The Norwegian aquaculture analysis 2021

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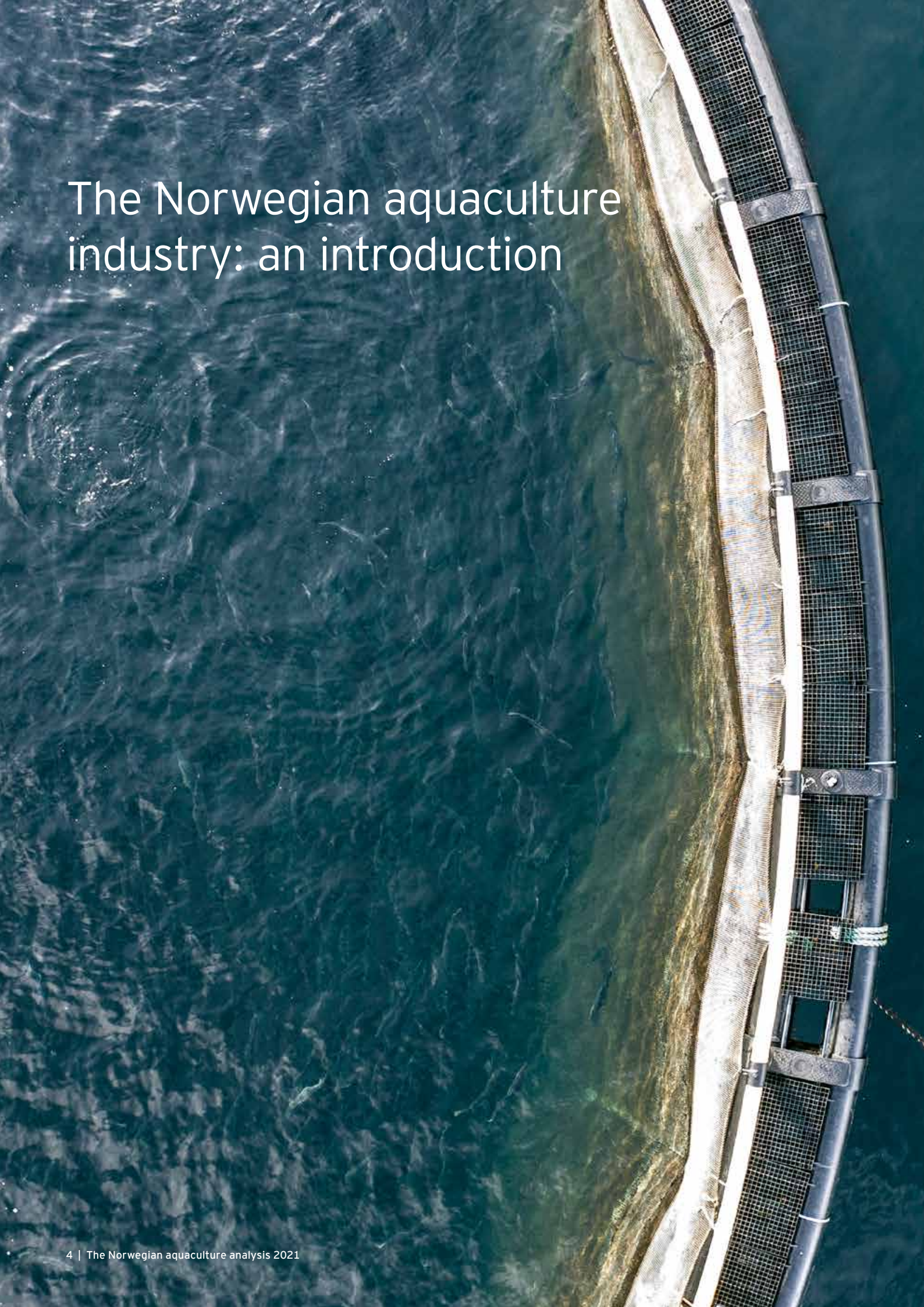
Contents

The Norwegian aquaculture industry: an introduction



Dear distinguished reader,

We are delighted to introduce the sixth annual edition of the Norwegian Aquaculture Analysis. In this year's edition, we have widened our scope to include an overview of the aquaculture sector in Iceland and Chile – two growing and important harvest clusters different from Norway in both markets and upstream qualities.

It was inspiring for us to receive feedback that our annual analysis has become a source for insights and trends and a benchmark tool for the industry, investors and suppliers interested in the aquaculture sector.

The overview covers a short update on land-based production and development licenses, the potential future impact of climate on the global industry and opportunities within seaweed farming.

As always, the report focuses on topics of special interest and relevance to the industry. As land-based aquaculture steadily develops and grows in importance and volume, the industry is also experiencing that things take time, challenging investors' confidence.

The unique and extensive EY Seafood Company Database (EY-SCD) – with a comprehensive volume of key financial figures – has been expanded with key data for 1,247 companies within various segments of the aquaculture value chain. The key data ranges from technical solutions to the production and export of salmon and trout and substantiates the quantitative and qualitative analysis presented. We also offer our market perspectives for the industry, going forward.

The development licenses regime in Norway has contributed significant investments in other production technologies such as closed or semi-closed systems as well as offshore fish farming. In this edition, you can read more about the status of the various initiatives that have been granted development licenses.

The 2021 UN Climate Report released in August 2021 rightfully received a lot of attention. In earlier editions of our report, we have brought forward thoughts on sustainability within the aquaculture sector. This year, we take a look at the potential impact of climate on the global aquaculture industry.

As a multidisciplinary provider of professional services to the industry, the EY team possesses in-depth knowledge about the characteristics of each segment of the aquaculture value chain. The segments are seamlessly tailored with EY core professional services within Advisory, Corporate Finance, Tax & Legal Services, Audit and Accounting. Specialist seafood sector teams are located in numerous seafood clusters and marketplaces around the world.

For the seafood industry, global trade and export to far markets have been a matter of concern. The effect of the pandemic on world trade this year has resulted in protectionist discriminatory interventions such as toll barriers and the breaking up of trade agreements and unions.

From a global perspective, this may, in the short term, impose obstacles for global export and hence result in structural implications for the production location. But looking ahead, this could also bring land-based aquaculture close to consumers as the only secure supply option, hence driving new projects – given operational and biological risks are controlled.

While analyzing the industry, we have identified five megatrends that will affect the global food industry:

- Growing world population
- Increasing rate of digitalization
- Growing middle class coupled with urbanization
- Increasingly health-conscious consumers
- More focus on sustainability and exploited resources

These trends will greatly impact the global potential and development on both the supply and demand side, with the pandemic's effect on urbanization, health, and biotechnology as important contributing factors.

While analyzing trends, it is vital to base observations on a larger global framework with implications greater than those created locally. We observe growing consciousness and awareness within the aquaculture value chain about sustainability and preventive health.

This awareness affects the whole value chain and not just farming. The latter has been experiencing volume constraints due to biological challenges, regulations and a need for technical development.

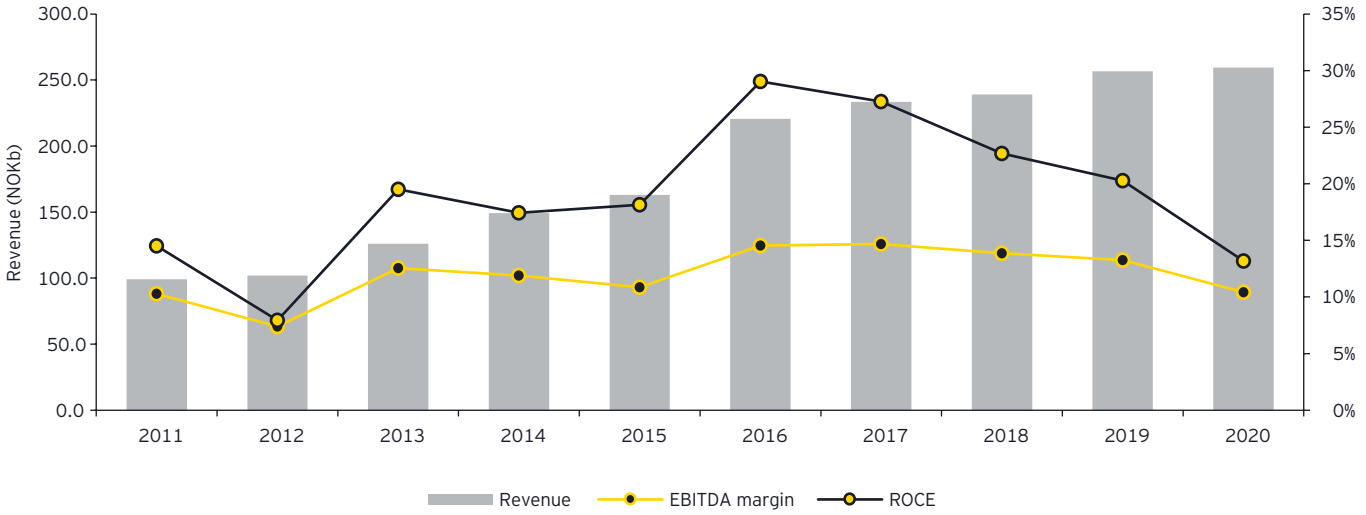
We should bear in mind that salmon and trout constitute a marginal volume of global seafood production. Hence small shifts or changes in underlying drives of consumption will form a solid basis for both demand and price of produce.

We sincerely hope you find our report useful and interesting. Please don't hesitate to contact us to discuss the aspects of this exciting industry.

Eirik Moe
Sector Leader, Assurance, Ernst & Young AS

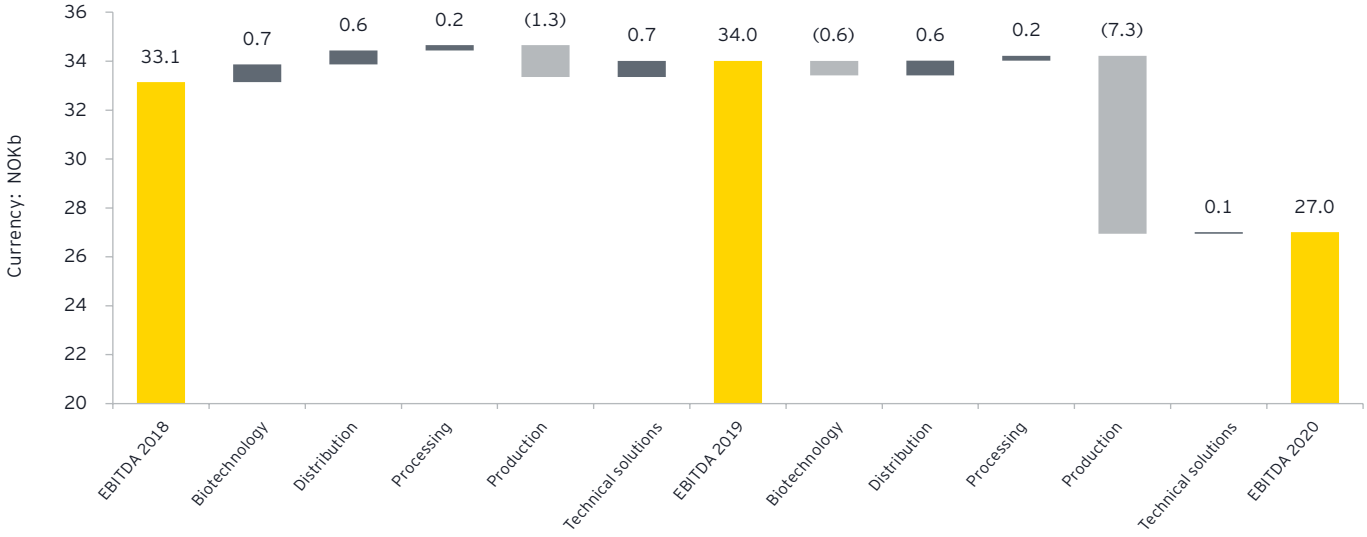
Key highlights

The Norwegian aquaculture industry 2011–20



- The trend observed in 2019 has continued in 2020, with a growth in revenue and a reduction in margin.
- Multiple companies across segments report a negative impact from COVID-19 on their 2020 figures. However, if we exclude the production segment and the trading subsegment, we observe a revenue growth of almost 7% with only a slight reduction (0.4%) in the EBITDA margin. So, once again, the sea farming subsegment is the primary trend driver.
- In the upcoming pages, we will comment on the key changes that have come into effect since last year's edition. We will also cover a complete 10-year history, further description and analysis toward the end of this report.

EBITDA bridge 2018–20



Technical solutions

Transactions

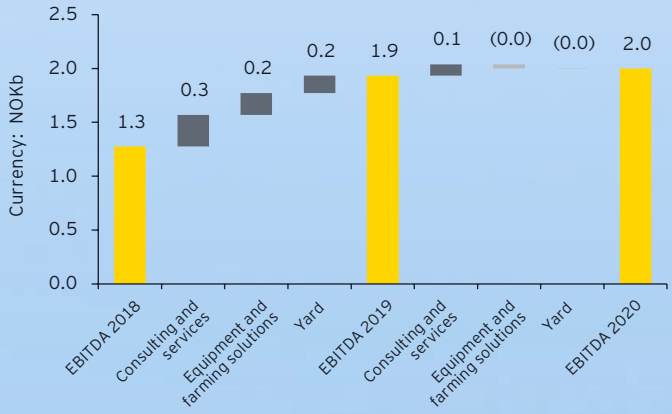
- In 2020 and 2021 (as per December 2021 data), 30 deals involving companies in this segment were announced. In 17 of the transactions, these companies were the target. There was a fairly even split between strategic and financial buyers. This is in line with a historical trend of increased deal activity in the segment, though the interest from financial investors heightened in 2021. Nonetheless, the majority of transactions were still dominated by strategic buyers. This demonstrates the continued importance of companies using M&A to gain market share, enabling a more complete product portfolio and economies of scale.

Stagnating revenue but stable margins

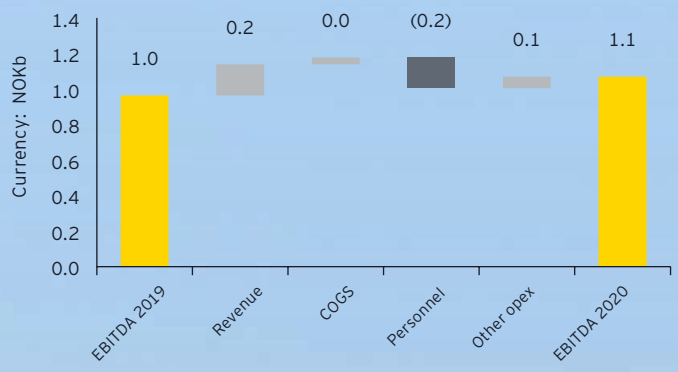
- Technical solutions companies have experienced double-digit revenue growth over the past six years (13.9% p.a. from 2014–19), with the exception of 2018. However, revenue growth stagnated in 2020 (+3.1%), which can potentially be explained by the uncertainty resulting from the pandemic, leading to project postponements and cancellations.
- Despite the stagnating revenue growth, ongoing cost or project management initiatives resulted in EBITDA margins remaining at 2019 levels (7.5%), as the cost base increased by 3.1%. Through this increased efficiency, the segment appears to have recovered from the all-time low EBITDA margin witnessed in 2018.
- Activity in the yard subsegment was, for the most part, strong in 2020 with a high number of orders, including well-boat newbuilds. However, despite the growing demand for newbuilds, one of the largest players in this subsegment performed particularly poorly with a 38% reduction in revenue. This is likely an important factor behind the stagnation of revenue growth in 2020. Reasons for this poor performance include difficulties in delivering projects due to COVID-19-related factors, such as labor shortage. Margins in the subsegment continued to remain above the low point in 2018, with an EBITDA margin of 4.7% in 2020.

- In 2020, consulting and services was the only subsegment reporting an increase in EBITDA and positively contributing to the development in segment EBITDA. Nearly 60% of the companies experienced revenue growth from 2019 to 2020, and close to 55% reported improved EBITDA margins.
- Several companies nearly tripled their revenues between 2019 and 2020. However, despite this achievement, the subsegment reported the lowest YoY revenue growth (+2.7%) seen over the period 2011 to 2020. Nevertheless, the companies in the consulting and services segment continued to increase gross profit (72% in 2020), resulting in a NOK104m increase in EBITDA corresponding to a subsegment EBITDA margin of 16.3%.
- The equipment and farming solution subsegment saw weaker revenue growth in 2020 (+3.9%) compared with the previous years (14.3% p.a. from 2015 to 2019). This stagnation was mainly the result of a 19% reduction in revenue among small-sized companies with revenues below NOK100m. In contrast, the large and mid-sized companies reported revenue growth of 21% and 14%, respectively. Exports seem to have been relatively insulated from the challenging economic environment, with reported figures in the segment increasing from 2.1b in 2019 to 2.4b in 2020 (+14%), continuing the positive trend.
- There were large variations in profitability levels reported by the companies in 2020. This subsegment is predominantly made up of small-sized companies (of which approximately 70% report revenues below NOK50m). Although they witnessed a decrease in revenue, the EBITDA margins were 6.8% in 2020 (up from 6.2%), which was substantially higher than the 4.6% margins achieved by the subsegment as a whole. Leading this trend is a handful of companies reporting very high margin levels (>20%), partly due to niche product offerings and high market demand for certain products (such as delousing systems).

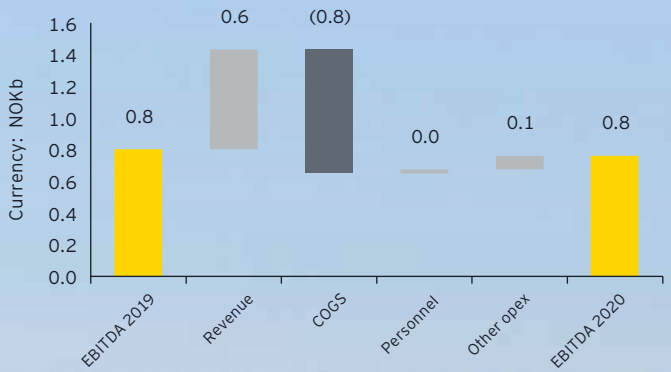
Segment EBITDA bridge



Consulting and services EBITDA bridge



Equipment and farming solutions EBITDA bridge

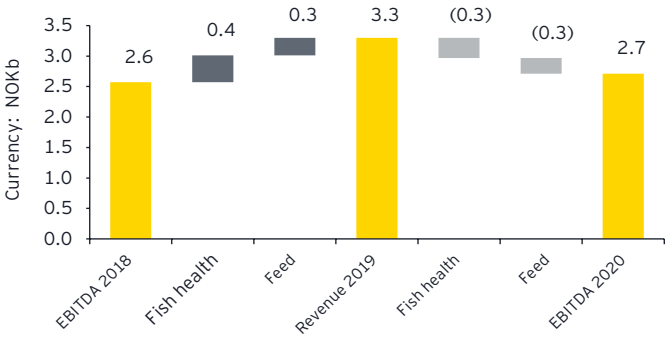


Biotechnology

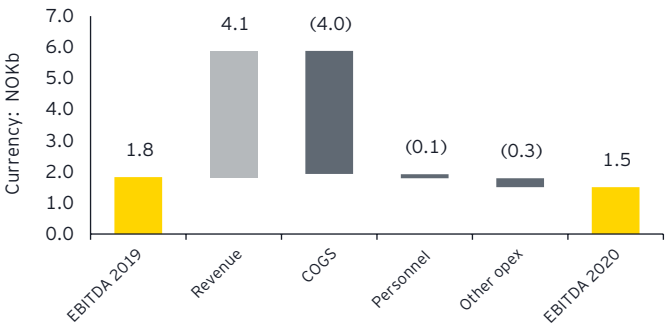
All-time-high revenue, but margins under pressure?

- The biotechnology segment experienced a significant increase in revenue (+10.8%) from 2019 to 2020, reaching a record-high NOK39.3b in 2020. From 2018 to 2020 the revenue growth reached 25%, significantly higher than the previous period.
- The feed segment was the primary growth driver. The growth was driven by higher sold volumes of feed, which coincides well with the observed higher harvest volumes.
- In 2020, the Norwegian feed segment produced more than 2,100k tonnes of salmonid feed. Despite a significant volume increase of 7.9% between 2019 and 2020, margins were affected by harsh competition and high raw material costs. As a consequence, EBITDA margins were reduced from the record-high of 6.4% in 2019 to 4.6% in 2020 – the lowest margin observed since 2014.
- Margins in the fish health subsegment grew from approximately 11% in 2013 to 21% in 2019. In 2020, margins decreased to 18%. This is still high compared with historical data, but a significant reduction from the 2019 record. The reduction is, to a large degree, driven by the cleaner fish producers and biotechnology firms working with fish genetics.
- Cleaner fish producers are seeing their EBITDA margins plummet. In the 2015 to 2018 period, margins were above 30%, which is significantly higher than the sub-14% margins achieved in 2020. According to the Directorate of Fisheries, there was a 15% reduction in the number of cleaner fish released into net pens in 2020. In addition, the achieved sales price of cleaner fish has gone down. The use of cleaner fish has been a topic of severe scrutiny over the last couple of years because the majority of fish released into net pens is never recovered.
- The breeding and genetics industry was impacted by the COVID-19 pandemic, specifically in relation to the export of their goods. This resulted in the production of genetic material that they were unable to sell.

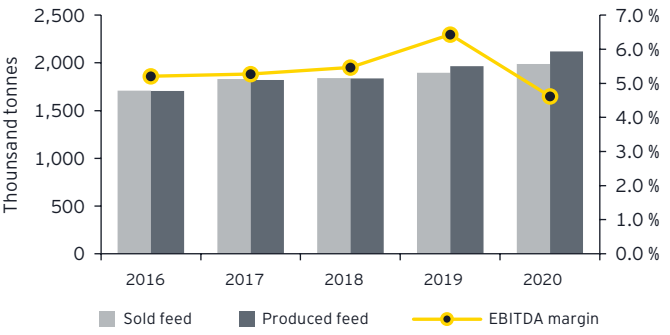
Segment EBITDA bridge



Feed EBITDA bridge



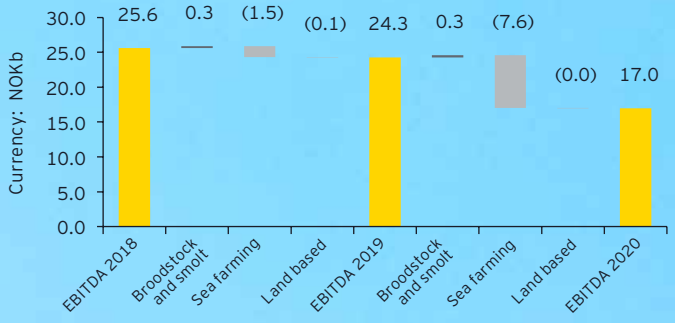
Feed EBITDA margin and volume development



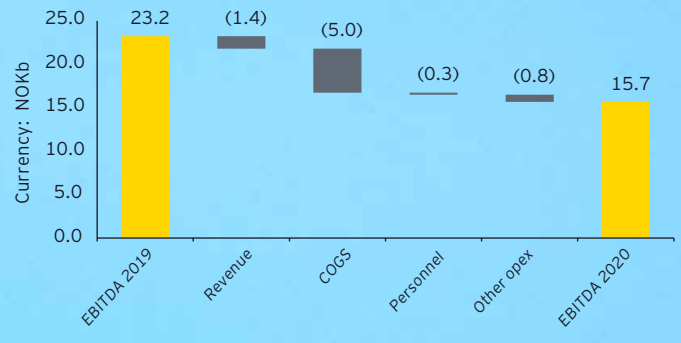
Source: "Mowi Salmon Farming Industry handbook 2020," *Directorate of Fisheries*, EY

Production

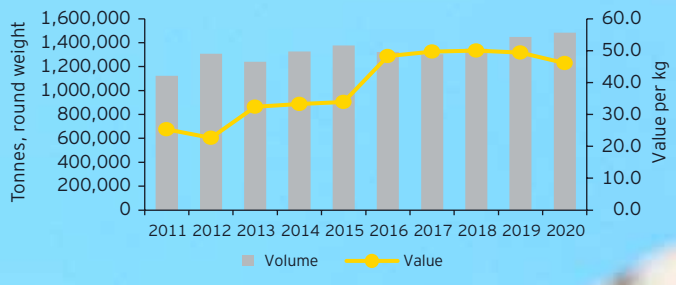
Segment EBITDA bridge



Sea farming EBITDA bridge



Price and volume development



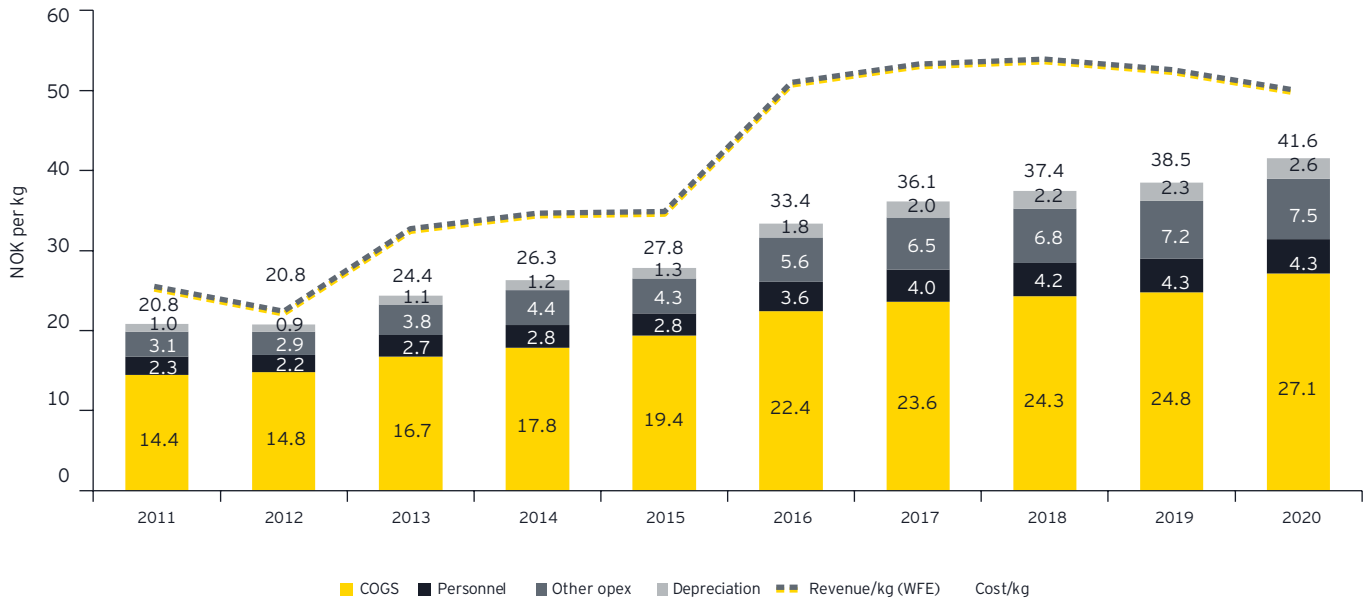
Record-high harvest volumes, but lowest EBITDA margin in eight years

- After achieving record-high revenues in 2019, the sea farming subsegment saw its revenues go down in 2020. This was despite a 2.9% growth in sold harvested volumes in 2020 compared with 2019. As such, the explanation for the revenue reduction was simply a lower sales price on salmon.
- The sea farming subsegment has been impacted by COVID-19 in multiple ways. A closedown of the food service industry (HoReCa) forced a shift in the distribution, and more volumes were moved to retail channels. We even observed an increase in the amount of fish processed in Norway before being shipped (normally most of the fish is shipped as head-on-gutted (HOG) and processed in other European countries). Freight, especially air freight, became a constrained resource, tightening the leash on distribution possibilities. Taking all of this into account, a price reduction of 6.2% (Fish Pool) and an increase in sold volumes is a fair performance in what we expect to be an outlier year in the long run.
- EBITDA was reduced by 33% during the period 2019 to 2020, and margins went from 30% to 21%. While price achievement mostly explains the drop in EBITDA, production costs also increased significantly in 2020. Assuming the same price achievement in 2020 as in 2019, EBITDA margins would still be down from 30% to 26%.
- Most all of the larger farmers report higher production costs in 2020. Biological challenges, hereunder lice, winter ulcers and algae are listed as the primary explanatory factors for the increased production cost. Additionally, COVID-19 brought on challenges related to logistics and freight which could also negatively impact costs.
- This resulted, once again, in an all-time-high cost per kg (WFE) metric in our analysis, increasing by 8.5% compared with 2019. Please note that our cost per kg is based on the financial statements of each entity. It will be higher than the cost per kg reported by the Directorate of Fisheries since they have pure-play production costs.
- It is worth noting that the 2020 EBITDA margins we observe in our analysis are lower than the 2015 EBITDA margins, even though the 2020 salmon price is more than 30% higher than that of 2015.

Transactions

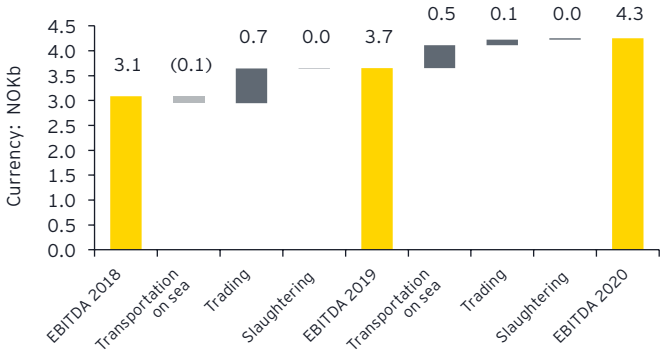
- Over the last couple of years, there have been a limited number of transactions in the sea farming subsegment in Norway, with most M&A activity taking place in other parts of the aquaculture value chain.
- Since our last edition, there have been some larger acquisitions of note: NTS' acquisition of SalmoNor and Måsøval's acquisition of Vartdal Gruppen. In addition, Aker ASA and SalMar ASA have established an offshore fish farming company, SalMar Aker Ocean.
- Further, in 2020 and 2021, strong capital markets have encouraged multiple conventional and land-based salmon farmers to raise capital and get listed on the Oslo Stock Exchange, most notably on Euronext Growth. This trend slowed down in the second half of 2021.

Cost/kg (WFE) development

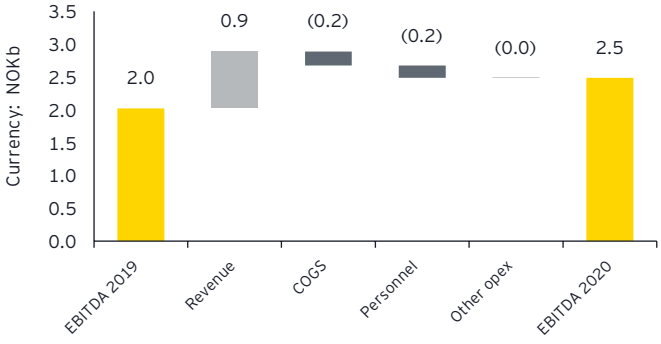


Distribution

Segment EBITDA bridge



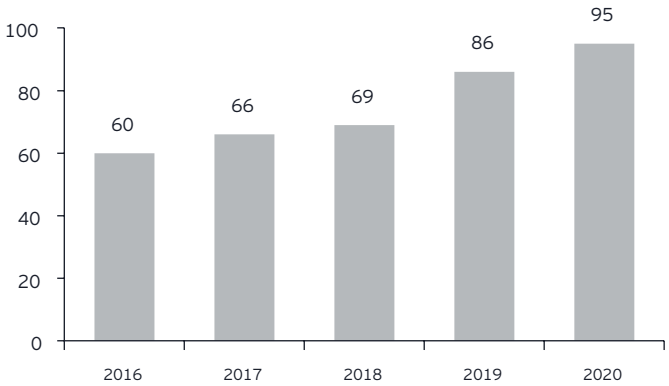
Transportation on sea EBITDA bridge



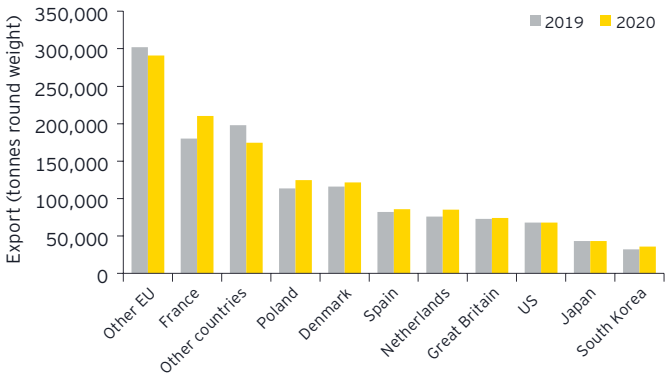
Never-ending growth for the well-boats companies?

- The distribution segment achieved a record-high EBITDA in 2020, crossing NOK4b in EBITDA for the first time. However, looking at the segment as a whole, revenues decreased slightly from 2019 to 2020, meaning that the EBITDA increase came through higher EBITDA margins. As apparent from the top left segment EBITDA bridge, transportation on sea was the primary reason for the YoY EBITDA growth.
- The transportation on sea subsegment primarily constitutes of three vessel categories: well-boats, processing vessels and feed vessels. Well-boat is the primary source of activity in the subsegment, achieving a staggering 12% revenue growth combined with an almost 3% increase in EBITDA margins (44% in 2020). Well-boats have become an integral part of the treatment cycle, continuing to reap benefits out of the biological issues faced by farmers. Processing vessels are not a new thing in 2020, but the scale of the subsegment has never been higher. In 2020, the processing vessels had an all-time-high revenue combined with a 46% EBITDA margin. Feed vessels also saw their revenues grow in 2020 (up approximately 9% from 2019) with a record-high EBITDA. Between 2014 to 2017, revenues for the feed vessels grew with a compound annual growth rate (CAGR) of 1.1%, which is minuscule compared with the CAGR of 19% observed in the 2018 to 2020 period.
- The number of well-boats continued to increase steadily, reaching 95 in 2020 according to the latest statistics from Kystrederiene. Given that shipyards still report decent backlogs and high activity, continued fleet growth is expected.
- The trading companies experienced a revenue decrease in 2020, despite high export volumes. This reduction was due to the previously-mentioned low sales price of salmon in 2020.
- According to the latest statistics published by the Directorate of Fisheries, the total export of Norwegian salmonoids reached 1,488k tonnes in 2020 (1,314k salmon and 87k trout), up from 1,429k in 2019. The share exported to Europe increased to 79% in 2020 (76% in 2019), with Poland and France being the largest markets.

Number of well-boats in Norway



Norwegian export of salmon



Market perspectives

Status and thoughts on the short-term future

Where are we?

The Norwegian aquaculture industry has fared quite well, despite the adverse impact of the pandemic. After all, even in times of great turmoil, one must eat.

While 2020 was the year with the lowest YoY revenue growth in our analysis, the industry still managed a 1.1% growth in what can only be described as a demanding market. However, excluding the production segment and the trading subsegment (i.e., the segments more closely linked to the salmon price), the industry grew by approximately 7% in 2020. This growth was primarily driven by the feed producers and the transportation on sea subsegment.

The salmon farmers were hit the hardest in 2020, as the combination of lower sale prices and higher costs severely impacted the achieved margins. The EBITDA margins for the sea farming subsegment in 2020 were lower than the margins achieved in 2015, even though salmon prices were up by more than 30% in the same period. This means that margins would have been negative in 2020 with the 2015 prices, or roughly zero if we adjust the 2015 prices for inflation.

Large, medium and small-scale sea farmers unanimously agree that production costs continue to trend upward.

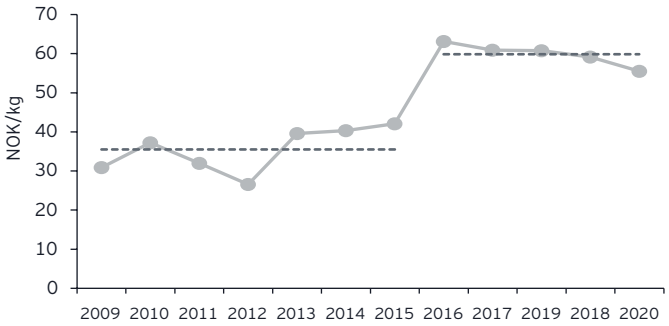
Where are we going?

The salmonoid industry is still going strong, and the fact that it managed to grow despite COVID-19 is a clear sign of an underlying growth trend. We expect this trend to continue in 2022, supported by very strong global demand drivers.

Salmon price

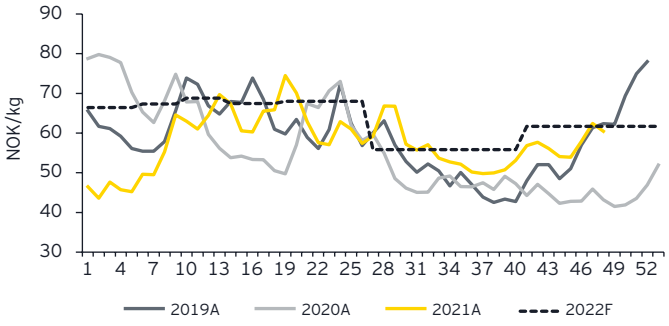
Salmon prices are, unsurprisingly, quite sensitive to the supply. There is a noticeable shift in salmon prices before and after 2016. In 2016, there was a supply shock wherein the global volume of harvested salmon significantly decreased. This resulted in a notable increase in salmon prices in 2016. The high pricing has stayed since, albeit facing a somewhat downward trend recently (as illustrated in the chart).

Annual salmon price (Fish Pool)



According to Fish Pool, the average spot price for salmon in 2020 was NOK55.5 per kg, down 6.2% from NOK59.2 in 2019. By mid-December 2021, the year-to-date average salmon price grew to 57.7 – an uptick from 2020, but not quite the same as in 2019. However, in the second half of 2021, the salmon price crossed both the 2019 and 2020 marks.

Weekly salmon price (Fish Pool)



Forward prices on Fish Pool tell the story of an industry expecting higher sale prices in 2022 compared with the 2019 to 2021 period. The expected average price for 2022 is in line with the record price observed in the year 2016. The higher sales price sentiment seems to also be supported by the key salmon analysts in Norway. If the high harvest volumes of 2019 and 2020 continue into 2022, the estimated price would result in all-time-high revenues in 2022.

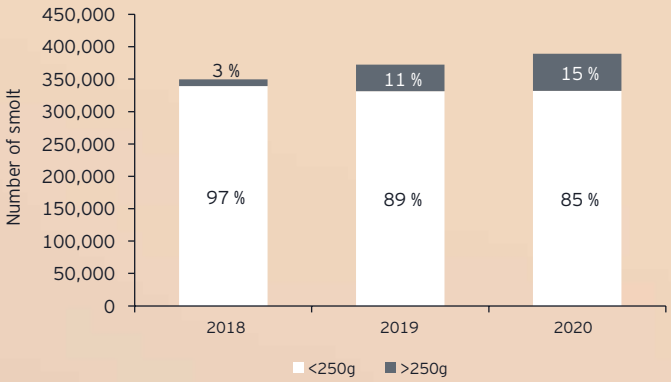
But how about the margins?

High production costs remain a concern

As we have illustrated in our analysis of the sea farming subsegment, production costs have continued the upward trend. This is naturally a source of concern for the fish farmers, both in terms of profitability and potential competition from alternative production technologies. With the current cost levels, the spreadsheet production costs stipulated by the projected grow-out land-based facilities are starting to come very close to the sea-based costs. However, as we all know, there will always be deviations between spreadsheet calculations and actual results. Most of the land-based projects are still in the construction phase or the early production phase.

Please refer to our land-based sections for more information on the status of this subsegment.

Smolt release (2018-20) by size



Source: *Directorate of Fisheries*

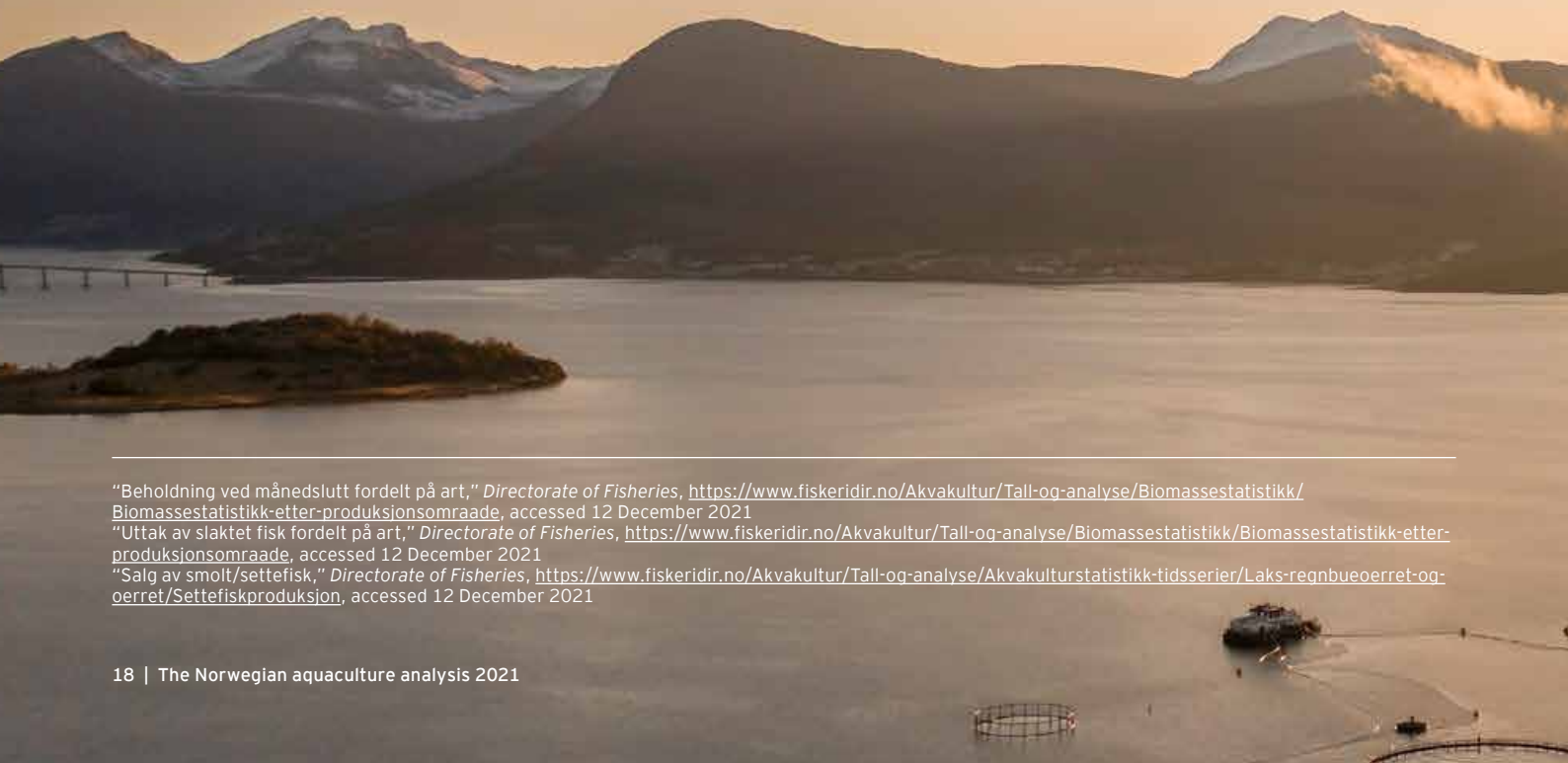
Increased visibility of post-smolt strategies

Biological challenges have brought on a trend of increasing the smolt size to reduce the time in the sea. Based on statistics from the Directorate of Fisheries, approximately 15% of all smolt released in 2020 were larger than 250g. This is quite the leap from the 3% in 2018.

The post-smolt strategy is predominately used in the southwest coastal regions. More than half (55%) of all smolt larger than 250g released in 2020 was released in Vestland and Rogaland. Rogaland is the only Norwegian region where the majority of smolt released (approximately 2 out of 3) is larger than 250g.

The full effect of post-smolt strategies remains to be seen as harvest volumes of post-smolt generations are still small in the grand scale of things. In theory, less time spent in the sea phase will naturally reduce the salmon's exposure to the elements. It is important to keep in mind that a post-smolt strategy is capital intensive, as it requires larger onshore smolt facilities. Furthermore, growing fish in land-based facilities is neither risk-free nor cheap – the fish still needs to be fed.

Put simply, if the production cost on land is the same as the production cost at sea, the gain of a post-smolt strategy as opposed to putting smaller smolt directly in the net pens, is related to lower mortality and less fish treatment expenses.

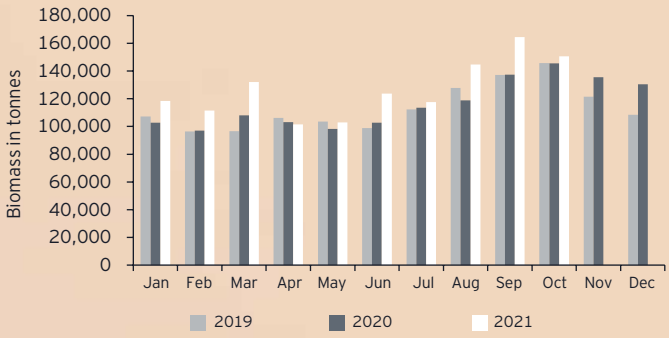


"Beholdning ved månedslutt fordelt på art," *Directorate of Fisheries*, https://www.fiskeridir.no/Akvakultur/Tall-og-analyse/Biomassestatistikk/Biomassestatistikk-etter-produksjonsomraade, accessed 12 December 2021
"Uttak av slaktet fisk fordelt på art," *Directorate of Fisheries*, https://www.fiskeridir.no/Akvakultur/Tall-og-analyse/Biomassestatistikk/Biomassestatistikk-etter-produksjonsomraade, accessed 12 December 2021
"Salg av smolt/settefisk," *Directorate of Fisheries*, https://www.fiskeridir.no/Akvakultur/Tall-og-analyse/Akvakulturstatistikk-tidsserier/Laks-regnbueoerret-og-oerret/Settefiskproduksjon, accessed 12 December 2021

Record-high harvest volumes in 2021

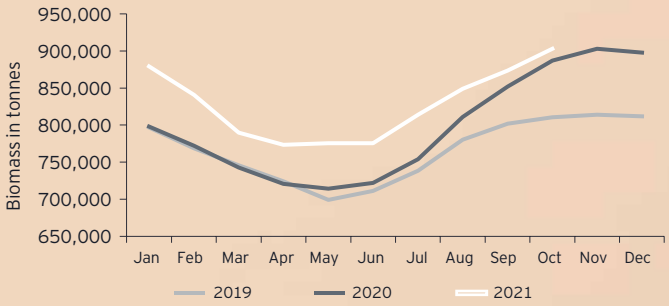
The year 2021 is on track to be another record year for the salmon industry in terms of harvested volumes. The Directorate of Fisheries reports a record-high standing biomass throughout 2021. While this could have been due to postponed harvesting, they also report large harvest volumes. The year-to-date harvest volumes on October 2021 are 12% higher than that at the same time last year.

Monthly harvested volumes



Source: *Directorate of Fisheries*

Standing biomass at month-end



Source: *Directorate of Fisheries*

Unrealized potential in digitalization?

As discussed in previous versions of this analysis, there is still a large untapped potential for fish farmers to adopt new technologies. Embracing digitalization will help them transition from experience-based to knowledge-based operations.

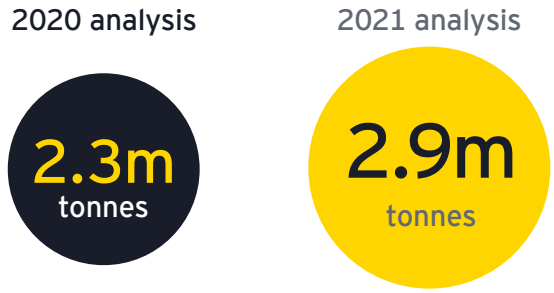
There are large amounts of data available. By teaming up with other players in the industry and utilizing existing information, an improved basis for implementing measures to reduce production costs could be achieved.

A short update on land-based salmon farming

More industry players are getting on the train, not wanting to be left behind

For a long time, conventional salmon farmers have been waiting to see how the land-based industry evolves. In that time, they gained experience and knowledge of Recirculating Aquaculture Systems (RAS) technology in their smolt facilities. However, several conventional farmers are now starting to walk up onshore – including Grieg Seafood and their backing of Proximar Seafood, Salmar's investment in Columbi Salmon and Kvarøy Fiskeoppdrett's partnership with Artic Seafarm. Lerøy Seafood Group has also invested in post-smolt plants with an option to expand into full grow-out facilities. Additionally, several feed companies have taken financial stakes in selected land-based projects, examples being Nutreco's investment in Nordic Aqua Partners and Cargill's investment in Salmon Evolution.

Identified planned land-based capacity



Planned land-based volumes continue to increase …

In our last year's analysis, identified planned land-based production volume skyrocketed from 1m tonnes in 2019 to 2.3m tonnes in 2020. This year, the rate of growth has slowed, with the identified volume increasing to 2.9m tonnes in 2021. This slowdown is not surprising as many investors now wait for large-scale projects to become operational and thus gain more insights into actual operational and financial development and performance. Actual production volumes are still low and large-scale proof of concepts are still in their early days even though a few players are steadily increasing their harvesting volumes.

An increasing number of large-scale land-based projects have managed to raise sufficient capital and start the construction phase, and some have even put fish in their tanks. Despite the progress, there are still challenges that these first movers must overcome.

Over the past year, we have seen several facilities experiencing considerable technical challenges which have led to fish mortality incidents. It is not always straightforward to assess from the outside whether these are ad hoc incidents or if they represent more permanent technological challenges. From failure comes the learning that may gradually reduce the risk for some of these types of incidents going forward.

… while share price volatility indicate investor uncertainty

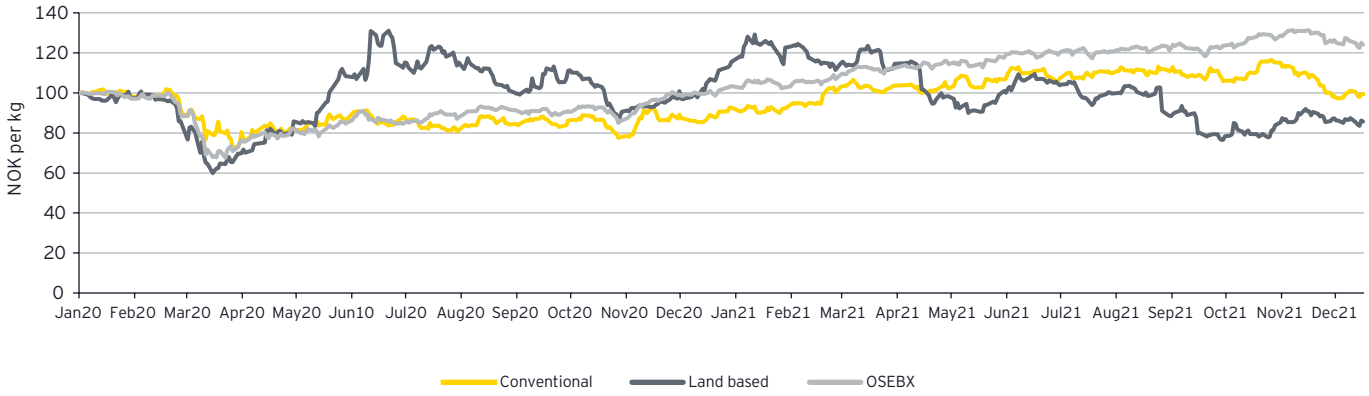
There are now multiple land-based entities listed in Norway, both on Euronext Growth and Oslo Børs. While the entities are listed in Norway, the projects are both domestic and international. Below is a simplified index where we have included listed land-based entities, conventional farmers, as well as Oslo Børs Benchmark Index (OSEBX – the main index in Norway) for comparison. In the event that one company takes up more than 35% of the index, we have capped it at 35% – except for the start of the period where only two land-based entities are listed.

One can immediately see that the volatility is quite different in the land-based index compared with the conventional farmers' index, which shows a development more in line with OSEBX than their land-based counterpart.

The land-based farming of Atlantic salmon is still in the early stages and faces several risk factors including immaturity of the technology used, lack of large-scale proof of concepts, raising capital and the anonymity of operating costs. Looking at the fluctuating index, one could wonder if the investors have underestimated the risks. Now that problems are materializing, the market has repriced the risk.

Negative events in one company may affect the perceived risk of the land-based farming companies in general, resulting in investors demanding a higher rate of return on these investments. Additionally, increasing interest rates and fear of rising inflation also affect the share prices of these growth companies. As investors turn more skeptical, they require greater transparency, which some land-based companies have been criticized for not showing in 2021.

Simplified index (100 = 1 Jan 2020)



The Norwegian development licensing scheme

What is the status of the ambitious and innovative development projects?

High interest and great expectations

Volume growth is on top of the Norwegian salmon farming industry wish list. To achieve growth and find new sustainable concepts and technologies, the Norwegian Government launched the development licensing scheme in 2015. Since our last update of granted development license projects in our 2019 edition, it is now time to take a new look at these projects.

From the time the scheme launched to the time it closed for new applications in 2017, the Directorate of Fisheries received 104 project applications. As of today, 112 development licenses have been granted, split between 23 projects.

Company	Development licenses granted	No. of licenses	Maximum allowed biomass	Current status
Nordlaks Oppdrett AS	Havfarm 1 (ocean-based farming)	13	10,140	Began operations in summer 2020 and harvested the first fish in January 2021. Mortality of 19%.
Nordlaks Oppdrett AS	Havfarm 2 (ocean-based farming)	8	6,240	Awaits approval on site location in the Tysfjord area. If granted permission, the project will move forward and enter into a building contract.
Ocean farming AS (SalMar)	Ocean Farm (offshore solution)	8	6,240	Started operations in November 2017. Received approval for converting eight licenses into ordinary licenses in July 2020.
Mariculture AS (SalMar)	Smart Fishfarm (offshore solution)	8	6,240	An updated and bigger version of Ocean Farm. Expected to be operational in the second quarter of 2024, depending on location and volume approvals and entry of construction contracts.
Reset Aqua AS	RESET (closed solution)	8	6,240	The concept is based on RAS technology and is currently under development.
NRS ASA	Artic Offshore Farming (offshore solution)	8	5,990	Plan to harvest the first fish in the first half of 2022. The farm will be located off the coast of Tromsø in Northern Norway.
Eidsfjord Sjøfarm AS	Eidsfjord Gigant (closed solution)	7	5,175	The fish will be grown up to 2.5kg in the construction, and then transferred to open-net pens. The company was granted licenses in October 2021, thus the concept is currently under development.
Mowi Norway AS	The Egg (closed solution)	6	3,120	Mowi and Hauge Aqua (designer of the solution) have ended their collaboration due to the cost being too high for Mowi. Hauge Aqua plans to further develop the solution on its own, starting by building post-smolt eggs.
Salaks AS	FjordMAX (semi-closed solution)	6	4,680	Under planning and development, with production estimated to start in 2023. The project will be located in Solingen in Northern Norway at an existing farming site.
Midt-Norsk Havbruk	Aquatraz (semi-closed solution)	4	3,120	Three generations of Aquatraz cages have been deployed and are currently in use. The company will start testing the fourth and last generation in autumn 2021. The project development was projected to be completed by the end of 2021.
Other	Projects with MAB <= 3,120	43	31,344	Various offshore, closed and semi-closed solutions
Total licenses granted		117	88,529	

Source: *Directorate of Fisheries**

* *"Oversikt over søknader om utviklingstillatelser," Fiskeridirektoratet*, https://www.fiskeridir.no/Akvakultur/Tildeling-og-tillatelser/Saertillatelser/Utviklingstillatelser/Status-ja-nei-antall-og-biomasse, accessed 15 November 2021.

What is the status of some of the most prominent projects?

SalMar's Ocean Farm is the first and currently the only development project that has been granted permission to convert the development licenses they were awarded. The total price tag of the project is capped at approximately NOK1b. Ocean Farm has completed two production cycles, both showing strong biological results.[1] Norway is at the forefront of developing offshore fish farming technology, and the success of this project contributes to belief in offshore production.

One large Norwegian company that strongly believes in offshore farming is Aker ASA. In August 2021 they entered a partnership with SaMar ASA to establish a new joint company, named SalMar Aker Ocean AS. The joint company aims to become a leader within offshore farming and will start production in Norwegian waters.[1] However, before they can start this journey, a regulatory framework for offshore fish farming must be established. Is this the start of a new, bright blue era?

After harvesting their first cycle of fish in Havfarm 1, Nordlaks applied for permission to convert the development licenses of the ~1b project in April 2021.[2] The bid got rejected by the Directorate of Fisheries, with them arguing that it is too early to evaluate the project based on only one cycle. In the report, the Directorate also listed challenges regarding growth, diseases, and an average mortality rate of 19%.[3] The Company appealed against the refusal[2], and in March 2022 they were granted conversion of all 13 development licenses.[4]

Midt-Norsk Havbruk (MNH) collaborated with Seafarming Systems AS in developing the semi-closed solution Aquatraz. The project has, since 2018, launched one new generation of Aquatraz cage each year, continuously developing the concept based on new learnings. In autumn of 2021, the fourth and last generation of Aquatraz were to be tested, with the project estimated to be completed by year-end.[5] After the finalization of the project, MNH is expected to apply for license conversions, with Seafarming System AS aiming to commercialize the concept.

One question that has been asked by many is whether these capital-intensive constructions will be profitable without the reasonably priced development licenses. If they are not, these solutions will not solve the challenges the industry is facing today. However, as the Directorate of Fisheries comments, these projects will have generated valuable knowledge that will benefit the industry as a whole.

Are licenses for closed solutions on their way?

In August 2021, the Seafood Ministry presented its proposal for a new licensing scheme for closed solutions to access new areas of farming and reduce biological issues. The scheme, which will now be sent to a hearing, will include licenses of a total capacity of 15,000 tonnes.

To receive licenses, three environmental criteria must be met: zero release of sea lice eggs and sea lice, a minimum of 60% of waste collection and strict requirements regarding escapees. The Ministry suggests two different ways for awarding the licenses – an auction after a prequalification competition or an innovation competition. If the scheme is approved, it will be a breakthrough for developers of closed-system solutions. It may also become an important contributor to the long-awaited production growth.[6]

1 "Salmar ASA: Enters partnership with Aker to create world leading offshore farming operations," *GlobeNewswire*, https://www.globenewswire.com/news-release/2021/08/26/2286758/0/en/SalMar-ASA-Enters-partnership-with-Aker-to-create-world-leading-offshore-farming-operations.html, accessed 15 September 2021.
2 "Shock as giant Havfarm project is refused permanent licences," *Fish Farmer Magazine*, https://www.fishfarmermagazine.com/news/shock-as-giant-havfarm-project-is-refused-permanent-licences/, accessed 15 September 2021.
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Good-to-know facts about the development licensing scheme

- The development licensing scheme offers temporary production licenses with a duration of a maximum of 15 years.
- To receive development licenses, a project must contribute to radical and significant innovation which involves substantial investments and risk.
- The licenses are reserved to only support innovation of production technology and new installation.
- The primary focus is on sharing knowledge with the intention of benefiting the entire industry.
- Development licenses may be converted to permanent ordinary salmon production licenses if a set of criteria are met.
- These criteria are not the same as success criteria. The project can be a nonviable concept (e.g., failing construction, too expensive to operate, commercial failure, etc.), but still fulfill the given criteria and be granted a conversion of licenses.
- The cost of converting a development license to an ordinary license is NOK10m (must be adjusted for inflation)
- When converted into ordinary production licenses, there is no additional requirement for applying the concept for further operations and locating the farming site.

Seaweed: a new resource for Norwegian aquaculture

What is the status of global and national seaweed production?

What is seaweed and how is it used?

Seaweed is a plant-like organism that grows in various shapes, sizes and colors (red, brown and green), and is rich in nutrients (e.g., iodine), vitamins and carbohydrates. Some species also contain a fair amount of proteins.

Globally, there a several thousand species of seaweed. However, commercial production is centered around 10–15 species, such as Japanese kelp, nori and wakame.[1,2]

The global seaweed market more than tripled between 2000 and 2018, reaching 32.4m tonnes. During this period, cultivated seaweed production accounted for 31.4m tonnes with Asia representing 99% of global production volumes.[1] About 85% of the cultivated seaweed was used for human consumption.[2]

Norway is one of the leading global producers of wild-harvested seaweed, with annual volumes of 130,000 to 180,000 tonnes (mainly Laminaria hyperborean).[3] The harvested seaweed has traditionally been used to extract raw material of alginate, as well as produce seaweed flour. However, as excessive wild harvesting contributes negatively to the ocean's ecosystems, there is limited growth potential within wild harvesting.

Seaweed cultivation in Norway is in its nascent stage, but there is significant potential for growth

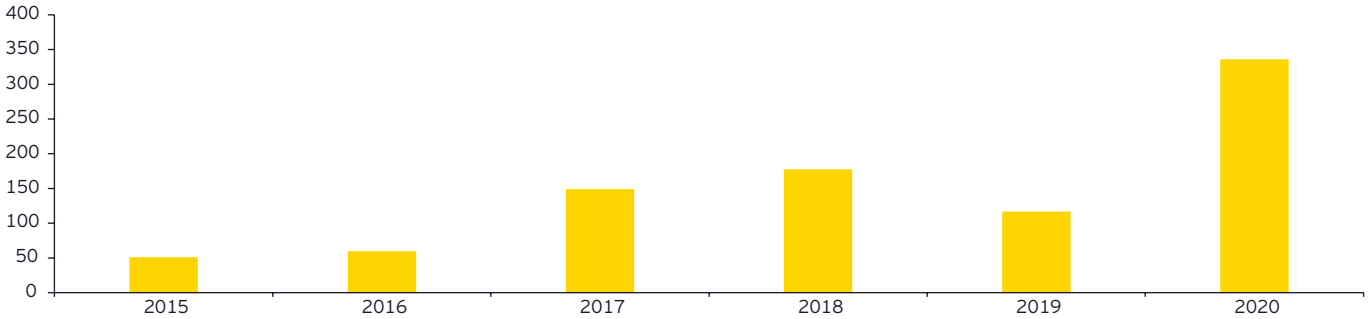
Although Norwegian seaweed cultivation experienced rapid growth in 2020, the industry is still characterized by unstandardized production technologies, manual labor, and low volumes.[4,5]

In 2020, there were 27 seaweed suppliers with production, utilizing a total of 228 licenses and producing 336 tonnes of seaweed with a value of NOK8.6m.[6] The production consisted of the two species – sugar kelp and winged kelp.[6]

Norwegian seaweed farmers are clear that volumes can quite easily be increased by utilizing more of the current licenses (45% utilization in 2020[6]). However, the Norwegian seaweed industry is currently in a "chicken or the egg" dilemma. Farmers are waiting for the market to demand more Norwegian seaweed, whereas the market is waiting for farmers to produce larger and more stable volumes.

Major market players within human food, animal feed and biorefineries in Europe and Norway show large interest in Norwegian seaweed, but require stable volumes to include the products in their assortments. A sugar kelp biorefinery, for instance, is estimated to require a minimum yearly supply of 65,000 tonnes of seaweed to break even.

Volume from Norwegian seaweed cultivation (metric tonnes)



Source: "Statistikkbanken," *The Directorate of Fisheries*, 2021

1 "The State of World Fisheries and Aquaculture 2020." *Sustainability in action,* FAO 2020
2 *Globefish Research Programme Volume 124:* "The global status of seaweed production," *trade and utilization.* FAO 2018
3 "Tarehøsting," *The Directorate of Fisheries*, https://www.fiskeridir.no/Yrkesfiske/Havmiljoe/Tarehoesting, accessed 16 December 2021
4 Araújo R, Vázquez Calderón F,Sánchez López J, Azevedo IC,Bruhn A, Fluch S, Garcia Tasende M,Ghaderiardakani F, Ilmjärv T,Laurans M, Mac Monagail M,Mangini S, Peteiro C, Rebours C, Stefansson T and Ullmann J (2021), "Current Status of the Algae Production Industry in Europe: An Emerging Sector of the Blue Bioeconomy," *Front. Mar. Sci. 7:626389*, 27 January 2021
5 Kjell Magnus Norderhaug (HI), Jorunn Skjermo SINTEF, Kari Kolstad NMBU, Ole Jacob Broch SINTEF, Åshild Ergon NMBU, Aleksander Handå SINTEF, Svein Jarle Horn NMBU, Erik-Jan Lock (HI) og Margareth Øverland NMBU, "Mot en ny havnæring for tare?," *Fisken og havet NR. 2020-5*, 11 November 2020
6 "Statistikkbanken," *The Directorate of Fisheries*, https://www.fiskeridir.no/Tall-og-analyse/Statistikkbanken, accessed 14 November 2021

How can seaweed be an important factor for the future of Norwegian aquaculture?

The Norwegian seaweed industry shares many similarities with the early stages of sea-based Atlantic salmon farming. Researchers are positive that through industrialized production methods, seaweed can play a prominent role in the future of Norwegian aquaculture production.[1]

Researchers estimate a national biomass potential of 20m tonnes of seaweed by 2050, with a potential of 75 tonnes produced per hectare in near-coastal locations, and 150 to 230 tonnes per hectare at and outside the continental shelf.[2] Compared with salmon farming, seaweed benefits from being self-sufficient in nutrients and other input factors, meaning that cost levels are mainly related to the number of FTEs involved in cultivation. With more efficient, automated production methods, cost levels are expected to drop significantly. Driven by the long national coastline, Norway can also take advantage of being able to deliver stable seaweed volumes for an extended period of time.

Seaweed represents a new, valuable form of biomass with a broad range of possibilities and can be used in animal feed, food and biorefined materials, for example.[1,3] Introducing seaweed as a marine-based protein source can contribute to reduced use of soy in both the agricultural and aquacultural industries, and thereby resulting in more area-efficient and sustainable feed.

Research shows that adding seaweed to animal feed can reduce the need for antibiotics and contribute to reduced methane production from livestock. The latter is estimated to reduce emissions by 20%–90%, depending on the seaweed type (red algae has the best potential).[3,4]

Seaweed also provides unique opportunities for developing circular bio economies where waste from fish feed spillage and feces in salmon farming are naturally absorbed and used as fertilizer by seaweed.[1] The concept is called integrated multi-trophic aquaculture (IMTA) and creates a circular system that reduces environmental impacts and improves productivity. Thus, creating a more sustainable salmon farming industry.

If the seaweed potential of 20m tonnes is realized, industrialized seaweed production can recycle and upcycle 40,000 to 48,000 tonnes of nitrogen, 4,000 to 6,800 tonnes of phosphorus and 2m to 2.4m tonnes of CO_2. This equals almost 24% of the Norwegian CO_2 emissions from salmon-based farming in 2018, and more than 100% of the nitrogen spillage in 2019 (approximately 55,000 tonnes).

According to the mass balance principle, the carbon footprint will be neutralized if, for example, phosphorus, nitrogen and CO_2 are removed from either outgoing or incoming water masses. This means that seaweed cultivation does not necessarily need to recycle and upcycle direct emissions from salmon pens to be environmentally positive.

1 Kjell Magnus Norderhaug (HI), Jorunn Skjermo SINTEF, Kari Kolstad NMBU, Ole Jacob Broch SINTEF, Åshild Ergon NMBU, Aleksander Handå SINTEF, Svein Jarle Horn NMBU, Erik-Jan Lock (HI) og Margareth Øverland NMBU, "Mot en ny havnæring for tare?," *Fisken og havet NR. 2020-5*, 11 November 2020
2 Broch OJ, Alver MO, Bekkby T,Gundersen H, Forbord S, Handå A, Skjermo J and Hancke K, "The Kelp Cultivation Potential in Coastal and Offshore Regions of Norway," *Front. Mar. Sci. 5:529*, 19 January 2019
3 Hidden champion of the ocean. Seaweed as a growth engine for a sustainable European future, *Seaweed for Europe 2020*
4 "Lerøy dobler tareproduksjonen," *Lerøy Seafood*, https://www.leroyseafood.com/no/smakfull-sjomat/miljo_og_samfunn/leroy-dobler-tareproduksjonen, accessed 16 December 202

Factors that will help the seaweed industry evolve:

- Specific coastal zone and license planning for seaweed cultivation
- National government involvement, with incentives that support innovation and development
- Collaboration between seaweed farmers, research facilities, and actors from similar industries
- Specialized actors along the value chain
- Standardized techniques and technologies
- Safety standards and certifications (e.g., for food safety)
- Utilization of breeding techniques
- Utilization of biorefineries

The impact of climate change on the marin

A | Overarching climate change pressures on the marine environment

A1 | Water temperature: compared with the 1986–2005 average, water temperature might increase by between 0.6 °C to 2 °C in the upper 100 m depth. The warming being more prominent in the Northern Hemisphere, especially the North Atlantic. For aquaculture, warming might lead to more pathogen activity and increased harmful algal and jellyfish blooms, and decrease in suitable productions sites[1]. Warming also leads to mass movements of species in search for favorable environmental conditions, with serious risk to food security and related economic losses likely to run hundreds of millions of dollars[2].

A2 | Oxygen-depletion: excessive growth of plant life (algae) in marine or freshwater caused by run-off from human activities such as from agriculture and aquaculture (eutrophication) cause oxygen-depletion in the ocean. The risk is increased with warmer water temperatures leading to reduced mixing in the water column and less oxygen availability in deeper waters. Even slight overall reductions in the levels of oxygen dissolved in the oceans can induce oxygen stress in marine organisms, while increased reduction can cause ecosystem collapse. It is expected an oxygen loss of about 3–5% by the end of the century[3]. Globally there are over 400 "dead zones"[4], even found in Norwegian fjords[5], the biggest being in the Baltic Sea[4].

A3 | Ocean acidification: as the ocean absorbs 25% of all anthropogenic emissions from the atmosphere, the CO_2 dissolves and forms carbonic acid, thereby increasing the acidity of the ocean. Present day change in acidity is occurring faster than 10 times any rate from the last 300 million years, and the effects will threaten food security, harm fishing industries and alter ecosystems. Acidification has been shown to affect Phyto- and zooplankton, carbonate shells and skeletons of a range of marine species[6], and have already cost the oyster industry in the Pacific Northwest significant losses[7].

Risk factor, Biodiversity and ecosystem decline

1. Widespread coral bleaching is an issue for coral reefs around the world as a result of changes to the Earth's climate. A warming event of 1°C for even a short duration can have severe consequences[8]. Unless steps are taken to reduce local pressure and reduce the emission of greenhouse gases, the percent of threatened reefs will increase to more than 90 percent by 2030 and to nearly all reefs by 2050[9].

2. Large scale migration of Tuna to deeper waters implies a drastic change in species migration pattern and fish landing. This in tandem with rapid coral bleaching is affecting both environmental quality and livelihoods in the Maldives[1].

3. Global mean sea-level could rise with 26 cm by 2050 and 53 cm by 2100[10], and as a consequence it is likely that mangroves are at risk[11]. These coastal ecosystems serve as nursery for marine life and buffer against erosion and storm surges. Its wellbeing is directly linked to healthy fisheries and economic well-being of fishermen.

4. Invasive species has increased along with ocean warming over the past 40 years. It is predicted that as ocean temperatures further increase, so will rates of introduced species in the Pacific, leading to a loss of native species abundance[12]. This can result in huge economic impacts and fundamental disruptions of aquatic and terrestrial ecosystems[13].

Catch rates and effort

5. Due to the shifts in fish distribution and migration behavior, low-income communities in the tropical south (e.g., Brazil, India, Thailand) will suffer losses. Whereas the northern countries such as Greenland, Norway, Canada could experience about 30–70% increase in their fish landing[1].

6. In Malawi, fisheries catch will potentially decrease by 10–60% toward the end of the century. Even in the business as usual scenario by 2050 there could be a decrease of 20% fish catch. This has strong negative consequences on livelihoods, creating a need for capacity building and promotion of fish farming and aquaculture[1].

7. Overfishing is threatening the marine resources of the Central Atlantic region and climate change is expected to result in an increase in the occurrence of extreme events (swells, storms, extreme rainfall, rising temperatures, rising sea levels, etc.) affecting mainly the artisanal sector fishing communities along the coast[1].

8. FAO considers freshwater aquaculture within South-East Asia; Vietnam, Laos, Laos, Bangladesh, Myanmar and China, as most vulnerable to climate change[1].

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1 "Impacts of climate change on fisheries and aquaculture," *FAO Fisheries and Aquaculture Technical Paper*, 2018.
2 "Ocean warming," *IUCN*. website, https://www.iucn.org/resources/issues-briefs/ocean-warming, accessed, 26.10.2021
3 "Ocean deoxygenation," *IUCN* website, https://www.iucn.org/resources/issues-briefs/ocean-deoxygenation, accessed 26.10.2021.
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5 "Hypoxia effects on fish in west Norwegian fjords: harnessing the power of multidisciplinary studies," *prosjektbanken forskningsradet* website, https://prosjektbanken.forskningsradet.no/project/FORISS/301077?Kilde=FORISS&distribution=Ar&chart=bar&calcType=funding&Sprak=no&sortBy=date&sortOrder=desc&resultCount=30&offset=30&ProgAkt.3=SHP-Strategiske+h%C3%B8gskoleprogram, accessed, 26.10.2021.
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7 "Ocean Acidification Hotspots," NRDC website, https://www.nrdc.org/resources/ocean-acidification-hotspots, accessed 28.10.2021

e environment

Future expectation from global megatrends

Reputational and transitional risks

- Consumer behavior and transparency: increased pressure on industries in aquaculture and wild fisheries to be sustainable in operations and entire value chains. Loss of competitiveness for companies lagging behind as customers take increasingly responsible choices. Regulatory requirements to provide consumers with information on the product's environmental and social impacts, may also be a disadvantage to producers with high life cycle climate impacts through feed and/or transport. Transparency of the life cycle impact of products may also favor local production and in some cases land based production close to the customer. Emerging circular economies and technological advancements in land based aquaculture could decrease demand for global (CO_2 based) exports of seafood, with local products increasing its market presence.
- Sustainable finance: policy and regulators demanding transparency and reporting on all operations and banks determining loan rents from performance on sustainability issues. A taxonomy for green aquaculture is likely to have significant requirements for life cycle climate impacts through for example feed and transport, as well as requirements to limit impacts on local biodiversity and run-off of nutrients (nitrogen and phosphorus).
- Physical climate impacts: changing climate and environmental conditions create new suitable areas for production, decreasing opportunities in some areas while creating opportunities in others. Warming temperatures will impact conditions for aquaculture directly and indirectly through increased acidification, oxygen-depletion, spread of diseases, introduction of new species, and more.
- Reputational risk: environmental and ethical issues in the industries, if not solved, could greatly decrease reputation among local communities, consumers and other stakeholders. Examples are: Overfishing, trawling and rates of bycatch in wild fisheries; and eutrophication, feed sources (soy, wild fish fatty acids), animal welfare and parasites / diseases in aquaculture. CO_2 emissions associated with distribution in both industries is another large footprint.

8 "What is coral bleaching?," *Great Barrier Reef Foundation* website, https://www.barrierreef.org/the-reef/coral-bleaching, accessed 26.10.2021.
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Aquaculture in Iceland

Growth and advancements

The beginning

Aquaculture has a long history in Iceland. However, the industry did not experience significant growth in the country until the end of 2010, when it began advancing at a rapid pace.

Icelanders have long transferred fish to lakes and rivers to maintain a sustainable population of fish. Yet, farming fish for commercial use is a relatively new concept in the country. The first efforts of fish farming included fertilizing and hatching salmonids, which were then released into freshwater streams. This method has since been further developed into more modern practices.

Production of farmed fish for commercial consumption was not an established industry until the late 20th century, though there are signs of fish farming from much earlier. The first signs of modern aquaculture in Iceland originated in the 1950s when people started experimenting with small bodies of fresh water and tanks. The following decades were characterized by innovation and the adaption of practices from neighboring countries.

Land-based fish farming in tanks containing seawater was first used in 1978, which allowed for the creation of optimal temperature and salinity conditions for the fish.[1] Several land-based fish farms using this technology were built in the 1980s due to the high market price of salmon. However, this costly method of raising fish did not prove to be sustainable as salmon prices decreased shortly after.

Since then, salmon has mostly been harvested in conventional sea-based farming, which decreases construction costs and energy costs compared with land-based farming.

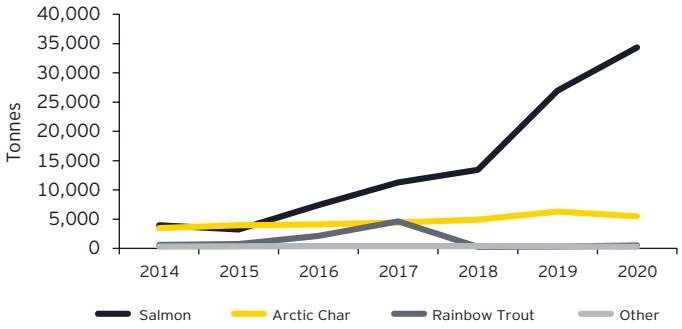
Current market composition

Species and statistics

The aquaculture industry in Iceland has grown exponentially recent in years. The industry saw a big growth spike with a doubling of the production from 2018–20 and growing by 709% over the last 10 years.

The players focus mainly on the farming of Atlantic salmon and Arctic char, while also experimenting with numerous other species of fish – including Atlantic halibut, Atlantic turbot, Atlantic cod and other fish species. These experiments were made possible by using geothermally heated water to control the temperature of tank water. Rainbow trouts have also been produced similarly, but their production has practically stopped compared with before.

Aquaculture production by species 2014–20 (tonnes)



Source: "Heildarframleiðsla í fiskeldi árin 2009–20 (tonn af óslægðum fiski)," *Ársskýrsla dýralæknis fisksjúkdóma 2020*, February 2021, MAST, 2021

Production of rainbow trout increased significantly from 2014 to 2017 and exceeded the production of Arctic char in 2017. Rainbow trout accounted for 22.2% of all aquaculture production in 2017. However, production of rainbow trout essentially stopped in 2018 due to the fish farms' focus on salmon. This was because of the changing demands from Russia, a very large importer of rainbow trout at the time. This trend altered the global supply of the species and made many companies move into salmon farming, a much bigger and less volatile market.

At the same time, fish farms also recognized that the Icelandic conditions were not ideal for rainbow trout and realized it would be more beneficial to focus on farming other fish. As a result, salmon farming grew even faster than originally anticipated during this time.

Production of rainbow trout increased by 64% from 2019 to 2020, still only accounting for 490 tonnes in total. With the big dip it took, it is unlikely that it will reach the same capacity it once did. But there are signs that rainbow trout production might keep increasing to a more substantial level.

1 „Aquaculture," *Government of Iceland*, https://www.government.is/topics/business-and-industry/fisheries-in-iceland/aquaculture/#:~:text=The%20first%20aquaculture%20experiments%20in%20Iceland%20began%20in,ample%20cold%20spring%20water%20free%20of%20fish%20pathogens, accessed 14 october 2021.
2 "Ársskýrsla dýralæknis fisksjúkdóma 2020," February 2021, *MAST*, 2021.

Biomass allowance

The list of companies involved in fish farming in Iceland ranges from small organizations focused on fertilizing specific rivers to publicly listed companies with a significant global presence. The biomass allowance of these companies differs greatly, and there is a big difference in biomass between sea-based fish farming and land-based fish farming. The maximum biomass allowed is much smaller in land-based farming, which takes up just over 25,000 tonnes. Sea-based farming, on the other hand, accounts for 93,500 permissible tonnes.

It is not accurate to solely look at the allowable biomass, as the utilization differs greatly between sea-based fish farming and land-based fish farming. Companies in land-based farming rely on a heavily controlled environment to grow their fish. The elements are harder to control in sea-based farming, where many factors such as temperature, ocean current and water depth play a role. We expect to continue to see much higher utilization of biomass allowance in land-based farming as opposed to sea-based farming in Iceland.

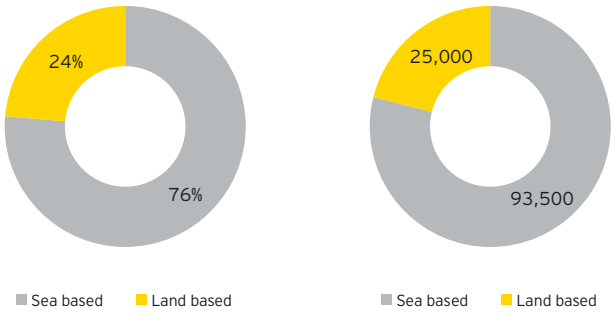
While there is a major difference in biomass allowance between land-based and sea-based farming today, we expect to see it progressively get smaller in the coming decades. This is because sea-based farming is consistently getting closer to the maximum possible capacity off the coasts of Iceland, while the growth of land-based farming will not be limited by the same restrictions. Evolving technology in the industry will also eventually lead to higher efficiency, hence enabling regulators to allow greater biomass.

Despite restrictions, there is still room for aquaculture to grow in Iceland as the maximum possible biomass limit has not been reached yet. Furthermore, with advanced technology, aquaculture could move further away from land and grow bigger with the introduction of offshore fish farming,

New and emerging technology might enable Icelandic fish farms to utilize the area off the south and southeast coasts of Iceland. Currently, this area is not being used for fish farming due to the wave height in the area. Almost all other required conditions, such as temperature and ocean depth are met, due to which the possible expansion into offshore farming in that area should not be ruled out indefinitely.

The maximum theoretical capacity of sea-based fish farming around Iceland is unknown. However, looking at the maximum biomass currently allowed, we can see that the total production from all the fish farming happening in Iceland does not even account for half the allowed biomass in sea-based fish farming. Hypothetically speaking, there is still room for the market to at least double, based on the numbers. This is not simple since each permit is bound to very specific rules and regulations, but it gives some idea of the growth possibilities.

Revenues for land-based farming and sea-based farming differ greatly as well, which is consistent with the permissible tonnes of biomass. As we can see in the figure below, sea-based farming in 2020 accounted for a much greater portion of the market at around 76%, while land-based fish farming accounted for roughly 24%.[3]



The development of the market composition will be a very interesting thing to consider in the coming years. The industry is undergoing a lot of change and innovation in parallel with the rapid growth that both segments are experiencing.

3 *Skatturinn*, https://www.skatturinn.is/, accessed 17 October 2021.

Total market value

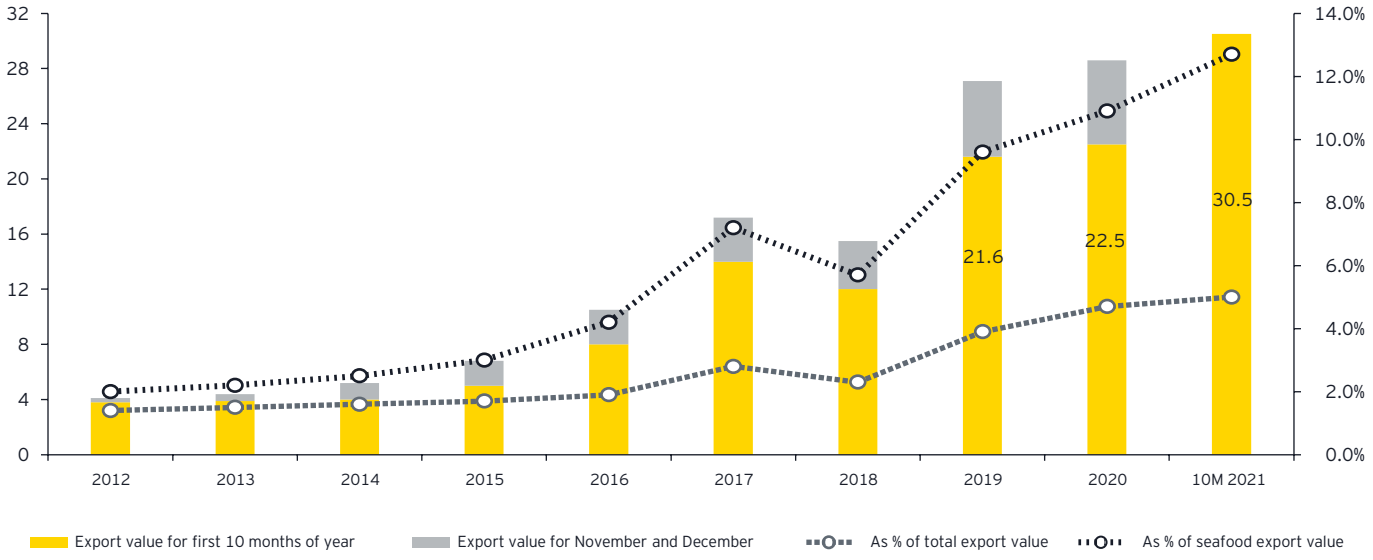
The export value of aquaculture products totaled ISK 30.5b in the first 10 months of 2021. In comparison, the total export value for the whole year of 2020 totaled only ISK 28.6b. This accounts for roughly a 35% increase from 2020 to 2021 for the first 10 months of each respective year. This increase is in line with the anticipated increase in total tonnes produced. As we can see in the graph below, we can expect the proportion of November and December production to contribute greatly to the total production of 2021.

Aquaculture has long lived in the shadows of fisheries in Iceland which have been a major component influencing the country's GDP for decades. But as we can see in the graph below, there is evidence that aquaculture is progressively attempting to lessen the gap between the two industries.

Along with the growth that the market has seen, aquaculture has also become more important to the country as a whole. As we can see in the figure above, aquaculture accounted for less than 2% of total export value in 2012. However, in the first 10 months of 2021, that same number increased to almost 6%. The growth within the seafood industry is proportionately much greater as aquaculture only accounted for roughly 2% of seafood export value in 2012 but accounted for 12.7% in the first 10 months of 2021.

We can expect each of these values to increase in the next few years following the growth of the market. The percentage that aquaculture accounts for within the seafood industry will steadily grow as aquaculture is currently growing faster than the fishing industry.

Export value of aquaculture products by years and 10 months (ISKb at a fixed exchange rate)



Source: "Útflutningsverðmæti eldisafurða á ári hverju og fyrstu 10 mánuðuum ársins 2021," Fiskeldi: Metárið 2020 nú þegar toppað, 6 November 2021.

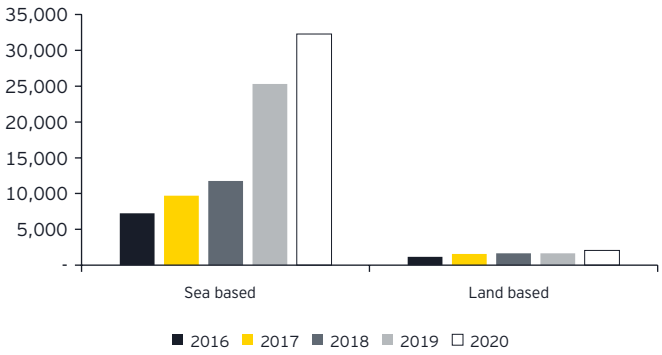
Sea-based vs. land-based

While sea-based and land-based farming differs significantly with respect to the total number of companies involved, they both have very few key players.

A significant portion (85%) of land-based farming is controlled by just two companies, while 86% of the offshore market is controlled by three key companies. The market today provides an opportunity for many smaller players to consolidate. Consolidation in sea-based farming could increase the utilization of biomass allowance by economies of scale. Similarly, land-based companies would be able to utilize each others' specialties to cut down on the costs associated with land-based farming.

Land-based farming nearly doubled between 2016 to 2020, while sea-based farming grew exponentially – greatly contributing to the tremendous growth that the industry has seen as a whole. The total production gap between the two is expected to reduce in the coming years.

Production of salmon in tonnes (slaughtered)



Source:
"Heildarframleiðsla á laxi til slátrunar 2016-20, annars vegar úr landeldi og hins vegar úr sjókvíum", *Ársskýrsla dýralæknis fisksjúkdóma* 2020, February 2021, MAST, 2021.

Land-based production of salmon for commercial consumption more than doubled between 2016 to 2020, from 1,177 tonnes in 2016 to 2,074 tonnes in 2020. On the other hand, the

production of salmon in offshore aquaculture saw a 345.5% increase between 2016 and 2020.

There are many reasons behind this increase. The biggest reason could be the increase in demand, both domestically and internationally.

The scale of sea-based salmon farming is expected to increase even further in the coming years, although the growth can be expected to slow down once sea-based fish farming nears its capacity. On the other hand, land-based farming is expected to increase at a more rapid pace than it has until now.

Environmental factors

Some of the advantages of growing fish in Iceland stem from the geothermal heat in the country, as well as the high ocean temperature originating from the Mexican Gulf Stream. As a result, land-based operations are located in areas known for their geothermal heat, while sea-based operations are mainly located on the West Fjords and East Fjords where the ocean provides adequate growing conditions for the fish. The vast majority of fish farms in Iceland operate recirculating aquaculture systems (RAS), aiming to maintain a steady water temperature throughout the changing seasons.

These environmental factors have been the reason for tremendous opportunities in the industry, but they cannot be counted on at all times. The winters in Iceland can get harsh, causing ocean temperatures to fall below appropriate conditions, and resulting in layers of ice hindering access to the sea-based cages.

These conditions have created difficulties at times, but they also come with a set of advantages unique to Icelandic aquaculture.

Salmon in Iceland grows relatively slower due to environmental factors such as lower ocean temperatures. These environmental factors are not optimal for salmon growth but luckily they aren't optimal for various bacteria either. This results in a fish that grows slower but safely from bacterial infections, salmon lice, and other afflicting difficulties that are common in other parts of the world.

Export

Aquaculture products from Iceland are exported worldwide, with Poland, Denmark, the Netherlands, and the US being the biggest importers.

As we can see in the graph above, export to the aforementioned countries has increased significantly, correlating directly with the production growth. Growth has been steady in exports to the US and Norway, but we can see that the trend follows an exponential pattern for almost all of the other countries, resulting in a 74% compound annual growth rate (CAGR) for the period.

Production is expected to increase further, but it is unlikely to maintain the growth rate it has seen in the last years for an extended period. Future demand is too high for the current supply capabilities, but the market seems to be trying to accommodate the demand by increasing land-based biomass and constructing new production facilities.

Licenses

Currently, 69 entities hold licenses for fish farming in Iceland, most of them being for land-based farming. The process which companies must follow to receive a license for aquaculture differs between sea-based farming and land-based farming. The main reason is that the ocean cannot withstand an unlimited capacity of sea-based farming while capacity for land-based farming can increase as much as each facility allows for.

Land-based farming opportunities in Iceland are multifaceted due to the unique environmental advantages in Iceland. Land-based farming facilities in Iceland have since long used geothermal heat to create optimal growing conditions, encouraging the use of green energy and sustainability.

Numerous land-based facilities are currently being built, which indicates this growth. The increased demand calls for continuous growth and offers a range of opportunities to companies in the market. However, the process in which companies receive licenses to operate has proven to discourage some of this growth. This is primarily due to the time it takes for a license to go through the necessary stages of approval.

Additionally, the general public can appeal at each step of the approval process, which can set companies back considerably. As a result, some companies find that once they have gotten a license approved, they spend a long time constructing their facilities or growing fish from juveniles that their license will be close to expiring by the time they start production or realize income.

Based on the growth that the market has seen, one could assume that this aspect does not affect the market substantially. However, it undeniably fosters a market with a few big key players as smaller entities are unlikely to be able to bear the significant risks and delays associated with new projects.

Value chain

When looking at the value chain for Icelandic aquaculture, we see that a considerable part of it is not in Iceland. Interestingly enough, only one segment in the aquaculture value chain predominantly occurs in Iceland, which is production.

Much of the Icelandic value chain is located in Norway, where most of the feed, equipment, and sea cages are imported from. This would indicate that there are a lot of opportunities for Icelandic companies to attempt to transfer a bigger part of the value chain to Iceland.

Future market outlook

One of the key industry challenges is the environment for granting of licenses. Due to the fast growth that the market is currently experiencing, licensing and permits will be vital in maintaining the rate at which the market is growing.

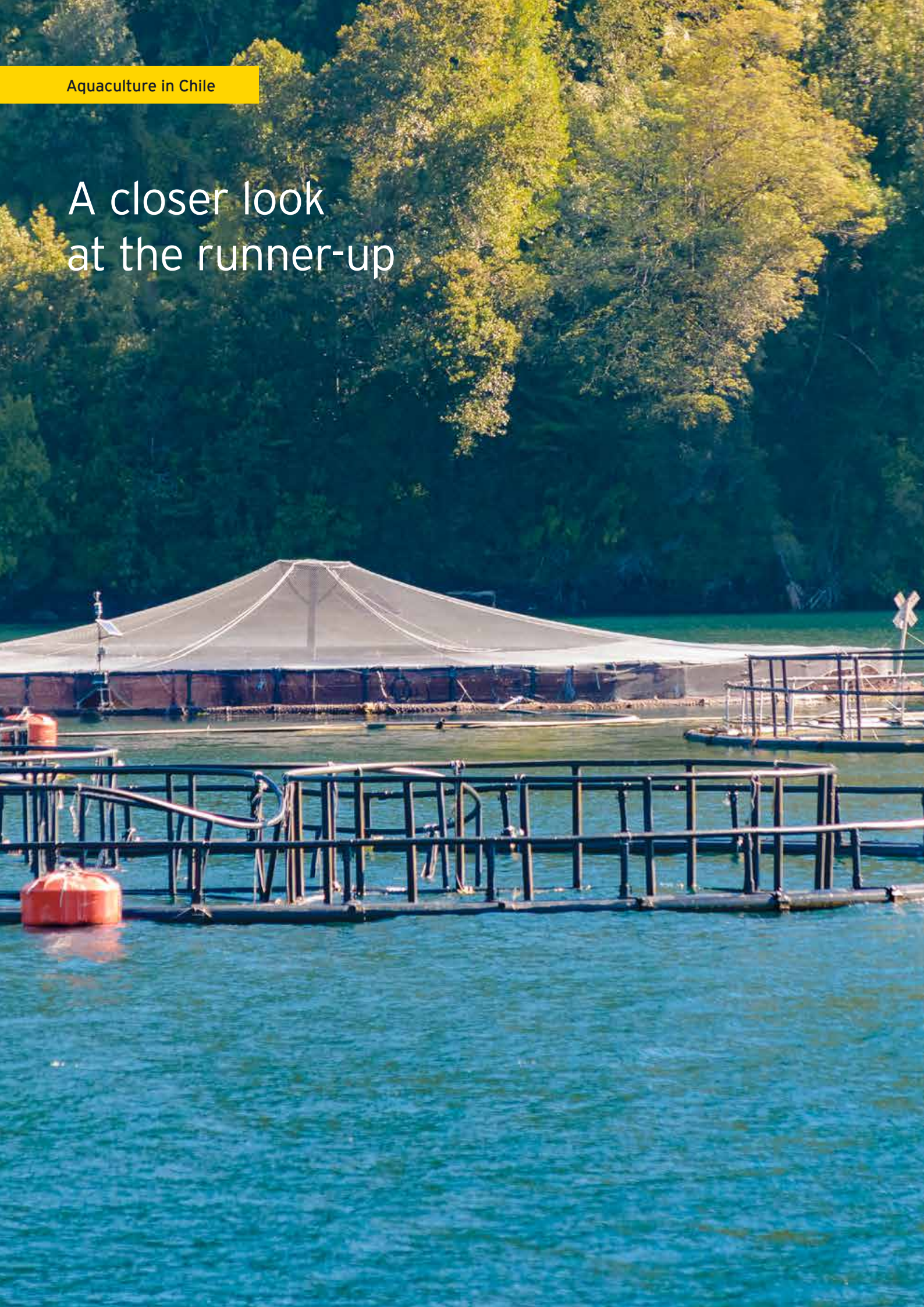
The limit to how much sea-based fish farming can expand results in high expectations on land-based fish farming. However, there is still significant room for growth in the sea-based sector, which takes a great deal of pressure off land-based operations.

Aquaculture has been a tremendous addition to the value of the economy. But greater growth opportunities can be uncovered by domesticating a larger proportion of the value chain. The fishery industry in Iceland has proven that the country possesses the skills and resources needed to do so. A vast array of opportunities will become available with the continued growth of the market, many of which the Icelandic companies will be able to take advantage of.

Top 10 export countries by export value

Source: "10 stærstu viðskiptalönd í útflutningsverðmæti eldisafurða," accessed 28 October 2021. *Radarinn, Mælaborð sjávarútvegsins*

A closer look at the runner-up



Status of the Chilean aquaculture industry

Chile is the second-largest salmon producer in the world, contributing to 32.5% of the global production volume in 2020. In terms of exports, aquaculture is the second largest industry in Chile, after the mining industry. In recent years, salmon exports in Chile reached record figures despite the global health contingency.

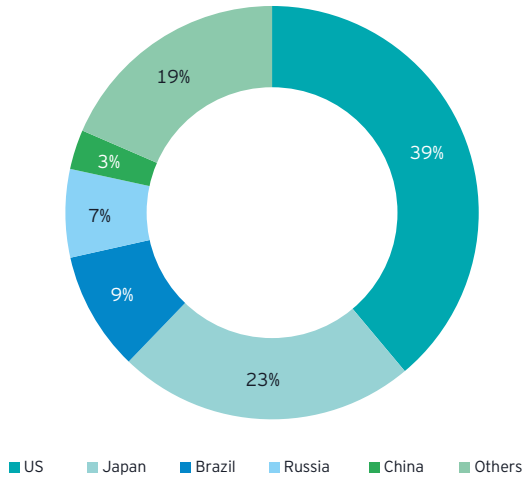
The main fundamentals that sustain the Chilean industry's solid position are its market maturity, competitiveness and sustained growth during the last 10 years. This is explained by several factors such as favorable geographical conditions, political and economic stability, favorable regulatory framework and tax incentives, a robust chain value and access to international capital markets. In addition, the presence of international key players in the local industry has contributed positively to best practices and new technology. A cluster of startups (focused on biotechnology and artificial intelligence), venture capital investors and continuous M&A, JVs, and IPO transactions have also played a key role in the development of the aquaculture industry in Chile.

On the other hand, the Chilean aquaculture industry has several areas to improve, concerning industry-leading standards, best practices and new sustainability challenges. Production is still volatile between seasons. Even though the aquaculture industry has been able to penetrate and obtain a stake in markets such as Russia and Asia, there still exists a concentration risk in its main market, the US.

Although Chilean farmers show higher yields in seawater and lower mortality rates at harvest than their competitors, the operating margins are lower than in other countries (e.g., Norwegian farmers). This can probably be explained by several factors such as the geographical distances that generate higher freight costs and the challenge to deliver fresh products to different markets. There are also limitations with regard to market access, partly due to the feed ingredient choices which have an impact on customer segments that are willing to pay a higher price for premium salmon.

Highlights[1]	2020
Production volume	1,046k tonnes
Export value	US$4,382m (6.1% of Chilean total exports)
Export volume	779k tonnes, 7.5% higher than in 2019
Harvest growth	6%

Main export markets for Chilean aquaculture[2] (2020)



1 "Highlights," October 2021, Chilean Customs Agency, (www.aduana.cl), 2021
2 "Main export markets for Chilean aquaculture," October 2021, *Consejo del Salmón* (www.consejodelsalmon.cl), 2021
3 "Aquaculture and Commodities Outlook – Salmon, Shrimp and Feed Ingredients Markets," October 2021, *DSM Webinar Series* (https://www.youtube.com/watch?v=AXQ5IIhx65s)
4 "Memoria Anual 2020," December 2020, *Kontali, Aquabench, Multiexport Foods*, 2021

Hit by COVID-19: aiming for operational improvements

Trends and development

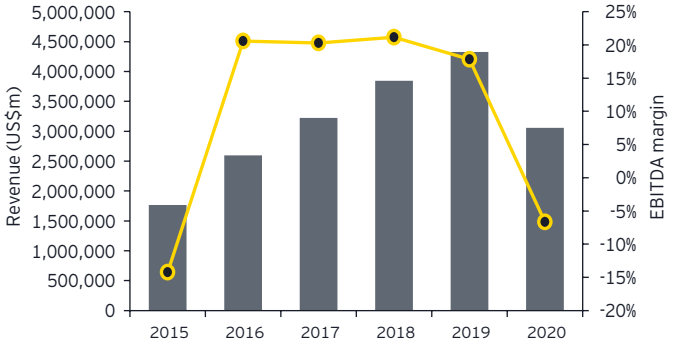
As can be observed in the graph, publicly listed Chilean fish farming company revenues have increased significantly from 2015 to 2019, after the massive algae bloom in 2015. The increase is primarily driven by a production increase and the higher market prices between 2016 and 2019. The EBITDA margin fluctuated between 15% and 20% during 2016 to 2019, which indicates that the industry was able to maintain a certain level of operational efficiencies in parallel with production increase, though lagging behind the EBITDA margins of their Norwegian peers (which have ranged between 30% to 36% in the same period). The year 2020 represented a singular situation due to the negative impact of COVID-19 on market prices, reducing revenues and resulting in a negative EBITDA margin.

The current Chilean industry competitiveness and the consumption pattern evolution of international markets have led to a rethinking of the long-term development strategy for Chilean aquaculture companies.

The local aquaculture industry has made important efforts in terms of ESG, sustainability reporting and community development. These efforts are beginning to be translated into better operational practices, less use of antibiotics, international certifications, traceability records and a culture of environmental consciousness.

From an operational point of view, a species diversification trend was observed over the last few years. The industry continues to produce alternative salmonid spices, specifically Coho salmon (Pacific salmon) and rainbow trout, which seek new market access, shortened production cycles, and lower exposure to operational risks. Additionally, these alternative species have helped the industry access new markets, mainly in Asia, due to the consumer preferences of coho and trout over Atlantic salmon in certain market segments.

Revenue and EBITDA development[1]
(for companies where information is publicly available)



In addition, a new trend toward further operational efficiency is being observed in Chile, where the incorporation of RAS facilities, the use of post-smolts and digitalization stand out in the same way as in Norway and other salmon-producing countries.

Tax incentives related to research and development for new technologies and investments are available for general developments (law n°20.241). Such tax incentives have been applied for projects that involve farming systems prototypes to improve seawater process, disease mitigation and algae bloom, genetic enhancement, production traceability and reduced scale size slaughter and process plants for piloting and bench testing.

Please note that our analysis in this section of the report is based on publicly available information. In general, only information about publicly listed entities is available in Chile. The companies included in our analysis represent around 43% of the total Chilean industry production.

Industry challenges	
Issues	**Potential impact**
Chilean constitutional process	A new national aquaculture policy, with a focus on greater environmental regulation (to be approved or rejected in 2022)
Climate change and production increase	Impact of pathogenic agents (e.g., algae bloom)
Cost control and lack of labor force	Pressure on cost increase and competitiveness
Social license to operate	Increased pressure on stakeholders to comply with ESG issues
Lack of geographic locations	Pressure on regulation to grant new licenses (concessions) and challenges to relocate existing licenses

1 "Revenue and EBITDA development," Companies Financial Statements for the years 2015-20, October 2021, *Comisión para el mercado financiero* (www.cmfchile.cl), 2021

The relentless focus on cost per kg

Productive processes and efficiency

The Chilean salmon production sector is actively evolving its production processes, looking to embrace new technology and innovation, applied science, strong human capital and leading market practices. The rising maturity of the individual market players in Chile should lead them on a path of increasing performance improvement and cost efficiency across different components of the production value chain:

- Large-scale smolt production facilities with increased automation (RAS facilities) – according to EY analysis, the cost of smolt of the most efficient RAS operators is about 20% lower than that of the average players, ranging from US$2 to US$3 per smolt
- Selective genetic programs for faster-growing, more resistant salmon: such eggs can be twice as expensive as traditional eggs – however, this higher cost is compensated with increased productivity in the smolt production and ocean farming stages
- Use of higher-energy feed varieties gaining terrain, especially in connection with the different egg genetics selections – this helps to accelerate growth in the ocean farming stages, thus compensating approximately 10% higher cost of such feed varieties
- Automatic feeding installations and remote feeding monitoring for farm sites – leveraging both the central experts' control of the process as well as improving the efficiency and consistency of the feed process
- Underwater robots for monitoring, cleaning and mortality removal – saving on diving costs and limiting risks to human life (associated with the use of divers)
- Limited mortality and morbidity – through increased disease control and treatments

Based on an EY market research performed in 2020, the ex-farm cost of the Chilean salmon industry was around US$3.7 per kg WFE. Looking strictly at the numbers, Chile now appears to be more cost-efficient than the global top producer, Norway, which has an average ex-farm cost of US$3.9 per kg WFE (2019).

While one might think that the difference might arise just from Norway´s significantly higher labor cost per kg WFE of salmon than Chile, there are several other factors that directly or indirectly impact the difference in production costs:

Mortality rates: Norway has had higher mortality rates than Chile (~16%2 vs. ~11%1 in 2019) which may in part be due to the prohibition of the use of antibiotics to prevent diseases and restrictions while using chemicals for sea-lice (Caligus) treatments. This forces producers to use other methods (e.g., freshwater or thermal baths routines) which can cause stress and higher mortality. However, more regulatory restrictions of antibiotic use in Chile are expected in the future due to increased market and regulatory focus. In 2020, the mortality rates were almost on an equal level at 15%1,3 in both Norway and Chile, following algae outbreaks and bad weather in Chile, underlining how specific events may impact the relative numbers every year.

Smolt sizes: While regulations in Chile limit the number of fish harvested per concession per cycle, the Norwegian regulation limits the biomass density per concession. This has incentivized Norwegian salmon farmers to stock larger and more expensive smolt, with 300g smolt gradually becoming more "normal." For larger farming companies, this can even go up to 500 grams for some farmers, while Chile smolt is stocked at 125g to 250g typically. The larger smolt stocked in the ocean allows Norwegian farmers to increase the productivity of their concessions.

Egg genetics: Another interesting factor is the trend among Norwegian farmers to stock only females, paying more for eggs (genetics) and smolt. This helps to have better control over the fish maturing process and more consistency in the size of fish harvested.

Thus, the slightly more cost-efficient salmon production in Chile may have less to do with the efficiency of the processes themselves and more to do with the strategic choices taken to optimize end-to-end salmon production within the regulatory restrictions of each country.

1 https://www.aqua.cl/wp-content/uploads/2021/01/Newsletter-Aquabench_en.pdf
2 Fiskehelserapporten 2019, *Veternærinstituttet*, 2020
3 *Fiskehelserapporten 2020, Veterinærinstituttet*, 2021

With sustainability on the agenda

Moving in the right direction …

As for the rest of the world, one of the main industry challenges in Chilean aquaculture is to make sure they work under the best environmental, economic and social standards. There is an increased awareness of, and emphasis on, incorporating a sustainable approach within safety, occupational health, food safety and protection of the environment in close conjunction with the local regulatory authorities and under the strict oversight of end-market customers. Currently, the main challenges are related to the controlled use of antibiotics and the negative impact on sediments below the fish farms.

Several aquaculture companies with operations in Chile, including five of the most important global players listed in the Infotrade 2019[1] export ranking, have published their 2020 Sustainability Reports. All of them have reported according to the standards of the Global Reporting Initiative (GRI) and as members of the Global Salmon Initiative (GSI), where they included adherence to the Sustainable Development Goals (SDGs) of the 2030 agenda. Additionally, the majority have verified these reports under GRI Standard. Although reporting does not necessarily equal actions, this confirms the companies' high focus on industry sustainability.

Another positive sustainability trend is that multiple companies have advanced in obtaining certifications that consider the environmental, social, safety and productive thematic areas, currently reaching 80%2 of certified biomass under standards such as the Aquaculture Stewardship Council (ASC), the standards for Good Agricultural Practices (GLOBALG.A.P.) and the Best Aquaculture Practices (BAP) for seawater centers.

On the regulatory side, there is an increased focus on environmental compliance and oversight. In July 2021, the National Fish & Aquaculture Service (Sernapesca), together with 10 other state organizations, launched the National Audit Network for the Sustainability of Fish and Aquaculture. The purpose of this network is to improve industry surveillance and maintain sustainability standards across different processes. It is important to highlight that the compliance scope with legal regulations that govern the industry is undoubtedly the starting point where sustainability strategy must be built.

… but with more miles to go

Chilean aquaculture has important challenges to address while continuing to move forward in the sustainability field. This includes improving the relationship between the salmon industry and the surrounding communities, and the public. To improve the sector corporate image, it is essential to assure good practices that are fully compatible with the aquaculture ecosystem. Further, the industry players could address with greater emphasis the aspects associated with climate change, which influences the actual carrying capacity of marine ecosystems and strengthen the systems to minimize the risk of fish escape.

Top salmon producers in Chile	Net tonnes	GRI Report
Aquachile	163.989	✓
Australis	61.638	✓
Cermaq Chile	58.436	✓
Multifoods	52.484	✓
Camanchaca	58.436	✓
Mowi Chile	40.568	✓
Blumar	33.478	✓
Salmones Austral	30.330	-
Granja Marina Tornagaleones	29.757	-
Ventisqueros	24.806	-

1 Export Ranking Infotrade 2019, www.infotrade.cl
2 Salmonchile Sustainability Report 2019, https://www.salmonchile.cl/informe-sustentabilidad-2020/informe-2019/

Regulatory snapshot – tax and aquaculture licenses

Overall tax regime

Chile is a unitarian republic. This means that most taxes are centrally collected, with practically no regional or provincial taxes. The Chilean tax system is based on two major pillars: corporate taxes and value-added tax. Other taxes are minor ones in terms of relevance and collection (such as customs duties, stamp tax, municipal license, green taxes and sugar tax).

Local companies involved in the aquaculture business are subject to the general tax regime available in Chile, subject to a 27% Corporate Income Tax ("CIT" or "Impuesto de Primera Categoría"). As Chile's CIT is integrated with income tax payable by shareholders or owners, taxation of investors shall also be considered. Under the general regime, a final owner is only subject to tax on actual distributions paid with an overall tax burden of 35% when a double tax treaty is in place with the country of residence of the shareholder abroad (being the full CIT accreditable against the shareholder's tax).

Most relevant tax and investment incentives for the salmon industry

Aquaculture enterprises rendering activities in the very south of Chile are entitled to claim incentives granted by the "Austral" and "Navarino" laws. Both incentive schemes are regarded as important for promoting the investment in new aquaculture projects in Chile.

The first one grants a tax credit against the CIT that is determined based on the total value of the assets acquired new, or the finished construction, incorporated into an investment project that is destined for the production of goods or provision of services (the incentive would vary depending on the investment and can go up to a 32% tax credit – capped in US$5.3m per each year).

The second one establishes a preferential tax and customs regime for 50 years in the territory of Magallanes. Within the incentives granted it is possible to mention CIT exemptions, tax credits for employment taxes and VAT and/or customs exemptions.

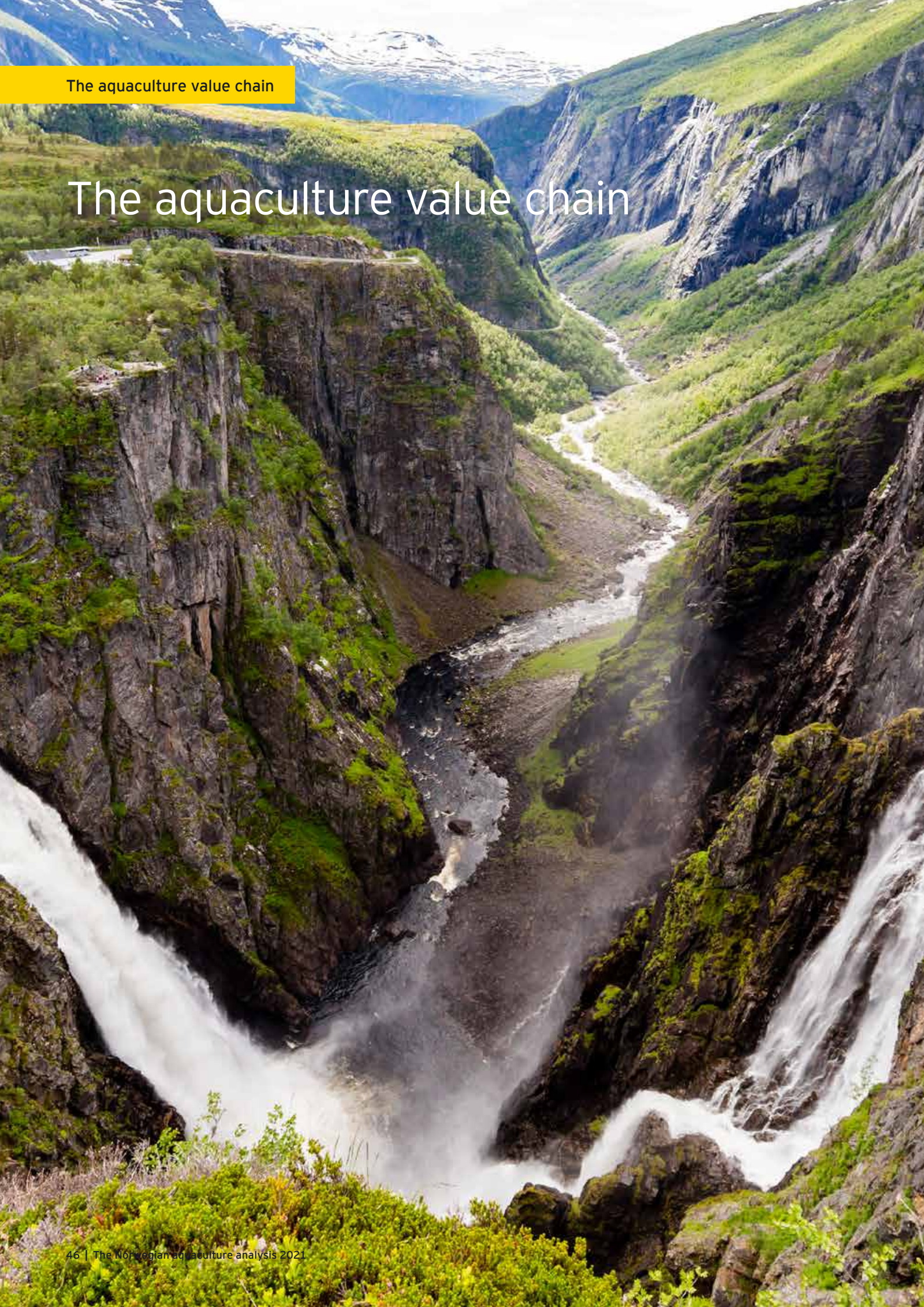
In addition, industry players should be aware that R&D activities performed in-house or with certain research centers in Chile can benefit companies with a tax credit against their CIT payments. This credit is equivalent to 35% of a base composed of total payments made in R&D projects, as soon as such project is duly certified by a Chilean Agency called CORFO. This incentive has an annual cap of UTM15,000 (approximately US$1m). In addition, taxpayers are allowed to deduct as an expense all amounts paid, not deducted as a credit, in connection with the R&D certified project. A preapproval process is required to obtain the incentive.

Aquaculture licenses in Chile

In Chile, aquaculture concessions can be granted for a period of 25 years (renewable unless the environmental reports do not allow it). Up to March 2021, the Chilean authorities have published a list of more than 3,200 aquaculture concessions that have been granted in Chile. It is still possible to get new licenses today through an administrative process that could take up to 90 days to be completed according to the current regulations (from the date when all required information is provided). The application and license are free of charge; however, companies incur costs associated with the process of providing all the documentation and details requested by the authorities to grant the license. Chilean regulations include a list of situations where the licenses can expire when certain requirements are met (non-use of licenses for two years, operating without complying with the minimum levels of operation, etc.).

From a tax perspective, such concessions are generally not depreciable for tax purposes and could trigger a capital gain upon their transfer.

The aquaculture value chain



Technical solutions	Biotechnology	Production	Distribution	Processing

When discussing the aquaculture industry, we primarily talk about the end product – salmon and trout. However, there are many other stages and actors in the industry. The aquaculture value chain includes broodstock (egg and spawn), smolt, edible fish, fish processing (based on farmed fish), export and trade and suppliers of goods and services.

For analytical purposes, the value chain and value creation can be presented in different ways.

In particular, there are three groups of suppliers – namely technical solutions suppliers, biotechnology suppliers and distributors – all of which can be challenging to present in a common value chain. These three can also be perceived as diverted or parallel activities.

Technical solutions suppliers are needed at every stage of the value chain. Hence, presenting them as just one segment can be misleading.

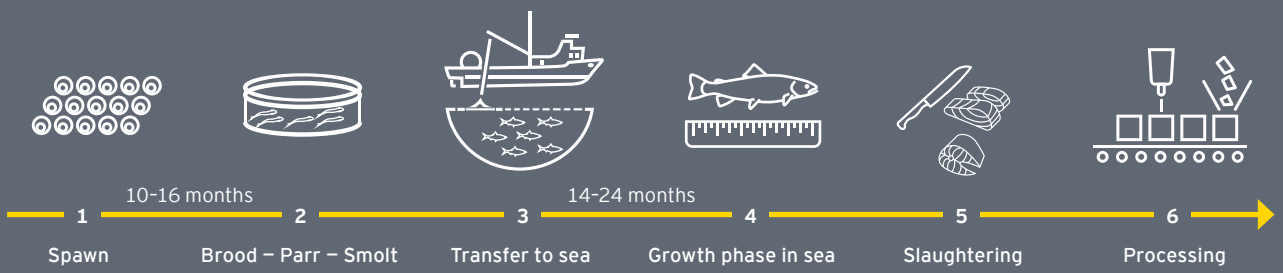
The above-mentioned challenge is almost the same for biotechnology suppliers, who deliver a wide range of products including feed, vaccines, medicines and cleaner fish. The common denominator for these products is the biological or pharmaceutical raw materials. The biotechnology manufacturers supply both egg and spawn producers, smolt producers and sea farmers.

The distribution phase is also complex. Sea transportation is needed for both transporting smolt from freshwater to net pens in seawater and transporting harvestable fish to processing plants. In addition, we have traders and exporters who purchase fish from sea farmers and provide it to the end-consumers, either slaughtered or processed.

The primary value-creating activity in the industry is production. The production cycle extends over three years. During the first year, eggs are fertilized and the fish are grown to 100g-250g in weight in controlled freshwater environments. Subsequently, the fish are transported into seawater cages where they are grown to about 4kg-5kg. This growing process takes 14 to 24 months, depending on the seawater temperature.

Despite the methodological challenges, we have decided to present technical solutions, biotechnology and distribution together with production and processing in one single value chain. This is to make the analysis easier to follow and interpret.

The Atlantic salmon life or production cycle



Technical solutions

About the segment

The technical solutions segment includes companies with approximately 50% or more of their business linked to the aquaculture industry, but not directly linked to any of the other segments. Hence, a wide range of products and services are provided by companies in this segment.

The largest companies within this segment are producers of technical solutions and services, specifically developed for the aquaculture industry – barges, well-boats, feeding systems, cages, mooring systems, sea lice treatments and software.

We have divided the segment into three subsegments:

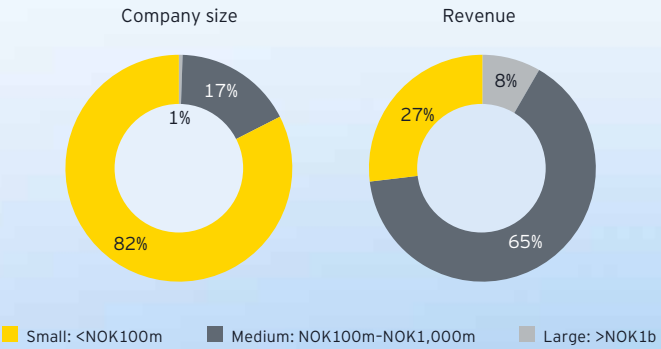
1. Consulting and services
2. Equipment and farming solutions
3. Yards

Segment highlights

While the segment has experienced continuous revenue growth, margins have been under pressure since 2016. This is in part due to increased competition among companies. However, in 2019, the margins increased in all of the subsegments, with only minor changes in the 2020 margins. Increased focus on farmers' environmental footprint and sustainability, as well as digitalization, has a positive spillover effect on this segment as it incentivizes farmers to invest in new technology. Despite the M&A activity being high in the last few years, the segment remains rather fragmented and is predominantly made up of small-sized companies (of which roughly 70% had revenues below NOK50m in 2020).

Key financials

Segment composition (2020)



In the period from 2020 to 2021, 30 deals involving companies in the segment were announced. In 17 of the transactions, these companies were the target, with an even distribution between industrial and financial players on the buy-side. This indicates a continuing trend of companies using M&A as a way of expanding their product offering and market position. However, it also highlights a fairly recent surge in interest from financial investors.

Consulting and services | Equipment and farming solutions | Yards

Consulting and services

The companies in this subsegment offer competency on various specializations across the whole value chain (asset-light), and ongoing maintenance and services on production facilities with vessels and machinery.

The subsegment is comprised of mid-and small-sized companies. The latter accounts for nearly 90% of the companies, indicating a fragmented competitive landscape. In the period from 2020 to 2021, we observed a total of 10 M&A transactions in this subsegment. Targets were both companies in the development and commercial phase, with buyers being primarily industrial companies. Some financial buyers participated in minority private placement transactions.

Revenues have more than quadrupled over the past decade, with a compound annual growth rate of 17.7%. In 2020, the activity was negatively impacted by the pandemic, leading to revenue growth of just 2.7%. Consulting and services show attractive double-digit margins throughout the period and seem to have recovered well from the lower EBITDA levels witnessed from 2017 to 2018. In 2020, EBITDA slightly improved to 16.3%, due to higher gross margins (72%) and a decline in other operating costs. Margins are primarily driven by mid-sized companies, indicating favorable effects from economies of scale and showing that a large number of small-sized companies are in a pre-commercial phase.

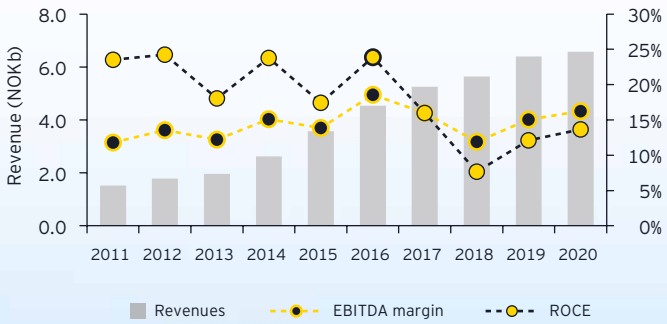
Part of this subsegment is capital-intensive and CAPEM has increased significantly over the last five years, primarily driven by vessel purchases for some of the service providers. In 2020, CAPEM was kept relatively close to 2019 levels, potentially indicating that companies held back on investments during the pandemic.

Return on capital employed (ROCE) is rising as the above-mentioned vessel purchases are starting to generate more returns.

Top five companies (2020 revenues)

1. SINTEF Ocean AS
2. Gildeskål Forskningsstasjon AS
3. Frøy Akvaservice AS
4. Letsea AS
5. Aqs AS

Key financials



Equipment and farming solutions

The companies in this subsegment offer a variety of equipment and solutions – from the largest players, such as AKVA Group offering nearly all kinds of equipment, to smaller and more niche players providing more specialized equipment.

EBITDA margins fell to an all time low in 2018 (4.3%), driven by a fall in gross margins and an increase in personnel expenses. These developments were in turn likely the result of a change in product mix and increased competition. Since then, margins have recouped somewhat, coinciding with a general growth across companies of all sizes. In 2020, the subsegment experienced high activity, though revenue growth was relatively modest (3.8%) compared with previous years. The decline in the growth rate can be explained by the competitive nature of the subsegment, and the negative impact of the ongoing pandemic. The EBITDA margin decreased to 4.6% (from 5.0% in 2019), and is still well below the 8.9% observed in 2016.

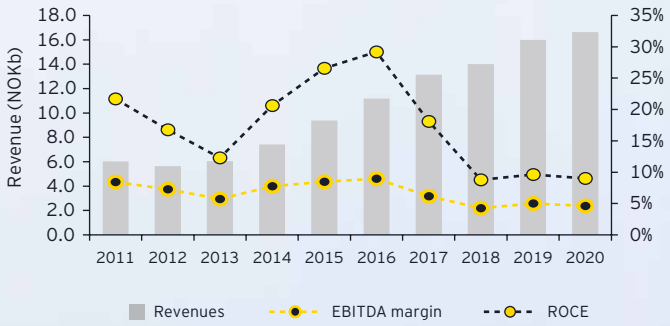
Following double-digit growth observed from 2013 to 2019, capital employed fell by 5.5% in 2020. The restrictive investment schemes during the pandemic and lower EBIT levels were likely contributing factors to this reduction. Meanwhile, the stagnant growth in EBIT since 2016 has resulted in a decline in ROCE.

We observe trends where companies in the subsegment partner together, either through M&A or joint ventures. In most cases, the companies continue as separate entities, yet have the advantage of knowledge-sharing opportunities and the ability to strengthen their market position through these collaborations.

Top five companies (2020 revenues)

1. AKVA Group ASA
2. Scale Aquaculture AS
3. Optimar AS
4. Egersund Net AS
5. Steinsvik AS

Key financials



Yards

Yards included in this subsegment primarily construct or retrofit well-boats, processing vessels and feed freight vessels.

The yards can only build a limited number of vessels at a time and the construction period may be longer than a year. This can lead to fluctuations in revenues, as observed in the chart. The well-boat industry continues to expand, resulting in a large number of well-boat orders in 2020 and 2021 – with several yards reporting high order backlogs. The number of newbuilds is driven not only by increased market demand for well-boat services but also by the replacement of older well-boats, as newer and more sustainable technologies are introduced.

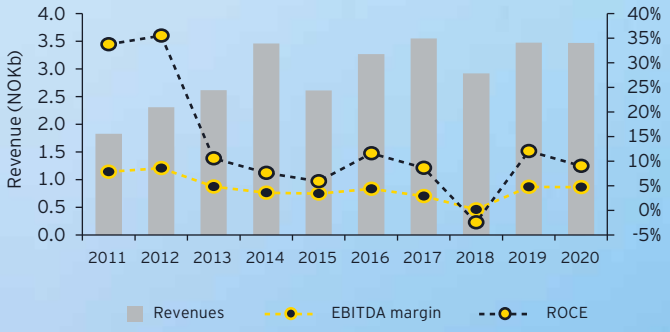
Despite strength in the demand for newbuilds, some yards have performed particularly poorly, which is an explanatory factor to the stagnation of the segment revenue growth in 2020. In fact, one of the largest players reported a 38% reduction in revenues. The reasons for this poor performance include difficulties in delivering projects due to COVID-19 related factors, such as labor shortages. Margins in the subsegment seem to have recovered well from the low point in 2018, with an EBITDA margin of 4.7% in 2020.

The top five players accounted for approximately 75% of revenues in the subsegment in 2020.

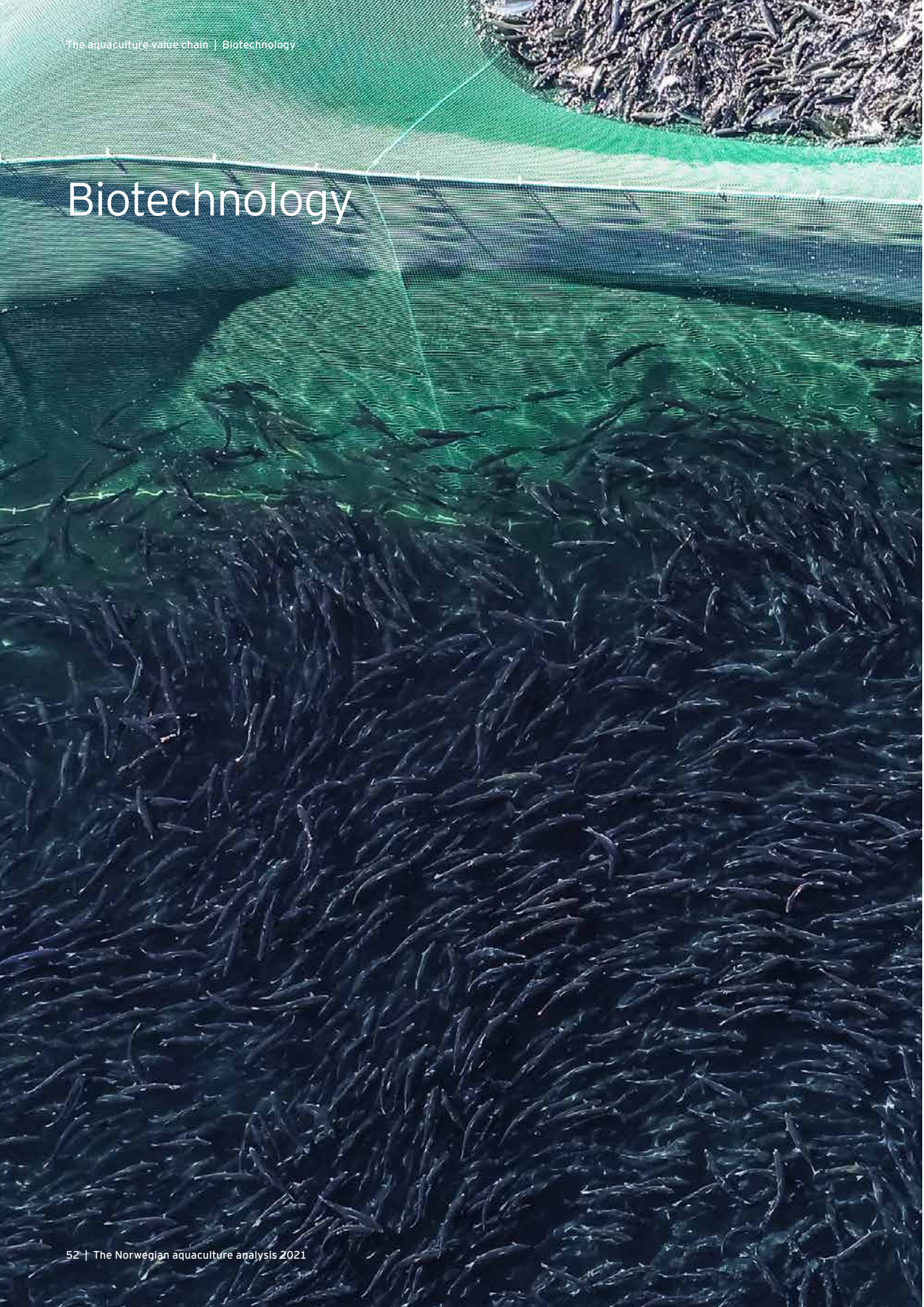
Top five companies (2020 revenues)

1. Aas Mek Verksted AS
2. Fitjar Mekaniske Verksted AS
3. Myklebust Verft AS
4. Sletta Verft AS
5. Grovfjord Mek. Verksted AS

Key financials



Biotechnology



About the segment

Biotechnology refers to the application of biological technologies in product research and development. Modern biotechnology has been used in aquaculture with regards to cases such as reproduction control, disease control, environmental management, feed production and biodiversity conservation.

We have divided the segment into two subsegments:

- Fish health
- Feed

Segment highlights

Biotechnology not only enhances production to meet demand, but also ensures sustainability and a response to environmental threats. Use of technology makes it possible to maintain healthy fish stocks at low prices by contributing to nutritious feed and effective disease prevention.

The biotechnology segment has seen a substantial growth in the past decade with a compound annual revenue growth rate of 8.9% from 2011 to 2020. The growth has been positively influenced by high salmon prices and stagnating volume due to biological issues, resulting in an increased demand for healthy and efficient fish feed, fish medicines, vaccines, etc.

While the revenue growth rate subsided, the EBITDA margin increased steadily in the period from 2016 to 2019. The segment experienced double-digit revenue growth from 2018 to 2019 and 2019 to 2020. At the same time, the segment experienced a record-high EBITDA margin in 2019 (9.4%), with a significant drop in margins in 2020 (7%). Significant revenue growth and positive margin development were observed in both the high-volume and low-margin feed subsegment, as well as in the high-margin fish-health subsegment for 2018 to 2019. From 2019 to 2020, the feed segment experienced lower margins despite continued revenue growth, while the fish health segment saw a dip in both revenues and margins.

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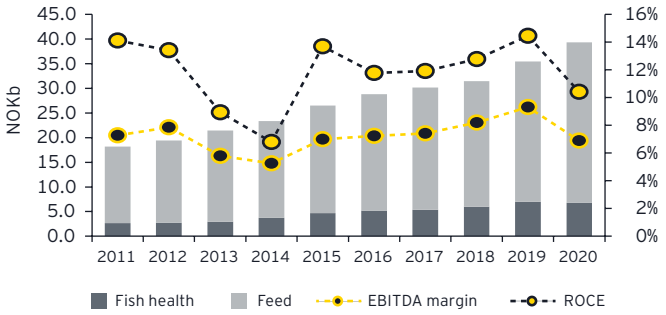
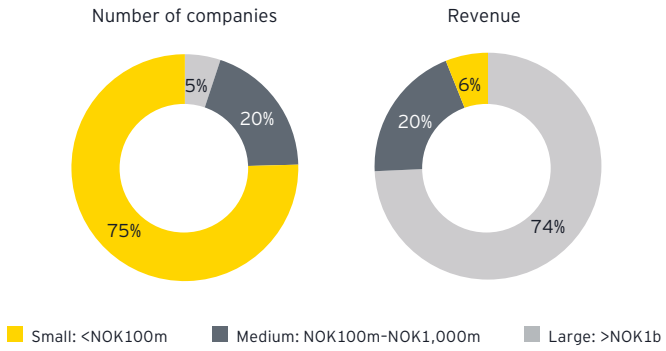
Key financials



Segment composition (2020)



Fish health | Feed

Fish health

The financial results in the fish farming industry depend on healthy and high-quality fish. Entities within the fish health subsegment provide products, services, research and development projects that are crucial for maintaining and improving fish health for the global aquaculture industry. The subsegment also includes the breeding and genetics companies that supply genetic material (i.e., fish eggs or fry) to the fish farmers. Contrary to the feed subsegment, where only a limited share of the produced volume in Norway is exported, companies in the fish health segment have a higher degree of export.

Finding the solution to biological challenges

Biological issues remain a significant challenge for Norwegian salmon farmers. Sea lice still represent the biggest threat to Norwegian fish health, but there are also other significant risks such as pancreas disease (PD), infectious salmon anemia (ISA) and hearth and skeletal muscle inflammation (HSMI).

Solving the sea lice issue demands a combined effort from the entire aquaculture industry, including research into pharmaceuticals and vaccines, breeding technologies and genetics, functional feeds and mechanical and biological methods for lice removals. Several companies within the fish health subsegment have provided medicinal treatments for combatting sea lice, and they are continuously developing new and improved pharmaceuticals.

Entities within the fish health subsegment invest heavily in research for finding new, sustainable and efficient solutions for battling sea lice and other aquaculture-related biological issues. However, despite the effort, the Norwegian Veterinary Institute concludes in its 2021 edition of the Fish Health Report that the challenges related to fish health and fish welfare have not been improved.

Revenue and margin decrease driven by selected industries

The focus on fish health and biology in the aquaculture industry has been the driver behind the revenue and margin growth in the fish health subsegment over the last decade. In 2020, both revenue and margins decreased.

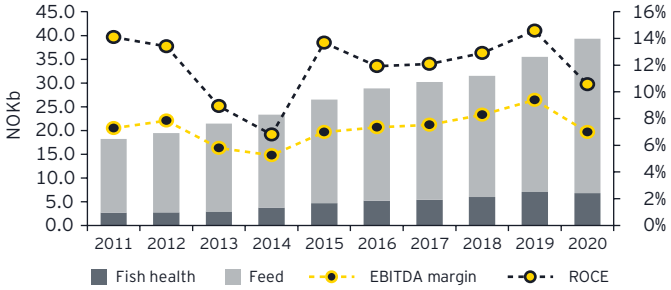
The reduction was driven by two groups of companies. The first group of companies was the ones within the cleaner fish industry, included in this subsegment. These companies saw a significant drop in both revenues and margins from 2019 to 2020. Secondly, the breeding and genetics industry was impacted by the pandemic, specifically the export of their goods. This resulted in the production of genetic material that they were unable to sell. Furthermore, they have used part of 2020 to build biomass stock in preparation for export in 2021.

Excluding the above-mentioned points, the fish health subsegment's revenue and EBITDA in 2020 were in line with 2019.

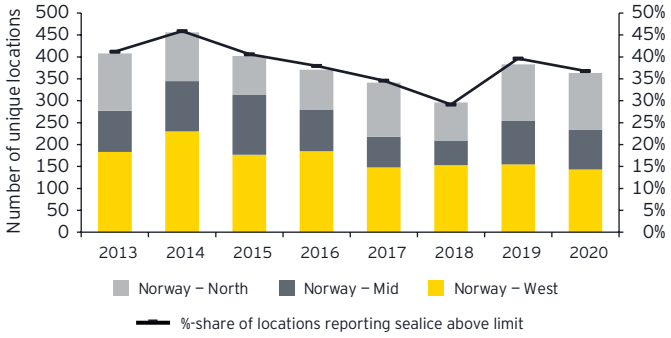
Top five companies (2020 revenues)

1. PHARMAQ AS
2. Veterinærmedisinsk Oppdragssenter AS
3. Nofima AS
4. Stim AS
5. Aquagen AS

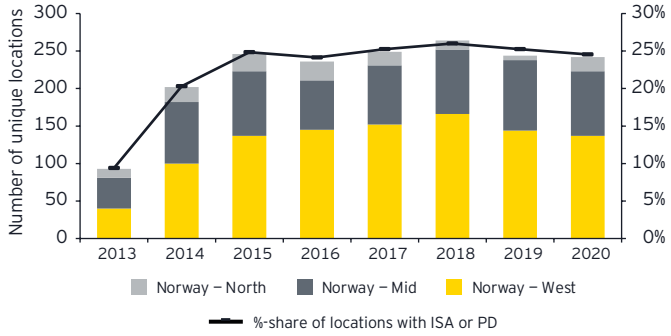
Key financials



Number of unique locations reporting sealice above limit



Locations with ISA or PD per region – roiling last four quarters



Fish health | Feed

Feed

The feed subsegment includes feed producers and companies producing and supplying input factors to feed production. Feed represents about half of the total production cost for salmonids and contributes to approximately 95% of the carbon footprint in conventional salmon farming. The correct ingredients are vital for both the health and quality of farmed fish. Thus, feed is a key focus area in the industry from both an economic, environmental and biological point of view. While the feed producers included in the feed subsegment produce feed and products to other species as well, salmonid feed makes up a significant amount of the total feed produced.

Shortage of conventional marine materials (mainly fish meal and fish oil) has resulted in a shift toward vegetable materials. While fishmeal and fish oil made up more than 80% of salmon feed in the '90s, today, conventional marine materials only constitute between 25%–30% of the average Norwegian fish feed. As a consequence, the long-chain omega-3 fatty acid content in the farmed salmon has declined. However, the feed procurers are investing heavily in finding alternative sources of omega-3 including byproducts from conventional fisheries, krill, algae, etc.

Consolidated feed production

The salmonid feed industry is largely consolidated and consists of a few large producers controlling the majority of the salmon feed output. Over the last five years, the top four companies have accounted for between 80%–90% of the revenues in the feed subsegment.

Continued revenue growth and margin improvement

The subsegment had a steady, but diminishing, revenue growth from 2011 to 2018, and the EBITDA margin was virtually unchanged in the period 2015 to 2018. This is largely explained by increased competition in the feed subsegment following Mowi's entrance to the market in 2014.

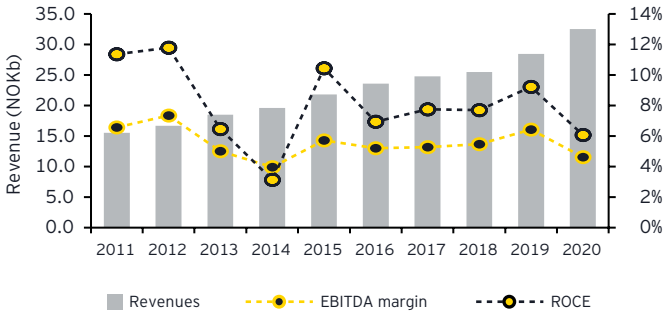
In both 2019 and 2020, the subsegment experienced a double-digit revenue growth (not seen since 2015) and the EBITDA margin increased to 6.4% in 2019 but decreased to 4.6% in 2020. The massive revenue growth in the subsegment was driven by higher sold volumes of feed as a consequence of the observed growth in biomass and harvest volume.

Feed producers report of increasing cost of raw materials and continued high competition in 2020. The combination of these factors put pressure on the margins in the subsegment, resulting in the observed decrease in 2020.

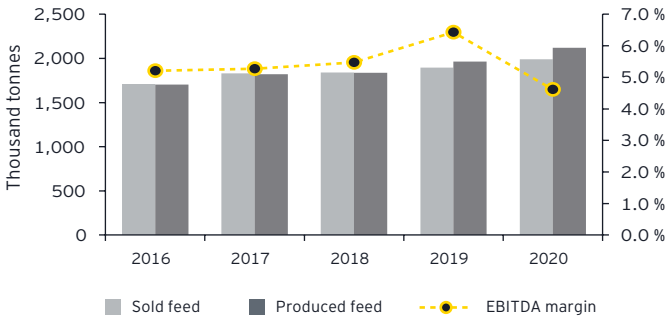
Top five companies (2020 revenues)

1. EWOS AS
2. Skretting AS
3. BioMar AS
4. Mowi Feed AS
5. Aker BioMarine Antarctic AS

Key financials



Feed EBITDA margin and volume development



Production

About the segment

The production segment consists of the fish's life cycle from the breeding and fertilization of eggs, through nurturing of fry to smoltification, to finally putting it to sea for growing to harvest size.

In this year's analysis, we introduce land-based farming as a separate subsegment. The current production volume in this subsegment is very limited, but given the current number of identified land-based projects, it may potentially become an important complementary production method in Norway. However, how many of these projects actually will materialize, remains to be seen.

To reflect the various stages of the production cycle, we divide this segment into three subsegments:

1. Broodstock and smolt production
2. Sea farming
3. Land-based farming

As ensuring quality in the first stages of the cycle is crucial to successful sea farming, there has been a large degree of vertical integration in this segment. The sea farming companies expand into upstream activities to facilitate access and high quality, both for the broodstock or eggs and in handling and vaccination of fry during the freshwater stage.

The segment consists of more than 200 companies.* However, a relatively small number of companies account for the majority of the value creation. In 2020, the 10 largest companies had a market share of about 55%, measured by revenue.

Segment highlights

The production segment has experienced substantial growth from 2011 to 2020, with a notable acceleration from 2016, driven by a significant increase in prices and favorable currency exchange rates for exports.

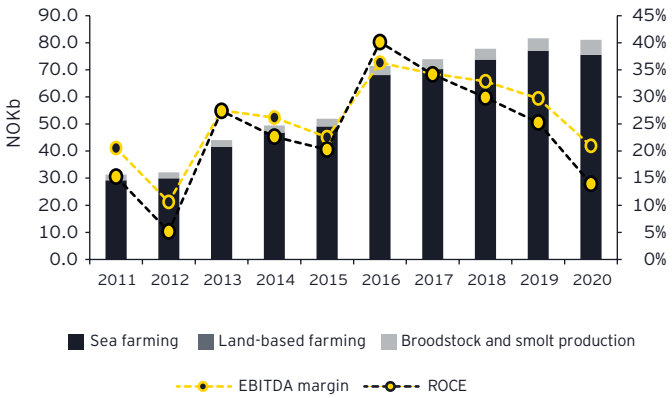
As a result of the increased profitability and higher demand for various supporting services, the sector has become a major contributor to value and job creation along the Norwegian coast.

There is a continuous concern about the sector's challenges related to sea lice and other biological and environmental issues. These challenges materialize in higher costs and are the main reason for the decline in the EBITDA margins since 2016.

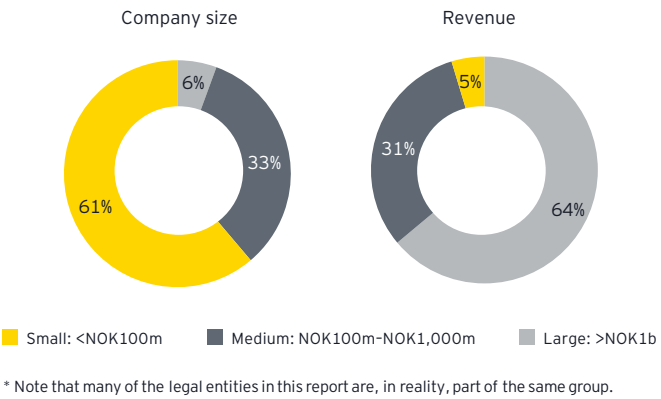
These challenges have plateaued the growth in production volumes in the past few years, paradoxically driving up prices and profits in the short term. In the long term, however, there is a need for sustainable growth in volume. Biological challenges and diseases are two of the major concerns the industry faces going forward.

There has been a significant increase in research and development (R&D) over the last few years to tackle the challenges facing the industry today. Most of the new innovations are focused on making aquaculture more sustainable, decreasing biological challenges while at the same time increasing volumes in the long run.

Key financials



Segment composition (2019)*



* Note that many of the legal entities in this report are, in reality, part of the same group.

Broodstock and smolt production | Sea farming | Land-based

Broodstock and smolt production

The companies in this subsegment are specialized in broodstock and smolt production. Some of the companies operate on a stand-alone basis, while others are owned fully or partially by sea farmers or other industry players.

As the industry faces increasing production challenges related to sea lice and diseases, the broodstock producers put a lot of effort into R&D. These companies work extensively to develop knowledge in areas such as breeding, spawn production and disease control. They aim to strengthen the breeding material and utilize genetic technology to improve resistance to diseases and enhance the growth rate.

Smoltification is the biological process that makes young fish ready for the transition from freshwater to seawater. Fish that has undergone this process is called a smolt. This is the middle stage of the production cycle and is operated by the smolt producers. In specialized fish farms where conditions are optimized, the smoltification process takes 10 to 16 months.

Stable growth

In the last decade, the smolt-producing companies have experienced continuous revenue growth, with increasing EBITDA margins in the period after 2018. The uptick in revenue growth and EBITDA margins observed in 2019 and 2020 are primarily driven by improved gross margin, explained by several companies as an effect of improved biological performance.

Vertical integration

All the top five companies by revenue in this subsegment are fully or partially owned by sea farming companies. Being present in the entire value chain enables the sea farming companies to control more of their production cycle. The high degree of cross-ownership and intergroup trade, along with other long-term business relations, is believed to contribute to the stable revenue growth and EBITDA margin observed in this subsegment. However, this is difficult to verify without direct insight into bilateral purchases and contracts.

Larger post-smolt

Over the last years, the production of larger smolt (250g–500g) has been introduced in the market. The larger smolt is typically referred to as post-smolt. Today, several smolt producers are looking to produce even larger smolts of up to 1kg. The reason for using larger post-smolt is to reduce the time in the sea, thus minimizing the time the fish is exposed to uncontrollable risk factors such as sea lice and diseases. However, increasing smolt size requires extensive investments in R&D and new facilities. While the post-smolt initiatives are still in their initial phase, preliminary reports from farmers indicate a reduced need for de-licing and reduced occurrences of PD.

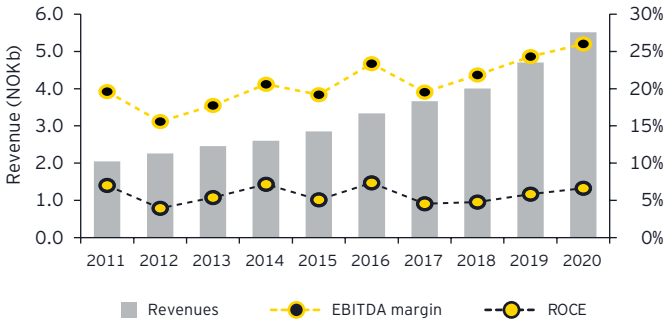
Recirculatory aquaculture system (RAS) technology

As RAS technology becomes more developed, we see an increase in land-based smolt facilities based on this technology. RAS is a way of recirculating water in the fish tanks, enabling companies to produce large quanta of fish with relatively low water consumption. Most of the existing smolt facilities in Norway are based on traditional FTS. However, most new smolt facilities are built using RAS technology.

Top five companies (2020 revenues)

1. SalMar Settefisk AS
2. Nordlaks Smolt AS
3. Helgeland Smolt AS
4. Laksefjord AS
5. Osland Stamfisk AS

Key financials



Broodstock and smolt production | Sea farming | Land-based

Sea farming

The final step in the production process is sea farming, which is by far the largest subsegment in the Norwegian aquaculture industry when measured by EBITDA contribution. This is where the fish are put into seawater and grown until harvest size (about 4kg–5kg). This process takes about 10 to 24 months, depending on smolt size and other growth factors.

High salmon prices since 2016

Over the last years, the sea farming segment has experienced record-high profitability as a consequence of all-time-high salmon prices. This resulted in EBITDA margins above 30% in the 2016 to 2019 period.

While demand has increased in recent years, sea farmers have struggled to increase supply correspondingly due to production constraints, sea lice and diseases. Consequently, the average salmon price for farmed Atlantic salmon more than doubled from 2012 to 2016 (to above NOK 60kg) and has remained fairly stable at NOK 60kg until 2020 when it dropped to NOK 55kg.

Volume growth in 2019 and 2020 after several years with stagnating production volumes

In 2019, the segment observed a notable increase in harvest volume for the first time in several years, with approximately 7% volume growth compared with 2018. In comparison, the compound annual volume growth rate from 2014 to 2018 was merely 0.4%. The volume growth is predominantly explained by an increase in the number of grow-out seawater licenses for salmon and trout in Norway over the last 5 years (from 990 in 2016 to 1,087 in 2020), and an increase in the number of development licenses from 8 in 2016 to 36 in 2020. The volume growth continued in 2020, increasing by another 2.6% from the record-high volumes of 2019.

Continued growth in cost per kg

Over the last years, disease, sea lice, extreme weather and other operational and biological challenges have led to a significant increase in production cost per kg. According to our analysis, cost per kg has spiked by 25% over the last five years.

Please note that our analysis is simplified as we look at the aggregated figures, i.e., annual accounts for each company. We are thus not able to differentiate between production cost and other costs, meaning that our numbers will deviate from the pure-play numbers reported by the Directorate of Fisheries.

The negative cost trend continued in 2020, with a significant jump in costs from the 2019 level. We observe increased costs for the majority of the Norwegian fish farmers and almost all the companies highlight biological challenges as the primary cause for the continued cost increase. In addition to sea lice, issues with winter ulcers and algae are frequently mentioned explanatory factors. Furthermore, COVID-19 brought on challenges related to logistics and freight which have had a negative impact on costs.

Higher cost per kg combined with a lower revenue per kg has resulted in the lowest EBITDA margin for the segment since we started working on the Norwegian Aquaculture Analysis. We note that the 2020 EBITDA margins are lower than the 2015 margins, even though the 2020 salmon price is more than 30% higher than that of 2015.

Increasing costs can, to a large extent, be explained by costs related to feed and health issues, primarily sea lice. Increased use of lice treatments, cleaner fish, specialized feed, service boats and investments in R&D drive operating costs. Delayed growth, starvation and forced early harvest to curtail harvest volumes and represents less visible costs that are also present due to sea lice.

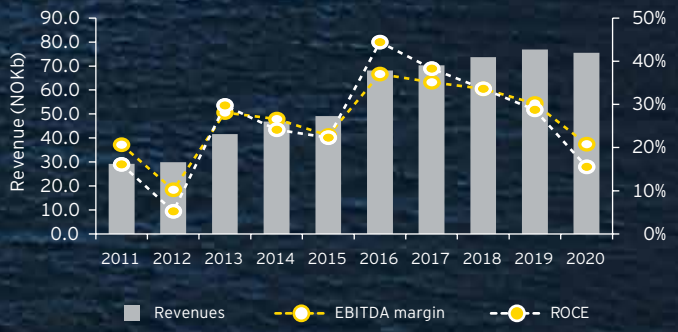
High investment levels

Over the last couple of years, there has been a significant increase in capital expenditure and R&D investments, with an increase in CAPM of approximately 50% from 2016 to 2020. R&D investments are especially related to alternative sea farming solutions, such as closed and semi-closed facilities at sea and offshore farming solutions, which can potentially increase supply in the long run.

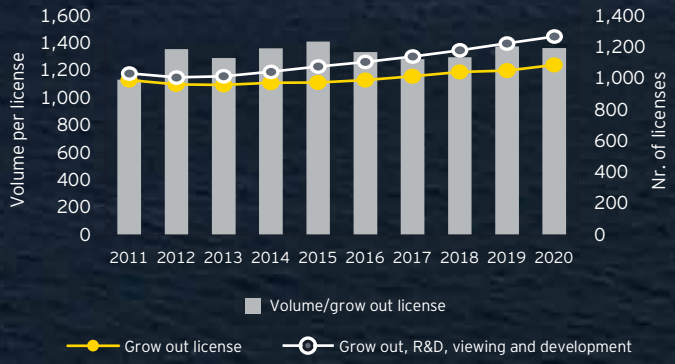
Top five companies (2020 revenues)

1. Mowi ASA
2. SalMar Farming AS
3. Cermaq Norway AS
4. Lerøy Midt AS
5. Nova Sea AS

Key financials

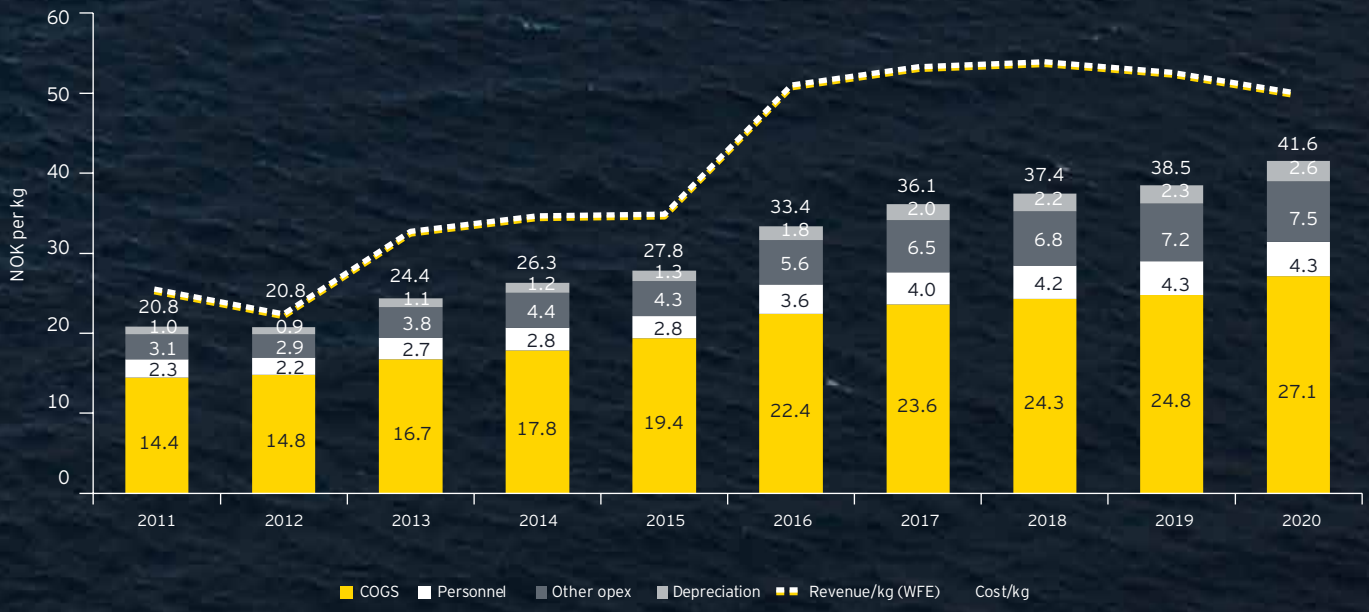


Development in number of licenses and harvest volume per license



Source: *Directorate of Fisheries*

Cost/kg (WFE) development



Land-based farming

The stagnating volumes in the sea farming segment (traditional net pen production) combined with increased demand over the last years have been the driving forces behind the emergence of land-based farming. As presented earlier in this year's analysis, there has been tremendous growth in planned land-based production projects (although how many will materialize are yet to be seen), with several of these projects planned in Norway. Land-based production can potentially be an important complementary production method to supply the market with the much sought-after product.

There is a large number of land-based farming projects in Norway. Even though we still have quite some time until several of these starts with full-scale production, we have included them in this year's analysis as a separate part of the production value chain.

However, since only Nordic Aquafarms AS has salmon production in Norway as of today, we have presented the top five companies based on planned capacity in Norway instead of basing the list on revenue.

Several of the Norwegian projects are based on flow-through technology rather than RAS. This is possible through a combination of sea temperatures and locating the facilities close to the ocean.

Please refer to the separate page on land-based farming earlier in the report for additional commentary.

Top five companies (based on planned capacity)

1. Andfjord Salmon AS (70 000 tonnes)
2. Salmon Evolution (51 500 tonnes)
3. Helgeland Miljøfisk AS (50 000 tonnes)
4. Ecofisk AS (40 000 tonnes)
5. Salfjord AS (40 000 tonnes)

Distribution

About the segment

The distribution segment includes companies offering services within the subsegments:

1. Trading
2. Slaughtering
3. Transportation on sea

Total revenue and margin development for the distribution segment is heavily influenced by the fact that the trading subsegment makes up 90%-95% of revenues. Trading is driven by the volume and price of fish sold. While part of the jump in revenue from 2015 to 2016 can be explained by volume and price, Mowi also demerged their trading business into a separate legal entity this year.

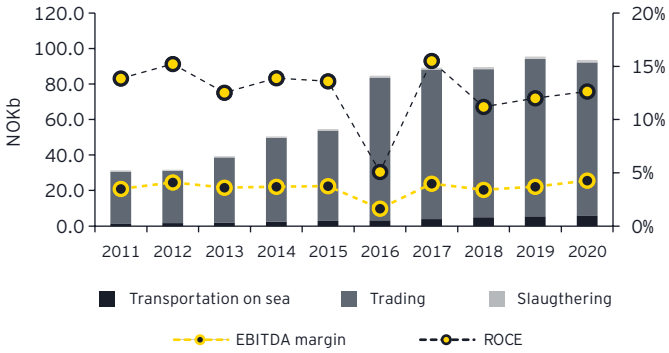
In 2016, there was a significant increase in the salmon price, resulting in a jump in revenues for the traders compared with 2015. Export increased YoY in the 2016 to 2019 period, with a small decrease in 2020 driven by a lower sales price.

The export of Norwegian salmonids has steadily increased, reaching new heights every year. The total export value of Norwegian Salmonids was NOK74b in 2020, a decrease from NOK 76b in 2019. The decrease was driven by a reduction in price, as the exported volumes increased from 1,429k tonnes in 2019 to 1,488k tonnes in 2020. Furthermore, a weak NOK as compared with EUR has also been favorable for the exporters. When taking into consideration the closedown of the food service industry (HoReCa), as well as a challenging logistics and freight situation, the increase in exported volumes in 2020 is impressive and indicates a strong underlying market demand.

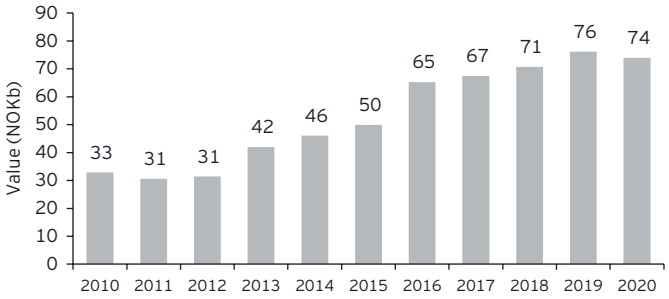
The overall export development is not surprising, as there is continued high demand for Norwegian salmon. Thus, an increase in salmon supply through more farmed fish will be welcomed in the market.

Transportation on sea continues its impressive revenue growth also in 2020, but the EBITDA margins are under pressure. Still, this subsegment continues to perform well and is reaping the benefit of increased harvest volumes as well as the continued biological challenges in the sea farming subsegment.

Key financials



Norwegian salmon and trout exports



Source: *Directorate of Fisheries*

1 "Nøkkeltall fra norsk havbruksnæring 2020," *Directorate of Fisheries*, 25.11.21

Trading | Slaughtering | Transportation on sea

Trading companies

Norwegian-registered trading companies for farmed salmon and trout include both independent trading companies and trading companies owned by salmon producers that have organized this activity in separate companies. Salmon producers that include trading as an integrated part of their production companies are not included in the subsegment, except Norway Royal Salmon ASA.

Volume growth

Revenue in the trading segment is closely related to the volume of fish sold and the price achieved. In 2020, the increase in harvested volumes was not sufficient to make up for the price decrease following COVID-19, resulting in a revenue decrease for the subsegment.

Please note that the large increase in revenue from 2015 to 2016 was driven by both a surge in the price of salmon and the fact that Mowi separated their trading business into a separate company (previously integrated with the production company).

The trading subsegment is a low-margin business. The companies typically sell fish both in the spot market and on fixed-price contracts. Historically, we have observed companies experiencing both favorable and unfavorable fixed contracts, impacting the achieved margins.

Norwegian exports

The vast majority of Norwegian-produced salmonids are being exported, and Europe is by far the most important export market. Approximately 79% of the 2020 export volume went to Europe, compared with 76% in 2019. Increased farmed volume led to a record-high export volume of Norwegian salmonids in 2020.

According to the Directorate of Fisheries[1], the total export value of Norwegian Salmonids was NOK74b in 2020, a decrease from NOK76b in 2019. The decrease was driven by a reduction in price, as the exported volumes increased from 1,429k tonnes in 2019 to 1,488k tonnes in 2020. Since the vast majority of the volume is sold in EUR, the weakening of NOK vs. EUR had a positive impact on the export value. When taking into consideration the closedown of HoReCa, as well as a challenging logistics and freight situation, an increase in exported volumes in 2020 is impressive.

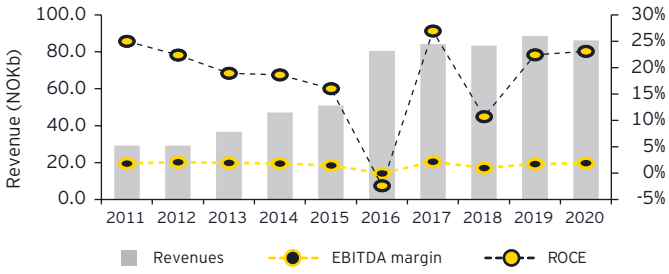
Continued strong export values despite COVID-19

Despite the pandemic, the export of salmonids remained strong in 2021. According to statistics from Sjømat Norge[2], the year-to-date export volume as of the end of October 2021 was 13.5% above the same period in 2020 (1,057k tonnes in YTD20 vs. 1,201k tonnes in YTD21).

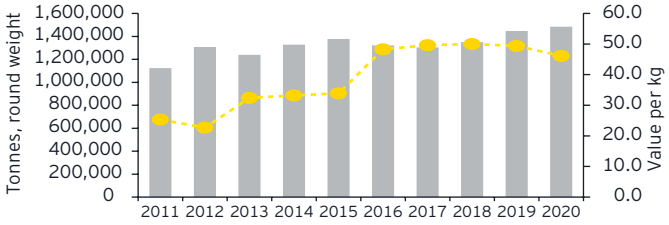
Top five companies (2020 revenues)

1. Lerøy Seafood AS
2. Mowi Markets Norway AS
3. SalMar AS
4. Sjor AS
5. Seaborn AS

Key financials

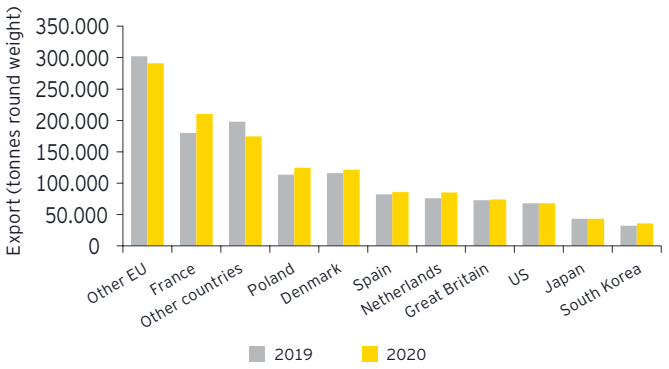


Sold volumes of slaughtered fish (round weight)



Source: *Directorate of Fisheries*

Export markets for salmon (volume)



Source: *Directorate of Fisheries*

1 "Nøkkeltall fra norsk havbruksnæring 2020," *Directorate of Fisheries*, 25.11.21
2 "Status per utgangen av Oktober," *Akvafakta*.no, 11.12.21

Trading | Slaughtering | Transportation on sea

Slaughtering companies

Companies in this subsegment offer slaughtering services. Similar to trading, slaughtering is offered by both independent suppliers and salmon producers as an integrated part of their value chain. This analysis includes only slaughtering businesses that are organized in separate legal entities and it will, therefore, underestimate the total size of the subsegment.

Continued revenue growth but diminishing margins

Larger harvest volume will naturally give the slaughtering subsegment more work and as such an increase in revenue is expected when harvested volumes increase. The negative EBITDA trend seen from 2016 to 2019 was broken in 2020.

We note that as the subsegment is relatively small, the financial performance of a few companies can have a high impact on the total subsegment performance.

This is evident when analyzing 2019. One of the larger entities accounted for 86% of the YoY revenue growth for the subsegment, but was not able to make this growth profitable and reported an EBITDA level more or less in line with 2018. It is interesting to note that in 2020 the same company maintained a record-high revenue, but was able to be more profitable than in 2019. Adjusting for this entity, the remainder of the subsegment performed in line with the previous years with a slight revenue increase and an EBITDA margin of approximately 11% in 2019 and 13% in 2020.

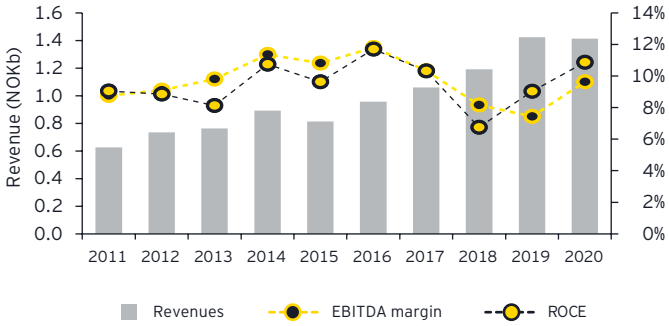
The future of slaughtering

A vital trend in determining the future of this subsegment is the entrance of slaughtering or harvesting or processing vessels. In 2018, Hav Line introduced a vessel with slaughtering facilities onboard with a plan to sail directly to Denmark. This brought on some political turmoil and led to the introduction of a regulatory requirement to sort farmed fish in Norway before export. Hav Line has since received a 10-year dispensation from this requirement. Given the current political sentiment, and the goal to secure workplaces along the Norwegian coastline, it seems unlikely that such a dispensation will be given to others shortly.

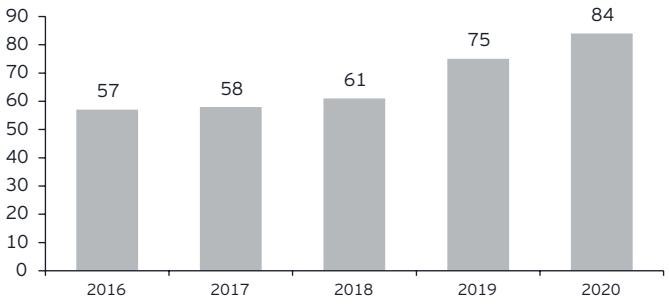
Top five companies (2020 revenues)

1. Pure Norwegian Seafood AS
2. Martin E Birknes Etft AS
3. Slakteriet AS
4. Viking Fjord AS
5. Arnøy Laks Slakteri AS

Key financials



Number of approved harvesting plants in Norway



Source: *Directorate of Fisheries*

Trading | Slaughtering | Transportation on sea

Transportation on sea

The subsegment consists of well-boat companies transporting smolt to sea farms and live salmon and trout from farming cages to harvesting and/or processing plants. The segment also includes companies that focus on the freight of feed. Most of these companies also offer sea lice and amoebic gill disease (AGD) treatment onboard well-boats, as well as services such as sorting and counting fish.

As barriers to entry are high in terms of required capital expenditure, the segment remains dominated by a few players. The five large companies make up approximately 47% of the revenue and 53% of the EBITDA in the subsegment in 2020 (numbers are higher if you include all the legal entities in the same groups as the top five).

Continued revenue growth

Transportation on sea has experienced tremendous growth over the last decade. This subsegment has thrived on the biological issues in the production segment, as a large share of the revenue growth has come on the increased treatment of AGD, sea lice and such.

This has also contributed to high EBITDA margins in this subsegment, especially in the period from 2015 to 2018. The substantial drop in EBITDA margins from 2018 to 2019 is somewhat misleading, due to vessel sales in several entities in 2018 significantly impacting the EBITDA margin that year. If we adjust for this, we observe a falling EBITDA margin trend from 2015 – 41.2%-35.1% in 2019, with an increase in 2020 at 36.9%.

Isolating the well-boats, we observe relatively stable margins in the 2015 to 2020 period, ranging from 40% to 44%, with 2020 achieving 44%.

The feed transportation entities report lower margins in 2019 and 2020 compared with the previous periods, with a significant drop from 2018 to 2019 or 2020 (going from 31% to 23%).

Processing vessels represent a growing venture area within aquaculture. We have identified multiple entities that are dedicated to processing vessels. The growth in this subsegment is predominantly attained through the addition of more vessels, and in 2020 we observe an EBITDA margin of 46%.

Investment patterns

High margins fuel willingness to invest. Several of the larger players are announcing that they are continuing the already ongoing expansion of the well-boat fleet. Based on numbers received from Kystrederiene, we observe a median age of 8 years for the active well-boat fleet (as of 2019).

Whether the new vessels will replace existing vessels or if they will increase the active Norwegian fleet could have different effects on the margins for this subsegment. If the newbuilds replace existing vessels, which could mean that the replaced vessels are either sold or moved to other markets (such as Chile, Scotland and Canada), the supply dynamics will not change much. Thus, we would not expect this to lead to reduced margins. If the newbuilds come in addition to the existing fleet, this could lead to increased competition, impacting margins negatively.

The market demands well-boat capacity with more flexibility. A regulatory requirement has been put in place which states that closed systems (onboard the well-boats) are mandatory for transportation through and in-between areas with disease-free status for infectious salmon anemia (ISA).

Innovation versus regulation

A key operation for the transportation subsegment is to transport farmed salmon and trout from fish cages to processing plants. The entry of vessels combining processing and transport may impact the demand for traditional well-boats offering purely transport solutions.

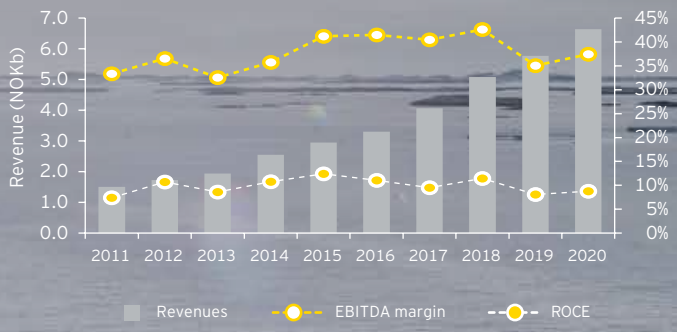
Continued consolidation

The subsegment has seen multiple transactions over the last couple of years. This trend continued going into 2020 and 2021, with DESS Aquaculture Shipping being merged with Sølvtrans Rederi, as well as a merger between Frøygruppen and part of NTS. On the other hand, we also observe that some SMBs and family owned businesses combine forces to invest in well-boats for joint use, motivated by the high market rates as well as higher operational flexibility.

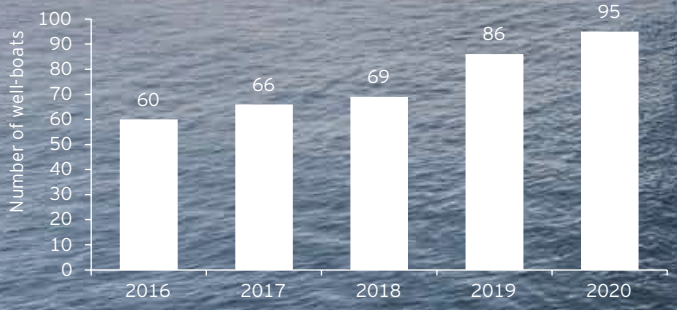
Top five companies (2020 revenues)

1. Rostein AS
2. Sølvtrans Rederi AS
3. Eidsvaag AS
4. Frøy Rederi AS
5. Norsk Fisketransport AS

Key financials

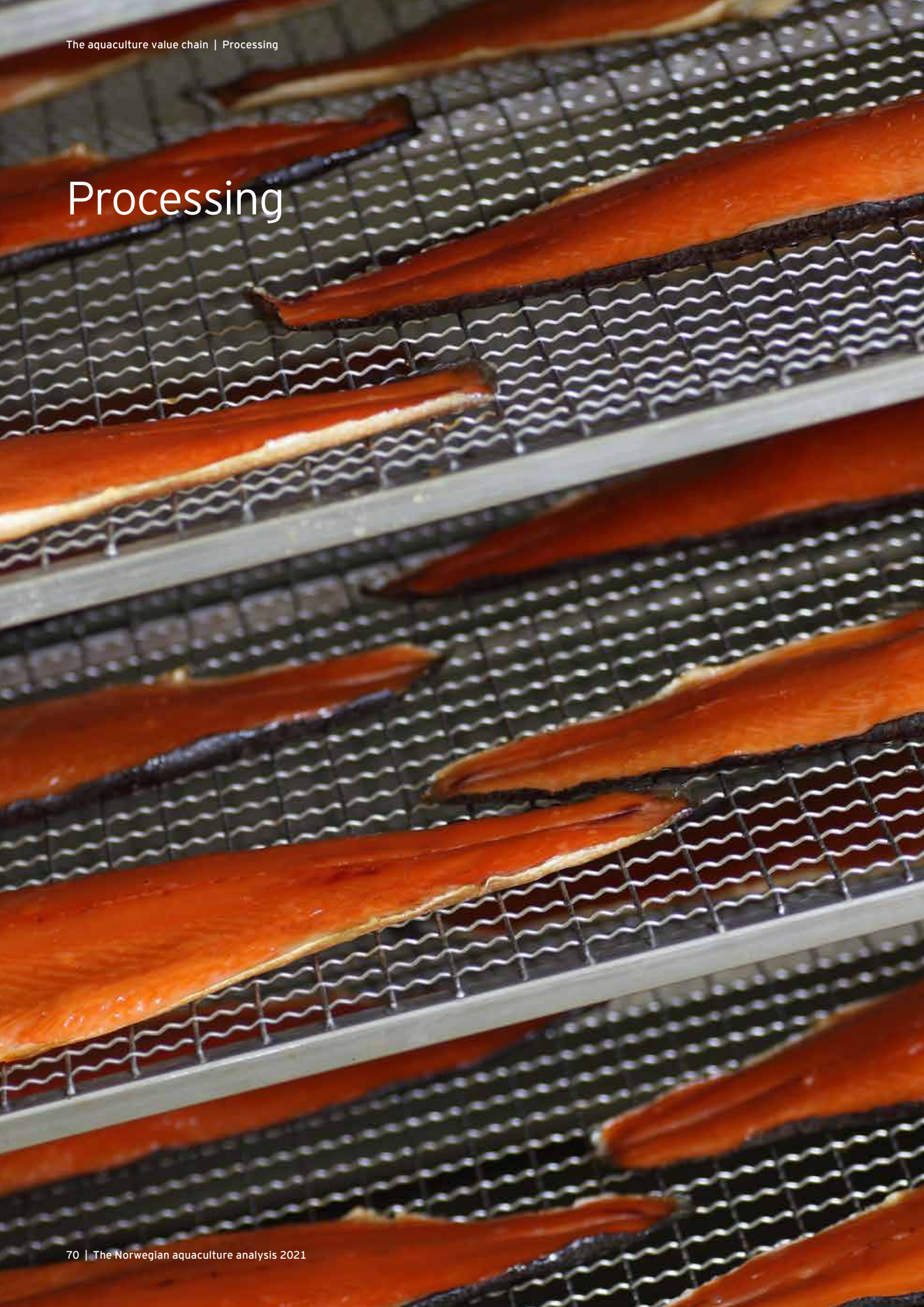


Number of well-boats



Source: *Directorate of Fisheries, Kystrederiene*

Processing



Technical solutions | Biotechnology | Production | Distribution | Processing

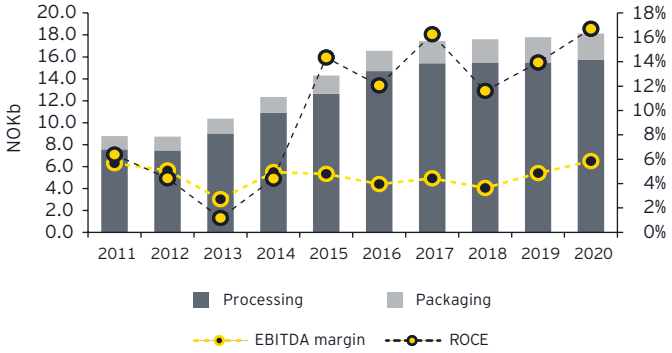
About the segment

The processing segment includes companies offering services primarily related to secondary processing and companies producing different types of packaging.

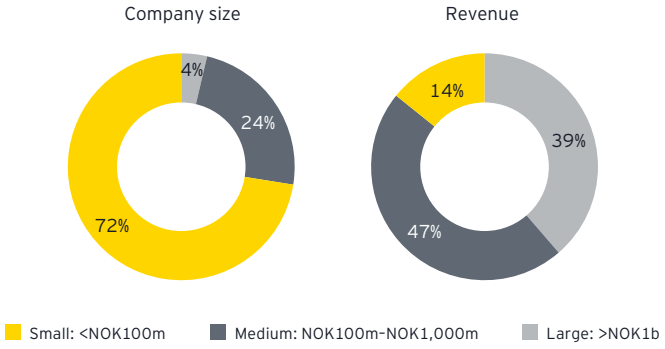
We have divided the segment into two subsegments:

1. Processing
2. Packaging

Key financials



Segment composition (2020)



Processing | Packaging

Processing

For the purpose of this report, we distinguish between primary and secondary processing. Primary processing is defined as slaughtering and gutting, while secondary processing is fileting, filet trimming, portioning, smoking and the like. In this section, we will take a closer look at the secondary processing, as primary processing is mainly covered under the presentation of the slaughtering subsegment. Secondary processing leads to products normally referred to as value-added products (VAP).

Processing is offered both by individual entities and salmon producers as a part of their value chain. However, our analysis includes only separate legal Norwegian entities and therefore underestimates the total size of the subsegment. Another factor is that the majority (approximately 80%) of Norwegian salmon is exported for further processing.

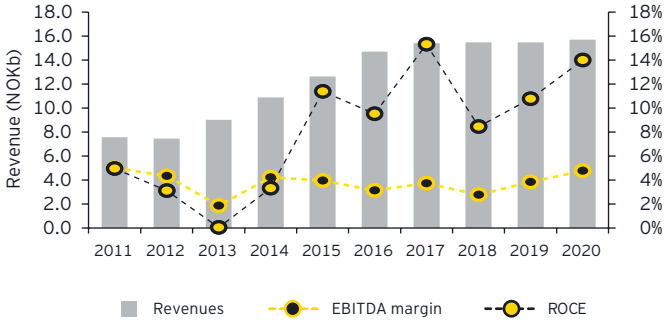
Stable revenue and margin levels

While margin levels have been fairly stable the last decade, the subsegment has experienced high revenue growth until 2016, when the revenue plateaued. This is seen in the context of the harvested volumes of salmonoids in Norway.

Top five companies (2020 revenues)

1. Sekkingstad AS
2. Hofseth AS
3. North Sea Seafood AS
4. Hofseth Aalesund AS
5. Norsk Sjømat Stranda AS

Key financials



Processing | Packaging

High-cost segment

As evident by the EBITDA margin, secondary processing is still demanding and costly in Norway, due to labor-intense production and the cost of raw material influenced by high salmon prices.

There have been discussions on whether more secondary processing – i.e., value-added products (VAP) – should be performed in Norway as opposed to abroad. This is a topic with a wide range of opinions. High labor costs, low unemployment in Norway (potential import of workers will be needed) and environmental impact are some of the focus points in this discussion. Today, Poland and Denmark are two of the main countries that receive round weight fish and process these prior to redistribution.

It's worth mentioning that in both 2020 and 2021, the export share of processed salmon increased compared with the previous years. As of mid-December 2021, processed volume accounted for approximately 15% of the exported volume. The pandemic might be the reason for the observed increase – the shift from HoReCa to retailers, transportation issues (easier and cheaper to transport fillets), etc.

Similar to other segments, the processing subsegment is to an increasing extent impacted by innovation in fish processing. As with the slaughtering subsegment, the processing subsegment will be affected by solutions such as the Norwegian Gannet vessel from Hav Line.

Processing | Packaging

Packaging

The packaging subsegment consists of small to medium-sized companies producing and providing all sorts of packaging and wrappings for fish and feed. While the companies generally produce for the aquaculture industry, a vast share also delivers products to other industries. In addition, several companies deliver products to the aquaculture industry but where the share of revenues from the aquaculture industry may not be high enough to be included in this analysis. Due to this, revenue for this subsegment may be somewhat misrepresented.

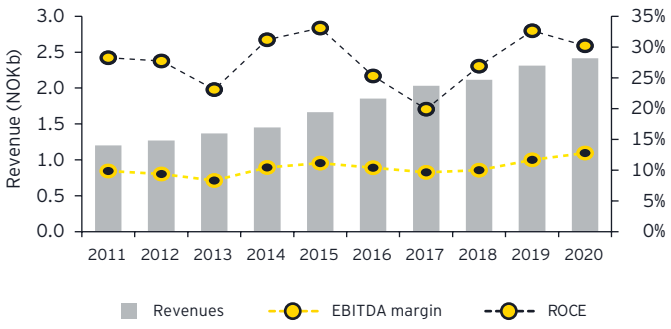
The products of the packaging subsegment are vital in keeping fish and fish products fresh during transportation and storage. Such products enable longer shelf life for the final fish products. Increased focus on sustainability will impact the subsegment going forward and innovations in this area may impact the segment substantially in the event the subsegment comes up with new solutions.

The subsegment has experienced steady growth, with a revenue CAGR of 6.9% over the last five years. Margins have remained relatively stable at around 10%, with an uptick in 2019 and 2020.

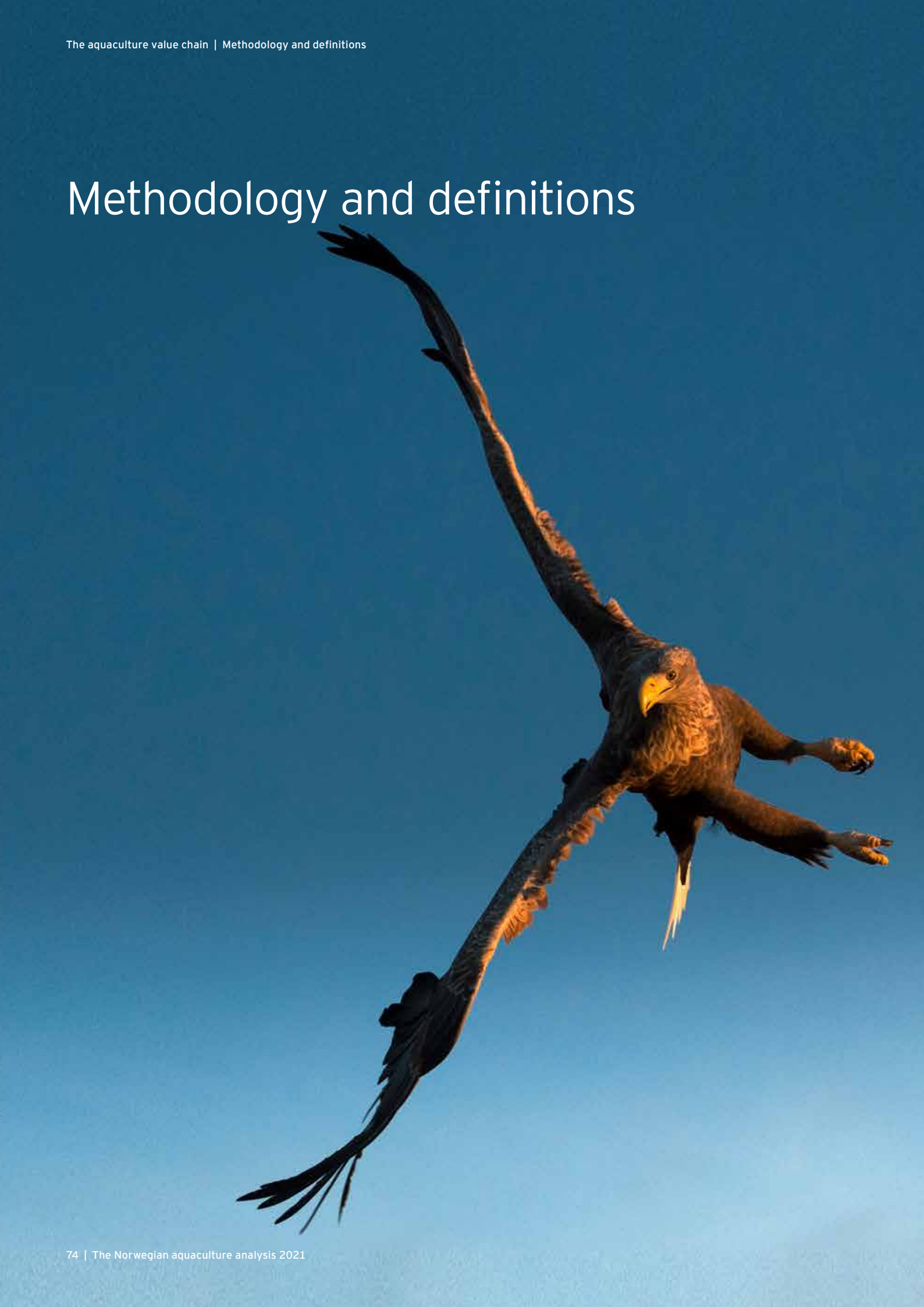
Top five companies (2020 revenues)

1. Vartdal Plastindustri AS
2. Bewi Eps Norway AS
3. Bewi Food AS
4. Accon AS
5. A/S Nesseplast

Key financials



Methodology and definitions



Inclusion criteria

A company is defined as a Norwegian aquaculture company if both of the following criteria are met:

- At least 50% of its turnover is generated in the aquaculture industry
- It is a Norwegian-registered legal entity

Value chain segments

- Technical solutions
- Biotechnology
- Production
- Distribution
- Processing

Each of these categories is further broken down into subsegments to capture the huge diversity within the industry.

Company size definition

- Large company: revenue above NOK1b
- Medium-size company: revenue between NOK100m and NOK1b
- Small company: revenue below NOK100m

Methodology

To analyze financial activity across the value chain, we have gathered information from standalone financial statements of individual legal companies. Accounting information is publicly available from the Brønnøysund Register Centre. The number of companies included in the analysis will vary slightly depending on the availability of financial information. For companies operating with divergent financial periods, adjustments have been made to present the data on a calendar-year basis.

Many of the identified companies offer products and services in more than one segment of the value chain. However, in this analysis, each company is linked to only one segment of the value chain based on its main activity. This simplification could result in subsegments being over or understated compared with the actual total. For larger industrial conglomerates with multiple subsidiaries, each entity is allocated to its respective best-fit segment.

The methodology does not capture or eliminate intercompany transactions or revenues in holding companies registered abroad.

Please note that the analysis is limited to the domestic aquaculture industry. Thus, foreign units owned by Norwegian companies are not reflected in the analysis. This may give a somewhat misrepresentative picture, particularly for the companies noted on the Oslo Stock Exchange, as many of them have a substantial part of their business outside Norway.

Calculations

EBIT: earnings before interest and taxes

EBITDA: earnings before interest, taxes, depreciation and amortization

Capital employed: fixed assets + immaterial assets (ex. licenses) + net working capital

Return on capital employed (ROCE): $\frac{\text{EBIT}}{\text{Capital employed}}$

CAGR: compound annual growth rate

WFE: whole fish equivalent

HOG: head on gutted

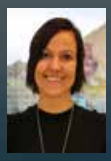
EY contacts

Assurance, Ernst & Young AS
Eirik Moe
Partner
+47 951 24 045
eirik.moe@no.ey.com

Assurance, Ernst & Young AS
Øyvind Nore
Partner
+47 918 15 268
oyvind.nore@no.ey.com

Assurance, Ernst & Young AS
Kai Astor Frøseth
Partner
+47 959 72 885
kai.astor.froseth@no.ey.com

Assurance, Ernst & Young AS
Amund Petter Amundsen
Partner
+47 920 34 503
amund.p.amundsen@no.ey.com



Assurance, Ernst & Young AS
Trine Hansen Bjerkvik
Partner
+47 950 81 671
trine.bjerkvik@no.ey.com

Assurance, Ernst & Young AS
Kjetil Håvardstun
Partner
+47 932 13 574
kjetil.havardstun@no.ey.com

Strategy and Transactions, Ernst & Young AS
Merete Skage
Partner
+47 982 06 499
merete.skage@no.ey.com

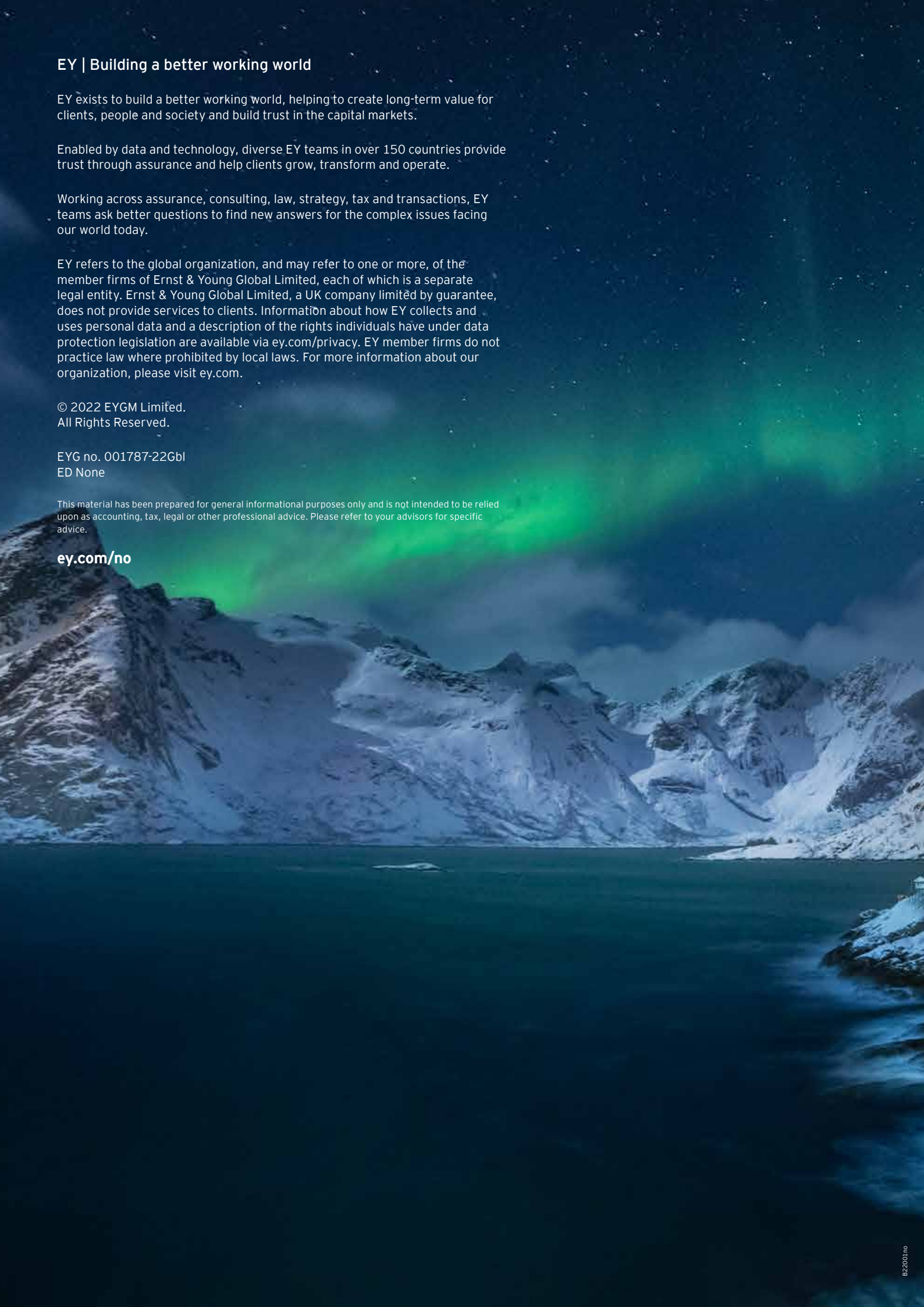
Consulting, Ernst & Young AS
Maria Borch Helsengreen
Partner
+47 957 42 213
maria.b.helsengreen@no.ey.com

Strategy and Transactions, Ernst & Young AS
Lars Christian Øverland
Director
+47 934 11 402
lars.christian.overland@no.ey.com

Strategy and Transactions, Ernst & Young AS
Jan Erik Åsland
Partner in Corporate Finance
+47 975 47 391
jan.erik.asland@no.ey.com

Tax & Legal, Ernst & Young AS
Gaute Ebeltoft
Partner
+47 982 06 476
gaute.ebeltoft@no.ey.com

Strategy and Transactions, Ernst & Young AS
Daniel Loe Laberg
Manager
+47 976 67 703
daniel.loe.laberg@no.ey.com



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