

# Norway's Fish and Fish Products Cluster

*Fight to Stay at the Cutting Edge Economically, Environmentally, and Socially*

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and Economic Development**

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Norway's fish and fish products cluster is a highly sophisticated and innovative world leader.<sup>1</sup> It is well positioned to play a key role not only in Norway's long-term economic development, but also in helping humanity sustainably meet growing protein needs in the twenty-first century. Nevertheless, the cluster faces significant challenges in meeting its environmental goals, maintaining its social license to operate, fulfilling its human resources requirements, and developing high value markets. To fulfill its potential, the cluster should emphasise environmental leadership, improving its international image, strengthening its workforce, and providing greater returns to local communities.

## Profile of Norway

Norway's territory mostly stretches along the Western and Northern coast of the Scandinavian Peninsula, although the country also has island territories including Svalbard in the Arctic Ocean. The country borders Sweden, Finland and Russia, while its important maritime neighbours are the UK, Denmark and Iceland in the North Atlantic, and Russia in the Barents Sea.<sup>2</sup>

Ocean resources have long played a key role in Norway's development. The country's rugged, mountainous geography historically dictated that settlement and communication occur largely by water. Aside from rich fishing resources, Norway also discovered considerable offshore oil and gas in the twentieth century, which has been a key driver for economic development. On land, Norway has considerable mineral resources.

Politically, Norway is among the most stable countries in the world, ranking at the very top of most democracy indexes.<sup>3 4</sup> It is also consistently receives among the ten best scores on Transparency International's Corruption Perceptions Index.<sup>5</sup>

Norway is also highly competitive economically. It ranks sixth in the World Bank's Ease of Doing Business Ranking,<sup>6</sup> and eleventh in the World Economic Forum's Global Competitiveness Index (GCI).<sup>7</sup> GCI results are provided in Table 1 and indicate the extent of Norway's strengths, but also that areas of modest weakness relate to the internal market, as well as infrastructure.

**Table 1: Norway's Performance in the Global Competitiveness Index, 2016-2017**

Pillar	Rank	Pillar	Rank
Macroeconomic Environment	1	Business sophistication	10
Institutions	6	Health and primary education	11
Higher education and training	7	Innovation	12
Technological readiness	7	Goods market efficiency	21
Labor market efficiency	9	Infrastructure	34
Financial market development	9	Market size	49

Norway's proximity and access to Europe help mitigate its internal market's limitations. The European Union (EU) is the second largest economy in the world in terms of purchasing power parity.<sup>8</sup> Norway is not a member of the European Union, it is only a member of the European Economic Area (EEA). EEA membership makes Norway party to EU policies of free movement of goods, persons, services and capital, as well as policies in a host of other areas including transportation, competition, social policy, consumer protection, environment, statistics and company law".<sup>9</sup> The only top ten export market for Norway outside Europe is the US.<sup>10</sup> The UK receives 13.5% of Norway's exports, well ahead of the Netherlands (6%) and Germany (5.7%). Still, at just over 30% exports are a relatively modest share of Norway's GDP.<sup>11</sup>

Norway's competitiveness has translated into high living standards. In 2015, the country's GDP per capita (purchasing power parity) was the tenth highest in the world at \$62,083.90.<sup>12</sup> This high income is complemented by good quality health and education services. As a result Norway has the world's highest human development index (HDI) score.<sup>13</sup>

## Overview of the Cluster

In 2013, fish accounted for 6.7% of all protein consumed by humans, and 17% of all animal protein.<sup>14</sup> With the growth of human population, some analysts predict that protein requirements for human nutrition will increase 50% by 2030.<sup>15</sup> Aquaculture may be especially important for meeting these nutritional demands as it is the fastest growing protein source.<sup>16</sup> Human consumption of farmed fish exceeded wild fish for the first time ever in 2014.<sup>17</sup>

Fisheries are also big business. In 2010, fishing and fishing products was the world's 34<sup>th</sup> largest cluster by export value.<sup>18</sup> At US\$101.5 billion, the cluster was larger than construction materials, construction services, footwear, leather, and aerospace engines, and almost equal to coal and briquettes.

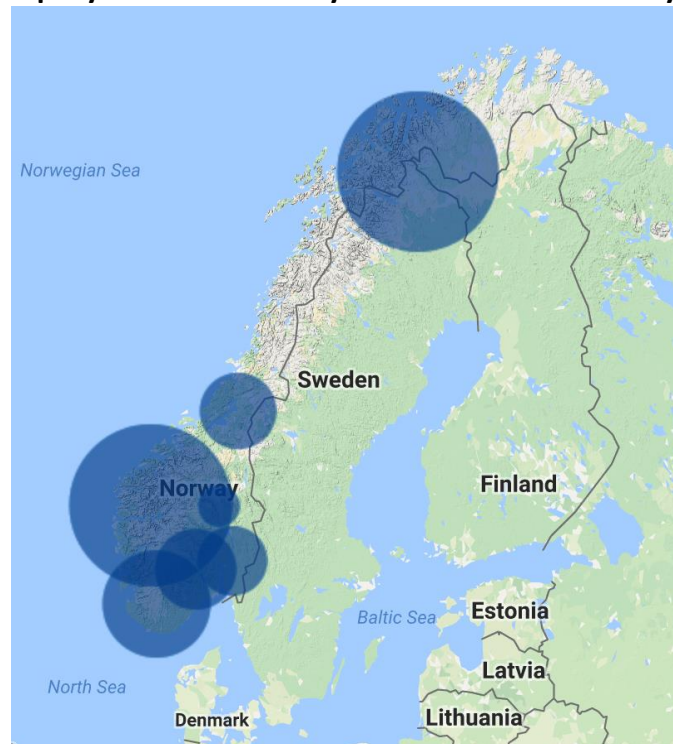
## The Importance of the Fishery for Norway

No doubt fisheries are important globally. Yet, they have long been particularly important for Norway, as important source of food, jobs, and exports.

Norwegians have historically been very reliant on fish protein.<sup>19</sup> Daily fish consumption averages over 130 calories in Norway, whereas the global average is just 34 calories.<sup>20</sup>

Fishing has also been a key employer.<sup>21</sup> Close to 100,000 Norwegians were employed as fish harvesters in 1950.<sup>22</sup> Figures in 2014 were considerably lower, with 11,000 Norwegians were directly employed in fishing and another 6,300 in aquaculture.<sup>23</sup> Many of these jobs are located in rural areas, as shown in Figure 1. The share of employment in fishing and fishing products is almost 38 times the European average in the Nord-Norge region of Norway, and more than twelve times the average in Vestlandet and eight times the average in Trøndelag.<sup>24</sup>

**Figure 1: Employment in Norway's Maritime Cluster by Region<sup>25,26</sup>**

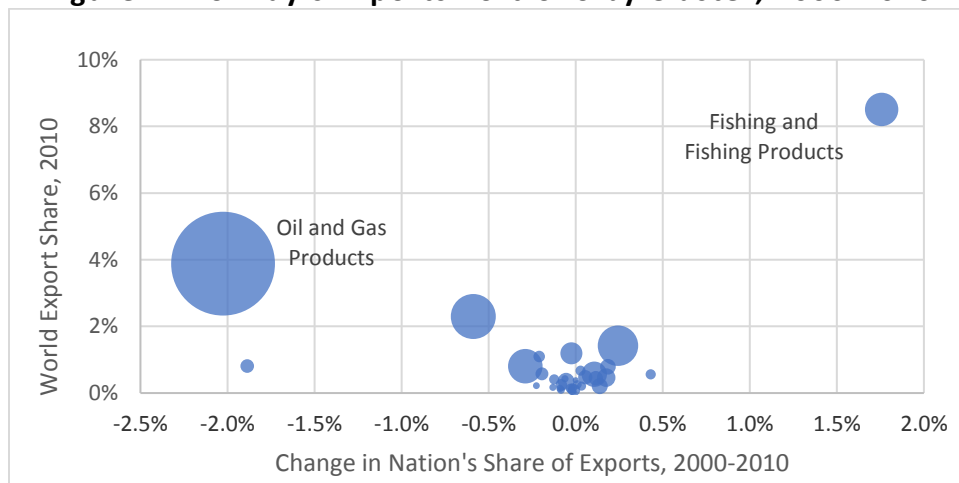


The long-term employment decline reflects largely the shift from the primary sector to industry and services as the economy has developed. Yet, fishing employment fell 13,000 from 1995-2014, long after the country had already attained a high level of economic development.<sup>27</sup> Increased employment in aquaculture was more than offset by declines in the capture fishery. Industry and the Government were seeking to reduce overcapacity as a means of promoting greater environmental sustainability and to ensure fishers earn good livelihoods.<sup>28,29</sup> Technological changes have also raised efficiency and displaced some human roles in production.

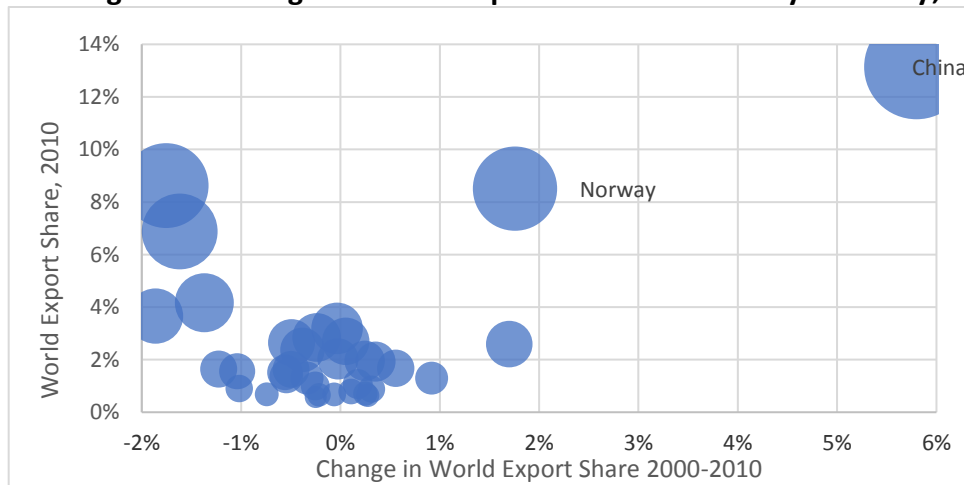
Norway exports much of the fish it produces. From 2000-2010 fishing and fish products were Norway's fifth largest cluster by export value, at US\$8,637.79 million, trailing oil and gas products, transportation and logistics, business services, and metal mining and manufacturing.<sup>30</sup> More specifically, Fresh, chilled or frozen fish was Norway's third largest export at a total value over US\$7.5 billion in 2010, and dried salted or smoked fish was its eleventh at US\$914 million.<sup>31</sup>

Perhaps even more impressively, as indicated in Figure 2, the fishing and fish products cluster was Norway's most significant as a share of all global exports and also its fastest growing.<sup>32</sup> From a global perspective, Figure 3 shows that Norway's fishing and fish products cluster was the world's second largest from 2000-2010 period and the second fastest growing behind only China.<sup>33</sup> Fully 19.7% of all global exports of processed Seafoods originated in Norway, with Poland a distant second at 11.4%.<sup>34</sup>

**Figure 2: Norway's Exports Portfolio by Cluster, 2000-2010**



**Figure 3: Fishing and Fishing Products Export Performance by Country, 2000-2010**

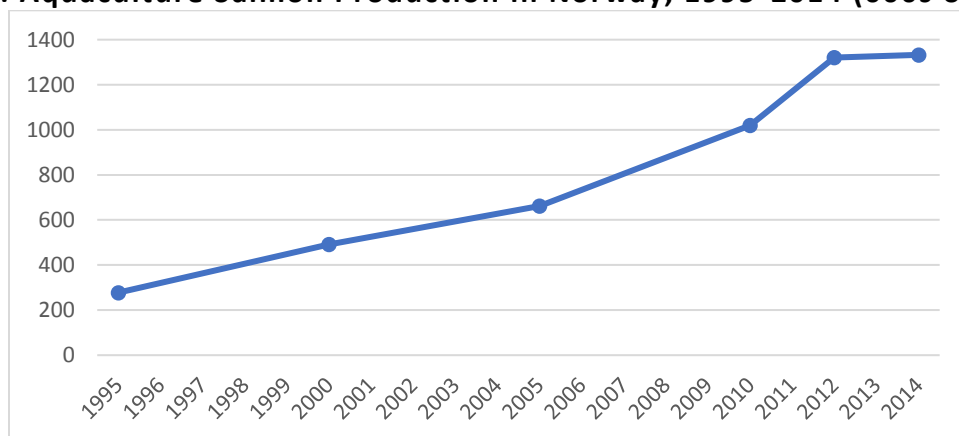


## Trends in Aquaculture

The global position of Norway's Fishing and fish products cluster is built largely on the production of farmed salmon. Salmon is widely considered the most valuable segment of seafood production in the world and two-thirds of global supply comes from aquaculture.<sup>35</sup> The fish require cool temperatures within a specific and the farms locate along the coast where there are strong currents to help flush out waste. The necessary environmental conditions can be found mainly in Northern Europe (mainly Norway and Scotland), Chile, and Canada.<sup>36</sup>

Salmon farming began in Norway at the beginning of the 1970s as a supplementary activity for coastal (agricultural) farmers.<sup>37</sup> It has since transitioned into an advanced modern industry, which has consolidated considerably in particular since 2000. Production has been growing at an enormous pace. From 1995 to 2014, salmon output increased almost five-fold from 277,600 tonnes to 1,332,500 tonnes, as shown in Figure 4.<sup>38</sup> Norwegian aquaculture also produced 10,033 tonnes of cod, 1,741 tonnes of halibut, 1,967 tonnes of blue mussels and 309 tonnes of Norwegian Arctic Char in 2012.<sup>39</sup>

**Figure 4: Aquaculture Salmon Production in Norway, 1995-2014 (000s of tonnes)**





Norway now produces 21% of the world's marine coastal aquaculture tonnage, is the largest aquaculture producer outside of Asia, and is second only to China in aquaculture value.<sup>40</sup> The FAO predicts further growth in Norwegian aquaculture of 48.1% between 2015 and 2025, which would raise production to close to two million tonnes per year.

A key outgrowth from the rise in aquaculture has been the feed industry. The roughly 200 fish species farmed around the world each have particular dietary requirements, which often vary through the life cycle.<sup>41</sup> Feed mixes can include other species of fish, fish oil, vegetable materials and oil, and poultry leavings. The companies that operate in this industry must be highly specialised and technologically sophisticated.

Norway's aquaculture industry is well ahead of its competing jurisdictions in terms of scale, sophistication and environmental sustainability. Chile is the primary competitor in farmed salmon, but it lacks Norway's advanced skills and innovation and has faced considerable disease and environmental difficulties.<sup>42</sup> Norwegian corporations are largely driving the development of salmon farming in these other jurisdictions. Asian aquaculture is high volume but faces perhaps even greater environmental challenges and produces relatively lower value product.

### Trends in the Wild Capture Fishery

Norway's other commercial fish are mostly harvested by the capture fishery.<sup>43</sup> Species include pelagics (herring and mackerel), whitefish (cod), Northern shrimp and Norway lobster.<sup>44</sup> At approximately 2.5 million tonnes per year, the capture fishery still produces higher volume than the aquaculture sector.<sup>45</sup> Much of this fish is lower value, however, particularly pelagics which are largely harvested as fishmeal for aquaculture salmon.<sup>46</sup> About 25% of wild caught fish are now being converted to aquaculture feed.<sup>47</sup>

Capture production is generally down since 2003, in contrast with aquaculture production.<sup>48</sup> Cod is the exception, as Norway's stocks in are among the most abundant in the world and exports reached record levels alongside salmon in 2015.<sup>49</sup>

There are two major types of capture producers.<sup>50</sup> Small coastal producers with boats generally below 15 metres in length operate from local communities. Larger industrial producers are generally trawlers operating offshore, based in Southern Norway. The coastal fleet has been consistently losing size for decades, while the industrial fleet continued growing before also declining by one-third from 2003 to 2011.<sup>51</sup>

Norway's capture fishery has less of a competitive edge on international competition than the aquaculture sector. Many other countries harvest the same species. The sector is also largely driven by mass production and cost-minimisation, whereas Norwegian salaries are high. Norway's edge is in environmental sustainability, which means its resources are more reliable and also can be more appealing for eco-conscious or ethical consumers. Norway also competes on quality, tied to the effective distribution and/or processing of the fish caught.

### Getting Fish to Market

The process of getting fish to market once caught has been transformed over the past century, and especially since the 1990s.<sup>52</sup> Previously, fish was brought to shore where it had to be processed in some way that would preserve it for the long periods required to reach markets. Now, however, fish can be flash frozen immediately when caught or slaughtered in the case of farmed fish. Transportation has also improved so that fresh fish can be delivered to markets very quickly, including via planes.

One result of these trends is that many fish products have much higher value than previously.<sup>53</sup> However, another consequence has been significant declines in the fish processing industry. Leading up to the turn of the century fully one-third of Norwegian plants closed and yet excess capacity remained.<sup>54</sup> Because fish processing jobs were often very unpleasant and low paid, whereas wages in Norway are generally very high, Norway was also a leader in automating fish processing, which further reduced employment in the sector.<sup>55</sup>

Further improving fish preservation and the logistics of distribution is a constant challenge. Marine Harvest, for example, has developed a salmon variety called Mowi that matures more slowly to be ready for slaughter and sale on a timelier basis.<sup>56</sup> The company has also established value-added capacity in Belgium to support its sales across the European continent, and is collaborating with distributors to improve its products. Smoked salmon is the most common value added product, but other options can include a variety of pre-made meals.

### World Leading Corporations

Norway's fishing and fish products cluster includes four of the world's ten largest fish harvesting companies: Marine Harvest, Skretting, Austevoll Seafood and EWOS.<sup>57</sup> Background information on each firm are provided in Table 2. They all have headquarters in the South of Norway, but operate subsidiaries around the world.

**Table 2: The Top Four Norwegian Fisheries Companies, 2010**

Firm	World rank	Countries of operation	Subsidiaries	Origin
Marine Harvest	4	25	108	Created in 2006 through merger of Pan Fish ASA (f. 1992), Fjord Seafood ASA (f. 1996) and Marine Harvest NV (f. 1965)
Skretting	6	30	16	Established in 1899, fish feed production began in 1963

Austevoll Seafood	8	22	82	Established in 1981
EWOS	10	9	14	Started in 1935 including feed production for salmon.

Marine Harvest is the world's largest salmon producer, producing 335,000 tonnes out of the global production of 1.4 million tonnes in 2011.<sup>58</sup> Most of this production (220,000 tonnes) took place in Norway, but Marine Harvest was also the leading salmon producer in Chile, Scotland, and Canada, and had operations in Ireland and France. The company grossed US\$ 2.75 billion and employed 5,000 people in 2010, and is known to be the most traded seafood stock.<sup>59</sup> Marine Harvest also owns a market leading fish distributor based in Bruges but with satellites across Europe, called MHVAP.

Skretting and EWOS are largely aquaculture feed producers, responsible respectively for 36% and 32% of salmon feed market share.<sup>60</sup> Feed represents 55% of the cost of production of farmed salmon. These companies have also been expanding into South America and East Asia to develop positions in feed for aquaculture operations in those countries.<sup>61</sup>

Finally, Austevoll is the world's largest producer of fishmeal, and second in salmon production. It may be the most vertically integrated of these major companies.

## Regulatory Framework

Experts consider Norway's fishery to have among the best regulatory frameworks in the world, based on strong design, monitoring and enforcement.<sup>62</sup> For example, the FAO identifies Norway's regulations on all discharges into the ocean to be a best practice.<sup>63</sup> Norway also has the best biological and economic data collection in the world.<sup>64</sup> Fisheries-specific regulatory

objectives have included not only environmental protection, but also steps to ensure producers can secure stable livelihoods.

### Regulating Aquaculture

Multiple levels of government are involved in the regulation of aquaculture in Norway.<sup>65</sup> Firms pay annual fees for inspection and regulatory management costs, though only to supplement what the government covers through general public revenues.

As of 1976, companies must obtain a license to start a salmon farm. Licenses identify a maximum allowable biomass. There is also a maximum density of biomass permitted for each farm and a biomass quota for each Norwegian region, developed by the Government based on the size of the region and the number of licenses issued to operate in the area. These limits have been adjusted over time based on the Government's assessment of the best available evidence.

Aquaculture licenses are indefinite and tradable, which means they can be speculated upon or mortgaged. The process of obtaining new licenses can be unpredictable however. The Government has also used licensing to promote industry consolidation.

Once they obtain a license, aquaculture operations must also secure approval for a particular site from county, municipal and national government entities, though counties take the lead. Licenses can be applied to different sites. Fish farms cannot be located within two kilometres of one another to prevent cross contamination of parasites or diseases.<sup>66</sup>

Norway has also explored steps to develop zoning for coastal areas.<sup>67</sup> This zoning would determine which areas could be sites for farms, which areas should be left fallow, and what zones would be free for marine traffic or capture fishing.

Regulations limit the share of the domestic aquaculture salmon market that can be controlled by a single firm to 25%. Companies, namely Marine Harvest, have approached these limits, which are unique to salmon and to Norway and could violate EU competition laws.<sup>68</sup>

### Regulating the Capture Fishery

Norway's environmental protection and resource management regulations are too complex to address in a meaningful way. We will focus more on aspects of regulation that focus on the industry's structure.

Wild fishing resources are owned by the Norwegian state, which grants indefinite licenses for quota to harvesters.<sup>69</sup> Harvesters must fish at least 20 weeks per year to be registered as full-time. Inactive licenses must be returned to the state, and fishers also automatically lose their quota at age 70.

As with many industries driven by small primary producers, historically Norway's fish harvesters had limited market power relative to venders and consumers. As a result, many fishers lived in poverty. This began to decisively change with the 1938 Raw Fish Act, which gave fisher harvesters' organisations the exclusive right to decide the raw fish price, radically altering the power relationship so many fish harvesters could leave poverty.<sup>70</sup> The key organisation today that bargains prices for capture product on behalf of fish harvesters is Norges Fiskarlag.<sup>71</sup> Norway also implements a fleet separation policy whereby fish processing companies may not control harvesting operations – they can only own up to 49% of shares. This prevents vertical integration and means processors have to compete for inputs, again shifting bargaining income and ultimately income to harvesters. Exceptionally, processors are allowed to own harvesting

operations in some Northern communities where otherwise catches would fall very far below processing capacity.

Industry is heavily involved in regulation. Norges Fiskerlag is an especially influential voice. Integrated management plans are in place for the Barents Sea and the Norwegian Sea. The steering group leading the plan is coordinated by the Ministry of Environment, but multi-sectoral groups also assist in its implementation.<sup>72</sup>

Norway has greatly weakened support for the wild fishery in terms of subsidies, as they were believed to be generating over-capacity.<sup>73</sup> Subsidies peaked at approximately 33% of landed value in 1980,<sup>74</sup> and declined by over 80% from 1991 to 1996.<sup>75</sup> The one subsidy that persists is an exemption from fuel taxes, which in 2011 was worth an estimated 6.3% of landed value.

The Government of Norway also establishes some training requirements. Operators of vessels longer than 15 metres must have a captain's license from one of Norway's marine training schools. For smaller vessels, there are no such training requirements, but every fisher must complete a safety course that is renewed every five years.

### Supporting Institutions

Norway's fisheries cluster has an array of institutions for collaboration, independent but often subsidised by government. These include explicit cluster organisations, other research and innovation partnerships, organizing bodies, and ecological labels. Fisheries are a remarkably technical field. It can be very difficult to deliver perishable often high-value product can reach consumers in a timely and appealing way. Protecting the natural environment and operating safely in very dangerous natural environments, can also be very challenging. These collaborations efforts are overwhelmingly geared towards addressing these challenges

## The Norwegian Innovation Clusters Programme

Since 2000, Innovation Norway, the Research Council and the state-owned industrial development corporation Siva have implemented the Norwegian Innovation Clusters Programme (NICP) with funding from the Ministry for Trade, Industry and Fisheries and the Ministry for Local Government and Modernisation.<sup>76</sup> The NICP currently supports 39 cluster projects with funding, advice, training, networking and promotional assistance. Program priorities are: (1) the general operation and development of the cluster; (2) links between the cluster and the most relevant national or international research, development, innovation and educational institutions; (3) collaborative innovation projects through platforms or infrastructure to identify or develop new products, services or technologies; and, (4) promoting collaboration between clusters around technology, innovation, expertise or business development.

There are three sub-programs under the NICP. For mature clusters that already have established patterns of systematic collaboration with R&D institutions, the NICP's *Global Centres of Expertise* (GCE) sub-program supports those with a global position (as of 2014) and the *National Centres of Expertise* (NCE) sub-program supports those with a national position (since 2006). The original *Arena* sub-program was launched in 2002 for clusters that are in early development but have good opportunities to collaborate for innovation. The three GCE clusters all directly support offshore oil and gas production, however three of the six NCE clusters are more directly relevant to the fishery. The NCE Aquaculture cluster includes more than 20 partners concentrated mostly in the Nordland coast, and is seeking to improve fish health, mitigate environmental issues, develop technology for safe operations and surveillance, promote product quality, improve the quality of fries and hatcheries, further develop cod farming, and advance the



sharing and delivery of education. The NCE Seafood Innovation Cluster includes more than 70 partners representing 150 enterprises along Norway's coast, although centred in Hordaland, and also is focused on promoting sustainable development. Finally, the NCE Instrumentation cluster has over 30 partners building tools for remote sensing, management and communication in the aquaculture and maritime sectors, among others. Less directly related NCE sectors are addressing improvements to culinary products and maritime renewable energy. Finally, relevant *Arena* clusters include the Arena Arctic Maintenance, the Norwegian Cod Cluster, the Arctic Maritime Cluster, and Legasea (focused on marine bio resources and remains from raw materials).

#### Other Research and Innovation Infrastructure

The sector benefits from a host of other research and innovation initiatives. Many of these are funded by Government, however many are also driven by industry and reflect collaboration to address common challenges.

Norway's Fisheries and Aquaculture Research Fund (FARF) seeks to promote innovation and address industry challenges.<sup>77</sup> In aquaculture, for example, the FARF has sought to improve disease control and explored diversification of production into new species such as lobster, halibut and mussels. The aquaculture industry pays almost half (46%) the costs through a 0.3% levy on exports, with the Government of Norway covering the balance.

As of 2012, Norway is also home to 45 separate research and development or training sites. Universities or polytechnic institutes operate several, as do corporations like Marine Harvest. Considerable non-industry research activities are focused on the marine environment and helping to improve understanding of fish stocks, the environmental impacts of fishing activities, and important broader environmental trends like climate change in the Arctic.<sup>78</sup>

## Industry Organizing

The industry is also organised in a host of different associations. These associations play key roles in coordination, regulation and resource management.

There are two major umbrella associations for the sector: The Norwegian Seafood Federation (NSF) which has approximately 500 members,<sup>79</sup> and the Norwegian Seafood Association (NSL) which has approximately 180 members.<sup>80</sup> Both associations represent operators in aquaculture, the capture fishery, processing, exporting, and retail. The NSF largely conducts lobbying and provides advice to its members in a host of technical and business areas. The NSL helps to facilitate information sharing and coordination across the industry, and promote the industry with government and consumers.

Norges Fiskarlag is very powerful in shaping capture fisheries policy, while its contracts also drive standards and quality improvement among harvesters.<sup>81</sup> Coastal fish harvesters have developed a second representative body called Norges Kystfiskarlag out of concern that Norges Fiskarlag was too beholden to industrial fishing operations. Norges Fiskarlag has five seats and Norges Kystfiskarlag one seat, together making up half of the National Fishermen's Council.

Fish harvesters also address common challenges through a host of levies. A 0.35% levy was collected for years from small-scale capture harvesters to help finance the repurchase of licenses to downsize the fishery, and the funds ultimately financed half the costs of decommissioning 400 vessels (roughly 15% of the coastal fleet) from 2003 to 2009.<sup>82</sup> Capture harvesters also pay 0.025% of their sales plus a lump sum of NK 3,000 per year into a national pension and healthcare fund run by the Government. The aquaculture sector also has a 0.75% export levy used to finance an export development fund worth \$70 million in 2012.<sup>83</sup>

## Ecological Labels

Actors from the Norwegian fishery are key players in major international environmental labelling initiatives.<sup>84</sup> These initiatives aim to improve standards and the industry's public profile.

Large parts of Norway's wild fishery have pursued certification from the Marine Stewardship Council (MSC).<sup>85</sup> The MSC is the best known ecological label for wild caught fish, with the World Wildlife Fund (WWF) as a key partner. Nine fisheries are currently certified, including for significant species like herring, cod and haddock. A tenth fishery is in assessment.

Skretting's parent company (Nutreco) and Marine Harvest have representatives on the Supervisory Board of the Aquaculture Stewardship Council (ASC). The ASC was founded in 2012 and is modelled after the Marine Stewardship Council (MSC), developing standards for responsible aquaculture in collaboration with producers, seafood processors, distributors, consumers and environmental non-government organisations (including again the WWF).<sup>86</sup> At present, 175 salmon farms have ASC certification, including 97 in Norway and at least 30 overseas that belong to Norwegian fish farming companies (Marine Harvest and Cermaq).<sup>87</sup>

Marine Harvest and an Austevoll subsidiary (Lerøy Seafood), were also among the key founders of the Global Salmon Initiative (GSI) in 2013.<sup>88</sup> The initiative aims to promote sustainable salmon production through improving feed, reducing disease and nutrient loading, and addressing other environmental or social impacts.

Finally, the four major Norwegian companies are also part of the Marine Ingredients Organisation (IFFO), which was founded in 2001 to represent the fishmeal, fish oil and wider marine ingredients industry in international policy-making fora. The IFFO has developed a Global Standard for the Responsible Supply of fishmeal and oil.

## Challenges

Appendix 1 provides a map of the fishing and fish products cluster and Appendix 2 the Diamond of Business Environment Quality. The Diamond highlights the cluster's remarkable strengths across a host of areas, but also faces challenges at each point on the diamond.

### Environmental Protection

Norway views envisions its fishing industry as a critical long-term, sustainable alternative to the oil and gas industry.<sup>89</sup> Yet, the industry has faced significant environmental challenges that threaten its continued legitimacy.

### Reducing the Ecological Impacts of Aquaculture

Environmental challenges have caused salmon farms to very controversial in many countries, including in Norway.<sup>90</sup> These concerns can be divided into the macro-level issue of fish feed, and more localised concerns about ecosystem contamination and fish health. Producers have pursued a host of initiatives to mitigate these concerns beyond certification schemes.

### Developing Sustainable Feed Sources

Salmon are naturally carnivorous fish. That means that their natural diet is comprised overwhelmingly of other fish. As previously mentioned, growing farmed salmon production has significantly increased demand for wild fish to be converted into feed and this is partly why humans now consume more aquaculture than wild caught fish. Much of this feed fish is comprised of species people are relatively less interested in eating, such as herring and mackerel

as well as various kinds of bycatch. Nevertheless, there is a significant ecological impact from fishing these species heavily just to convert them into relatively less biomass of another species.

Additionally, fish for feed is falling short of demand from salmon farms, increasing costs. Producers also estimate that as much as 10% of fish feed is ineffective in promoting growth.<sup>91</sup>

Given these challenges, salmon producers have been trying to shift farmed salmon to vegetable diets. Possible fishmeal substitutes include soybeans, sunflower meal, rape seed oil, and poultry products. The challenge is to develop feed that provides adequate nutritional value to both the salmon and the end customers. Grain fed salmon may contain less Omega-3 fatty acids, though Monsanto has made progress in cultivating plants that contain Omega-3s – a mixed blessing for the fishery because these could be an alternative to fish for people as well.<sup>92</sup>

Nevertheless, farmed salmon are among the most resource-efficient protein that humans can eat. They provide 65 kilograms of protein per 100 kilograms of feed, compared to just 20 kilograms of protein from chicken and 12 kilograms from pork.<sup>93</sup>

### Combating Parasites and Diseases

Local environmental issues are also a significant challenge for salmon farming. These issues revolve largely around protecting farmed salmon from diseases and parasites, and mitigating the impacts of farms on the surrounding environment.

Norway's salmon farms are producing enormous quantities of protein while directly occupying just 40 square kilometres of ocean space.<sup>94</sup> However, this means that the fish are densely packed together, notwithstanding biomass regulations. One consequence is that diseases or parasites can proliferate. This also concentrates a lot of excrement, which can pollute the wider natural environment – salmon farms are deliberately located in areas with currents to carry

away the waste. Farmed salmon can also infect or otherwise harm wild fish (notably through inter-breeding) if they escape or if wild fish approach the cages.

The worst disease incident took place in Chile, where an outbreak of infectious salmon anemia in 2008 reduced production by 75%.<sup>95</sup> Less dense production, especially in terms of greater distances separating farms, has protected Norway from a similar outbreak. The other most common salmon health concern is parasitic sea lice, which eat salmon's skin, increasing mortality and morbidity and making fish unsightly. Consumers are generally reluctant to consume salmon that have been sick out of fear of health effects, so diseases can depress product values. Farms have traditionally addressed these problems with antibiotics and pesticides, but these can contaminate the environment and affect people's perception of the fish's nutritional value.

Compliance with government regulations addressing these issues has been a significant issue in the past. One previous study found, for example, that 70% of sites did not meet risk management standards.<sup>96</sup> Nevertheless, beyond having strict regulations Norwegian aquaculture producers have been leaders in trying to address these problems. Moreover, competitors generally collaborate in many of these areas because they undermine the whole industry's image.

The industry has greatly improved husbandry methods. Salmon have been bred to be faster-growing, more resistant to diseases, and more attractive. The sector has also developed improved vaccines, processes to raise smolts (immature salmon) on land for 8-15 months before transferring them to ocean cages, and better feed to strengthen salmon immune systems.

Producers are also attacking the sea lice issue aggressively. Up to 44 measures were undergoing trials in 2012, including pumping fresh water through the cages, and electric shock treatments.<sup>97</sup> As well up to 4% of fish in some tanks may be species introduced that eat sea lice.<sup>98</sup>

Harvesters are also exploring changes to salmon enclosures.<sup>99</sup> Farms are increasingly using larger numbers of smaller enclosures. The industry is also improving enclosures to better resist weather events and escapes.

Finally, producers are improving worker training and developing very sophisticated monitoring systems in collaboration with Government. These advanced monitoring systems could allow producers and the government to track mortality rates and nutrition in real time.

These efforts have reduced the use of antibiotics and pesticides almost to zero on many farms.<sup>100</sup> The industry aims to operate wholly without these chemicals in the near future.<sup>101</sup>

### Wild Capture

Concerns about the environmental impacts of wild capture fisheries are longstanding. It was a political crisis in Norway when the herring stocks collapsed in the 1980s and the cod stocks collapsed in the 1990s.<sup>102</sup> However, Norway's management regime responded effectively and these stocks have recovered. For the ten most economically important fisheries the "aggregate spawning stock [...] has more than tripled since the late 1980s",<sup>103</sup> and Norway's wild fishing grounds are now generally healthy.<sup>104</sup> Of the Northeastern Atlantic stocks Norway shares with its neighbours, only 21% are estimated to be over-fished; a relatively low share.

Norway may be better positioned to handle day-to-day resources management than anywhere else in the world, with its sophisticated regulatory infrastructure. Yet Norway's fishery faces exceptional environmental threats.<sup>105</sup> These relate largely to the impacts of climate change, which while very difficult to model are predicted to most affect the kinds of polar regions where Norway's fisheries are largely concentrated. Changes in ocean temperatures and currents could affect the biology of wild and even farmed fish. As importantly, climate change may alter human

use of fishing areas. The Barents Sea could also become a major thoroughfare for shipping, and possibly also one of the largest oil and gas fields in the world, whereas conflicts with the oil and gas sector are already challenging.<sup>106</sup> Norway will have jurisdictional limitations and will have to co-manage much of the area with Russia.<sup>107</sup> Of course, climate change also may open up new fishing grounds, increase the ecosystem's productivity, and facilitate access to Asian markets.<sup>108</sup>

## Social License

The industry's environmental impacts, among other social and economic factors, have begun to threaten its social license to operate. Especially troubling is growing resistance from local communities towards the locating of fish farms along their shores.<sup>109</sup>

Increasing technological sophistication and capital intensity, as well as demographic declines, have meant that the industry provides fewer jobs for local communities than in the past.<sup>110</sup> This means fewer benefits are flowing to these communities, even though they are effected by local environmental damages. This pattern is particularly true for aquaculture, which may also compete for physical space with the local capture producers. As a result, communities have begun to reject fish farm sites or at least drag out the approval process.

More broadly, environmental non-governmental organisations have become increasingly effective at damaging the reputation of capture fisheries and aquaculture based on failures of the industry's worst performers. Their campaigns are highly internationally coordinated, so the reputation of Norway's industry is vulnerable to backlash based on events in Chile, for example.

The various measures to mitigate environmental impacts are part of the industry's broader strategy to build social license. The aquaculture industry wants to be known as dealing transparently and directly with its problems.<sup>111</sup> It is seeking to shift production out from fjords



and inlets into reinforced cages in the open ocean, to mitigate local environmental concerns and avoid vulnerability to local decision-making. It is also considering further steps to share more benefits with local communities, recognising that there will always be some negative environmental impacts. Finally, aquaculture firms have provided millions of dollars to help protect wild salmon stocks and build better relations with capture harvesters.

## Human Resources

The fishing and fish products cluster faces significant human resources challenges. The significant reduction in the sector's workforce belie its challenges in securing qualified workers. Yet, the population density is very low in many production areas, and skill demands are increasing as the industry becomes more technologically sophisticated. In some communities, the industry has had to turn to temporary foreign workers.<sup>112</sup>

Home ports for production through both the wild fishery and aquaculture are spread out across rural territories that have lost much of their population in recent years.<sup>113</sup> Out-migration of youth has been particularly significant, and many youth do not envision themselves working in the fishing industry. In the early 2000s, the industry was concerned that the average fish harvester was 50-55 years old. Yet, there have been only modest increases in the numbers of younger fishers since and 41.5% of fishers are above the age of 50 in 2011.<sup>114</sup>

The low entry of young people into the capture fishery partly reflects difficulties in obtaining a license, which can be very expensive. The Government of Norway and other parties have explored multiple ways to help young people obtain licenses, including leasing schemes.<sup>115</sup>

Jobs in the sector also now demand more advanced skills. In general Norway has very high wages because of its high GDP. Fishing is a very globalised sector where many competing regions

have relatively low wages however. This means that the fishing sector in Norway must achieve higher productivity to pay its workforce and to compete internationally, which in turn demands higher skills from workers and better technology. In aquaculture especially, production is now highly scientific and many employees must be highly trained to handle advanced technology and deal with parasites and diseases.<sup>116</sup>

## Market Development

This report has focused largely on the production or supply side of the fishing and fish products cluster. However, the cluster also faces considerable challenges on the demand side, notably in making the most of its market potential.

We have already note that Norway's close proximity to the European Union has been crucial for its broader economic development. In terms of fish products specifically, however, Spain, France, Germany, Italy, Sweden and the UK count among the top ten importers in the world. Together they represent approximately a quarter of global imports.<sup>117</sup> Their demand is also growing – fish imports to Germany and Sweden increased annually by 8.3% and 13.9% respectively from 2004-2014.<sup>118</sup>

Still analysts believe consumption has considerable room to continue growing not just in Europe, but in the US, Japan and across much of Asia.<sup>119</sup> The rise in popularity of sushi, particularly outside Japan, offers a special niche for Norway's farmed salmon in particular because farmed salmon does not contain parasites.

Yet, Norway has confronted significant barriers to accessing foreign markets. This is true within Europe, and more broadly.

Fisheries and agriculture are excluded from the EEA agreement. This gives Norway has greater flexibility in establishing its own fisheries management policies, but leaves it partly outside the common market. On the one hand, Norway's market access has recently improved, partly as compensation for Russia's ban on some EU food imports in response to European sanctions in which Norway participated.<sup>120</sup> On the other hand, Brexit may make it more difficult for Norway to access the UK, which again is its primary export market, and may also complicate the regulatory environment for Norwegian companies' salmon farms in Scotland.<sup>121</sup>

Outside of Europe, the US has pursued anti-dumping action against Norway's salmon industry, which partly spurred its shift of production to Chile and Canada.<sup>122</sup> The duties have now expired, but Norwegian producers remain not very interested in the American market. Norway also has not yet had significant experience exporting to China and other major emerging markets in Asia that could present critical new opportunities.<sup>123</sup>

These market access concerns partly reflect broader national issues, such as whether Norway should join the EU or how it should approach the Brexit situation. The fish and fish products cluster specifically, however, also must consider what steps it can take to improve its market access and promote higher demand for its products.

## Recommendations

There is no question that Norway's fishing and fish products cluster is an outstanding world leader in its field. Its component actors widely appreciate that they should not compete destructively with other businesses within the cluster, but strategically collaborate to grow the cluster as a whole and gain a larger share of overall protein consumption in their target markets.

The sector also is not complacent, but constantly striving to innovate and improve. It is already pursuing many initiatives we could recommend to address its critical challenges, including: developing technological solutions to relocate salmon aquaculture sites outside of coastal inlets or fjords; improving plant-based feed for aquaculture to minimise the use of wild-caught fish-feed; maximising the value of fish through measures to improve product handling, transportation, distribution, and marketing; and, participating in international labelling activities that improve standards for environmentally responsible production practices.

Our recommendations focus on other areas where the cluster could confront its most pressing challenges. We focus especially on strengthening the industry's social license to operate.

**RECOMMENDATION 1: THE CLUSTER SHOULD MAKE A STRONG PUBLIC COMMITMENT TO PRODUCING THE MOST ENVIRONMENTALLY RESPONSIBLE FISH PRODUCTS IN THE WORLD.**

Norway is eminently positioned to be the world leader not only in sustainable production of fish, but sustainable production of protein. The Government has put in place the world's most advanced regulatory regime, while the industry is the most innovative and technologically sophisticated. The Government or one of the major associations should seek to obtain buy-in from all the major players in the sector to commit to being the world leader in environmental sustainability, and use this commitment to guide business planning and policy-making.

**RECOMMENDATION 2: THE GOVERNMENT OF NORWAY SHOULD SCRAP THE EXEMPTION FROM FUEL TAXES FOR FISHING OPERATIONS.**

The fuel tax exemption would be inconsistent with a commitment to producing the most environmentally responsible fish products in the world, as it subsidises inefficient use of fossil

fuel resources that pollute the environment. Scrapping the subsidy would immediately raise production costs, but it could also stimulate the sector to become more energy efficient and therefore more environmentally responsible. This might also position Norwegian firms to sell equipment that improves energy efficiency in other jurisdictions

**RECOMMENDATION 3: THE CLUSTER SHOULD LAUNCH AN AGGRESSIVE PROMOTIONAL CAMPAIGN WITHIN NORWAY AND IN KEY EXPORT MARKETS HIGHLIGHTING THE EXCELLENCE AND ENVIRONMENTAL SUSTAINABILITY OF NORWEGIAN FISH PRODUCTS.**

Norway's fishing and fish products cluster needs to fight back against sustainability-based attacks on its social license to operate, especially when it comes to salmon aquaculture. There is no question that the industry's environmental record is not perfect, however its products have remarkable advantages in terms of environmental sustainability compared with many other industries. The campaign could focus in particular on comparing the sustainability of Norway's seafood products with the environmental impacts of meat and poultry products. The cluster should invest heavily in the campaign and set clear goals for reach and impact.

**RECOMMENDATION 4: THE CLUSTER SHOULD ENDEAVOUR TO DEVELOP A SUSTAINABLE LOCAL WORKFORCE.**

Developing a sustainable local workforce would help the fishing and fish products cluster overcome its human resources challenges and also develop stronger ties to local communities. The challenge is complex, but could be addressed through three two distinct approaches.

First, the cluster should invest to increase training opportunities for local people to work in the fishery. Local people have social connections in the area and therefore may be easier to retain, even if they require more training relative to educated workers from other areas.

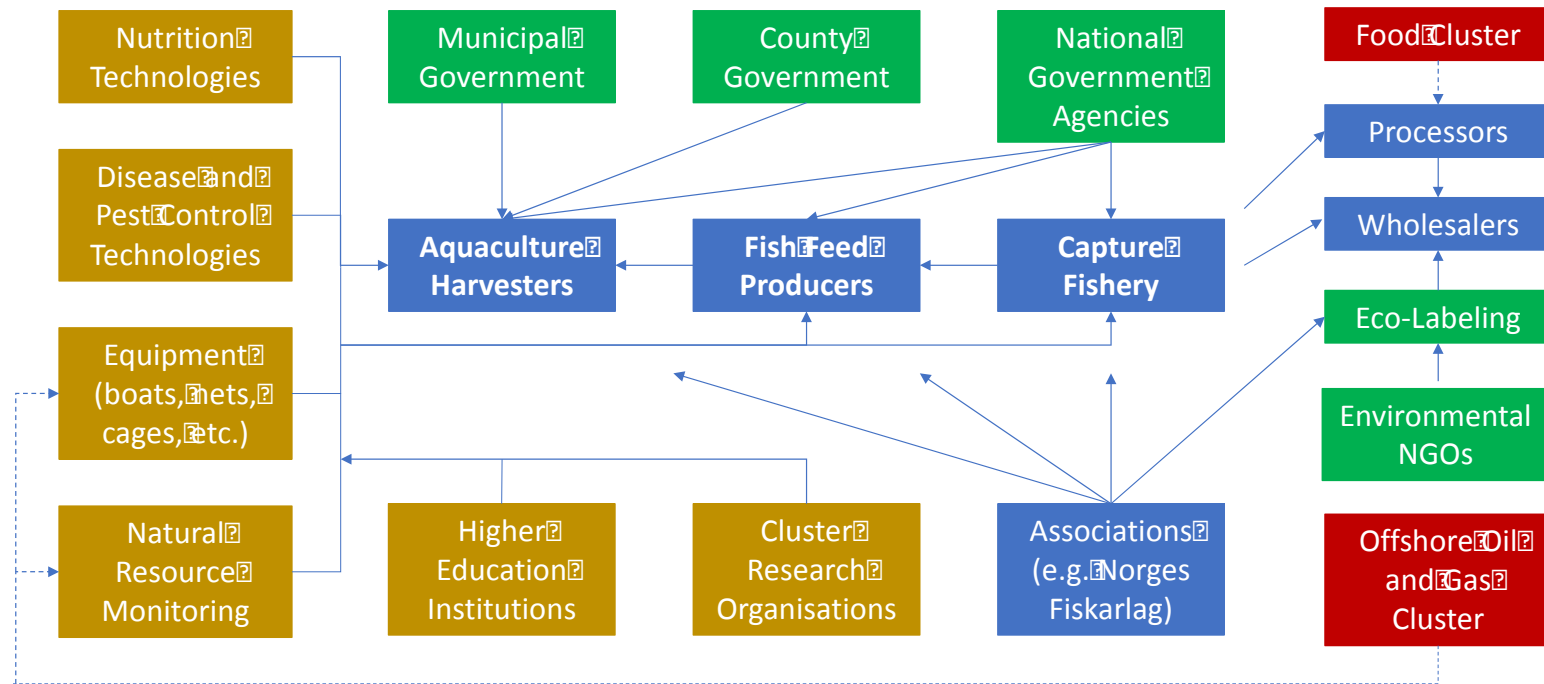
Programs could be delivered on site in partnership with Norway's higher education system, or the sector could create scholarship programs to attend higher education programs relevant to the sector at institutions outside the community. The Government of Norway and fishing associations must also continue to explore measures to help young people obtain fishing licenses. These initiatives could be connected with Norway's sophisticated income support and unemployment insurance systems, and potentially train workers to pursue coordinated seasonal occupations throughout the year not only within the fishery.<sup>124</sup>

Second, the cluster should explore options to attract permanent residents to work in the sector because the local population may not be able to fulfill the sector's labor needs.<sup>125</sup> Policy options could include recruitment of skilled foreign professionals, potentially through participation in relevant higher education training programs, and offering pathways to permanent residency for temporary foreign workers.

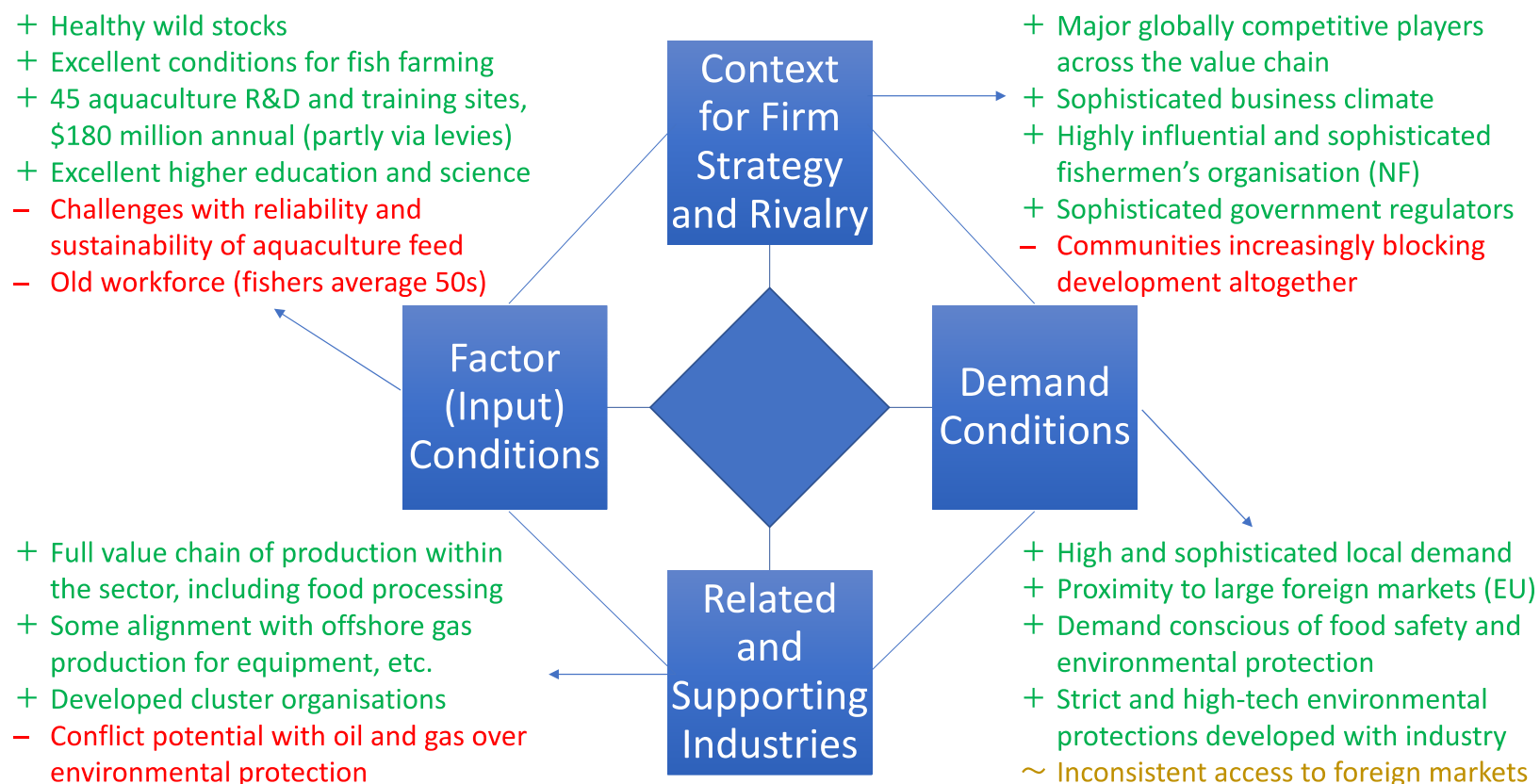
**RECOMMENDATION 5: IN CONSULTATION WITH LOCAL GOVERNMENTS AND INDUSTRY, THE GOVERNMENT OF NORWAY SHOULD DEVELOP A LOCAL GOVERNMENT ROYALTY SYSTEM FOR AQUACULTURE OPERATIONS.**

Capital intensity, technological sophistication and skills requirements are likely to only further increase, reducing positive economic connections between industry and local communities even if operators become more environmentally responsible and shift further offshore.<sup>126</sup> The Government of Norway must ensure that local communities are compensated for still unavoidable impacts of the sector's activities. The aquaculture industry should also strive to give local communities a stake, to possibly convert them from opponents to supporters, or at least neutrals. Royalty revenues could also help local communities become more attractive places to live, with better infrastructure and services, which could boost firms' recruitment.

## Appendix 1: Cluster Map of Fish and Fish Products in Norway



## Appendix 2: Diamond of Business Environment Quality for Norway Fish and Fish Products





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<sup>1</sup> Note on terminology: Throughout this report, we will refer to the fish and fish products cluster also as the fishery. We will distinguish between two key components within the cluster, namely the capture or wild caught fishery, and aquaculture or fish farms. Those working in the sector, particularly the capture fishery, may be referred to using the gender neutral terminology of fish harvesters or fishers.

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<sup>4</sup> The Democracy Ranking Association, "Democracy Ranking 2015," *Global Democracy Ranking*, 2015, <http://democracyranking.org/wordpress/rank/democracy-ranking-2015/>.

<sup>5</sup> Transparency International, "Corruption Perceptions Index 2016," *Www.transparency.org*, January 25, 2017, [https://www.transparency.org/news/feature/corruption\\_perceptions\\_index\\_2016](https://www.transparency.org/news/feature/corruption_perceptions_index_2016).

<sup>6</sup> World Bank Group, "Doing Business 2017: Equal Opportunity for All" (Washington: World Bank Group, 2017).

<sup>7</sup> Klaus Schwab and Xavier Sala-i-Martin, "The Global Competitiveness Report 2016-2017" (Geneva: World Economic Forum, 2016).

<sup>8</sup> Central Intelligence Agency, "Country Comparison: GDP (Purchasing Power Parity)," *CIA World Factbook*, April 30, 2017, <https://www.cia.gov/library/publications/the-world-factbook/rankorder/2001rank.html#ee>.

<sup>9</sup> European Commission, "Trade - Countries and Regions: Norway," *Ec.europa.eu*, April 30, 2017, <http://ec.europa.eu/trade/policy/countries-and-regions/countries/norway/>.

<sup>10</sup> Michael E. Porter, "Norway - Goods Exports Share to Leading Trade Partners, 2000-2010," International Cluster Competitiveness Project (Boston, MA: Institute for Strategy and Competitiveness, Harvard Business School, 2017).

<sup>11</sup> Michael E. Porter, "Total Exports as a Share of GDP, 2010 - High Income," International Cluster Competitiveness Project (Boston, MA: Institute for Strategy and Competitiveness, Harvard Business School, 2017).

<sup>12</sup> World Bank Group, "GDP per Capita, PPP (Current International \$)," *Data.worldbank.org*, 2015, [http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?year\\_high\\_desc=true](http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?year_high_desc=true).

<sup>13</sup> UNDP, "Human Development Report 2016 - Human Development for Everyone" (New York, NY: United Nations Development Programme, 2016).

<sup>14</sup> FAO, "The State of World Fisheries and Aquaculture 2016: Contributing to Food Security and Nutrition for All" (Rome: Food and Agriculture Organization of the United Nations, 2016), <http://www.fao.org/3/a-i5555e.pdf>.

<sup>15</sup> David E. Bell and Ryan Johnson, "Marine Harvest: Leading Salmon Aquaculture," Harvard Business School Case (Boston, MA: Harvard Business School, May 2, 2016).

<sup>16</sup> Ibid.

<sup>17</sup> FAO, "The State of World Fisheries and Aquaculture 2016: Contributing to Food Security and Nutrition for All."

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<sup>18</sup> Michael E. Porter, “World Exports by Cluster, 2010,” International Cluster Competitiveness Project (Boston, MA: Institute for Strategy and Competitiveness, Harvard Business School, 2017).

<sup>19</sup> Richard Williams, “Aquaculture Outlook - Report on Fact Finding Visits to Scotland and Norway” (Halifax, NS, April 2012).

<sup>20</sup> FAO, “The State of World Fisheries and Aquaculture 2016: Contributing to Food Security and Nutrition for All.”

<sup>21</sup> Praxis Research and Consulting, “Phase II Sector Study of Canada’s Fish Harvesting Industry: Appendix 4.21 Literature Review and International Comparisons of Fisheries Labour Force Issues” (Halifax, NS: Praxis Research and Consulting, 2003).

<sup>22</sup> Claire W. Armstrong et al., “Rebuilding the Northeast Arctic Cod Fisheries – Economic and Social Issues,” *Arctic Review on Law and Politics* 5, no. 1 (2014): 11–37.

<sup>23</sup> FAO, “The State of World Fisheries and Aquaculture 2016: Contributing to Food Security and Nutrition for All.”

<sup>24</sup> European Cluster Observatory, “Cluster Observatory - Sectors - Maritime,” 2017, <http://www.clusterobservatory.eu/index.html#!view=sectors;mode=one;sort=name;uid=Maritime>.

<sup>25</sup> From North to South, the three major fishing areas along the northwest coast on the map are Nord-Norge, Trøndelag, and Vestlandet.

<sup>26</sup> The Maritime Cluster, as captured by the European Cluster Observatory, includes: 01.70 Hunting, trapping and related service activities; 03.11 Marine fishing; 03.12 Freshwater fishing; 03.21 Marine aquaculture; 03.22 Freshwater aquaculture; 10.20 Processing and preserving of fish, crustaceans and molluscs; 13.94 Manufacture of cordage, rope, twine and netting; 25.29 Manufacture of other tanks, reservoirs and containers of metal; 30.12 Building of pleasure and sporting boats; and, 47.23 Retail sale of fish, crustaceans and molluscs in specialised stores.

<sup>27</sup> FAO, “The State of World Fisheries and Aquaculture 2016: Contributing to Food Security and Nutrition for All.”

<sup>28</sup> Praxis Research and Consulting, “Phase II Sector Study of Canada’s Fish Harvesting Industry: Appendix 4.21 Literature Review and International Comparisons of Fisheries Labour Force Issues.”

<sup>29</sup> K. Sainsbury, P. Gullestad, and Jake Rice, “Chapter 21: The Use of National Frameworks for Sustainable Development of Marine Fisheries and Conservation, Ecosystem-Based Management and Integrated Ocean Management,” in *Governance of Marine Fisheries and Biodiversity Conservation: Interaction and Coevolution*, ed. Serge M. Garcia, Jake Rice, and Anthony Charles, First (Chichester, UK: John Wiley & Sons, 2014), 301–16.

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- <sup>43</sup> FAO, "The State of World Fisheries and Aquaculture 2016: Contributing to Food Security and Nutrition for All."
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- <sup>48</sup> FAO, "The State of World Fisheries and Aquaculture 2016: Contributing to Food Security and Nutrition for All."
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- <sup>52</sup> Richard Williams, Interview, Telephone, May 3, 2017.
- <sup>53</sup> Bell and Johnson, "Marine Harvest: Leading Salmon Aquaculture."
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- <sup>55</sup> Williams, Interview.
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