for human consumption;
    - demand for mussel products increases;
    - ecolabel certification schemes (e.g., ASC) are getting even more popular, labelling plays an important role.
- Social factors data assumption:
    - population change remains at the same level as in previous periods;
    - there are difficulties to attract personnel, especially qualified;
    - regular education events increase the knowledge of mussel farmers;
    - there is a possibility of losing the knowledge about the sea.
- Environmental factors: there are no changes in environmental conditions in the Baltic Sea having a significant impact on mussel farming within the time period of 0–15 years estimated.

Industry drivers

- government support;
- financing;
- research on market potential;
- marketing activities;
- involvement of stakeholders;
- environmental situation.

By analysing processing possibilities, it was assumed that one processing site in the Baltic Sea could work with mussel farmers to process up to 10000 tonnes of mussels. In the survey, which was based on expert opinions, it was revealed that mussel farming could reach the **development stage** in 6–10 years.

Table 15. Realistic scenario of mussel farming development in the Baltic Sea region in upcoming years (prepared by Z. Ozolina)

	0–5 years	After the 5th year, 6–10 years	*Increase yearly, adjusted*	After the 10th year, 11–15 years	*Increase yearly, adjusted*
Forecast harvested mussel amount per year in the Baltic Sea (tonnes per year)	800–3000	2200–8000	*25–35%*	3500–13000	*10–13%*
Prospective full-time employees per year	4–20	15–53	*25–35%*	23–87	*10–13%*
Prospective tax payments per year, thous. EUR	40–150	106–400		172–642	
Prospective amount of nitrogen (N averagely 0.8 per cent in fresh mussel) tonnes per year, based on harvested mussel amount	6.6–25	17–65		28–105	

The forecast harvested mussel amount is growing rapidly in the next five years to reach a commercial scale. It should be noted that in Denmark, the amount of molluscs harvested in 2016 was 45130 tonnes, in Germany 44506 tonnes, and in Sweden 2317 tonnes, so the estimated volume does not exceed historical data.

The estimated number of full-time employees is based on the number of hours spent by the staff of St. Anna farm, and proportional to the number of hours spent.

Usually mussel farmers attract extra employees in the period of establishing the mussel farm and during the harvesting period that have not been included in this calculation.

Furthermore, it could provide researchers with co-operation sites and therefore the indirect effects of socioeconomic factors have not been included in the scenario analysis.

The expected amount of tax per year on a regional scale makes a significant contribution.

2.3. Rapid development scenario of mussel farming in the Baltic Sea region

Optimistic scenario is developed on the assumption that shellfish farming reaches commercial scale in the Baltic Sea

- Economic data assumption:
    - harvested blue mussels achieve their development phase in 6–10 years and mussel farms in the Baltic Sea can provide several processing sites with mussels and therefore the harvested mussel volume within 10 years would increase more rapidly and afterwards it would increase by 10–13 per cent per year which is above the industry growth rate, i.e., 1–3 per cent per year;
    - governmental and regional support has increased, compared to previous periods;
    - increased interest to attract alternative financing;
    - mussel farming receives greater support from the EMFF, regional, national structural funds than in previous periods;
    - mussel farmers provide mussels to several processing sites in the Baltic Sea region;
    - co-operation between mussel farmers and scientists is very good;
    - educational events increase the knowledge on mussel farming;
    - fresh mussel sales price is 6–10 EUR/kg for human consumption;
    - demand for mussel products increases;
    - ecolabel certification schemes are applied to mussel products, labelling plays an even more important role;
    - mussel farming is used as a tool to serve the ecosystem service.
- Social factors data assumption:
    - population change remains at the same level as in previous periods;
    - slight difficulties to attract personnel;
    - regular education events increase the knowledge of mussel farmers;
    - knowledge transfer;
    - increased public interest to improve the Baltic Sea water quality, change of behaviour increases demand for ecological and organic products and services.
- Environmental factors: there are no changes in environmental conditions in the Baltic Sea having a significant impact on mussel farming within the time period of 0–15 years estimated.

Industry drivers

- government support;
- financing;
- research institutions;
- research on market potential;
- marketing activities;
- involvement of stakeholders
- market demand;
- environmental situation;
- labelling and branding.

By analysing processing possibilities, it was assumed that several processing sites in the Baltic Sea could work with mussel farmers to process up to 10000 tonnes of mussels at one place. In the survey, which was based on expert opinions, it was revealed that mussel farming could reach the **development stage** in 6–10 years.

Table 16. Optimistic scenario of mussel farming development in the Baltic Sea region in upcoming years (prepared by Z. Ozolina)

	0–5 years	After the 5th year, 6–10 years	*Increase yearly, adjusted*	After the 10th year, 11–15 years	*Increase yearly, adjusted*
Forecast harvested mussel amount per year in the Baltic Sea (tonnes per year)	1500–5600	5400–20000	*25–35%*	8700–33000	*10–13%*
Prospective full-time employees per year	14–65	225–1000	*25–35%*	360–1800	*10–13%*
Prospective tax payments per year, thous. EUR	65–245	237–900		382–1400	
Prospective amount of nitrogen (N averagely 0.8 per cent in fresh mussel) tonnes per year, based on harvested mussel amount	12–45	43–162		70–260	

The forecast harvested mussel amount will be growing rapidly in the next five years to reach a commercial scale and to ensure large-scale recycling in the region.

The apparent volume is based on the fact that there are about three processing sites in the Baltic Sea Region, two of them in the western Baltic Sea and one – in the eastern part. The amount has been estimated based on the potential area size available.

The estimated number of full-time employees is based on the number of hours spent by the staff of St. Anna farm, and is proportional to the planned volume, plus an adjustment of 10 per cent that can be applied to the industrial development of shellfish farming.

The expected amount of tax payments per year at a regional level will make a significant contribution.

Currently and in the near future no significant development of the mussel farming industry is expected, hence its impact on the national economy as a whole and on certain related sectors will be insignificant. However, as the industry evolves, it will create additional demand for workforce in a number of related branches (e.g., suppliers and equipment service providers, employees of financial institutions, transport service providers, specialist mussel producers and employees of mussel farms, etc.).

In fact, Latvia has all the necessary initial socioeconomic preconditions for mussel farming: labour force, fishing tackles, the sea, topicality of environmental pollution prevention. However, the most important precondition for the development of this sector is the cost-effectiveness of mussel farming,

which, similar as in agriculture, can be achieved through targeted state and EU support policies (Konsorts, 2018).

From a biological point of view, the future growth potential of mariculture depends on whether the cultivated species depend on input from capture fisheries, or not. Stable capture fisheries, which are assumed in both projections, will obviously halt the production of mariculture species such as bivalves and macroalgae that critically depend on this fishery, but not the production of species that do not depend on it. There is already a faster increase in the production of macroalgae and molluscs than of marine carnivores globally, and this development is expected to continue (SAPEA, 2017).

Long-term impact of the climate:

According to the data and projections available on climate change in the Baltic Sea region in the next 100 years, the most probable changes are related to the increase of sea surface temperature and decrease of ice cover. These factors are not seen as very limiting for the blue mussel population. However, these projected conditions may increase the settlement of new species that are either spreading to the Baltic Sea area naturally or that have been deliberately or accidentally introduced by humans. The impact on blue mussel natural population is uncertain.

Situation and prognosis for the most important factors for blue mussels like salinity and acidification remain unclear, so we cannot estimate the impact of these factors, but simply consider them as potential threats.

Conclusions and recommendations

According to the **precautionary scenario**, mussels harvested in 6–10 years would contribute to the Baltic Sea region:

- harvested blue mussel amount – up to 340 tonnes per year;
- new workplaces – two full time employees;
- EUR 4200–17000 as tax payments per year;
- reduction of 0.7–2.7 tonnes of nitrogen per year from the Baltic Sea.

According to the **realistic scenario**, mussel farming could provide the following benefits in the Baltic Sea region in 6–10 years:

- harvested mussel amount – 2200 up to 8000 tonnes per year (adjusted data);
- 15–53 full-time workplaces;
- EUR 106–400 thousand as tax payments per year;
- removed amount of nitrogen 17–65 tonnes per year from the Baltic Sea.

Taking into consideration that certain mussel farming sites have been established during the last three years, it is not possible to assess the indirect effect of socioeconomic factors on related industries. Further research could therefore enable the assessment of the impact of mussel farming in coastal areas.

The assessment is based on information obtained over the period from 2016 to 2018. Considering that marketing aspects in this field are changing rapidly and social factors are influenced by marketing, a more in-depth research could provide more extensive information on this field.

Based on the conducted analysis, it can be concluded that mussel farming in the Baltic Sea region is at its pre-development stage and there are many ways to go. According to the sector experts, it takes from 15 to 20 years to build a mussel farming industry in the Baltic Sea. Recommendations for advancement of this sector are summarised based on the data presented above and the experience of authors and expert conclusions from the Baltic Blue Growth project meetings and reports:

Co-operation between mussel farmers ought to be strengthened at local, regional and transnational levels. Co-operation at local and regional levels could present the opportunity for sharing the equipment, accessing and obtaining licenses and permits, managing the business and marketing the products. Co-operation at a transnational level would give more possibilities for lobbying, as well as attracting funds for research and innovation.

It is necessary **to improve regulations and make the licensing process easier, to avoid unnecessary bureaucracy and time-consuming procedures**. E.g., in Latvia it is difficult, expensive and time-consuming to get the area permit to put a mussel farm in the sea, because of the same rules that are applied for wind parks. Procedures and rules for mussel farming shall be adjusted differently as compared for fish farming (since there is more pollution) or building wind parks (more construction and possible negative impacts). Today rules and licensing procedures for mussel farming are very different in countries around the Baltic Sea. There is a possibility for co-operation between the managing and controlling institutions to exchange the experiences and introduce similar and favourable regulatory regimes for mussel farming permit applications in the Baltic Sea region countries.

The linkages between fisheries sector and mussel farming should be strengthened. Over the last 10 years fishing industry has been affected by many factors, e.g., reduction of fish resources, catch quotas and fishing tackle, and fishing extinction may lead to the loss of important sea knowledge and reduction of coastal population in rural areas in future. Fishermen will have to change their way of fishing, but they have important advantages (knowledge about the sea and equipment) that they can use to start mussel farming as an additional business. Mussel farming can be also developed as a franchise business where, e.g., fishermen do the farming and grow mussels because that is what they like to do, whereas management and marketing issues can be handled, e.g., by a co-operative.

There is a future for aquaculture (fish, mussel and macroalgae production) in the Baltic Sea region, and **aquaculture sector has great potential to involve young enthusiasts with great ideas**, and this should be supported both politically and financially. Creating local or regional clusters with aquaculture and non-aquaculture activities addressing a common need and market application is a possibility to foster development. Contribution to education and innovation, technological innovation and market development is needed, too.

Research and development in mussel farming should be continued. There is a need for improved understanding and development of appropriate growing and harvesting technologies, environmental and ecosystem concerns, product development and possible new markets, etc. Even if the trials are not successful, it is important to record and save knowledge and lessons learned for further developments.

Improvement is needed in common understanding in monitoring and benchmarking of different farms, techniques and products. There is a need to standardise, e.g., calculations on the size of mussels and have a clear idea on what to compare. Since the industry is new within the Baltic Sea region, problems with comparing data and measurements come up and rise unnecessary discussions on what and how is measured and compared.

Mussel farmers need to communicate the value of the product. Communication is very important. Mussel farming provides locally produced valuable seafood product and helps to improve the ecological condition of the Baltic Sea at the same time. This is a unique selling proposition for the Baltic Sea mussel products. Increasing interest in the Baltic Sea region to encourage blue mussel farming requires new promotion activities. So far promotion activities of mussel farming and mussel products are not well-presented on websites and social networks in the Baltic Sea region.

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Annex 1, Survey

Socio-economic factors for the development of aquaculture, including shellfish farming

Hello!

We are inviting you to participate in the survey to find out importance of socioeconomic factors, including for development of mussel farming. Your feedback is very important to draw up the development scenarios for the Baltic Sea mussels farming within the transnational cooperation Programme Interreg Baltic Sea Region project "*Baltic Blue Growth*". Your answers will be used only in a summarized form with the aim to develop recommendations for the relevant State Authorities.
The estimated time for filling in the questionnaire – 10 min.

Questions regarding economics and market development

1. In your opinion, how important are below mentioned fields in the national economy of your country?

Field	Unimportant - 1									Very important - 10	Hard to say
1.1. Fishery*	1	2	3	4	5	6	7	8	9	10	
1.2. Marine aquaculture **	1	2	3	4	5	6	7	8	9	10	
1.3. Mussel farming	1	2	3	4	5	6	7	8	9	10	

** A fishery is an entity engaged in raising or harvesting fish caught in capture or in aquaculture (Fletcher et al. 2002)*
*** Aquaculture is farming of aquatic organisms, like fish, molluscs, crustaceans etc. (FAO, 1990-2017)*

2. In your opinion, how important is the below mentioned field in the development of your country's coastline?

Field	Unimportant - 1									Very important - 10	Hard to say
2.1. Fishery	1	2	3	4	5	6	7	8	9	10	
2.2. Marine aquaculture	1	2	3	4	5	6	7	8	9	10	
2.3. Mussel farming	1	2	3	4	5	6	7	8	9	10	

3. In your opinion, which of marine aquaculture field has the chance to develop in the next 10 years in your country?

Field	Small opportunities - 1									Very high opportunities - 10
3.1. Algae farming	1	2	3	4	5	6	7	8	9	10
3.2. Marine aquaculture	1	2	3	4	5	6	7	8	9	10
3.3. Mussel farming	1	2	3	4	5	6	7	8	9	10
3.4. Marine product processing	1	2	3	4	5	6	7	8	9	10
3.5. Wind parks	1	2	3	4	5	6	7	8	9	10
3.6. Wave parks	1	2	3	4	5	6	7	8	9	10

4. To what extent do you think fisheries affect regional employment of the coast in your country?

Not important Very important
1 2 3 4 5 6 7 8 9 10

5. In your opinion, how do below mentioned factors affect development of mussel farming (Factors listed in the alphabetical order)?

Factors	Not affect - 1									Affect very important -10	Hard to say
5.1. Climate change	1	2	3	4	5	6	7	8	9	10	
5.2. End-use market	1	2	3	4	5	6	7	8	9	10	
5.3. Environmental pollution	1	2	3	4	5	6	7	8	9	10	
5.4. Financing (subsidies, loans)	1	2	3	4	5	6	7	8	9	10	
5.5. Formal, also informal education	1	2	3	4	5	6	7	8	9	10	
5.6. Government support	1	2	3	4	5	6	7	8	9	10	
5.7. Labour force /Human resource	1	2	3	4	5	6	7	8	9	10	
5.8. Marketing events	1	2	3	4	5	6	7	8	9	10	
5.9. Tax	1	2	3	4	5	6	7	8	9	10	

6. In your opinion, how do below mentioned factors affect development of marine product processing (Factors listed in the alphabetical order)?

Factors	Not affect - 1									Affect very important -10	Hard to say
6.1. End-use market	1	2	3	4	5	6	7	8	9	10	
6.2. Financing (subsidies, loans)	1	2	3	4	5	6	7	8	9	10	

6.3. Formal, also informal education	1 2 3 4 5 6 7 8 9 10	
6.4. Government support	1 2 3 4 5 6 7 8 9 10	
6.5. Labour force /Human resource	1 2 3 4 5 6 7 8 9 10	
6.6. Marketing events	1 2 3 4 5 6 7 8 9 10	
6.7. Tax	1 2 3 4 5 6 7 8 9 10	

7. In your opinion, which stage of mussel farming development may be reached in a specified period in your country?

Period	Today	In 5 years	In 6-10 years	In 11-15 years	In 16 years and over a longer time period
7.1. **Introduction stage** (Sales are low, although they will be increasing. The costs for market launch is high)					
7.2. **Growth stage** (Sales volume is growing and the company has a profit from the realization of product. The company plans to invest in the development)					
7.3. **Maturity stage** (The company plans to maintain the existing market share; the company considers to invest in product upgrading activities)					
7.4. **Decline stage** (The sales volume starts to decrease, probably the market is saturated, probably the product brings profit)					
7.5. **Not started / will not be launched**					

8. In your opinion, which development phase of mussels for use in the Baltic Sea region may be reached in a specified period?

Period	Today	In 5 years	In 6-10 years	In 11-15 years	In 16 years and over a longer time period
8.1. **Introduction stage** (Sales are low, although they will be increasing. The costs for market launch is high)					
8.2. **Growth stage** (Sales volume is growing and the company has a profit from the realization of product. The company plans to invest in the development)					
8.3. **Maturity stage** (The company plans to maintain the existing market share; the company considers to invest in product upgrading activities)					
8.4. **Decline stage** (The sales volume starts to decrease, probably the market is saturated, probably the product brings profit)					
8.5. **Not started / will not be launched**					

Questions regarding legal acts

9. In your opinion, do you think the legal acts sufficiently regulates the following areas in your country?

Field	Yes, sufficiently regulate - 1 Major amendments needed - 10	Don't know
9.1. Fishery	1 2 3 4 5 6 7 8 9 10	
9.2. Marine aquaculture	1 2 3 4 5 6 7 8 9 10	
9.3. Mussel farming	1 2 3 4 5 6 7 8 9 10	

If the answer is 1-3, the question 10 is not relevant.

10. In your opinion, to what an extent are the legal acts necessary to develop marine aquaculture in your country?

		Nothing needs to be changed -1 Significant changes are required - 10	Don't know
10.1.	Updating of the licensing procedure	1 2 3 4 5 6 7 8 9 10	
10.2.	Regularly upgrading of the development strategy of the sector	1 2 3 4 5 6 7 8 9 10	
10.3.	Updating of the terminology	1 2 3 4 5 6 7 8 9 10	
10.4.	Updating of the legislation in the marine aquaculture sector	1 2 3 4 5 6 7 8 9 10	
10.5.	Updating of the legislation of the environmental law	1 2 3 4 5 6 7 8 9 10	

Questions regarding environment

11. Should mussel farming be subsidised if it is with aim to reduce contamination of nutrients in the Baltic Sea?

- Yes
- No
- Unwilling to respond

If the answer is "No" or "Unwilling to respond", please forward to the 13th question.

12. How much, do you think, should be a payment for improving the state of the environment in the Baltic Sea?

…. EUR per year by 1 inhabitant

13. What measures, in your opinion, should be introduced to improve the condition of the Baltic Sea environment (please mark up to 4 answers**)?**

Support for measures to reduce pollution
Limitation of shipping
Payment for pollution
Limitation of oil extraction and transportation at sea
Control of hydrotechnical building and use them in a sea
Stricter pollution control
Controlling / limiting the flow of tourisms in coastal areas and in a sea
Limitation of fishing activities in a sea

Questions about habits

14. How many times over the last 12 months have you consumed mussels?

0 1 2 3 4 5 6 7 8 9 10 and more

15. How much would you be willing to pay for 1 kg fresh / frozen mussels in the shop/trading sites?

……..(EUR/kg)

More frequently is being discussed the possibility of using insects as a source of protein, therefore you are asked to answer the following questions:

16. Would you consume food in which one of the ingredients is of insect origin?

No 1 2 3 4 5 6 7 8 9 10 **Yes**

17. Would you feed animals with a product in which one of the ingredients is of insect origin?

No 1 2 3 4 5 6 7 8 9 10 **Yes**

Overall questions

18. Gender

- Female
- Male

19. Age

- Under 18 years old
- 18-24 years old

- 25-34 years old
- 35-44 years old
- 45-54 years old
- 55-64 years old
- 65-74 years old
- 75 years or older

20. Education

- General basic education, vocational basic education or equivalent level (EQF level 1, 2 or 3)
- General secondary education, vocational education or equivalent level (EQF level 4)
- First level higher education (college) or equivalent level (EQF level 5)
- Bachelor's degree or equivalent level (EQF level 6)
- Master's degree or equivalent level (EQF level 7)
- Doctoral degree or equivalent level (EQF level 8)

21. In which sector are you occupied?

- Professional, scientific and technical services
- Regional government - municipalities, regional authorities
- Public administration - government, ministries
- Fisheries, incl. fishing, shellfish farming or aquaculture
- Other (please specify)….

22. Nationality (in an alphabetic order)

- Denmark
- Estonia
- Finland
- Germany
- Latvia
- Lithuania
- Poland
- Sweden
- Other:

Thank you for your answers!