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SKILLS REVIEW FOR THE AQUACULTURE SECTOR IN SCOTLAND

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Highlands and Islands Enterprise
Iomairt na Gàidhealtachd 's nan Eilean

CONTENTS

1 INTRODUCTION

1.1 ekosgen, in partnership with Imani Development, was commissioned by Highlands and Islands Enterprise (HIE) on behalf of the aquaculture Industry Leadership Group (AILG) to undertake a skills review of the aquaculture sector. The study included steering group representation from Skills Development Scotland (SDS).

1.2 The evidence base sets out the demand for and supply of aquaculture and related skills in Scotland, covering the scale and nature of the aquaculture sector in Scotland and the education and skills pipeline across all types of provision (schools, college, university, and work-based learning). The report also considered the drivers of change and challenges for the industry. This informed an initial assessment of key priorities for addressing skills challenges facing the aquaculture sector.

AN IMPORTANT SECTOR AND WORKFORCE

1.3 Scottish aquaculture is a highly valuable sector and an important asset for the national economy. A recent study commissioned by HIE found that in 2014/15 the sector contributed £620 million GVA to the Scottish economy and employed over 12,000 FTEs in onsite and offsite roles including production and sales, processing, transport and the supply chain.[1]

1.4 From its current strong position, the Scottish aquaculture sector has the potential for strong future growth. Whilst the *aquaculture Growth to 2030* strategic plan suggests that the sector's turnover could double to £3.6 billion and employment could grow to 18,000 by 2030;[2] HIE's study has suggested that a medium growth scenario to just under 14,500 jobs and £740 million GVA may be more likely, though this is highly dependent on a large number of factors that could influence a more negative or positive outcome.[3]

1.5 The importance of the aquaculture sector is also demonstrated by its role and prominence within rural and fragile economies. Aquaculture production businesses and jobs are concentrated within the Highlands and Islands and are vital in providing employment and other economic development opportunities in remote locations. As well as being a key driver of growth within the Highlands and Islands, the sector plays a wider role across Scotland with many processing, distribution and export operations businesses located in Aberdeenshire, the Scottish Borders and Dumfries and Galloway.

CHALLENGES AND OPPORTUNITIES

1.6 There are opportunities to realise significant growth within the aquaculture sector in coming years through maintaining and extending Scotland's already strong market position, improving fish welfare and demonstrating good environment stewardship. Aquaculture is a critical component of Scotland's Food and Drink sector, which has been identified as one of the Scottish Government's key sectors for driving economic growth. Research has highlighted the growing global market for seafood and aquaculture therefore plays a key role in Scotland's internationalisation activity.

1.7 Scotland, and the Highlands and Islands specifically, has a particularly advantageous geography for aquaculture production. Precautionary policy and regulatory regime has resulted in slower growth than from competitor countries and consequently the global market share of Scottish salmon fell from 10% in 2005 to less than 7% in 2017.[4]

[1] Steve Westbrook and Imani Development (2017), 'The value of aquaculture to Scotland', at: http://www.hie.co.uk/regional-information/economic-reports-and-research/archive/value-of-aquaculture-2017.html

[2] Food and Drink Scotland (2017) *aquaculture Growth to 2030: A strategic plan for farming Scotland's seas*

[3] Steve Westbrook and Imani Development (2017), 'The value of aquaculture to Scotland', at: http://www.hie.co.uk/regional-information/economic-reports-and-research/archive/value-of-aquaculture-2017.html

[4] Food and Drink Scotland (2017) *aquaculture Growth to 2030: A strategic plan for farming Scotland's seas*

1.8 Challenges include biological factors, and the current and potential future impacts of climate change on the aquatic environment. Sea lice, algal gill disease and other pathogens are posing increasing challenges to the industry. Fish welfare and environmental stewardship are key priorities for industry and the Scottish Government and are driving changes in the sector. Given the increasingly technological and innovative methods required to increase the productivity and scale of the sector, and combat the environmental and biological challenges facing aquaculture, there is a need to ensure the necessary and appropriate skills to address these challenges are available to the industry.

1.9 If the sector is to realise its growth ambitions, sufficient numbers of people need to be coming through the aquaculture skills pipeline.[5]

AIMS AND OBJECTIVES OF THE STUDY

1.10 The aim of this study is to provide an overview of the current and future skills needs of the aquaculture sector. In doing so the study will inform the development of an Industry Workforce Planning Strategy and Action Plan with regards to future plans for sector skills development.

STUDY APPROACH

1.11 The study ran from July 2017 to January 2018 and included extensive desk based research, consultations with stakeholders and employers, and an online survey of employers. The approach involved the following four strands of activity:

Literature review: The study began with an extensive review of the existing literature on current and future forecasts for the aquaculture sector in Scotland, and opportunities and challenges faced in the sector and current and emerging skills provision.

Consultations: Telephone consultations were undertaken with key stakeholders and employers in the aquaculture industry. The consultations focused on key drivers of change and challenges for aquaculture; the current and future aquaculture landscape in terms of skills supply and demand; and routes into aquaculture employment.

Online survey: An online survey was developed and sent to aquaculture employers. The survey explored similar themes to the telephone consultations and was undertaken in order to capture a broader view from the sector.

Data analysis: Data gathered from public sources and through data requests was used to analyse the scale and nature of the aquaculture business base, workforce and education and skills pipeline in Scotland. Data was requested from Scottish Funding Council for Further and Higher Education data.

STRUCTURE OF THE REPORT

1.12 The report is structured as follows:

Chapter 2 provides an analysis of the aquaculture workforce and business base in Scotland, giving consideration to geographical concentrations, variations by fish species and workforce profile;

Chapter 3 gives a review of the key drivers of change and challenges surrounding the aquaculture sector and skills supply;

Chapter 4 details the skills pipeline for aquaculture across all levels of education and training, from schools through to Higher Education Institution (HEI) provision;

[5] Ibid.

Chapter 5 provides an industry perspective on skills challenges and opportunities within the sector. This chapter is based on the fieldwork carried out with employers and stakeholders;

Chapter 6 provides a summary of the key findings and recommendations flowing from the study.

Appendix 1 sets out the approach to defining the aquaculture sector, and data limitations. **Appendix 2** provides the list of Stakeholders consulted with, and **Appendix 3** details the employers engaged with the research. **Appendix 4** sets out the HE HESA/JACS codes that informed the HE data analysis in Chapter 4.

2 THE AQUACULTURE SECTOR IN SCOTLAND

SUMMARY

- Aquaculture currently contributes around £620 million annually in GVA to the Scottish economy and it has been estimated that with a medium growth scenario this could grow to £740 million by 2030.
- The majority of Scottish aquaculture production is finfish rather than shellfish and within this Atlantic salmon is the key species, accounting for 95% of total Scottish finfish production in 2016.
- In 2016 there were around 225 aquaculture farming businesses in Scotland. Nearly 70% are based in the Highlands and Islands, and almost 80% are micro businesses. However, the industry is dominated by a small number of large employers.
- From 2010 to 2016 there has been a decline in the number of aquaculture businesses in Scotland but this is a reflection of concentration and consolidation rather than falling rates of production.
- In 2016 2,279 people in Scotland were employed in finfish or shellfish production (Marine Scotland). Just under 90% were employed within finfish farming. From 2010 to 2016 the number of people employed in Atlantic salmon production grew by over 400 or 40% to just under 1,500.
- It in 2015 there were 7,725 people employed in the immediate aquaculture supply chain and 28,703 in the wider shared supply chain.
- Aquaculture production and its employment is concentrated within the Highlands and Islands whilst processing and supply chain employment is more evenly spread across Scotland, with concentrations in areas including Aberdeenshire, the Scottish Borders and Dumfries and Galloway.
- There is a far higher rate of full-time working in the aquaculture sector than across all sectors, and this may partly reflect the dominance of males in the sector.

INTRODUCTION

2.1 This chapter presents an analysis of the aquaculture sector in Scotland. It draws on previous research to set out the value of the sector to Scotland's economy, and considers data from Marine Scotland's Scottish Fish Farms Production Survey and Scottish Shellfish Farm Production Survey to provide a composite picture of the production sub-sector. Data from UK Business Counts and the Business Register and Employment Survey (BRES), using Standard Industrial Classification (SIC) codes, is also considered to provide more detailed analysis of businesses and employment across the aquaculture sector, as well as its immediate and wider supply chain.

2.2 Whilst Marine Scotland analysis is able to differentiate between producers of particular species, SIC-based BRES/UK Business Counts data differentiates between Marine and Freshwater aquaculture. The latter also allows exploration of business size and the geographical distribution of businesses and employment with in the sector and supply chain. Another key difference is that UK Business Counts only includes VAT registered businesses whereas the Marine Scotland data captures all businesses in the sector.

2.3 Discussion of the approach to defining the aquaculture sector and limitations of the data is presented in Appendix 1.

2.4 Aquaculture in Scotland faces a remarkable set of opportunities and challenges in its progression through to 2030. It goes to the heart of Scotland's competitive position, since it is an increasingly large-scale and technological industry within the provenance-focused Food and Drink agenda. It is a rural industry driving not only local growth in economically fragile areas, but also the growth of the Central Belt with its processing,

distribution and exports service provision. In finfish in particular there is a trend towards consolidation and integration, with a small number of increasingly large companies seeking to control their supply chain. The challenges facing Scottish aquaculture reflects the challenges faced in building on the abundance of the natural capital resources of Scotland's marine environment more generally. The industry operates within carefully managed marine spaces and it is geographically diffuse; it must balance both competing and complementary interests of coastal communities and other resource users. Increasingly those interests must in turn be balanced with urban processing interests (e.g. demand for greater production levels) and sustainability objectives at a national level.

THE AQUACULTURE INDUSTRY AT PRESENT

Value and production

2.5 Aquaculture in Scotland is diverse and includes the farming of both finfish and shellfish species, as well as the harvesting of Seaweed. It is estimated to contribute over £1.8 billion annually in terms of turnover to Scotland's economy. The industry has set out a vision that the potential contribution of aquaculture to Scotland's economy could be as high as £3.6 billion by 2030, and could support around 18,000 jobs.[6] Research conducted by Steve Westbrook and Imani Development in 2017 estimates the GVA of the sector to be around £620 million and suggests that it is more likely that by 2030 Scottish aquaculture will have an annual GVA of £740 million and support just under 14,500 jobs.[7]

Finfish

2.6 In Scotland, finfish accounts for a much larger proportion of the aquaculture industry than shellfish and is dominated by the production of Atlantic salmon (*Salmo salar*)[8,9], although rainbow trout (*Oncorhynchus mykiss*), oysters (both *Ostrea edulis* and *Magallana/Crassostrea gigas*) and mussels (*Mytilus edulis*) are also key species for the industry.[10] Export values of Scottish salmon are difficult to interpret, but are estimated to be in the region of £600 million for 2017.[11] The main markets for farmed salmon are the USA, France, and China. Salmon production accounted for 95% of total finfish production in Scotland in 2015, approximately 171,000 tonnes (a 35% increase since 2005). This decreased slightly to 162,817 tonnes in 2016. Salmon production is heavily concentrated in Scotland with the five largest producers accounting for 92% of the total. The production of rainbow trout in Scotland increased by 46% in 2015 to 8,588 tonnes of fish, with a small decrease to 8,096 tonnes in 2016. Producers expect somewhat higher figures for both salmon and trout in the 2017 season.[12]

Shellfish

2.7 Mussels (*Mytilus edulis*) and pacific oysters (*Magallana/Cassostrea gigas)* are the main shellfish species produced in Scotland. Just over 8,000 tonnes of shellfish were produced in 2016 including 7,732 tonnes of mussels. Mussel production has increased by 61% from 2007. The value of farmed shellfish production in Scotland in 2016 was approximately £11.7 million. Other shellfish species that are farmed

[6] Food and Drink Scotland (2017) aquaculture Growth to 2030: A strategic plan for farming Scotland's seas

[7] Steve Westbrook and Imani Development (2017), 'The value of aquaculture to Scotland', at: http://www.hie.co.uk/regional-information/economic-reports-and-research/archive/value-of-aquaculture-2017.html

[8] Scottish Government (2017) *aquaculture*, at: http://www.gov.scot/Topics/marine/Fish-Shellfish

[9] Steve Westbrook and Imani Development (2017), 'The value of aquaculture to Scotland', at: http://www.hie.co.uk/regional-information/economic-reports-and-research/archive/value-of-aquaculture-2017.html

[10] Scottish Government (2017) *aquaculture*, at: http://www.gov.scot/Topics/marine/Fish-Shellfish

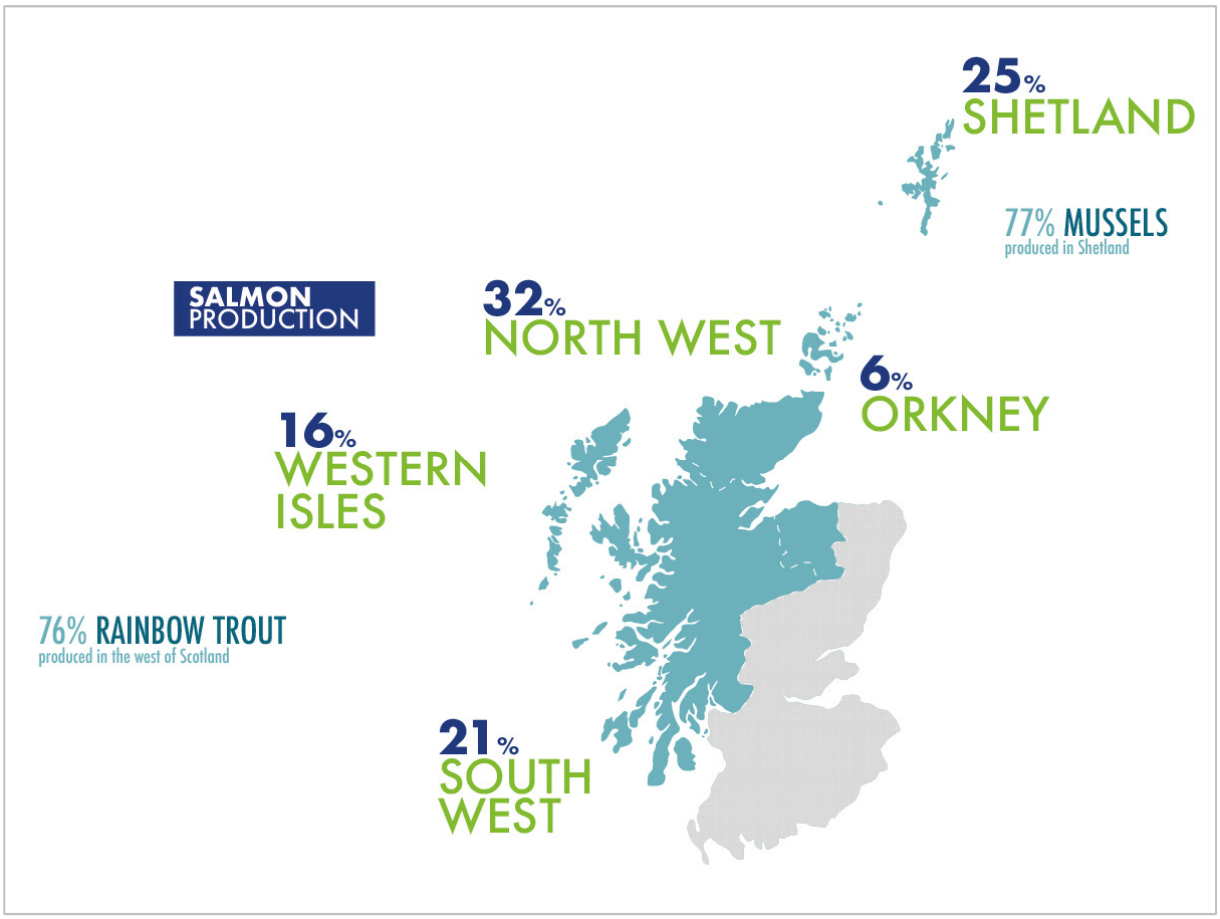
[11] http://scottishsalmon.co.uk/salmon-exports-reach-record-600m/

[12] http://www.gov.scot/Topics/marine/Fish-Shellfish/FHI/surveys

include native oyster, queen scallop, and king scallop but at much lower volumes.[13] However, the sector extends beyond production to processing and marketing.

Geographical distribution

2.8 The majority of aquaculture production, both finfish and shellfish, occurs in the Highlands and Islands region, with processing and supply chain employment occurring within the region, but also in the Central Belt and the North East of Scotland. Salmon production occurs mainly in the North West (32%) as does the production of rainbow trout (76%). Shetland is also important for salmon production (25%) as well as being the largest contributor of farmed mussels (77% of total). The South West of Scotland accounts for 21% of salmon production and the Western Isles account for 16%. South West Scotland accounted for 79% of Scotland's farmed Pacific oysters.[14]



Source: Steve Westbrook/Imani Development, HIE (2017)

THE AQUACULTURE BUSINESS BASE

2.9 This section provides analysis of the aquaculture business base. The analysis is split into two subsections – one based on data from Marine Scotland and the other on data from the UK Business Counts survey. The Marine Scotland data provides in-depth data on finfish and shellfish production while the UK Business Counts data offers broader analysis of the aquaculture sector, including analysis of business size.

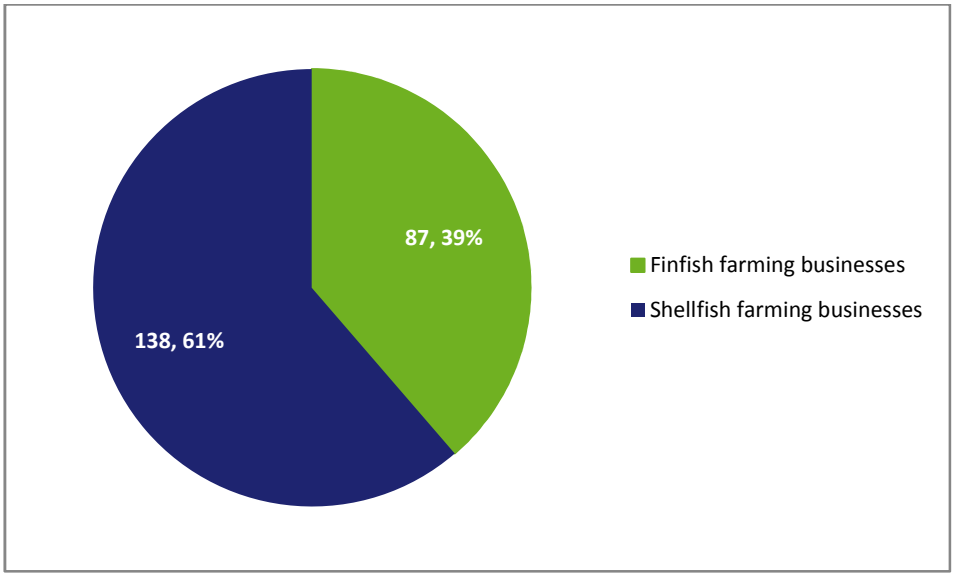
[13] Steve Westbrook and Imani Development (2017), 'The value of aquaculture to Scotland', at: http://www.hie.co.uk/regional-information/economic-reports-and-research/archive/value-of-aquaculture-2017.html

[14] Steve Westbrook and Imani Development (2017), 'The value of aquaculture to Scotland', at: http://www.hie.co.uk/regional-information/economic-reports-and-research/archive/value-of-aquaculture-2017.html

Marine Scotland analysis

2.10 Marine Scotland data is drawn from an annual survey of Finfish and Shellfish production. The data show that across Scotland in 2016 there were 225 aquaculture businesses in Scotland. As shown at Figure 2.1, 61% of these businesses were shellfish farming businesses whilst 39% were finfish farming businesses. The analysis was conducted by species e.g. trout. salmon in finfish and mussels, oysters and scallops in shellfish. Therefore, if a business farms both trout and salmon, they will have been counted twice.

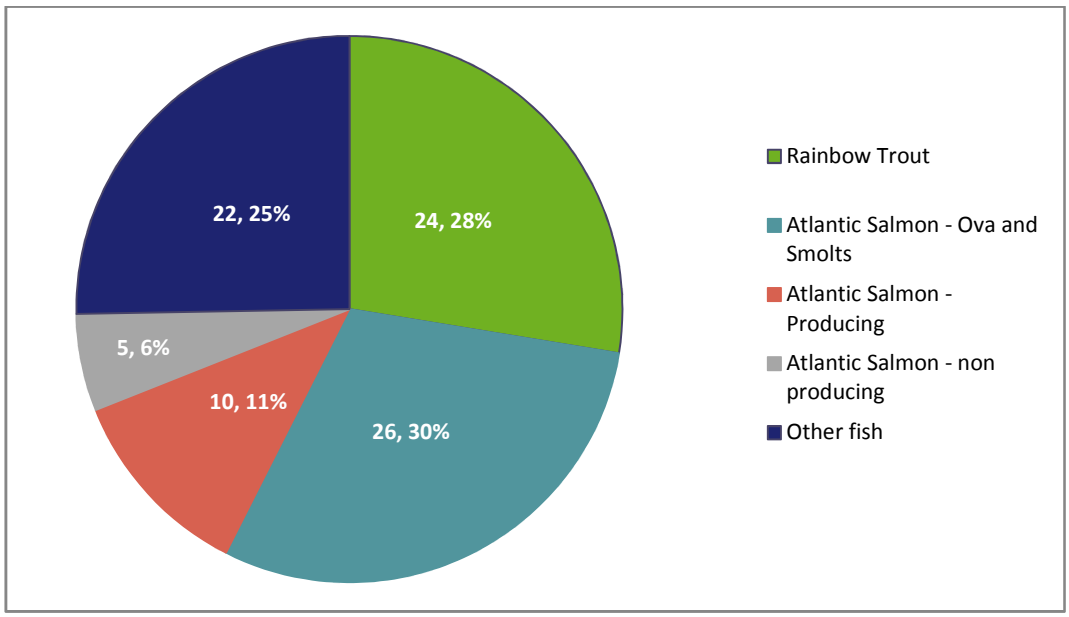
Figure 2.1: Aquaculture businesses by type, 2016



Source: Marine Scotland, 2017

2.11 The most common species for finfish farming (production) businesses in Scotland in 2016 was Atlantic salmon – ova and smolts, which accounted for 26 companies or 30% of all finfish farming businesses in Scotland (Figure 2.2). This was closely followed by rainbow trout (24 companies) and other fish (22 companies). Other fish includes brown trout/sea trout, halibut and cod. Non-producing companies are those that remain active and authorised but did not produce any Atlantic salmon for harvest in 2016.

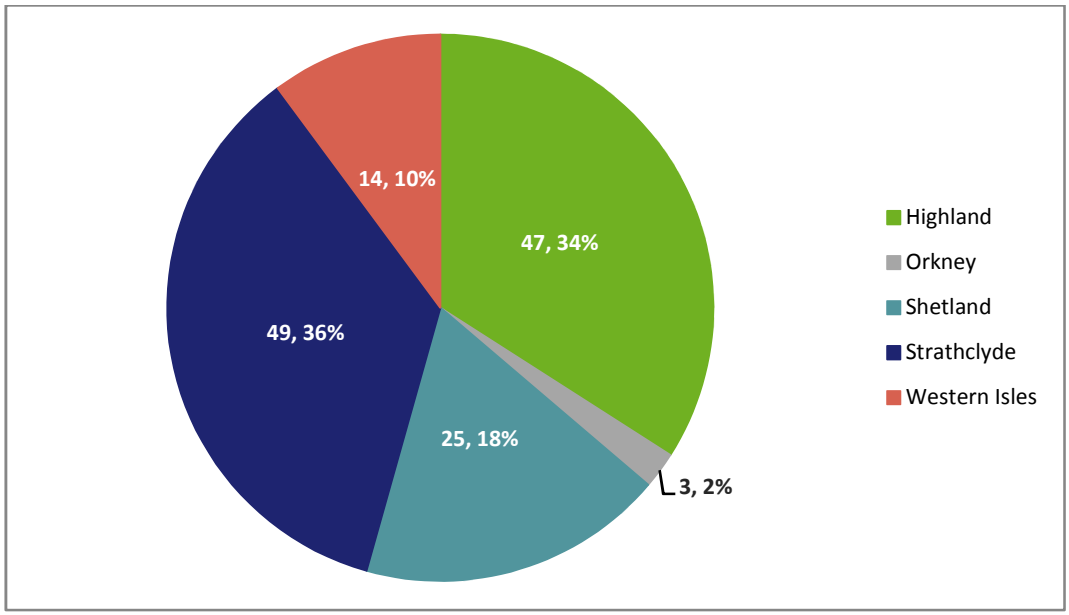
Figure 2.2: Finfish farming businesses by species, 2016



Source: Marine Scotland, 2017

2.12 Within Scotland, the majority of shellfish farming businesses are located in the Highlands and Islands. However, at sub-regional level, Strathclyde was the most common location, accounting for 49 companies or 36% of all shellfish farming businesses in 2016. As shown at Figure 2.3, Strathclyde was closely followed by Highland, which accounted for 34% (47 companies) and Shetland (18% or 25 businesses). In terms of production, this can be related to particular regional specialities. For example, Strathclyde produced 61% of Scotland's farmed oysters in 2016, whilst Shetland produced 74% of mussels.

Figure 2.3: Shellfish farming businesses by region, 2016

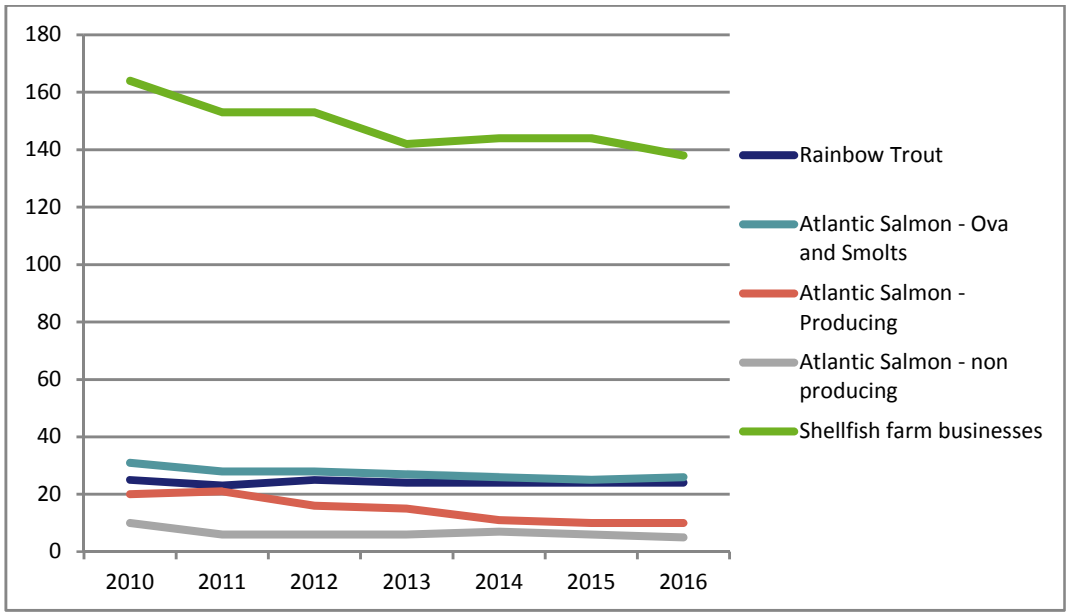


Source: Marine Scotland, 2017

2.13 From 2010 to 2016 there were declines in the number of aquaculture businesses across all species (figure 2.4). In total, this amounted to a reduction of 45 businesses. Reflecting a concentration within larger businesses, the most significant declines proportionally were within the production and non-production of Atlantic salmon. For both types the number of businesses fell by 50% between 2010 and 2016, this amounted to 10 Atlantic salmon producing businesses and 5 non-producing businesses. In absolute terms shellfish farm businesses saw the biggest with the number of businesses reducing by 26.

2.14 Whilst there has been a decline in the number of aquaculture businesses, it is important to note that this is reflective of concentration and consolidation and is not a sign of a declining sector. This is demonstrated in the increases that have taken place in production levels, and demonstrates the links between innovation and productivity as companies shift to new models of working. For example, over the period from 2010 to 2016 there was a 58% increase in rainbow trout production and a 6% increase in Atlantic salmon production.

Figure 2.4: Aquaculture businesses by species, 2010-2016

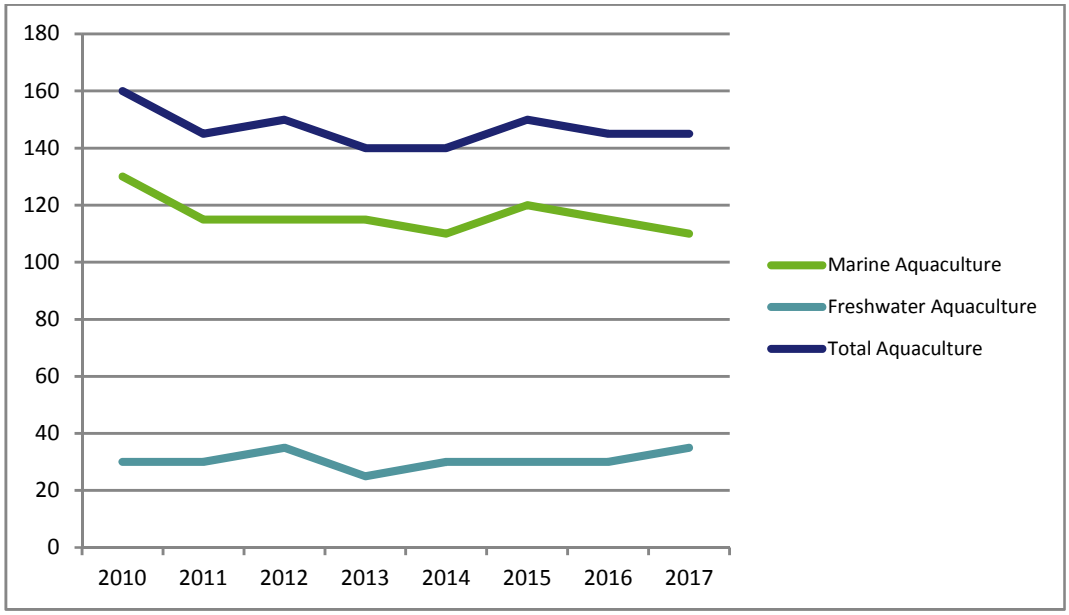


Source: Marine Scotland, 2017

UK Business Counts analysis

2.15 UK Business Counts data differs from Marine Scotland data in that businesses are categorised differently (split only by marine and freshwater aquaculture), and only includes those over the VAT threshold (those with an annual turnover exceeding £85,000). The data show that across Scotland there are 145 aquaculture (110 marine aquaculture and 35 freshwater aquaculture) businesses. Within the core aquaculture sector there has been a small decline of around 9% (15 businesses) over the period from 2010 to 2017(figure 2.5). This trend is present in the Marine Scotland data presented above, and is driven by a decline in the number of marine aquaculture businesses.

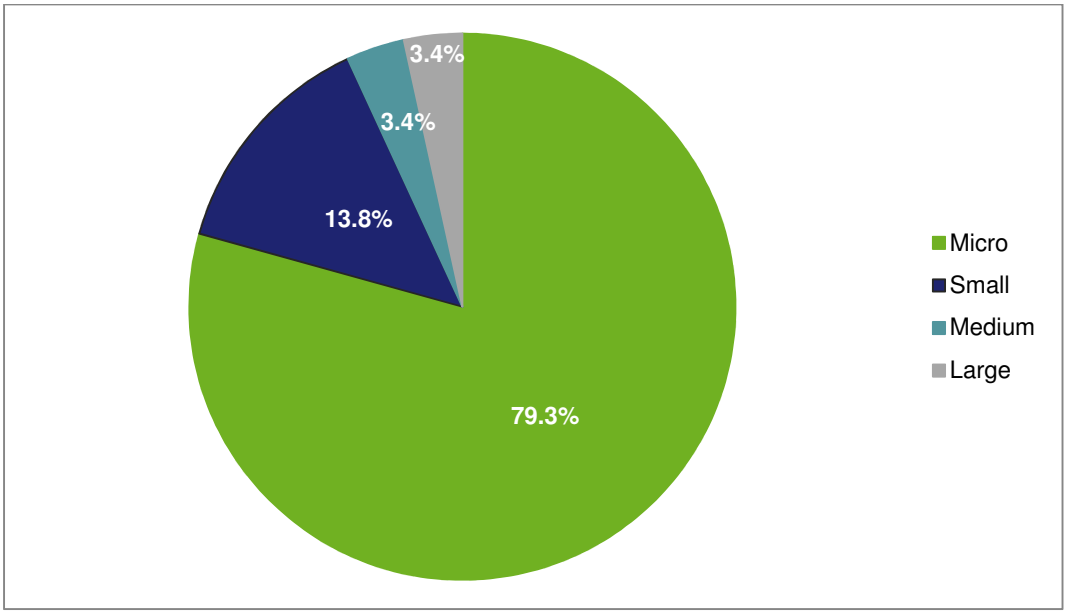
Figure 2.5: Aquaculture Business Base in Scotland, 2010-2017



Source: UK Business Counts, 2017

2.16 The vast majority (79% or 115) of aquaculture businesses in Scotland are micro businesses, employing less than ten people. Fourteen percent (20) are small businesses, (employing 10 to 49 people) with the medium (50 to 249 employees) and large (250+) size bands accounting for just 3% (5) of businesses each (Figure 2.6). However, in the period from 2010 to 2017 there has been a decline of 25 businesses within the micro size band. This has been accompanied by a growth in large aquaculture businesses from none in 2010 to five since 2013.

Figure 2.6: Aquaculture Businesses by Size band



Source: UK Business Counts, 2017

2.17 As seen for shellfish businesses above, aquaculture businesses in Scotland are heavily concentrated within the Highlands and Islands region, with 69% of the total business base located in the region. Within the Highlands and Islands, there is further concentration within particular local authority areas. As shown at Table

2.1, Highland, the local authority with the largest geographical area and population in the region, accounts for 35 businesses. It is followed by Shetland, which accounts for 25 businesses, and Argyll & Bute, where 20 aquaculture businesses are located. Orkney and Eilean Siar account for five aquaculture businesses each and there are no businesses located within Moray[15].

2.18 Whilst there is still a clear concentration of aquaculture businesses within the Highlands and Islands, this has decreased from 81% to 69% since 2010. In the period from 2010 to 2017 the number of aquaculture businesses in the Highlands and Islands fell by 20 or 18%. By comparison, the number in the rest of Scotland grew by five. It should be noted, however, that this does not reflect the consolidation within the sector, and should be read in conjunction with production volumes over the same period. As shown at Table 2.1, outside of the Highlands and Islands, there are aquaculture businesses located within Perth & Kinross, Stirling, Aberdeenshire, Dumfries & Galloway, Edinburgh and Fife.

Table 2.1: Aquaculture businesses by local authority

Local Authority (Highlands and Islands Region)	Number of aquaculture Businesses	Local Authority (Rest of Scotland)	Number of aquaculture Businesses
Highland	35	Dumfries & Galloway	10
Shetland Islands	25	Aberdeenshire	5
Argyll & Bute	20	Edinburgh	5
Eilean Siar	5	Fife	5
Orkney Islands	5	Perth & Kinross	5
Moray	0	Stirling	5
Total	**90**	**Total**	**35**

Source: UK Business Counts, 2017
Total does not sum to number of aquaculture businesses across Scotland as local authorities with less than five businesses are listed as having zero

2.19 Due to the small number of large and medium sized aquaculture businesses across Scotland it is not possible to disclose where these are located. All small aquaculture businesses in Scotland are located within the Highlands and Islands – five in Highland local authority, five in Shetland and five in Argyll & Bute. Outside of the Highlands and Islands, each of the local authorities with aquaculture businesses accounts for five micro businesses, except from Dumfries & Galloway, which is home to ten micro businesses.

2.20 Within the aquaculture supply chain there is a much larger business base at just under 3,100 businesses in Scotland. The immediate supply chain is made up of 115 processing and preserving of fish, crustaceans and molluscs businesses. There are 2,950 businesses in the wider aquaculture supply chain which includes the following sectors/subsectors:

- Manufacture of prepared feeds for farm animals (15 businesses);
- Wholesale of other food, including fish, crustaceans and molluscs (225 businesses);
- Retail sale of fish, crustaceans and molluscs in specialised stores (195 businesses);
- Freight transport by road (2,200 businesses); and
- Veterinary activities (315 businesses).

[15] It should be noted that the number of businesses listed by local authority does not add up to the total number of aquaculture businesses in Scotland as, due to disclosure reasons, local authorities with less than five aquaculture businesses are listed as having zero.

2.21 All of these sectors/subsectors encompass activities pertaining to aquaculture, though some are perhaps more directly related than others. For example, fish processing is likely to fall within the processing and preserving of fish, crustaceans and molluscs sector.

2.22 In terms of location for the immediate supply, just over one third (40) of businesses are located in the Highlands and Islands. Aberdeenshire is the local authority that accounts for the largest amount of businesses at 30. Within the wider supply chain there are significant differences in the location of businesses, reflecting the variety of sectors included. Just under 30% (65) of Wholesale of other food, including fish, crustaceans and molluscs are located in the Highlands and Islands. By comparison, no 'Manufacture of prepared feeds for farm animals' businesses are located in the region and the Highlands and Islands accounts for just 11% of Freight transport by road businesses.

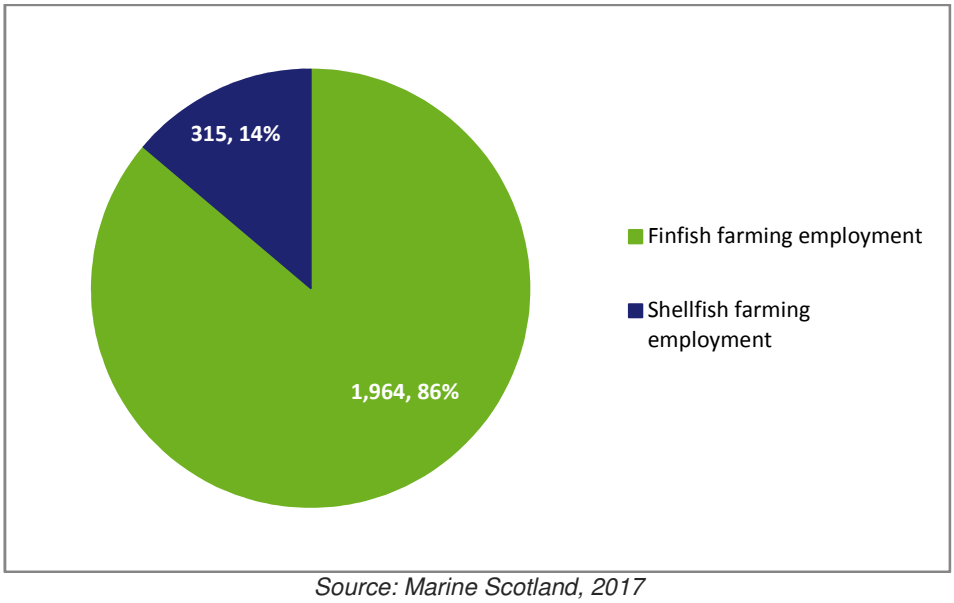
EMPLOYMENT IN THE AQUACULTURE SECTOR

2.23 This section provides analysis of employment within the aquaculture sector. The analysis is split into two subsections – one based on data from Marine Scotland and the other on data from BRES. The Marine Scotland data provides in-depth data on finfish and shellfish production by species while the BRES data offers broader analysis of the aquaculture sector and supply chain.

Marine Scotland analysis

2.24 Marine Scotland data shows that in 2016 2,279 people in Scotland were employed in finfish or shellfish production. As shown at Figure 2.7 the vast majority (1,964 or 86%) were employed within finfish farming. There were 315 employments in shellfish farming.

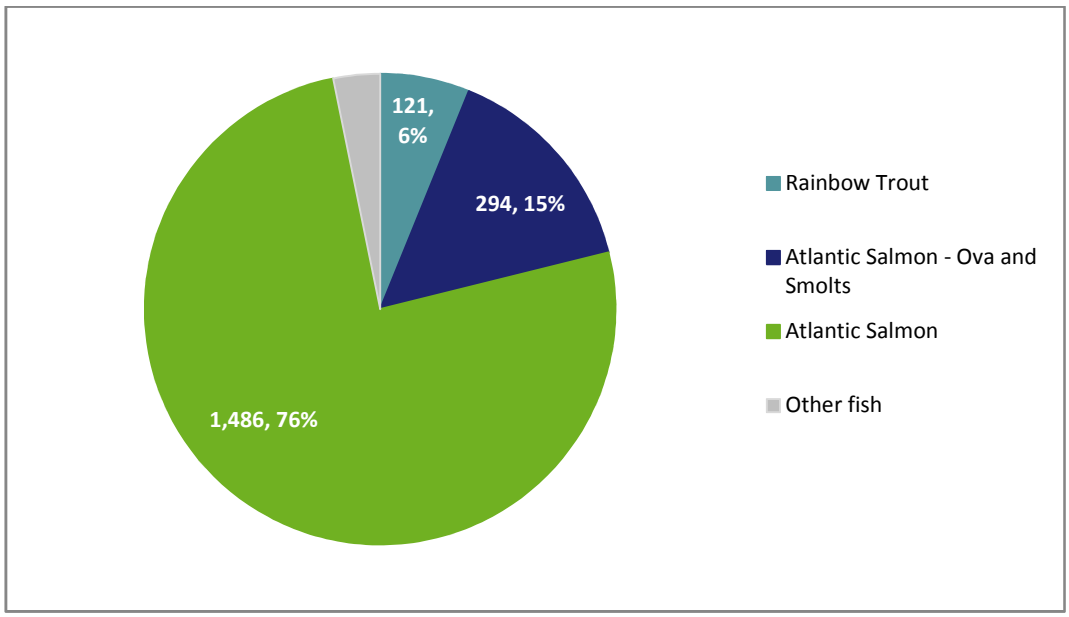
Figure 2.7: Aquaculture employment by type, 2016



Source: Marine Scotland, 2017

2.25 Within finfish farming, Atlantic salmon accounted for over three quarters of employment. Atlantic salmon – Ova and smolts accounted for a further 15% of employment whilst rainbow trout and other fish accounted for just 6% and 3% respectively (Figure 2.8).

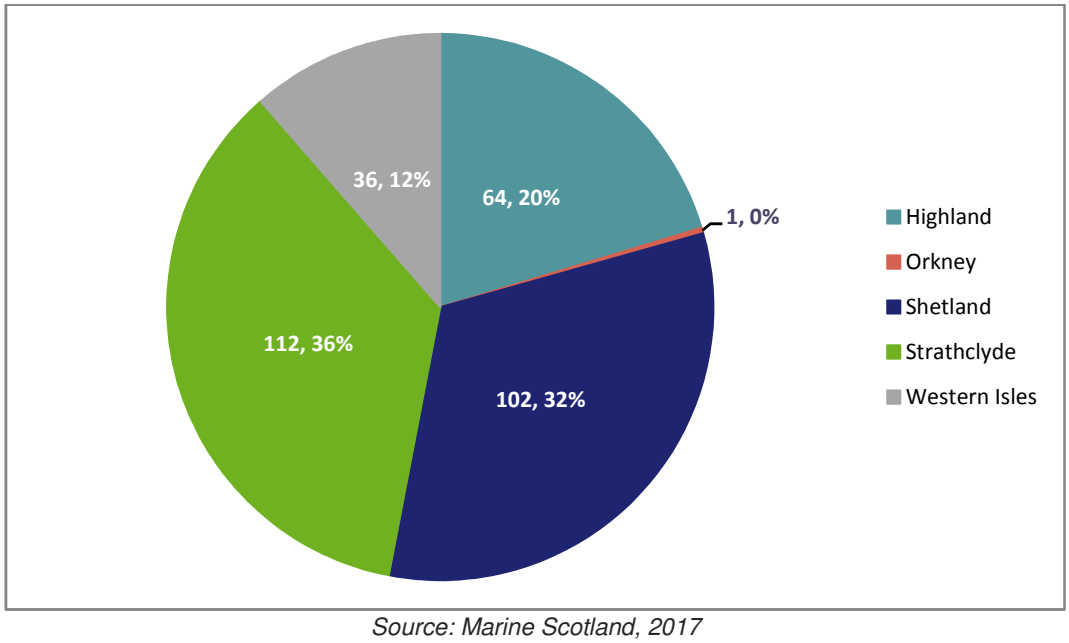
Figure 2.8: Finfish farming employment by species, 2016



Source: Marine Scotland, 2017

2.26 In 2016 over one third (36%) of Scottish shellfish farming employments in aquaculture were located in Strathclyde (Figure 2.9). Shetland accounted for the second highest number of employments at 102 or 32%. As Shetland accounted for just 20% of businesses, this suggests that businesses in Shetland tend to employ a larger number of workers than those elsewhere in Scotland. As with businesses, employment regionally can be related to a speciality in oyster production in Strathclyde and mussel production in Shetland. A geographical breakdown is not available for finfish.

Figure 2.9: Shellfish farming employment by region, 2016



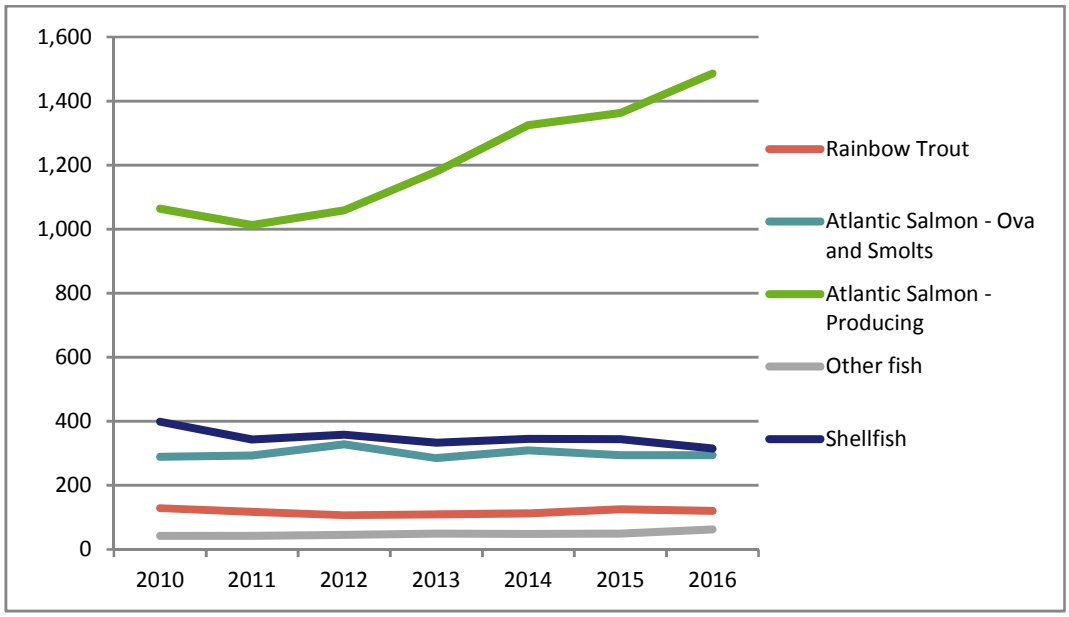
Source: Marine Scotland, 2017

2.27 Whilst no data exists on gender employment in finfish, for shellfish, 87% of employees were male and just 13% female, with females more likely to work in processing rather than on production sites, as identified through consultations.[16] This is reflective of the gender imbalance referred to by stakeholders more widely within the sector. Perhaps related to the dominance of male employees, the data also showed that 85% of employees in the aquaculture sector (across both finfish and shellfish) in 2016 Scotland worked full-time, this compares with 67% across all sectors in Scotland. Within shellfish farming there is also a significant number of casual workers (those employed occasionally, and not on a permanent contract) largely as a result of the seasonality of the produce. Casual labour accounted for 17% of the total workforce in 2016.

2.28 Overall from 2010 to 2016 there has been a growth of 355 jobs or 18% in the aquaculture sector. This has been driven by very significant growth (400 jobs or 40%) in employment within Atlantic salmon production (Figure 2.10). This is reflective of the concentration of employment as alongside this growth in employment there has been a significant fall in the number of Atlantic salmon businesses.

2.29 Within the other fish category there has been proportionally significant (47%) growth, though this was starting from a small base so amounts to a growth of just 20 jobs. Employment in rainbow trout and Atlantic salmon – ova and smolts production has been fairly stable from 2010 to 2017. For shellfish production there has been a significant decline of 84 jobs or 21% in employment from 2010 to 2017. The reasons for this are not clear. There was a particularly significant fall from 2010 to 2011 when the number of jobs in shellfish farming in Scotland fell from 399 to 343.

Figure 2.10: Aquaculture employment by species, 2010-2016



Source: Marine Scotland, 2017

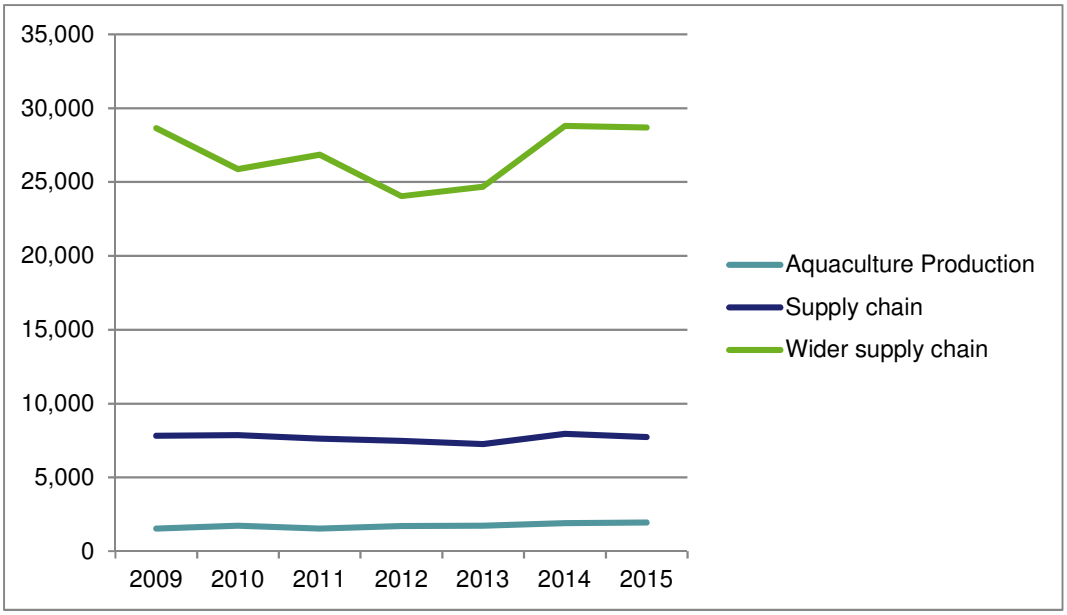
BRES analysis

2.30 In 2015 there were 1,944 people in aquaculture production employment, 7,725 in the immediate supply chain employment and 28,703 in wider supply chain employment across Scotland. It must be stressed that whilst those employed in the wider supply chain may be readily co-opted into aquaculture activity, these should not be considered part of the aquaculture workforce. It should also be noted that wider supply chain employment captures employees that work across, and are influenced by, a large number of sectors, not just aquaculture. Between 2009 and 2015, there was significant growth in aquaculture production of 403 jobs or

[16] http://www.gov.scot/Resource/0051/00518472.pdf

26% and a small decline of 89 jobs or 1% in the immediate processing supply chain. Employment within the wider supply chain in 2015 was at a similar level to 2009 (around 29,000), although it fell to 24,048 in 2012 before starting to increase again. (Figure 2.11).

Figure 2.11: Employment within the aquaculture Sector, 2009 to 2015



Source: BRES, 2017

2.31 The immediate supply chain and production of aquaculture accounts for a small share of total Scottish employment at 0.30% and 0.08% respectively. Combining the immediate supply chain and production employment leads to a **total immediate employment within aquaculture of nearly 10,000 jobs**, amounting to a share of just under 0.4% of total employment.[17] This has been fairly stable since 2009 though the total share for production has grown from 0.06%. As expected given it accounts for a wider range of jobs, the wider supply chain accounts for a higher share of total employment at 1.13%. Again this has been fairly stable, although it did drop as low as 0.99% in 2012 when employment dipped to 24,048.

2.32 It should be noted however, that share of total employment varies widely between regions, reflecting a concentration of employment within particular areas. Production jobs are particularly concentrated within Highland, Shetland, Argyll & Bute and Orkney, as these areas account for nearly 90% of all production jobs As shown in Table 2.2, the location quotients[18] for production jobs in Shetland and Orkney are 42 and 44 respectively, whilst 11 local authorities report no production jobs. However, even within Shetland and Orkney, aquaculture production jobs account for just 2.6% and 2.7% of total employment respectively.

2.33 In terms of the direct aquaculture supply chain, research estimates that Scottish processors employed around 3,500 FTEs in 2014. Although the total number of FTEs decreased by 12% from 2008 to 2014 in Scotland, there was a 62% increase over the same period to 1,100 FTEs in the rest of the UK. It is important to note that since 2014, the categorisation in Seafish's annual survey of UK processors has changed. Under

[17] It should be noted that this is only accounting for employment in VAT registered business, and because of its reliance on SIC code definitions which may help explain the difference between this figure and that in the *Value of aquaculture* study.

[18] Location Quotients are a measure of the concentration or degree of specialism of a particular industry or occupation in a local area or region in comparison to a larger geography – usually national, and in this case, Scotland. A Location Quotient of greater than 1 indicates a greater degree of specialism in aquaculture in a particular area compared to the national workforce

the new categorisation – employment in salmon and freshwater fish processing was around 3,200 FTEs in Scotland which equates to a reduction of around 4% from 2014.[19]

Table 2.2: Employment within aquaculture Production by Local Authority

Local Authority	Production jobs	% of total employment in area	% of national production employment	Location quotient
Highland	500	0.4%	23.8%	6.71
Shetland Islands	400	2.6%	19.9%	42.49
Argyll & Bute	400	1.0%	18.5%	15.72
Orkney Islands	300	2.7%	14.3%	44.24
Eilean Siar	200	1.9%	10.5%	31.06
Stirling	100	0.2%	3.9%	2.71
Dumfries & Galloway	0*	0.1%	1.7%	0.89
Edinburgh	0*	0.0%	1.7%	0.16
Perth & Kinross	0*	0.0%	1.1%	0.57
Angus	0*	0.1%	1.0%	0.89
Fife	0*	0.0%	0.9%	0.06
North Lanarkshire	0*	0.0%	0.7%	0.18
East Lothian	0*	0.0%	0.6%	0.69
Inverclyde	0*	0.0%	0.4%	0.44
North Ayrshire	0*	0.0%	0.3%	0.24
Clackmannanshire	0*	0.0%	0.3%	0.54
Glasgow City	0*	0.0%	0.3%	0.02
West Dunbartonshire	0*	0.0%	0.3%	0.26
Scottish Borders	0*	0.0%	0.15%	0.12
Aberdeenshire	0*	0.0%	0.05%	0.02
Renfrewshire	0*	0.0%	0.05%	0.02
Total	**2,000**	**0.1%**	**100%**	**1.00**

Source: BRES, 2017

2.34 Immediate supply chain employment is not quite as geographically concentrated as aquaculture production employment, although Aberdeenshire does account for 30% of total jobs. As shown in Table 2.3, Aberdeenshire, Shetland and Scottish Borders all have location quotients close to 7, reflecting the concentration of immediate supply chain jobs in these areas. However even within these areas the aquaculture immediate supply chain accounts for only 2% of total employment. There is also a smaller concentration of immediate supply chain employment within Eilean Siar and Dumfries & Galloway, these areas have location quotients of 5.91 and 5.09 respectively. Eight local authorities have no immediate supply chain jobs and a further eight have less than 50.

[19] Steve Westbrook and Imani Development (2017), 'The value of aquaculture to Scotland', at: http://www.hie.co.uk/regional-information/economic-reports-and-research/archive/value-of-aquaculture-2017.html

Table 2.3: Employment within aquaculture immediate supply chain by Local Authority

Local Authority	Immediate supply chain jobs	% of total employment in area	% of national supply chain employment	Location Quotient
Aberdeenshire	2,300	2.2%	30.4%	7.10
Dumfries & Galloway	900	1.6%	12.1%	5.09
Scottish Borders	900	2.2%	11.7%	6.97
Highland	700	0.6%	9.2%	2.04
Aberdeen City	400	0.2%	5.5%	0.75
Argyll & Bute	400	1.1%	5.1%	3.42
South Lanarkshire	400	0.3%	5.0%	1.05
Shetland Islands	300	2.2%	4.3%	7.18
Edinburgh	300	0.1%	3.7%	0.29
Eilean Siar	200	1.8%	2.6%	5.91
North Lanarkshire	200	0.1%	2.4%	0.45
Moray	200	0.5%	2.3%	1.58
East Lothian	100	0.4%	1.5%	1.32
Angus	100	0.3%	1.4%	1.02
Glasgow City	100	0.0%	1.0%	0.06
Falkirk	100	0.1%	0.7%	0.27
South Ayrshire	0*	0.1%	0.4%	0.22
Fife	0*	0.0%	0.4%	0.06
Inverclyde	0*	0.0%	0.1%	0.12
North Ayrshire	0*	0.0%	0.1%	0.08
Perth & Kinross	0*	0.0%	0.1%	0.04
Orkney Islands	0*	0.1%	0.1%	0.04
West Lothian	0*	0.0%	0.1%	0.02
Stirling	0*	0.0%	0.0%	0.01
Total	**7,700**	**0.3%**	**100%**	**1.00**

Source: BRES, 2017

2.35 In terms of employment status for both aquaculture production and the immediate supply chain, nearly 90% of employees work full-time. This is far higher than the rate of full-time working across all sectors, which is 67%. Reflecting that it represents a broader range of jobs, the wider supply chain rate of full-time working is closer to the across-sector rate at 76%.

3 DRIVERS OF CHANGE AND CHALLENGES

SUMMARY

- The *Scottish aquaculture: a view towards 2030* roadmap and the *aquaculture Growth to 2030* strategy set out the ambitions for the sector over the next 12 years, identifying innovation and skills as priorities to support the sector's growth.
- A lower growth scenario would see finfish production grow by 50% from 2014/15 to 2030: the more ambitious industry aspiration is to double growth by 2030 to between 300,000-400,000 tonnes per annum. Both will require skills development to supply an increase in the number of jobs, and accommodate changes in the types of jobs needed in the sector.
- Both higher and lower scenarios depend on overcoming significant challenges and capitalising on opportunities in the short, medium and long term. For challenges such as sea lice and meeting planning requirements, progress is required urgently (i.e. by 2021). Other trends are likely by 2025 (e.g. expansion into more exposed sites), while new operational models are unlikely to be at scale by 2030.
- Currently a key driver for change in the sector and focus of the Scottish Government is fish welfare and environmental stewardship.
- In common with many other sectors, new innovations in aquaculture have and will continue to have an important impact on the sector. There has been a move towards more automation of processes and the application of technology to enhance production and productivity. This changes business models and staffing structures, and will shift more jobs into the supply chain proportionate to on-farm jobs.
- The development of Closed System Aquaculture (CSA) in Scotland would have implications for the skills required in the sector and the supply chain.
- Most R&D and innovation in the sector has been in response to other challenges such as disease and fish health management, as well as climate change and the environmental impact of aquaculture. The industry is taking a proactive approach to addressing current barriers to growth, as well as forecasting and responding to future challenges. This is driving the demand for higher technical skills.
- A considerable amount of engineering takes place in Scotland to supply farm cages, gear and some equipment; however, well boats and much R&D comes from international supply and knowledge networks.
- Changes in the global market mean that Scotland's market share is decreasing. Capacity and production constraints, in part associated with availability of skills, mean that Scotland is not currently able to meet demand for salmon and is therefore becoming a marginal producer.
- Intra-sector working (e.g. between trout and salmon farming) and cross sector collaboration offer key sources of skills development for the aquaculture sector, particularly in terms of skills which are not viewed as traditional to the industry, such as digital.
- Wider issues including industry perception, rural infrastructure and connectivity act as constraints to skills supply.

INTRODUCTION

3.1 This Chapter provides a review of the drivers of change and challenges for skills in the aquaculture sector. Firstly, it presents a summary of the policy and strategy drivers for the sector. It then discusses some of the key challenges facing aquaculture. The chapter also explores how these will affect the future needs of employers and skills demands for the future aquaculture workforce.

KEY DRIVERS AND CHALLENGES

3.2 The aquaculture industry has been described as an 'anchor industry' that supports sustainable and inclusive economic growth, particularly in the Highlands and Islands and Scotland's fragile rural areas. However, the success and socio-economic contribution of shellfish, finfish and seaweed are not yet considered to be close to reaching their full potential, and will continue to under-perform unless key barriers such as access to finance and improving business skills are addressed. The sector's potential growth over the next 12 years or so (as outlined in the Value of Aquaculture research in 2017)[20] is a promising prospect. However, some of the factors driving growth for the industry may also serve to inhibit it, and these factors all have skills implications. These are explored below, drawing on previous research and literature, and through findings from consultations with employers and industry stakeholders.

STRATEGIC AND POLICY DRIVERS

Strategic approaches for the aquaculture sector

3.3 Two key documents have set the context for growth and development of the aquaculture sector in Scotland. The *Aquaculture Growth to 2030*[21] strategy, which sets out the strategic priorities for the sector and *Scottish aquaculture: a view towards 2030*[22], an innovation roadmap for the sector. The latter sets out the aspirations for the sector to retain a premium product, and to realise transformational growth, the journey to achieve this, and the identified priorities to be addressed in the short, medium and long-term future.

3.4 These strategy documents support the evidence base and research requirements for many of the industry's actions going forward, the primary recommendations for each of these are highlighted below. They are drawn on throughout the remainder of this chapter, along with the *Value of Scottish Aquaculture* report.

Table 3.1: Key factors for consideration in the aquaculture sector

Growth to 2030	Innovation Roadmap 2030
• Industry leadership and ambition • Enabling and proportionate regulation • Accelerating innovation • Skills development • Finance • Infrastructure	• Management of biological threats • Streamlining planning and regulation • Meeting market demand • Applied research / skills development • Managing environmental risk • Improving spat availability • Finance • Developing new production models

3.5 Collaboration and co-operative working across the breadth of the aquaculture sector is essential to driving growth. A key priority has been the formation of an Industry Leadership Group (ILG), which is tasked with outlining priorities and delivering progress against the issues identified in both 2030 reports as well as

[20] Steve Westbrook and Imani Development (2017), 'The value of aquaculture to Scotland'

[21] Scotland Food and Drink (2016) *aquaculture Growth to 2030: A strategic plan for farming Scotland's seas*

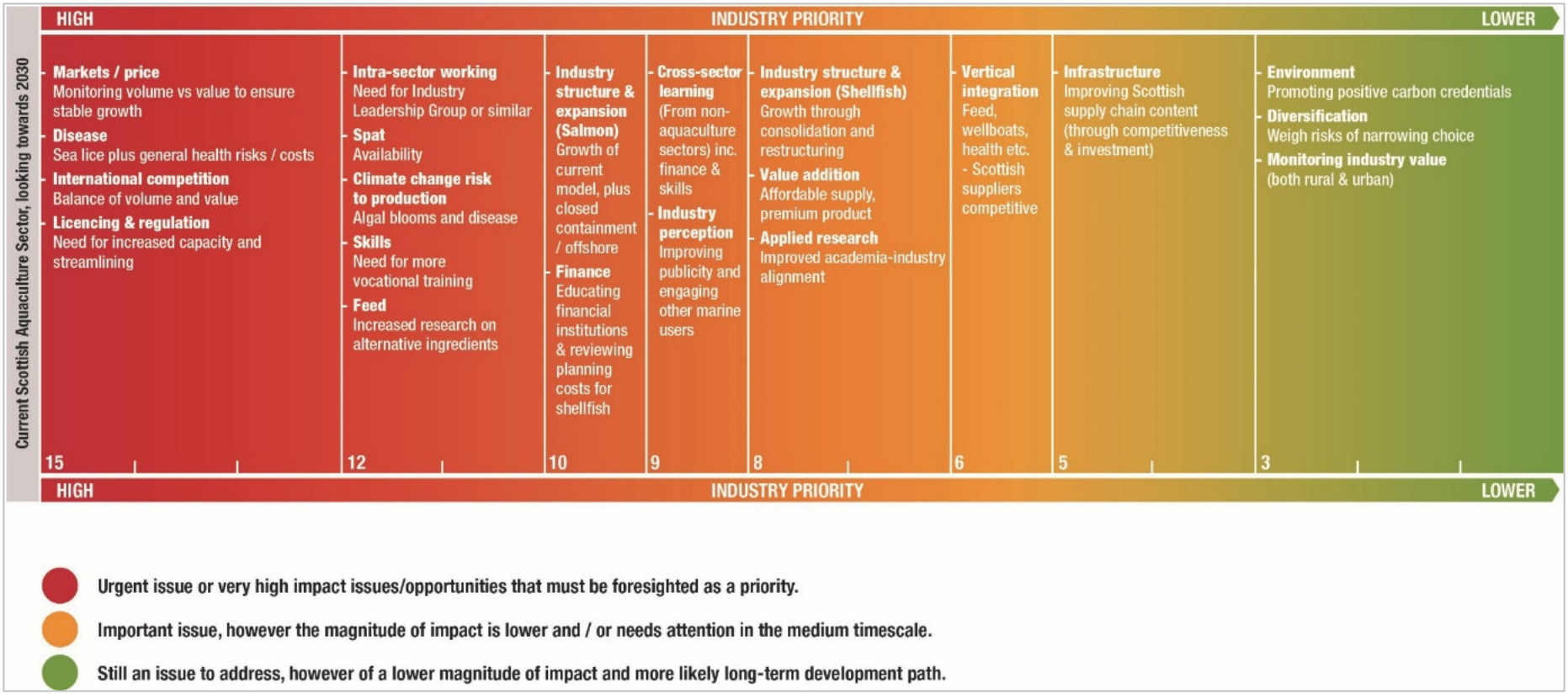
[22] Imani Development, SRSL/HIE, SAIC (2017) *Scottish aquaculture: a view towards 2030*

reviewing and updating these over time. The ILG is key in trying to overcome the varying challenges, and in creating opportunities for the wider sector. Issues such as changing modes of production remain complex, uncertain and interdependent. They include reviewing opportunities for more exposed sites, regulatory review, assessing social impacts and technological developments.

3.6 Key to all of this will be capturing gains throughout the Scottish aquaculture value chain, integrating skills and production objectives for competitiveness in supplier services, processing and retail.

3.7 Figure 3.1 sets out the key industry priorities to 2030 for the aquaculture sector in Scotland. The issues are ranked from high (urgent issue) to low (less urgent) based on 5, 10, and 15-year timescales (2021, 2025, and 2030). Some progress is urgent (i.e. by 2021), some trends likely by 2025 (e.g. expansion into more exposed sites), while new operational models unlikely to be at scale by 2030. The priorities listed below are discussed in more detail in the following section.

Figure 3.1: Key industry priorities of the Scottish aquaculture industry to 2030



Source: Imani Development, SRSL/HIE, SAIC (2017)

3.8 The development of the sector to 2030 is reliant on skills growth, and ensuring that skills supply meets industry demand now and in future. This is an overarching point that spans many of the other issues. Addressing the concerns around innovation, disease, infrastructure, regulatory reform etc. will require skilled individuals with specific knowledge of the aquaculture sector from on-farm husbandry staff through to industry stakeholders.

WIDER STRATEGY AND POLICY

Marine Scotland aquaculture Science and Research Strategy

3.9 Marine Scotland's 2014 *Aquaculture Science and Research Strategy*[23] sets out priorities requiring focused research. These are:

- Nutrition
- Stock Improvement
- Health and Welfare
- Food Safety and Hygiene
- Technology and Engineering
- Wild-Farmed Interactions
- Markets, Economics & Social Science
- Capacity
- Blue Biotechnology and Growth

3.10 These R&D and innovation areas reflect the 2030 Roadmap priorities, though the latter adds that a focus on applied research and technological innovation in the Scottish context is required (acknowledging much of the research relating to Scottish aquaculture is undertaken elsewhere, notably Norway).

Strategic Farmed Fish Health Framework

3.11 Fish welfare and environmental stewardship are the biggest drivers for change in the sector and the Scottish Government is placing a great deal of priority on addressing these issues. In December 2017 the Strategic Farmed Fish Health Framework Working Group was launched with the aim of:

- delivering a high level framework for farmed fish health by Spring 2018;
- overseeing and facilitating the implementation of the fish health framework and providing updates on progress against agreed milestones within each of the priority work streams.

3.12 Membership is drawn from the shellfish and finfish sub-sectors, the Scottish Aquaculture Innovation Centre (SAIC), veterinary professionals, regulatory bodies and Marine Scotland. At the time of writing, the Framework is in draft form and not available but it may have implications for the skills need of the existing workforce and new entrants.

[23] Ministerial Group for Sustainable aquaculture (2014) aquaculture Science & Research Strategy, at: http://www.gov.scot/Resource/0045/00456584.pdf

Scotland's Economic Strategy

3.13 Scotland's Economic Strategy[24] (SES), published in 2015, is focused around four priorities: Innovation, Inclusive growth, Investment and Internationalisation – the 'Four I's'.

3.14 The development and improvement of skills in education and training contributes particularly to Innovation and Inclusive growth. The Innovation priority of SES is particularly important for raising the level of skills in aquaculture. Higher skill levels will mean that aquaculture can continue to innovate, address barriers to growth and maintain its competitiveness. This is in line with aquaculture sector strategies to 2030 which recognise a proportionate shift in jobs to automated models of production, with more supply chain jobs required in engineering and technical services proportionate to on-farm management.[25,26,27]

STEM Education and Training Strategy for Scotland

3.15 The Science, Technology, Engineering and Mathematics Education and Training Strategy for Scotland[28], published in 2017, is particularly important for aquaculture, as STEM skills are key to the sector's growth. In recognition of the growing importance of STEM to the Scottish economy, the Strategy seeks to address how education and training can be improved so as to meet growing demand for STEM skills. The strategy outlines two key aims: to improve levels of STEM enthusiasm, skills, and knowledge in order to raise attainment; and to encourage uptake of more specialist STEM skills required by many sectors. This is evident in the upskilling requirements of the aquaculture sector, including overcoming common research challenges (e.g. spat availability in shellfish, sea lice in finfish) – see figure 3.1.

INDUSTRY CHALLENGES

Research, development and Innovation

3.16 One of the key skills drivers in aquaculture is the scale of innovation and technological change the industry has seen in recent years. This has been, at least in part, driven by the need to address biological challenges and mitigate environmental impacts that have arisen as a result of industry expansion and intensification. While producers have sought to meet demand, there is also an imperative to grow the aquaculture sustainably and minimise the impact on the marine environment.

3.17 R&D and innovation in the sector has also been in response to increasing automation as businesses seek to improve their productivity and competitiveness. Processes such as feeding are now much more mechanised. Monitoring of fish stocks also makes greater use of digital technology, e.g. cameras and remote sensing of environmental conditions such as oxygen levels.

3.18 In terms of future offshore development, ongoing research and investment is needed in developing large-scale technology for offshore equipment (such as cages). This will range from innovation in cage design, to offshore renewable power generation, to remote cameras and sensors to monitor higher rates of wear and tear. A range of engineering and associated scientific skills will be required to support this development. Consultations suggest that more exposed sites using existing technology will be the norm before 2030, but new offshore models are under development and will require a potentially large shift in skills and technology beyond 2030.

3.19 Closed System Aquaculture (CSA), as well as Recirculating Aquaculture Systems (RAS) are proven, viable technologies used to raise salmon and other species in Canada, U.S.A. and China. However, CSA is not yet widely

[24] Scottish Government (2015) Scotland's Economic Strategy at: https://beta.gov.scot/publications/scotlands-economic-strategy/

[25] Food and Drink Scotland (2017) *aquaculture Growth to 2030: A strategic plan for farming Scotland's seas*

[26] Steve Westbrook and Imani Development (2017), 'The value of aquaculture to Scotland', at: http://www.hie.co.uk/regional-information/economic-reports-and-research/archive/value-of-aquaculture-2017.html

[27] Imani Development, SRSL/HIE, SAIC (2017) *Scottish aquaculture: a view towards 2030*

[28] Scottish Government (2017) *Science, Technology, Engineering and Mathematics - Education and Training Strategy for Scotland*

used on a commercial scale for grow-out production of salmon. Various different types of technology is being trialled in Norway, as well as Scotland where Machrihanish now has the world's largest land-based tank for growing market-sized salmon.

3.20 CSAs can be sited on land or water and deliver the primary benefit of having more control over the growing environment for the fish, providing better farming system but also improving animal welfare and reducing environmental issues. The benefits of CSA include reduced water pollution; preventing sea lice issues; reducing the risk of disease transfer to wild salmon; and treatments are more effective in a controlled environment.

3.21 Skills are currently required to undertake the R&D of CSAs and, if they are adopted by the sector in Scotland, there will be specific skills required to produce and maintain the tanks and equipment. The workforce will also need to have the skills and knowledge to work in a new environment, with different process and new types of equipment.

3.22 The *Scottish aquaculture: a view towards 2030* report identifies a need to review technological innovation pathways for the sector in order to address the innovation constraints and provide a roadmap for the sector going forward. Required actions to overcome these constraints could include the promotion of Scottish entrepreneurs, the encouragement of cross-sector partnerships (e.g. with Oil & Gas), and addressing access to markets, particularly for aquaculture SMEs. These constraints and associated actions invariably have skills implications. These are considered in more detail below.

Disease

3.23 Sea lice are the overriding issue for the industry and needs to be addressed in the immediate future (by 2021) to ensure production targets are met and the future of the sector is secure. Reduced production and productivity through mortalities and lower quality/size of harvested fish[29,30] as a result of sea lice is becoming a serious problem for the Scottish salmon industry. If this is not addressed then the implications for Scottish salmon production are significant.

3.24 Sea lice have the potential to restrict the growth of the industry, despite attempts of the sector to manage it. Effective management of sea lice is a major priority for salmon producers[31,32] and Scotland has invested around £30 million annually over the last five years to improve sea lice control.[33] Its investments in biological and engineering solutions will help to reduce the use of medicinal treatments, with their associated negative environmental impacts. These non-chemical approaches include the mechanical removal of sea lice using 'cleaner fish' such as wrasse. Funding is available to assess the effectiveness of this method and to improve efficacy and fish welfare.[34,35]

3.25 In addition to sea lice, there are other diseases that can disrupt production of farmed fish. Controlling these diseases is key and increased monitoring and reporting is required in the short term (up to 2021). If diseases are not contained it will lead to increased costs of production, and the persistence of negative perceptions of the industry. If the issue of sea lice and other diseases is solved or largely addressed, it will have a positive impact on the entire industry, including planning and environmental impact.[36]

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[29] Steve Westbrook and Imani Development (2017), 'The value of aquaculture to Scotland', at: http://www.hie.co.uk/regional-information/economic-reports-and-research/archive/value-of-aquaculture-2017.html

[30] Imani Development, SRSL/HIE, SAIC (2017) *Scottish aquaculture: a view towards 2030*

[31] Steve Westbrook and Imani Development (2017), 'The value of aquaculture to Scotland', at: http://www.hie.co.uk/regional-information/economic-reports-and-research/archive/value-of-aquaculture-2017.html

[32] Imani Development, SRSL/HIE, SAIC (2017) *Scottish aquaculture: a view towards 2030*

[33] Food and Drink Scotland (2017) *aquaculture Growth to 2030: A strategic plan for farming Scotland's seas*

[34] Steve Westbrook and Imani Development (2017), 'The value of aquaculture to Scotland', at: http://www.hie.co.uk/regional-information/economic-reports-and-research/archive/value-of-aquaculture-2017.html

[35] SAIC News release: Scottish aquaculture Innovation Centre to fund industry-changing research on sea lice control. [online] Available at: http://scottishaquaculture.com/wp-content/uploads/2015/04/SAIC.project-announcement-Mar-2015.pdf [Accessed 15 August 2017].

[36] Imani Development, SRSL/HIE, SAIC (2017) *Scottish aquaculture: a view towards 2030*

3.26 The succession of diseases over the longer term is also an important issue and requires constant monitoring throughout the sector. Support needs to be given to develop the fish health and veterinary science skills necessary, to ensure adequate resources are available to develop technology and techniques to eliminate diseases for both finfish and shellfish.

International competition

3.27 The volume of Scottish salmon produced is lower than global market demand for it.[37] If supply continues to be constrained, Scotland may lose out on opportunities as Norway and Chile have the capacity to grow and keep pace with demand. Scotland needs to address these supply constraints as a matter of urgency if we want to retain and potentially grow global market share.[38]

3.28 In 2017, exports of Scottish salmon were valued at £600 million, with a 26% increase on tonnage exported on 2016 figures. Exports included processed as well as whole salmon and the tonnages are therefore not relatable to farm production tonnages. In 2017, the top three markets for Scottish salmon were:[39]

- **USA**: £193 million
- **France**: £188 million
- **China**: £69 million

3.29 The largest market for Scottish salmon is the UK, with Chile and Norway supplementing supply as Scotland cannot keep pace with demand. Imports from these countries reduce the market price of salmon in the UK through competition, and expanding Scotland's export market becomes less profitable.

3.30 The challenge for Scottish salmon producers will likely remain in finding the balance between volume and value, i.e. ensuring that a unique high-quality product is retained, while also growing as a proportion of global market share as demand increases. Scottish salmon production cannot expect, or afford, to remain at current levels and also retain the value proposition – if it produces a decreasing proportion of global demand, it risks being marginalised and superseded by alternative source countries. Ownership structures are also an important consideration with a small number of companies producing salmon globally and so keeping their Scottish production volumes as part of their international production portfolio.

3.31 In terms of sustainable economic growth, the constraints placed on the future growth of the industry paint a different picture going forward:

- The international industry is a profitable, sustainable and high-end industry;
- Scotland is not a large volume producer and is falling behind international competitors in growth terms.

Statutory regulation

3.32 The growth of the Scottish aquaculture sector is, in part, dependent on the regulatory process. International competitors are pursuing greater volume growth in countries such as Norway and Chile. This could result in Scottish production becoming too small and high-cost in relation to the global industry. There is pressure on policymakers to ensure that legislation maintains standards such as environmental and social, whilst enabling sustainable industry growth.

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[37] Imani Development, SRSL/HIE, SAIC (2017) *Scottish aquaculture: a view towards 2030*

[38] Steve Westbrook and Imani Development (2017), 'The value of aquaculture to Scotland', at: http://www.hie.co.uk/regional-information/economic-reports-and-research/archive/value-of-aquaculture-2017.html

[39] http://scottishsalmon.co.uk/salmon-exports-reach-record-600m/

3.33 Time critical issues for the sector are around the cost and time needed to get planning permissions, leases and licenses and the complexities of getting this documentation. Industry actors consider that these need to be addressed by 2021; the majority of the aquaculture industry see the streamlining of these procedures as a top priority[40,41], which is reflected in both the aquaculture Growth to 2030 paper and the Innovation Roadmap to 2030 reports. In addition to this, regional differences in interpretation of rules and the sometimes conflicting aims of planners, licensers, and the government in relation to aquaculture development can cause problems and should be addressed in the longer term (2021–2025). However, they should not be streamlined at the expense of environment and fish health, or a well-regulated industry. Nor should it present a barrier for new entrants to the sector. It is important that the regulation/legislation is proportional and maintains a balanced and environmentally sustainable marine resource.

3.34 The development and implementation of aquaculture policy and regulation has a crucial role in ensuring that Scotland can be one of the global leaders. It is important the industry is underpinned by a regulatory and policy landscape that allows Scottish business to compete on cost and quality. There is an opportunity to align with other food and drink sub-sectors in Scotland by moving the development role into the Scottish Government's Food, Drink & Rural Communities Directorate.

Intra-sector working

3.35 There has been a lack of "information industry networks" where industry can communicate and access information. However, industry bodies such as the Scottish Salmon Producers Organisations (SSPO), Scottish Shellfish Marketing Group (SSMG) and Association of Scottish Shellfish Growers (ASSG) continue to play an important role for their members. Evidence suggests that these types of networks are beneficial to the industry, especially in areas requiring R&D and skills development. Illustrating this, industry requested the formation of the Industry Leadership Group (ILG) in 2017. It is hoped that the ILG will help to drive sector growth and ensure alignment between the industry and Government.

3.36 More industry collaboration will benefit the sector through knowledge and skills transfer (i.e. trout learning from the salmon model), along with more collaboration between industry and academia for greater knowledge exchange. This would more closely align goals and outputs for the sector, ensuring Higher and Further Education Institutions are producing graduates with the skills required by industry.

Cross-sector learning

3.37 There are opportunities for the Scottish aquaculture sector to learn from other players in the sector (such as Norway for salmon and New Zealand for shellfish). There is also potential for knowledge sharing with sectors such as Oil and Gas in relation to technology and offshore operations. The Oil and Gas sector has a large number of staff in transition including Health and Safety and engineers who could bring knowledge and transferrable skills to aquaculture. These workers are used to working in remote and exposed areas and would be able to adapt to conditions on aquaculture farms. Although the aquaculture industry has the option to recruit Oil and Gas workers during periods of downturn, many report that they lose these people once the industry picks up, making this a less sustainable route to meeting the skills demand for the sector. There is also the possibility of using decommissioned oil rigs for aquaculture sites. The Oil and Gas sector understands what a larger sector requires in terms of supply chain development and intra-sector training which will be useful in taking aquaculture to scale.

3.38 In terms of technology transfer, there can also be lessons learned from terrestrial agriculture and other sectors developing new technologies that could be applied in the aquaculture context. Other related industries include Offshore Renewables (operating in exposed seas) and Marine Biotechnology.

[40] Food and Drink Scotland (2017) *aquaculture Growth to 2030: A strategic plan for farming Scotland's seas*

[41] Imani Development, SRSL/HIE, SAIC (2017) *Scottish aquaculture: a view towards 2030*

Climate change and the environment

3.39 The impact of climate change and the associated changes to environmental parameters are an ongoing concern for aquaculture and require monitoring and management. Climate change affects the temperature of water which has consequences for the spread of sea lice and the development of algal blooms. These pose a considerable risk to the sector and the emergence of new pathogens under changing climatic conditions are also of concern and require constant monitoring.

3.40 Although it is low carbon, aquaculture can lead to some environmental impacts through its use of antibiotics and chemicals on sites, as well as the potential impact of diseases. Despite a significant investment and effort from industry to address these issues, the real or perceived negative environmental impacts of finfish farming and the wider impacts on fish stocks remain a concern. It attracts largely negative media coverage which may be detrimental to its development. The finfish industry needs to continue to focus on the low carbon footprint of production in comparison to most protein sources. Raising awareness about these positive environmental credentials, and its proactivity on addressing issues, would help to counter some of the negative perceptions of the sector. It could potentially be incorporated in SEPA's Environmental Impact Assessments (EIA).

3.41 In addition, industry has highlighted that improved efficiency, particularly in terms of waste management should be addressed as it is a key area for growth and can also help to improve the environmental footprint of the sector. Industry has also highlighted that clear standards and protocols should be adopted in terms of biosecurity and health issues.

Feed

3.42 Although finfish production in Scotland is recognised as a low carbon protein supply, sourcing alternative sustainable ingredients to ensure feed production can continue to meet the demands of a growing industry remains a challenge. The primary issue is ensuring a cost effective and sustainable source for the protein elements of the feed as an alternative to fisheries sources. Feed already constitutes around 40% of the production costs for salmon so the aim of the industry is to bring this amount down, while also ensuring optimal feed formulations are used for fish welfare, growth rates and ultimately to ensure a quality product for the end consumer. There remains a sense of urgency in developing alternative protein sources and this needs to be addressed in the short to medium term, including by making sure the research and development skills are in place to work in this field

3.43 A further consideration for the feed industry is increasing levels of vertical integration, with some of the larger finfish producers beginning to produce their own feeds in order to improve efficiencies, reduce costs and have greater control over the production process.

3.44 Although there is in-house capacity for research into probiotics and antibiotics by the feed sector, it is acknowledged that the whole sector benefits from academic and private sector engagement on the development of alternatives.

Industry structure and expansion

3.45 As outlined in chapter 2, aquaculture production is concentrated in the Highlands & Islands, but the supply chain extends in to other parts of Scotland. Competition for space from other marine users is a major consideration when looking at developing production sites and means that the sector needs to find other ways of expanding. Industry is increasingly looking to create sites 'offshore' in more exposed areas (better termed 'more exposed sites', though some ambitious models are accurately 'offshore'). However, it is unlikely that this will be viable in Scotland in the short term partly due to the lack of technology and because of the regulatory process. It does however remain part of the industry focus looking ahead to 2030.

3.46 Although not viable yet in Scotland, there are examples of successful technological innovations in Norway, where there is significant investment in offshore technology. These can be very different to the current operational model (for example, see Salmar's trial site[42]) but they are not expected to be significant in volume delivery in the next decade: rather more immediate and viable is the expansion of the current open pen model into more exposed sites and possibly at greater scale. Nevertheless, because of the ownership structure of a number of Scottish aquaculture producers, the flow of Norwegian innovation IP presents a key learning opportunity for Scottish aquaculture in future. Since the publication of the *Aquaculture Growth to 2030* and *Innovation Roadmap to 2030* reports, there have been developments in offshore cage technology that have been granted development licenses to trial the concepts.[43]

3.47 Although several species are farmed in Scotland, the Scottish aquaculture industry is not diverse when it comes to the species that are farmed. For the foreseeable future, Atlantic salmon will continue to dominate Scottish production. There are opportunities to increase the volume and value of non-salmonid farmed fish including halibut and trout, as well as shellfish and seaweed. There are clear knowledge platforms and investment pathways that have been developed through the 'salmon model' which are being applied to trout farming. Technological and knowledge transfer is important in the short term to ensure that the industry is able to scale up.

3.48 For shellfish, there is still scope for development in Scotland, however most operations remain small-scale. This means that they face issues in accessing finance and scale of development opportunities. The availability of spat is a serious constraint for the mussel industry and development of hatcheries for the shellfish sector needs to be addressed. There are also concerns in production; whilst there is room for expansion, growth needs to be in line with demand.

3.49 As a result of consolidation and vertical integration, there is a small number of large producers that supply chain companies sell in to. This potentially limits opportunities for SMEs to enter and operate in the sector. It can also make supply chain companies vulnerable to economic shocks as a result of a narrow customer base. Sector resilience would be strengthened if there was a greater mix of business sizes and models across the aquaculture value chain. This requires a regulatory and financial landscape that supports the growth of innovative SMEs and allows new entrants and new business models.

3.50 Increasing the production volume of finfish and shellfish could have significant positive consequences for Scottish innovation throughout the supply chain through creating demand, but also maintaining relatively significant volumes which would justify Scotland-specific high value research relative to other countries. If Scottish production were to drop in terms of market share, which is already happening, supply chain activities are likely to suffer, and Scotland would increasingly be a user of external innovation. Increasing volume as a proportion of global market share, as a minimum, must therefore remain a primary focus for Scottish aquaculture, regardless of industry ownership structures.

3.51 When assessing Scottish aquaculture skills development, industry ownership structure is an important consideration in terms of where operations take place, what options exist for the workforce and what supplier links are possible. A considerable amount of engineering takes place in Scotland to supply farm cages, gear and some equipment; however, well boats and much R&D comes from international supply and knowledge networks. Understanding the reasons for this is essential in order to pinpoint what segments should be targeted for competitiveness and skills development, and what may be less valuable and less efficient in its benefit to the Scottish economy. With increased vertical integration, the industry seeks to directly capture these potential economic and efficiency gains in the supply chain that are increasingly off-site (i.e. not direct jobs on a fish farm). It is therefore crucial that skills development is done at a strategic level and includes awarding bodies and industry bodies as well as direct private sector representation from the farming companies and suppliers.

[42] https://www.salmar.no/en/offshore-fish-farming-a-new-era/
[43] Undercurrent News: Marine Harvest given greenlight for offshore 'egg' farm concept, at: https://www.undercurrentnews.com/2017/06/02/marine-harvest-given-greenlight-for-offshore-egg-farm-concept/

Access to finance

3.52 Access to finance is a cross-cutting issue and a considerable challenge for the industry. There is a lack of understanding of the industry amongst banks, particularly for shellfish, and this inhibits access to funding to fuel growth and innovation. Equally, some stakeholders note that the industry's boom and bust in the 1990s has deterred banks unduly now that the industry has consolidated and matured. The industry's assets have not been seen as viable collateral for loans, which means that loan finance has been more limited than in countries such as Norway, where equipment and licence are accepted by banks in the loan process. Further, in salmon production, internal company financing is the norm where businesses in Scotland must demonstrate competitiveness within an international portfolio of production. Scottish banks are now beginning to finance. The opportunity stretches through the supply chain into manufacturing and services, as a single salmon site requires up to £4 million in capital investment, of which a significant proportion is spent in Scotland.[44] If companies do not have access to this finance, it will impact the future of the industry as new sites will not be opened due to lack of finance.

3.53 Banks need to work with industry to ensure the future of the industry. There is an immediate requirement to educate Scottish financial institutions to open up more financing options by 2021.[45] This is already happening for finfish as industry/industry bodies and larger producers are working together to achieve this, so the main focus should be on helping shellfish producers access finance.

Industry perception and quality

3.54 Ongoing work and marketing effort is key to improving the public perception of the industry. Continuing to demonstrate good environmental stewardship, and communicating any improvements are key to this, as is engaging other marine users as pressure for space in onshore waters is increasing. Improving public perception of the industry could provide a significant opportunity for the industry going forward for a number of reasons. At present, the industry is arguably not seen as an attractive employment or career option for many in the labour market (as discussed in Chapter 5). Raising awareness and challenging conventional perceptions of the industry can help to overcome this.

3.55 Maintaining Scotland's current market share within an expanding global market would require a significant increase in the total volume. Key to growing the overseas market will be maintaining a margin for Scottish quality and provenance rather than competing by volume with Norway and Chile. However, a drop in market share poses the risk of marginalisation.

3.56 There is considerable opportunity to exploit the provenance of Scottish aquaculture produce and develop Scotland's brand, focusing on the health benefits of eating seafood; low carbon protein; sustainability; traceability; quality; and other valuable characteristics. However, at present Scotland's price premium is being eroded through negative publicity based on producer's failures to fully address environmental and fish health concerns. Research suggests that there is scope to further capitalise on provenance through innovation in areas such as product development, packaging, and marketing. Current marketing is done in-house by large companies, or by Seafood Scotland, Scotland Food & Drink and Scottish Development International, which are supported by the Scottish Salmon Producers Organisation (SSPO), however there is potential to do more around developing the 'Scottish Salmon' brand independently of the producer company to secure the value to the Scottish economy. Dawnfresh have sought to develop the trout market in a manner similar to salmon, and there is likely scope for this from a commercial and a diversification perspective for Scotland. For shellfish, great gains have been made by pooling of processing and marketing functions by the Scottish shellfish Marketing Group (SSMG) which now covers the majority of production of mussels. Loch Fyne has created its own brand across its operations.

[44] Imani Development, SRSL/HIE, SAIC (2017) *Scottish aquaculture: a view towards 2030*

[45] Imani Development, SRSL/HIE, SAIC (2017) *Scottish aquaculture: a view towards 2030*

Infrastructure and connectivity

3.57 The main issues in terms of processing infrastructure are processor price constraints, improved use of by-products and the need for innovative processing methods/technology. These were identified in the *Scottish aquaculture: a view towards 2030* report as areas for industry to address by continuing to work with the wider sector up to 2030.

3.58 As identified above with regard to industry expansion, there is also a pressing need to develop more sites and at scale, both onshore and offshore. Whilst there are technological challenges to such approaches, there is a need to consider the practical implications of this move in terms of required physical infrastructure. For example, local authorities and industry need to work together to identify these sites and their requirements, whilst carefully considering other established marine users in these areas.

3.59 Alongside developments considering more remote offshore sites, ongoing research and investment is needed in developing large-scale technology for offshore equipment (such as cages). Current equipment in use on existing finfish farms is not sufficiently robust for more extreme conditions.

3.60 Connectivity in rural and remote areas has a significant impact on rural development. Improving reliable connectivity and digital infrastructure has been a priority are for UK and Scottish Government policymakers, with Scottish Government's commitment to deliver superfast broadband access to 100% of premises in Scotland by 2021 ("R100"). HIE have led a £146 million investment in fibre optic broadband for the region since 2013[46] , significantly improving access in rural areas. Around 8 out of 10 of the region's premises are able to access superfast services, but there remains more to do to reach the most remote locations. This impacts on the aquaculture industry in a number of ways. Sites can be in remote locations, not yet served. They are increasingly dependent on digital connectivity for site management and monitoring as systems become increasingly automated and digital. Remote working requires a degree of connectivity from an operational point of view and maintaining contact with staff. While fibre may be closer, and mobile services are improving, there may be a commercial investment required to provide services. There is also an impact in terms of skills. Where there is a lack of connectivity this can often impact on the attractiveness of the work. 'Digital loneliness' can present a considerable barrier to the supply of skills for the sector: consultees have suggested that someone may be willing to work on a remote farm if they can access emails and social media, which is very different to remote working without access.

3.61 The aquaculture sector is increasingly valued as making a case for public infrastructure, and for retaining young people by providing employment opportunities in fragile communities. Increasingly, housing provision is seen as an infrastructure component of aquaculture site agreements, for example in island communities.

3.62 Maintaining infrastructure such as transport is vital to these communities and the sector. Industry bodies need to work with transport providers to highlight the need for aquaculture traffic (such as employment). In order to do this, they will need to liaise with local authorities on transport priorities. For example, it is well known that ferry services are a crucial link for transporting aquaculture produce and should be considered when planning changes to ferry operation, and a joined-up approach with transport authorities could be of value.

[46] HIE (2016) Creating a Digital Region: Digital Highlands and Islands, May 2016

4 SKILLS SUPPLY

SUMMARY

- At school level there were just under 282,000 entries and just under 220,000 passes in aquaculture related subjects in Scotland in 2016.
- In the period from 2010 to 2016 there was a decline in entries and passes in aquaculture related subjects at SCQF Levels 3-5 but an increase in entries and passes at SCQF Levels 6 and 7.
- Over the period from 2014/15 to 2015/16 there was a sharp rise in enrolments on Fish Production/Fisheries Further Education courses.
- Since 2010 the overwhelming majority of students studying aquaculture Fish Production/Fisheries Further Education courses have studied on a part-time basis and for courses not resulting in a qualification.
- Following significant growth in enrolments from 2013/14 to 2015/16 Shetland College accounted for 75% of all enrolments on Fish Production/Fisheries Further Education courses in Scotland in 2015/16.
- Aquaculture related subjects at school and in further education and training continue to be dominated by males who accounted for 56% of entries to aquaculture related subjects at school in 2016; 90% of enrolments on Fish Production/Fisheries Further Education courses in 2015/16 and the vast majority of starters on the aquaculture MA.
- At apprenticeship level, 50 people started an aquaculture Modern Apprenticeship in 2016/17. NAFC recently launched a new aquaculture Management Technical Modern Apprenticeship (SCQF Level 9), with thirteen apprentices starting the course in September 2017.
- At Higher Education level, there were 1,539 students studying aquaculture related courses across 11 Scottish institutions in 2015/16.
- Just over half of students studying aquaculture related courses were enrolled on Zoology degrees with 7% (112) specifically studying aquaculture.
- Over three quarters of students studying aquaculture related degrees are studying for their first degree. However, over the period from 2010/11 to 2015/16 there has been a decline in the number of students studying aquaculture related undergraduate degrees and an increase in the numbers studying Postgraduate degrees.
- Following graduation, in 2015/16 38% of graduates from aquaculture related degrees were in work or studying and working. However, it is not possible to tell what sector they were working in.

INTRODUCTION

4.1 This chapter provides an overview of the education and skills provision for the aquaculture sector in Scotland. It sets out the total number of entrants and passes at school level in aquaculture related subjects and then provides analysis of Further and Higher Education provision in aquaculture related subjects including entrants, level of qualification, subject studied and profile information. In addition, it also details the apprenticeships that are available in aquaculture related subjects.

4.2 The analysis in this chapter draws on data from Scottish Government and Scottish Qualifications Authority (SQA), Skills Funding Council (SFC), and Skills Development Scotland (SDS).

CONTEXT

4.3 As noted in previous studies, the Higher Education aquaculture-related courses provided by Scottish Institutions are highly regarded globally. Scotland has been a leader in providing training and skills development in aquaculture for many years through institutions such as the University of Stirling, North Atlantic Fisheries College (NAFC) Marine Centre in Shetland and St. Andrews University, and is internationally renowned for delivery in the sector. This has been strengthened with the introduction of the Scottish Aquaculture Innovation Centre and further work through industry associations, such as the Scottish Salmon Producers Organisation (SSPO) and the Association of Scottish Shellfish Growers (ASSG). However, there are limited courses and qualifications specific to aquaculture at present, and evidence suggests that this shortage is critical.

4.4 There is a demand for more courses throughout Scotland, and there is also a need for a more vocational, or practical aspect to courses. Training providers are trying to address this demand. The delivery of Apprenticeships in aquaculture at SCQF Level 5 (SVQ Level 2) and SCQF Level 7 (SVQ Level 3), introduction of an SVQ in Boat building and repair and the recent development of the Technical Modern Apprenticeship in aquaculture Management at SCQF Level 9 (SVQ Level 4) indicate that providers are seeing the need to create further training opportunities, in addition to the traditional BSc and MSc courses already on offer. There are also a number of other Apprenticeship frameworks that are under consideration. In addition, SDS is continually engaging with industry to assess demand for work based learning to expand the Apprenticeship Family. For example, they are currently exploring demand for a rural skills Foundation Apprenticeship that would cover agriculture, forestry, and aquaculture.

SCHOOLS PROVISION

4.5 This section provides analysis of entries and passes for school qualifications in aquaculture-related subjects. This includes Biology, Chemistry, Health and Food Technology for SCQF Levels 3-7. Additional subjects include Environmental Science at SCQF Levels 3-6, General Science for SCQF Levels 3-5, and Biotechnology for SCQF Level 6.

Entries

4.6 In 2016, there were a total of 281,965 entries to aquaculture related subjects across SCQF Levels 3-7, 55% of which were male (Table 4.1). While entries for SCQF Levels 3-5 decreased by around 9% from 2010 to 2016, they increased for SCQF Level 6 and 7 (by 3% and 13% respectively or 10% and 33% respectively when considering data from 2007).

4.7 From 2010 to 2016 there have been more male entrants than female entrants each year for aquaculture-related subjects at school level. In 2016 there were ~113,000 male entrants compared to ~90,000 female entrants at SCQF Levels 3-5. The overall decrease of entries at these levels was greater for females (-13%) than males (-6%). At SCQF Level 6 there were ~6,000 more male entrants than females, and ~2,000 more male entrants at SCQF Level 7.

Table 4.1: Aquaculture-related entries for pupils in Scotland, SCQF Levels 3-7, 2010/11-2015/16

Entries	2010	2011	2012	2013	2014	2015	2016	Change, 2010-16
SCQF Levels 3-5 (National)								
All	223,423	221,308	222,601	216,227	208,358	205,783	202,797	-9%
Female	*103,262*	*101,044*	*101,442*	*98,240*	*93,643*	*91,262*	*89,938*	*-13%*
Male	*120,161*	*120,264*	*121,159*	*117,987*	*114,715*	*114,521*	*112,859*	*-6%*
SCQF Level 6 (Highers)								
All	65,652	66,582	66,670	67,115	70,083	71,027	67,363	3%
Female	*29,846*	*30,404*	*30,545*	*31,026*	*31,587*	*32,330*	*30,664*	*3%*
Male	*35,806*	*36,178*	*36,125*	*36,089*	*38,496*	*38,697*	*36,699*	*2%*
SCQF Level 7 (Advanced Highers)								
All	10,410	11,143	11,686	11,881	12,099	12,388	11,805	13%
Female	*4,383*	*4,616*	*4,836*	*5,009*	*5,217*	*5,044*	*4,971*	*13%*
Male	*6,027*	*6,527*	*6,850*	*6,872*	*6,882*	*7,344*	*6,834*	*13%*
Total: SCQF Levels3- 7								
All	299,485	299,033	300,957	295,223	290,540	289,198	281,965	-6%
Female	*137,491*	*136,064*	*136,823*	*134,275*	*130,447*	*128,636*	*125,573*	*-9%*
Male	*161,994*	*162,969*	*164,134*	*160,948*	*160,093*	*160,562*	*156,392*	*-3%*

Source: SQA, 2017

Passes

4.8 In 2016, there were a total of 219,912 passes across SCQF Levels 3-7, with a pass rate of 78% (Tables 4.2 and 4.3). The number of passes from 2010 to 2016 follows broadly the same pattern as entries, with a decrease at SCQF Levels 3-5 (down 19%), and an increase at SCQF Levels 6 (0.4%) and 7 (17%). This represents a pass rate decrease of around 9 percentage points (from 89% to 80%) for SCQF Levels 3-5 and a pass rate increase of around 2 percentage points (from 75% to 77%) for SCQF Level 7. At SCQF Level 6, despite the marginal increase in passes, the pass rate decreased by around 2 percentage points from 74% to 72%.

4.9 In 2016 there were ~90,000 male passes compared to ~72,000 female passes at SCQF Levels 3-5 (55% male to 44% female). The decrease in passes at this level was greater for females than males. At SCQF Level 6 there were ~3,000 more male passes than females (53% male to 47% female), and ~1,000 more male passes at SCQF Level 7 (56% male to 44% female). The ratios are therefore broadly similar across levels, with slightly closer parity in SCQF Level 6.

4.10 Overall, this reflects broader trends for entries in STEM subjects. Even though fewer school pupils are taking aquaculture-related subjects, a greater proportion of those that do are taking them at a higher level. However, the overall pass rate across SCQF Levels 3-7 has also decreased, which is a concern for the potential supply of students for FE, HE or Apprenticeship study.

Table 4.2: Aquaculture related passes for pupils in Scotland, SCQF Levels 3-7, 2010/11-2015/16

Passes	2010	2011	2012	2013	2014	2015	2016	Change, 2010-16
SCQF Levels 3-5 (National)								
All	199,152	198,723	198,393	193,765	165,771	164,174	162,026	-19%
Female	92,035	90,882	90,430	88,182	74,546	72,353	71,897	-22%
Male	107,117	107,841	107,963	105,583	91,225	91,821	90,129	-16%
SCQF Level 6 (Highers)								
All	48,554	49,612	50,155	50,052	51,145	51,759	48,741	0.4%
Female	22,093	22,818	23,110	23,382	23,317	23,910	22,830	3%
Male	26,461	26,794	27,045	26,670	27,828	27,849	25,911	-2%
SCQF Level 7 (Advanced Highers)								
All	7,829	8,574	9,029	9,353	9,206	9,510	9,145	17%
Female	3,385	3,713	3,826	4,072	4,080	4,024	4,040	19%
Male	4,444	4,861	5,203	5,281	5,126	5,486	5,105	15%
Total: SCQF Levels3- 7								
All	255,535	256,909	257,577	253,170	226,122	225,443	219,912	-14%
Female	*117,513*	*117,413*	*117,366*	*115,636*	*101,943*	*100,287*	*98,767*	-16%
Male	*138,022*	*139,496*	*140,211*	*137,534*	*124,179*	*125,156*	*121,145*	-12%

Source: SQA, 2017

Table 4.3: Pass rate in aquaculture-related subjects for pupils in Scotland, SCQF Levels 3-7, 2010/11-2015/16

Pass rate	2010	2011	2012	2013	2014	2015	2016	Change, 2010-16
SCQF Levels 3-5 (National)								
All	89%	90%	89%	90%	80%	80%	80%	-9 p.p.
Female	*89%*	*90%*	*89%*	*90%*	*80%*	*79%*	*80%*	*-9 p.p.*
Male	*89%*	*90%*	*89%*	*89%*	*80%*	*80%*	*80%*	*-9 p.p.*
SCQF Level 6 (Highers)								
All	74%	75%	75%	75%	73%	73%	72%	-2 p.p.
Female	*74%*	*75%*	*76%*	*75%*	*74%*	*74%*	*74%*	-
Male	*74%*	*74%*	*75%*	*74%*	*72%*	*72%*	*71%*	*-3 p.p.*
SCQF Level 7 (Advanced Highers)								
All	75%	77%	77%	79%	76%	77%	77%	+2 p.p.
Female	*77%*	*80%*	*79%*	*81%*	*78%*	*80%*	*81%*	*+4 p.p.*
Male	*74%*	*74%*	*76%*	*77%*	*74%*	*75%*	*75%*	*+1 p.p.*
Total: SCQF Levels3- 7								
All	85%	86%	86%	86%	78%	78%	78%	-7 p.p.
Female	*85%*	*86%*	*86%*	*86%*	*78%*	*78%*	*79%*	*-7 p.p.*
Male	*85%*	*86%*	*85%*	*85%*	*78%*	*78%*	*77%*	*-8 p.p.*

Source: SQA, 2017

COLLEGE PROVISION

4.11 Colleges in Scotland deliver a range of provision of relevance to the aquaculture industry. This includes short courses related to fish health, workboats, safety and water quality, as well as National Progression Awards (NPAs) in aquaculture, and Scottish Vocational Qualifications (SVQs) that form part of wider Apprenticeship education and training. SVQ courses include qualifications in aquaculture Management at SVQ Levels 2, 3 and 4. As mentioned, the SVQ Level 4 course has been recently developed and is currently only available at NAFC. Data on aquaculture education delivery in Scotland's colleges is captured by SFC within the *Fish production/fisheries* superclass. No further disaggregation of the data into *Fish production* and *Fisheries* is available.

Total enrolments, FTEs and credits

4.12 Enrolment levels to *Fish production/Fisheries* courses were relatively steady from 2010/11 through to 2014/15. However, there was a sharp rise in 2015/16 to 435 enrolments, up from 162 in the previous year (Table 4.4). The reason for this rise is unclear. Enrolments to Fish production/Fisheries courses only accounted for around 0.2% of all college enrolments in Scotland in 2015/16 (281,051).

4.13 A considerable proportion of enrolments were on a part-time basis, demonstrated by the low number of FTEs in comparison to overall enrolments. The number of credits per enrolment were also low, down from 2.8 in 2014/15 to less than one in 2015/16. The low number of credits and FTEs in comparison to enrolments indicates a high number of short courses being taken.

Table 4.4: College enrolments, credits[47] and FTEs for FE Fish Production/Fisheries courses, 2010/11-2015/16

Level	2010/11[48]	2011/12	2012/13	2013/14	2014/15	2015/16
Enrolments	156	93	136	121	162	435
FTEs	31.71	25.36	20.92	20.37	32.25	28.97
Credits	-	-	-	297.83	456.32	407.62
Credits per enrolment	-	-	-	*2.5*	*2.8*	*0.9*

Note: Credits measure the volume of learning activity, and provide an indication of the level of activity being delivered. One credit is equivalent to 40 hours of learning.
Source: SFC, 2017

4.14 Due to the low level of FTEs and credits, the remaining analysis focuses on enrolments only.

Enrolments by college region

4.15 College provision for *Fish Production/Fisheries* college courses is available across two of Scotland's 13 college regions, as well as SRUC/land-based delivery.[49] Provision is concentrated in the Highlands and Islands college region which accounted for approximately 95% (412) of all enrolments in 2015/16 (Table 4.5).

[47] Credit data was only recorded from 2013/14

[48] During 2010/11, there were 6 enrolments (and 7 FTEs) on HE level Fish Production/Fisheries courses. The 6 enrolments were at Scotland's Rural College (SRUC). All 6 were male, full-time enrolments, of which 3 were 16-19 with the remaining 3 in the 25 and over age group. All other enrolments, FTEs and Credits were at FE level

[49] This covers total delivery by SRUC, data for which is not captured on a geographical basis by SFC

Table 4.5: Enrolments to FE Fish Production/Fisheries courses by college region, 2010/11-2015/16

College region	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	Change, 2010/11-2015/16 (%)
Highlands & Islands	120	58	70	94	148	412	+243%
SRUC/Land-based	42	35	56	9	2	23	-45%
Aberdeen and Aberdeenshire	0	0	10	18	12	0	0%
Total	**162**	**93**	**136**	**121**	**162**	**435**	**+169%**

Source: SFC, 2017

Enrolments by FE institute

4.16 Nine colleges across Scotland deliver FE-level *Fish Production/Fisheries* College courses. However, the pattern of provision has changed, and it is increasingly dominated by one provider - Shetland College of Further Education (including NAFC)[50] – which accounted for around 75% of all enrolments in 2015/16. In the period from 2010/11 the number of enrolments on Fish Production/Fisheries courses at Shetland College has grown from zero to 329, in contrast to the decrease at other providers. This growth is concentrated within the period from 2014/15 to 2015/16 when enrolments increased by over seven times. Elsewhere, enrolments at Orkney College and Barony College have declined significantly.

Table 4.6: Enrolments to FE Fish Production/Fisheries courses by institution, 2010/11-2015/16

College	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	Change, 2010/11-2015/16 (%)
Shetland College of Further Education	0	1	0	18	43	329	-
Inverness College	58	34	46	52	63	54	-7%
Lews Castle College	0	5	18	12	34	28	-
Land-based	0	0	0	0	2	23	-
Orkney College	59	15	6	0	8	1	-98%
Banff and Buchan College of Further Education	0	0	10	18	0	0	0%
Barony College, SRUC, Dumfries and Galloway	42	35	56	9	0	0	-100%
North East Scotland College	0	0	0	0	12	0	-
North Highland College	3	3	0	12	0	0	-100%
Total	**162**	**93**	**136**	**121**	**162**	**435**	**+169%**

Source: SFC, 2017

Mode of study (FT/PT split)

4.17 Since 2010, enrolments in FE-level *Fish Production/Fisheries* courses have been overwhelmingly part-time, accounting for 100% of enrolments in 2014/15 and 2015/2016. With the exception of 2011/12 where full-time study accounted for 10% of enrolments, in previous years full-time study has accounted for less than 5% of enrolments.

[50] This is NAFC Marine Centre; it is captured as *Shetland College as Further Education* by SFC statistics

Table 4.7: Enrolments to FE Fish Production/Fisheries courses by mode of study, 2010/11-2015/16

Mode of study	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	Change, 2010/11-2015/16 (%)
Full-time	9	9	5	3	0	0	-100%
Part-time	153	84	131	118	162	435	+184%
Total	**162**	**93**	**136**	**121**	**162**	**435**	**+169%**

Source: SFC, 2017

Profile of learners

4.18 The age profile of the Fish Production/Fisheries students tends to be slightly older. In 2015/16 those aged 25+ accounted for 66% of total enrolments. Fourteen percent of those enrolling on *Fish Production/Fisheries* courses were aged between 20 and 24, while the under-16 and 16-19 cohorts accounted for around a tenth of enrolments each.

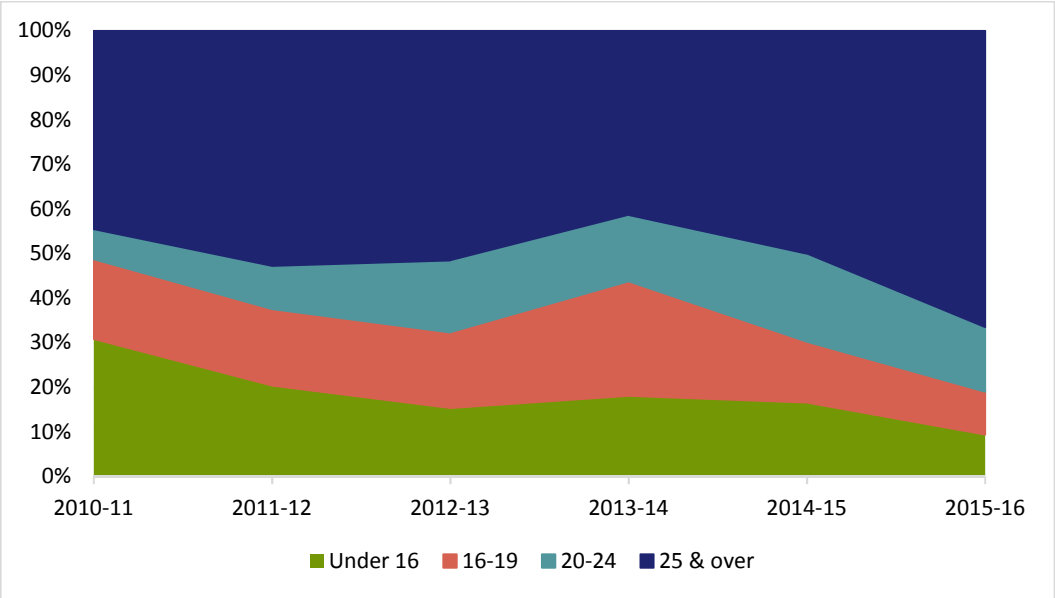
Table 4.8: Enrolments to FE Fish Production/Fisheries courses by age, 2010/11-2015/16

Age	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Change, 2010/11-2015/16 (%)
Under-16	50	19	21	22	27	41	-69%
16-19	29	16	23	31	22	42	-46%
20-24	11	9	22	18	32	63	+113%
25 & over	72	49	70	50	81	289	+49%
Total	**162**	**93**	**136**	**121**	**162**	**435**	**+169%**

Source: SFC, 2017

4.19 The proportion of enrolments accounted for by those aged 25 and over has increased considerably over the time period, from 44% in 2010/11 to 66% in 2015/16 (Figure 4.1). However, there has been some fluctuation in the intervening years. The proportion of enrolments amongst those aged 20-24 has also increased over this time period, from 7% to 14%.

Figure 4.1: Age profile of enrolments to FE Fish Production/Fisheries courses, 2010/11-2015/16



Source: SFC, 2017

4.20 Males have accounted for over 85% of those enrolling on Fish Production/Fisheries FE-level College courses from 2010/11 to 2015/16. The gender imbalance was at its greatest during 2015/16, where males accounted for 93% of enrolments. This reflects the strong over-representation of males in the sector.

Table 4.9: Enrolments to Fish Production/Fisheries FE-level courses by gender, 2010/11-2015/16

Gender	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	Change, 2010/11-2015/16 (%)
Female	18	12	15	14	24	29	+61%
Male	144	81	121	107	138	406	+182%
Total	**162**	**93**	**136**	**121**	**162**	**435**	**+169%**

Source: SFC, 2017

Provision by qualification aim

4.21 In 2015/16, 75% of all enrolments to FE-level *Fish Production/Fisheries* courses were for courses that do not lead to any recognised qualification, up from around 15% in the previous two years. Of the remainder, 5% were for "Other non-advanced certificate or equivalent"; 8% led to school level qualifications (Intermediate 1 & 2, or Highers and Advanced Highers); and 8% resulted in qualifications at SVQ Levels 2 and 3 (Table 4.10).

4.22 Since 2010/11, the number and range of enrolments by qualification type has varied each year. In comparison to 2015/16 where the increase in enrolments is dominated by courses that do not result in a recognised qualification, around half of enrolments in 2014/15 were for SVQ Level 2 (27%) or school level qualifications (22%). A further fifth (21%) led to "other recognised qualifications".

Table 4.10: Enrolments to FE Fish Production/Fisheries courses by qualification, 2010/11-2015/16

Qualification aim	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	Change, 2010/11-2015/16 (%)
Programme not leading to recognised qualification	66	16	0	18	23	341	417%
Other non-advanced certificate or equivalent	0	9	37	26	12	23	-
SVQ: Level 2	22	14	26	25	36	22	0%
Highest level of study (unit)intermediate 1	0	0	0	11	14	16	-
SVQ: Level 3	11	12	10	16	13	13	18%
Highest level of study (unit) intermediate 2	0	0	11	15	30	11	-
Highest level of study (unit) higher	0	0	6	7	0	9	-
Highest level of study (unit) advanced higher	0	0	0	3	0	0	-100%
National units alone (formerly National Certificate modules)	31	20	18	0	0	0	-100%
Any other recognised qualification	26	22	28	0	34	0	-100%
HNC or equivalent	6	0	0	0	0	0	-100%
Total	**162**	**93**	**136**	**121**	**162**	**435**	**+169%**

Source: SFC, 2017

APPRENTICESHIP FAMILY PROVISION

Modern Apprenticeship Aquaculture Framework

Starts by level and gender

4.23 The Modern Apprenticeship (MA) Aquaculture Framework covers 'relevant SVQs (or alternative competency based qualifications), Core Skills, and industry-specific training'[51]: for example, general skills of problem solving and communication, and specific requirements of first aid and boat handling qualifications.

4.24 A total of 50 people started the Framework in 2016/2017 (MA Level 2-5), accounting for 0.2% of all MA intakes across Scotland. While the total number of starters decreased from 77 in 2013/14 to 44 in 2014/15, they have since increased slightly in each year.

4.25 There are significantly more males that enrol on this MA than females reflecting the gender imbalance in the industry (Table 4.11). In 2015/16 there were only 6 females enrolled on the Aquaculture MA compared to 47 males.

Table 4.11: Total number MA aquaculture starts by level and gender, 2013/14-2016/17

Level	2013/14		2014/15		2015/16		2016/17*	
	Female	Male	Female	Male	Female	Male	Female	Male
MA Level 2	1	63	1	27	6	26	0	39
MA Level 3	1	12	2	17	0	21	11[52]	
MA Level 4	0	0	0	0	0	0	0	0
MA Level 5	0	0	0	0	0	0	0	0
MA All	**2**	**75**	**3**	**44**	**6**	**47**	**0**	**50**

Source: SDS, 2017

Leavers and achievements

4.26 A total of 59 people completed[53] the Aquaculture Framework (MA Level 2-5) in 2016/17, accounting for 0.2% of all MA completions across Scotland (Table 4.12).

4.27 Achievement levels for Aquaculture framework leavers in 2016/17 overall was just over 85% For males, the achievement rate was 89%, whilst for females it was 25%. However, this is based on small numbers of females.

Table 4.12: Total number of female and male aquaculture MA leavers, 2013/14 – 2016/17

Level	2013/2014		2014/2015		2015/2016		2016/2017		Achievement rate, 2016/17
	Female	Male	Female	Male	Female	Male	Female	Male	
MA Level 2	0	35	1	36	2	44	42[54]		86%
MA Level 3	0	7	2	29	2	54	0	17	82%
MA Level 4	0	0	0	0	0	0	0	0	-
MA Level 5	0	0	0	0	0	0	0	0	-
MA All	**0**	**42**	**3**	**65**	**4**	**98**	**59**		**85%**

Source: SDS, 2017

[51] https://www.skillsdevelopmentscotland.co.uk/media/41563/aquaculture-framework-l2-revised-2.pdf

[52] No gender breakdown for starts at MA Level 3

[53] It should be noted that leaver and achievement data for any given year is not related to data for MA starts in the same year. Further, leaver and achievement data do not relate directly to starts data from previous years, since Apprentices do not take a set length of time to complete, though there is a maximum length of time.

[54] No gender breakdown for leavers at MA Level 3

Other Modern Apprenticeship Frameworks

4.28 There are other modern apprenticeship frameworks of relevance to aquaculture. For example, the MA in Food Manufacturing Operations has a specific pathway for Seafood Processing. MA data is not collected by pathway, however the number of people undertaking a work based learning qualification through this Seafood Processing pathway is estimated to be around 200 annually. In addition, there are cross sectoral MA Frameworks that the aquaculture sector will be accessing, including Engineering, Business Administration, Procurement, etc.

4.29 In 2017, the delivery of a new Technical Modern Apprenticeship[55] in Aquaculture Management at SCQF Level 9 (SVQ Level 4) was launched at NAFC Marine Centre. Aimed at providing the skills required for farm management, it was developed in consultation with aquaculture employers and industry bodies, and complements existing Aquaculture Modern Apprenticeship frameworks. There were a total of **14** starts in October 2017. It is anticipated that UHI and Polaris Learning may also deliver the Technical Modern Apprenticeship in future.[56]

UNIVERSITY PROVISION

4.30 There are a number of higher education institutions that offer aquaculture-related courses. The HESA/JACS courses included for the analysis are set out in Appendix 4. In 2015/16 there was a total of 1,539 students studying aquaculture-related courses across 11 Scottish institutions (Table 4.13). This represents a 6% reduction in the number of students compared with 2010/2011, but is an increase in the total number of students studying in 2013/2014 and 2014/2015.

Provision by subject

4.31 Zoology accounts for the largest number of students studying aquaculture-related subjects (51%), followed by Marine biology (13%). Aquaculture accounted for 7% of students in 2015/2016, a 1% increase on the previous academic year. Over the period from 2010/11 to 2015/16 there has been a very significant fall (84%) in the number of students enrolled on Environmental chemistry courses. The reasons for this are not clear. There has also been a 26% fall in Environmental biology students and, perhaps most significantly, a 15% reduction in aquaculture students. Over the same period there have been growths of 29% and 11% respectively in Marine zoology and Marine biology enrolments.

Table 4.13: Students studying aquaculture related courses at Scottish Higher Education Institutions by subject, 2010/11-2015/16

Subject	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Change, 2010/11-2015/16 (%)
Zoology	830	678	656	605	606	788	-5%
Marine biology	177	205	162	167	190	196	11%
Marine zoology	130	132	148	139	157	168	29%
Marine/Freshwater biology	129	222	207	182	180	138	7%
Environmental biology	167	151	183	121	119	124	-26%
Aquaculture	131	96	131	129	115	112	-15%
Environmental chemistry	74	28	23	9	7	12	-84%
Freshwater biology	0	0	0	0	0	1	-
Marine chemistry	0	0	1	0	0	0	-
Total	**1,638**	**1,512**	**1,511**	**1,352**	**1,374**	**1,539**	**-6%**

Source: SFC, 2017

[55] Though part of the Modern Apprenticeship family, this is effectively delivered at degree level, and is referred to by both SDS and Lantra, the Sector Skills Council as a Technical Modern Apprenticeship rather than a Modern Apprenticeship

[56] Lantra (2015) Scottish Higher Level Apprenticeships: A Technical Modern Apprenticeship in aquaculture Management at SCQF 9 – Framework Document for Scotland

Provision by institute

4.32 Ten universities in Scotland delivered aquaculture related courses in 2015/16. With 378 enrolments, the University of Aberdeen was the largest provider. It was followed by the University of Glasgow (361) and the University of Stirling (271). In total these three institutions accounted for just under two thirds of all aquaculture related enrolments in Scotland (Table 4.14).

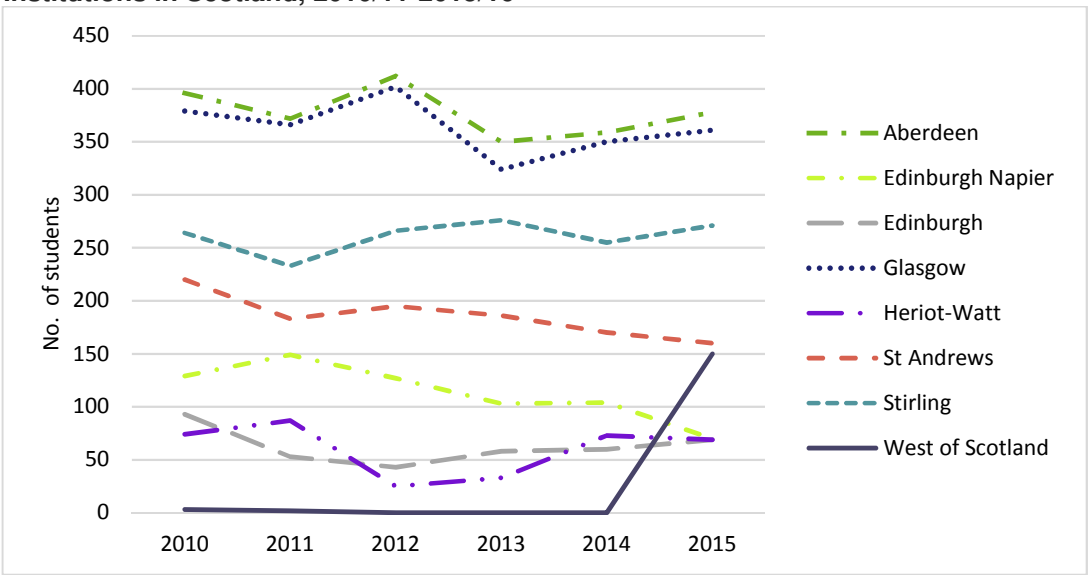
Table 4.14: Students studying aquaculture related courses at Scottish Higher Education Institutions by institution, 2010/11-2015/16

Institution	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Aberdeen, University of	396	372	412	350	359	378
Glasgow, University of	379	366	402	324	350	361
Stirling, University of	264	233	266	276	255	271
St Andrews, University of	220	183	195	186	170	160
West of Scotland, University of the	3	2	-	-	-	150
Edinburgh Napier University	129	149	127	103	104	70
Edinburgh, University of	93	53	43	58	60	69
Heriot-Watt University	74	87	25	33	73	69
Robert Gordon University	1	1	1	2	3	7
Highlands and Islands, University of the	1	1	1	-	-	4
Dundee, University of	78	65	39	20	-	-
Total	**1,638**	**1,512**	**1,511**	**1,352**	**1,374**	**1,539**

Source: SFC, 2017

4.33 Across most institutions there has been a reduction in aquaculture related enrolments from 2010/11 to 2015/16 (Figure 4.2). Most significantly, the University of Dundee has seen a reduction in enrolments from 78 in 2010/11 to none in 2014/15 and 2015/16. Over the same period Edinburgh Napier University and the University of St Andrews have also seen significant falls of 59 and 60 enrolments respectively. Against the trend, the University of the West of Scotland has seen a significant increase in aquaculture related enrolments resulting from an increase in its course portfolio, from very small numbers in 2010/11 and 2011/12 and none from 2012/13 to 2014/15 to 150 in 2015/16.

Figure 4.2: Total number of students studying aquaculture related courses across different Higher Education Institutions in Scotland, 2010/11-2015/16



Source: SFC, 2017

Provision by level

4.34 In 2015/16 the majority of students studying aquaculture-related courses at Scottish HEIs were studying them as a First degree (77%), followed by postgraduate taught degrees (14%) and then postgraduate research degrees (8%). In the period from 2010/11 to 2015/16 there was a 10% growth in the number of students studying Postgraduate research degrees, accompanied by a fall in the number of Undergraduate students studying aquaculture-related degrees as a First Degree (a decrease of 8%) or Other Undergraduate degree (38% decrease). However, it should be noted that only a small number of students study Other Undergraduate degrees and therefore the 38% reductions accounts for just eight students.

Table 4.15: Students studying aquaculture related courses at Scottish Higher Education Institutions by course level, 2010/11-2015/16

Level of study	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Change, 2010/11-2015/16 (%)
Postgraduate Research	106	101	148	114	107	117	10%
Postgraduate Taught	218	202	180	167	220	221	1%
First Degree	1,293	1,201	1,159	1,046	1,023	1,188	-8%
Other Undergraduate	21	8	24	25	24	13	-38%
Total	**1,638**	**1,512**	**1,511**	**1,352**	**1,374**	**1,539**	**-6%**

Source: SFC, 2017

Provision by age

4.35 In 2015/16 nearly half (48%) of students studying aquaculture related courses at Scottish HEIs were aged 20-24. Just under one third (32%) were aged 16-19 and the remaining 20% were 25 or older. Over the period from 2010/11 to 2015/16 the share of each age group has remained fairly stable as there has been a similar decline (5% or 6%) in the number of students across all age groups (Table 4.16).

Table 4.16: Students studying aquaculture related courses at Scottish Higher Education Institutions by age, 2010/11-2015/16

Age	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Change, 2010/11-2015/16 (%)
16-19	527	496	454	402	466	494	-6%
20-24	789	731	728	670	608	739	-6%
25+	322	285	329	280	300	306	-5%
Total	**1,638**	**1,512**	**1,511**	**1,352**	**1,374**	**1,539**	**-6%**

Source: SFC, 2017

Provision by domicile of students

4.36 In 2015/16 over half (61%) of students studying aquaculture related courses at Scottish HEIs were Scottish domiciled. Following this, 17% were from elsewhere in the UK and 12% were European Union domiciled (Table 4.17). This could be of importance for industry as, arguably, Scottish domiciled students are more likely to stay on to live and work in Scotland after graduation, as identified through consultations. Over the period from 2010/11 to 2015/16 there has been a reduction in students from all domiciles, apart from Other Overseas. The most significant decline has been in rest-of-UK domiciled students where there has been a reduction of 25% or 89 students.

Table 4.17: Students studying aquaculture related courses at Scottish Higher Education Institutions by domicile, 2010/11-2015/16

Domicile	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Change, 2010/11-2015/16 (%)
Scotland	952	902	893	798	804	944	-1%
Rest of UK	355	298	286	264	261	266	-25%
European Union	193	189	174	146	161	184	-5%
Other Overseas	138	123	158	144	148	145	5%
Total	**1,638**	**1,512**	**1,511**	**1,352**	**1,374**	**1,539**	**-6%**

Source: SFC, 2017

Graduate destinations

4.37 Almost two fifths (38%) of graduates in aquaculture-related subjects in 2015/16 were in work/in work and studying six months after graduation. By degree, the proportion of graduates in employment was lowest for those who studied aquaculture, at 25%. A further two fifths of graduates (43%) in aquaculture related subjects were classified as 'other', which includes those due to start work. However, it is not possible to tell if any of these graduates or others who studied wider aquaculture-related subjects pursued careers in the aquaculture sector.

Table 4.18: Graduate destinations of students who studied aquaculture-related subjects, 2015/2016

2015/2016	Full / Part time work	In work and studying	Full/part time studying	Unemployed	Other*
Zoology	39%	2%	12%	9%	38%
Marine biology	38%	6%	3%	6%	49%
Environmental Biology	31%	2%	8%	12%	47%
Marine zoology	40%	0%	31%	4%	25%
Marine/Freshwater biology	33%	0%	7%	7%	54%
Aquaculture	22%	3%	9%	6%	59%
Total	**36%**	**2%**	**11%**	**8%**	**43%**

Notes: *Other includes: Due to start work, Other, Ineligibility/explicit refusal/non-response, Missing

Source: HESA Graduate Destinations survey from SFC, 2017

5 SKILLS CHALLENGES AND OPPORTUNITIES

SUMMARY

- Skills demand is greatest in production rather than other parts of the sector, such as processing or the wider supply chain. Leadership and organisational management skills are in demand across the sector, along with boat skills and engineering skills, in part led by consolidation in the sector.
- The sophisticated growth of finfish has driven the need for farm management skills. There is also a strong need for Fish health/husbandry skills, and also Digital skills, driven by expansion, automation and intensification of production.
- The primary skills requirement in shellfish is for personnel. Succession planning is also driving a need for replacement demand. Where consolidation is occurring, shellfish is starting to see skills needs akin to those in finfish, e.g. skills to work within a more technical approach to production.
- The supply chain demonstrates similar technical skills demand to those reported by finfish and shellfish employers.
- In future, demand for technical skills is expected to increase, with more specialist and niche skills required, as the industry develops and adopts more sophisticated and innovative techniques and technology. Softer, transferable skills are also required both now and in future to be able to continually adapt to changes within the sector.
- Fish health and welfare is the key priority for the sector and there is a requirement for R&D skills to develop and apply solutions. There will also be a need for skills to adapt to changes driven by fish health and welfare concerns, for examples in equipment, processes and ways of working.
- The potential introduction of Closed System Aquaculture will have implications for skills and new ways of working.
- There is a shortage in the supply of workers generally, but also those with the right level of experience. This is a factor of the location of production sites. Local infrastructure is crucial to ensure locations are attractive as places to live, work and learn. Companies are also piloting new ways of working to make the sector more attractive, e.g. shift patterns similar to those found in the oil & gas industry.
- The sector suffers from a lack of awareness generally, and in relation to the career opportunities available and skills required. It also compares less favourably to other high value sectors, or those where work is considered more attractive. Industry engagement in schools, colleges and communities can help to address this, but is limited at present.
- Brexit is beginning to have an impact on the supply of much needed international workers, especially in processing. Brexit will also potentially negatively impact the supply of international students who come to Scotland to study, and then stay and work in the sector.
- Whilst the provision of in-house training by companies is often high quality, it is not co-ordinated across the industry and is leading to inconsistency of training.
- Gender occupational segregation in the sector's workforce represents an untapped resource that can help address some skills issues.
- The pipeline of entrants from education is currently insufficient to meet demand. There is also a challenge in ensuring industry-relevant skills. The development of the Apprenticeship Family (Foundation, Modern and Graduate) is beginning to address this, particularly through the new Technical Modern Apprenticeship. However, industry needs to support the development of the skills pipeline by offering more opportunities for vocational training and degrees with work-based learning.

INTRODUCTION

5.1 This chapter draws on the findings of consultation with employers and stakeholders, and the online survey of companies across finfish and shellfish production, and the wider supply chain. It explores the skills needed by the aquaculture sector, and the supply-side issues and challenges faced by the sector in meeting this demand. It explores approaches to address skills priorities for the industry, and overcome challenges. The aquaculture supply chain shares many of the same skills issues and these are also explored in this chapter. Many of the skills issues identified in the research are not unique to aquaculture, but how they impact on the sector pose some specific challenges now and going forward. Finfish and shellfish are structured quite differently and share some key skills issues, although there are some that are specific to one or the other.

Respondent profile

5.2 We engaged employers and stakeholders as part of the research. Nineteen stakeholders responded through telephone and face-to-face consultations. A total of 38 employers engaged in the research, either through telephone consultation, or an online survey. Of these, 23 were aquaculture producers, with slightly more representation from shellfish producers.

Table 5.1: Survey respondents by sub-sector

Survey sample sub-sector	N	%
Finfish	10	29%
Shellfish	13	34%
Supply chain	15	37%
Total	**38**	**100%**

5.3 Supply chain companies participating in the research included companies engaged in engineering, marine services, transport and logistics, pharmaceuticals and fish health, feed, hatcheries and research.

5.4 All participant shellfish producers were micro and small businesses. Finfish producers engaged in the research were mostly medium-large enterprises. Compared to the current industry structure, medium-large enterprises were over-represented in the research. While not a truly representative sample, this provides a greater coverage in terms of total workforce for the sector.

Table 5.2: Survey respondent business size (producers)

Survey sample business size (producers)	N	%	Sector %
Small/Micro	16	66.7%	93%
Medium	4	16.7%	3.5%
Large	4	16.7%	3.5%
Total	**24**	**100%**	**100%**

5.5 Appendices 1 and 2 set out details of stakeholders and employers consulted and engaged in the research.

SKILLS DEMAND IN AQUACULTURE

5.6 Employers and stakeholders report skills demand to be greatest in production, rather than in other areas of the sector, such as processing and the wider supply chain. To a great extent, this demand is being driven by the growth, and growth ambitions of the industry. There are nevertheless areas of common demand throughout aquaculture, as well as specific skills needed in each sub-sector. The following sections set out the skills demand of the aquaculture sector and its supply chain.

Current skills demand

Skills demand across the sector and supply chain

5.7 Engineering skills are a key requirement across the sector, highlighted by both industry stakeholders and the majority of aquaculture production and supply chain companies, and there is a shortage in the workforce. This covers a range of engineering skills, from mechanical engineers for routine maintenance, through to design engineers for example fish pen fabrication.

5.8 For many larger companies, the need for engineering skills is often addressed by recruiting engineers from other sectors, such as Oil & Gas. Smaller companies find it more difficult to attract staff from other sectors, and report that engineering roles are the most difficult to fill. The demand for engineers cuts across many sectors in the economy and it is a very competitive market place. As one large employer noted:

> "Engineering posts are the most hard to fill. With the Liberty aluminium plant in Fort William coming online, this is great for the area, but ultimately there will be competition for recruitment [of engineering] skills."

5.9 Boat skills are also key across aquaculture and there is significant unmet demand. There is a requirement for boat piloting and associated certificates, as well as an increased demand for a range of boat-handling and boat-base working skills – and for staff who understand safety protocols that are needed alongside this. This is demonstrated by the following comments from a shellfish employer, and a finfish employer:

> "Health and Safety is a challenge. Working from boats so you need boat and crane skills."

> "Boat skills – not just driving boats, but whole range of different specialist vessels, feed barges, etc."

5.10 As the sector has grown and developed, there have been developments in the skills needed to manage and run aquaculture businesses resulting in a growing need for business management and commercial skills and knowledge. Our primary research shows that this is particularly acute in production companies, largely due to consolidation and expansion of finfish companies, with a shift towards fewer but larger producers. Managing larger operations, and larger work forces requires strong leadership and management. As an example, a large finfish producer reported an unmet need for corporate finance and senior management skills. These are required to achieve the company's growth aspirations. Given the growth aspirations for the sector as a whole, it is clear that improved business management and leadership development capability is a key requirement. The recently-introduced Technical Modern Apprenticeship in Aquaculture Management is designed to address this, with a focus on farm management, in contrast to the focus on fish husbandry in the Aquaculture Modern Apprenticeship framework.

5.11 The majority of employers across all sub-sectors report that they need staff to have a range of softer, transferable skills to respond to the current and future needs of the sector. This includes team working, building positive relationships and customer care. The recent development of the SSPO Community Charter identified a need for farm managers and staff to be more sensitive to the local community in which they are based. Underpinning all of this is the need for workers who are able to adapt to the changes within the sector, and develop new skills and knowledge to respond to changes to ways of working, processes and equipment as the sector continues to evolve. Employers specifically value all-round and highly transferable STEM and analytical skills. Reflecting this, employers are also looking for staff who proactively manage their careers and understand the need to adapt to changing circumstances.

Producers: Finfish

5.12 Many finfish producers report an overall challenge in meeting the demand for and securing the right skills, the right range of skills, and recruiting or developing management capabilities. Fish farm management and

leadership skills are critical for many finfish producers. Finfish has grown steeply over the last few decades and as a result, managerial roles in finfish companies are more complex, requiring people who can fulfil the range of business management functions e.g. finance, marketing HR and business management. As one larger employer observed:

> "We find it really difficult to get farm managers and upwards…There has always been a problem in higher management, even for the farmers."

5.13 Alongside the growth of the sector, finfish has seen significant consolidation in recent years. Whilst the overall workforce has remained relatively stable in recent years, it has become increasingly concentrated in a smaller number of companies. Consequently, there is a need for managers to manage, develop and motivate larger workforces within individual companies, as one producer identified:

> "[There is a] difficulty for managers as they will need to manage more people, potentially across a number of different sites."

5.14 Most finfish companies also report a lack of skilled assistant managers in the current workforce. Whilst this contributes to the overall demand for farm management skills, there is also an issue here for succession planning. In common with many other sectors, evidence from consultations and the employer survey indicates that the aquaculture workforce is ageing. Succession planning is therefore an immediate priority and as one company stated:

> "We have a high level of retention. But succession planning needs to happen because of people retiring. We need to have the people with the equivalent skills to take over from these people once they retire."

5.15 Consulted stakeholders agreed that there is a wider lack of succession planning, which is acting as a possible barrier to new entrants, and to career progression. For example, one stakeholder said the following:

> "Succession planning [is] not something that is particularly prioritised in aquaculture as there is a low churn and people tend to stay in the industry. This can make it difficult for new people to come into the industry and affect career progression."

5.16 Maintenance of fish health and disease control is vital for the industry. Compounding this is the intensification of finfish production and as a result, there is a significant demand for specialist skills, relating to fish health, biology and husbandry. As fish farming processes have evolved and become more sophisticated, so the particular skills, roles and skills levels have changed. Many new roles have been introduced and some more traditional activities and roles have changed or ceased to be relevant. Some larger companies now have more than 80 different occupations in their business structure. One employer noted that because of the scale of change and innovation in the sector:

> "more technical skills are required across the company and thus the sector, and not just in specialist roles."

5.17 With a move away from manual processes to mechanised and automated systems, the demand for Digital Technologies skills is increasing. Examples include fish feeding. In the past, fish feeding has been a manual task, but technology now means that fish can be fed using an automated system with little need for someone to be on site to carry out the feeding. Similarly, pens can be monitored remotely – for oxygen, temperature, turbulence, fish behaviour, etc. This remote monitoring can be managed from virtually anywhere in the world which has implications for the retention and creation of jobs in the Highlands and Islands, particularly because a sizeable proportion of the aquaculture value chain is already located outside of Scotland.

Producers: Shellfish

5.18 Some of the skills required by shellfish producers differ from those required in finfish. The structure of the shellfish industry is quite different, with a large number of small producers. Shellfish producers tend to be micro businesses, often owner-operators and lifestyle businesses. As one shellfish producer observed:

> "In shellfish, there are a lot of middle-aged men, so no [there are not enough young people]. That said, we have three staff in their twenties."

5.19 Shellfish is quite distinct from finfish in terms of its use of technology and the production processes. Consultees identified that the primary skills requirement is man-power for low-skilled work on shellfish courses. This is frequently seasonal, so there is not necessarily the same demand for year-round staffing, particularly in small businesses.

5.20 As with finfish, succession planning is a key consideration for shellfish companies although the profile of that succession is different. The owner-operators are often the "early pioneers" of the shellfish aquaculture industry, and this is particularly true in oyster farming. As these owners and workers approach retirement age, there is a lack of a pipeline of new people entering the sector to take over production. This was recognised by one stakeholder:

> "Operators are older, and young people are not coming through, so when a small business owner retires, the business closes."

5.21 Whilst shellfish production tends to be low-tech in comparison to finfish, some companies are looking at how technology can be developed and applied to production, and starting to deploy this. They therefore need more technical skills alongside the more labour-intensive tasks, i.e. skills to deliver and work within more innovative approaches to aquaculture production, as well as more specialist skills and roles. One oyster producer commented how this approach sets them apart in the industry:

> "We do things differently to most others in Oyster farming. We perhaps need the skills that would have been needed at a Marine Harvest 15 years or so ago, but most others don't."

5.22 Whilst small producers prevail, in Shetland there has been consolidation in production. This consolidation means that production and company operations are becoming more sophisticated and require different and higher level skills. Examples of skills required include biologists, food production experts (aquaculture-equivalent agronomy experts), and support functions such as business administration. There is also a growing need for in-house R&D expertise, e.g. in hatcheries. Until recently, R&D within companies had been virtually non-existent or at best, very small scale.

Supply chain

5.23 The study considered 'Supply chain' to include everything up to, but not including, retail; e.g. logistics, engineering, basic and value-added processing, etc. Employers in the aquaculture supply chain report similar demands for technical skills to those reported by finfish and shellfish producers. For example, there is demand for boat skills amongst marine and engineering companies. There is also an increasing need for workers with a high level of expertise, in a wide range of roles and disciplines, e.g. product development scientists or electrical engineers, particularly in aquaculture support and Marine Engineering companies. One company identified the scale of this need:

> "[There is a] lack of skills, especially technical people. [Across the] whole spectrum of engineers – mechanical, electric[al], software, new product…there is a massive shortfall of these individuals."

5.24 There is also a demand for chemistry, environment and fish health specialists in supply chain companies. This need has increased as the industry has developed, become more sophisticated and production has intensified. This is demonstrated by the following example:

> "Disease management – this is the operational side, and technological developments are heavily focused on this. It is a significant part of what we do. Water quality standards, training in biological controls, it is very specialised and requires bespoke training."

5.25 Processing companies and operations also require an increased level of technical skills. Advances in production methods are driving a need for greater levels of quality assurance during processing and value-added preparation, as well as in automated processing. This is in line with other areas of Food & Drink, e.g. the Whisky industry. It demonstrates that some skills needed by the sector do not require an aquaculture background, and underlines the importance of transferable skills, and STEM skills.

5.26 There is an increasing demand for R&D skills in many parts of the supply chain. Companies are diversifying into other types of activities, which is driving demand for such skills. For example, there is a trend of vertical integration in feed companies, which is impacting on the skills they need. Feed production companies are now involved with developing and producing on-farm delivery systems, e.g. feed barges, sprayers, waste recovery, etc., as well as the feed itself. It should also be noted that some producers are also integrating feed and associated systems into their internal supply chain. The skills required therefore now extend to IT and engineering as well as nutrition, as demonstrated by the following quote from a nutrition company:

> "Feed is moving from a core to a commodity product, we are moving to an innovation and R&D-heavy product, and a whole feed technology and product approach as an offer."

5.27 As discussed earlier, much of the R&D expertise in aquaculture production (largely Atlantic salmon) is owned and takes place outside of Scotland, for example in Norway, as one interviewee commented:

> "A lot of R&D is coming from Norway and as a result Scotland is not really investing in it."

5.28 This means that a considerable proportion of the R&D capacity in Scotland is effectively imported, which has a potential negative impact on the R&D capacity in Scotland. For example, well-boat technology is developed outside of Scotland effectively limiting Scottish-based expertise in these high value-added activities.

5.29 However, there are examples where companies are investing in their R&D capacity in Scotland. Illustrating this, an engineering company is developing a range of innovative nets, and products to assist cleaner fish requiring a range of technical skills. Another example is an aquaculture service company that is investing heavily in R&D for fish welfare and disease management and so is providing opportunities to skilled researchers, as illustrated by this quote:

> "We are investing heavily in R&D for fish welfare and fish health – disease management."

5.30 Alongside the softer skills in demand across the whole of the sector, supply chain companies are looking for staff who have sound knowledge and understanding of the aquaculture industry and this is often lacking. By understanding the sector, their staff would be more attuned to customer needs and arguably make supply chain companies more responsive to sector needs and innovative in designing bespoke solutions.

Future demand and key changes in roles and skills

5.31 There is a general recognition across the aquaculture sector that the demand for technical skills will continue to increase. The trend in technological development and intensification of production is likely to continue across producers and supply chain companies. Consequently, technical roles will become increasingly important, and will likely gradually replace or redefine existing manual/operative roles. This is an immediate need, and will continue to be in future, since technology is changing constantly.

5.32 As the sector works towards increasing its capacity and output, employers anticipate that the use of technology in fish production will increase. The technology is likely to become more sophisticated so companies anticipate demand for greater levels of digital skills in order to use automated systems for example in feeding and monitoring. One finfish producer noted that:

> "The main focus will be on digital and ICT literacy, as so many things use sophisticated computer programmes, e.g. feeding. This will be the challenge going ahead."

5.33 Given the importance and policy focus on fish health and welfare, it is expected that demand for skills in fish biology and fish health will also increase. Producers and stakeholders expect that this will not only be for a greater number of workers with these skills, but in a wider range and often in more niche specialisms.

5.34 It is anticipated that more specialist skills will be required in disciplines that support the aquaculture industry as new models of production evolve. Production companies are now exploring the possibility of locating fish farms further offshore and developing these will demand engineering and oceanography skills as well as new equipment, processes and ways of working to respond to offshore conditions. This will range from innovation in cage design, to offshore renewable power generation, to remote cameras and sensors to monitor higher rates of wear and tear.

5.35 There is likely to be more diversification in the sector as a result of improvements to fish farming processes, a move to different (more remote/extreme) sites that are conducive to alternative species, or in response to climate change. These changes will involve new expertise and understanding, e.g. in terms of fish health and fish biology. As one finfish producer noted:

> "In the longer term, with climate change, we may need to look at new species as a potential replacement for salmon. Have one eye on beyond 2030!"

5.36 Production in Scotland may move towards more Closed System Aquaculture either on land, sea or a combination. This will influence the skills that will be required in R&D, aquaculture production and the supply chain.

SUPPLY OF SKILLS IN AQUACULTURE

Skills supply challenges

Availability of labour

5.37 One of the key challenges identified by consultees for the supply of skills to the aquaculture sector is a limited workforce to recruit from in areas where aquaculture producers' farming sites are located. This view applied to all skills and role types and includes recruitment of school leavers and those leaving tertiary education and recruitment of older people who may take up employment in the sector. Production sites in both finfish and shellfish are often in remote, sparsely populated areas. This is a challenge that faces most industries in remote and rural areas, and is not unique to aquaculture. The following comments illustrate the issue and the view that if it is not tackled, the limited local supply of workers will negatively impact on the aquaculture sector's growth:

"[The aquaculture sector] won't be able to grow if it can't get the right people for the right job. There will be less profit and will struggle to get new sites [or] expand if they can't perform to the levels required. It will be the same for the supply chain."

"I don't think that everyone can get someone, it's just a much smaller pool."

5.38 As discussed in more detail below with regard to the how the sector is viewed, aquaculture tends not to be seen as an attractive employment option, particularly, though not exclusively, amongst young people. There is a perception amongst employers and stakeholders that there are not enough young people entering the sector, or people with experience who may move from other sectors. As these employers commented:

[There is] not a lot of people coming out of the education system looking for a job in the sector."

"The sector needs a steady stream of…people from Modern Apprenticeships."

Experience and quality

5.39 Along with an overall shortage in the number of potential recruits, there is general agreement amongst stakeholders and employers that there is a shortage of people with the right level of expertise required by this evolving sector. This is illustrated by the following comment from an employer:

"Because of the change in the industry, there are more skilled jobs, and these are harder to fill. The unskilled labour [we need] is there, but people such as nutritionists are not so much…engineers too."

5.40 Aquaculture companies reported that there is a lack of experienced workers. For some, this was a lack of people with work experience in the aquaculture sector; for others, it was a more general lack of people with any work experience. Employers are often looking to recruit people with some employment experience rather than directly from school, college or university, as they are more likely to have the skills and experience to carry out the roles. They are also more likely to have a good knowledge of aspects of work, such as health and safety, as well as an appreciation of the more general needs of a working environment, such as team working and attitude towards work.

5.41 Some employers noted that they had previously offered internships or placements. It was agreed by employers that a more consistent approach to graduate programmes, work placements and internships across the industry would contribute to the attainment of work-relevant knowledge.

5.42 Having the right attitude to work and the challenges thrown up by the aquaculture sector was cited as being of equal importance to qualifications. Some employers considered that with the right attitude and willingness to learn, they are able to train workers to be competent in a given aquaculture role.

5.43 Nevertheless, a consequence of the lack of skilled workers is that companies have to train up employees on the job. This has required a financial outlay to deliver the training, but can also end up with over-commitment of resource and duplication of effort, e.g. through work shadowing, to ensure that roles are fulfilled adequately whilst a new employee is being trained. As a finfish producer pointed out:

"[We] have to spend more time training and educating people which means that the costs of training increases. At the moment we have three people doing the job of one and a half people in smolt production."

5.44 An issue facing employers across the sector is that trained and experienced workers often move from one employer to another. This means that although the sector as a whole has limited churn and a relatively stable workforce, individual employers often lost staff to other aquaculture and supply chain employers. As one supply chain company commented:

> "I see the same faces at different companies… [There is] a lot of movement in the sector."

Recruitment challenges

5.45 Whilst the supply of skills for the aquaculture sector is challenging in itself, recruitment and the attraction of workers is arguably an even greater barrier. Even if the skills in demand are available, workers have to be attracted to work in aquaculture rather than move into another sector. There are a number of issues around the recruitment of the skills required by the sector, which often overlap with the skills supply challenges discussed above.

Geography and remoteness

5.46 Shellfish and finfish production is usually located in rural and remote areas. This compounds the issue presented by small local populations, as it can make it hard to recruit people into the area to work. Though this is not unique to aquaculture it is a key recruitment challenge faced by the majority of employers. Roles in aquaculture production can often mean remote working, though this does not always mean lone or isolated working. Working in these locations requires someone who is capable and willing to work in that environment. It is also difficult to attract people from other parts of the Highlands and Islands and Scotland to work and live in more remote parts of Scotland as illustrated by the following quotes from aquaculture employers:

> "There is a general lack of willingness to move to remote locations to work in aquaculture, not just for the growing of fish, but in supply chain companies too."

> "Location is key. Unless you are keen to get in [to aquaculture], or are able to be persuaded, you are not really going to move [to remote areas]."

5.47 It should also be noted that it is not just about the availability of work for prospective aquaculture workers. Other factors come into play, including employment opportunities for partners, digital and physical connectivity, availability (and affordability) housing, schools and access to other amenities and services, such as GP surgeries. All of these factors influences prospective employees' views on living and working in a particular area, and as one employer put it:

> "There is a lack of affordable housing and related infrastructure, so it is difficult to attract people here who may consider working in the industry…[There is] no real working-living proposition."

5.48 The weather and environment, real and perceived, of fish farms can also make it unattractive Whilst the image of working in aquaculture and the Marine environment may be good on a bright summer day, it is a much less attractive proposition in frequently harsh and extreme conditions. Capturing this, an employer commented that:

> "The crux of the matter is application and work philosophy of individuals – the willingness to work in a Force Eight gale, for example."

5.49 However, recent investment in remote and fragile communities is perceived to be beginning to address this issue. For example, some companies such as Marine Harvest are, in some cases taking the initiative themselves by building houses for workers. This proactive approach and investment in infrastructure is reflected in the following quotes:

> "There is a lack of housing and companies are having to buy or rent places for their employees. They are also working with housing development companies to try and solve this problem."

> "Companies are getting involved in [other infrastructure] – jetties, piers etc. We are having to find the solutions ourselves, investing in communities."

5.50 New working arrangements are being trialled as a way of addressing the issue of remoteness. It is understood that a number of producers are piloting an on/off shift structure similar to work patterns in the Oil & Gas industry, and a similar trial is being tested by some supply chain companies. One producer stated that:

> "We are looking at structuring shifts like the oil industry, so two weeks on, two weeks off. [There is an] appreciation that people won't want to live remotely on a permanent basis. Being able to offer two-on two-off shifts helps to overcome the remoteness problem…so far the flexibility in the working pattern being trialled is working well."

5.51 Whilst this may have a positive impact on staff recruitment and retention, there are implications for local communities of having temporary as opposed to permanent members of the community.

Awareness and attractiveness of the aquaculture sector

5.52 The industry needs to be seen as an attractive and responsible industry, which is able to offer good career prospects and development opportunities if it is going to be able to attract the workers that it needs. However, there are a number of challenges to this.

5.53 There is perceived to be a lack of awareness of the aquaculture sector and the career opportunities it offers. Employers and stakeholders report that in their view, it lacks any real profile, or consistent and accurate image. Potential employees are therefore either unaware of the sector, or hold misconceptions of what opportunities exist within it for employment and career development. The common image is of a labour intensive sector, working in challenging conditions and there is a lack of awareness of how the sector and the jobs within it have changed.

5.54 Employers acknowledged that industry engagement with schools and colleges was limited, and that there was a responsibility for them to increase activity in this regard. Businesses conducting open days, giving talks at schools and colleges, and providing work placements or tasters are all ways to positively engage young people, and help to influence career choices.

5.55 Portrayal of aquaculture in the media can also impact negatively on its image, which in turn affects recruitment. Media coverage of the sector often focuses on negative stories, for example management of predation[57], disease and environmental impacts of aquaculture.[58]

5.56 The lack of profile, combined with a negative image, adversely impacts on recruitment. It contributes to a lack of understanding on the variety of roles, career options and progression pathways in the sector. It often discourages people from considering aquaculture as a career option and workers often choose to enter other sectors even if the wages or salaries on offer are lower than in aquaculture. One shellfish employer said that workers often choose what they perceive to be a more attractive option:

[57] Fish farms under fire for seal death toll, The Times, 22nd October 2017; https://www.thetimes.co.uk/article/fish-farms-under-fire-for-seal-death-toll-ph5kqwdtq

[58] Scots concern as scientists warn of shellfish farming expansion over flatulent clams study, The Herald, 14th October 2017: http://www.heraldscotland.com/news/15596280.How_concerns_over_flatulent_clams_is_causing_a_stink_within_the_Scots_shellfish_industry/?ref=mr&lp=2

> "Locations like this [Mull] where there is a large tourist industry are challenging. Tourist related jobs are easier even though they don't pay well."

5.57 Aquaculture often competes for staff with the Oil and Gas sector and a key example is recruiting engineers. It can be difficult for aquaculture to compete with oil and gas employers for staff, particularly for smaller companies who cannot offer such attractive remuneration packages. As reflected in this comment from an aquaculture supply chain company:

> There is currently an availability of people that we can recruit as a result of the downturn in the oil industry. But when the industry picks up again, there is no way that we will be able to compete with them. The money that the oil industry can pay…[The] energy sector has grown to a place where they can offer high pay and we just aren't there."

5.58 Employers also have to contend with the comparative attractiveness of options within the sector. For example, people with the technical skills required by industry may consider it more attractive to work for a research organisation or industry body rather than in a production company.

International workers

5.59 There is clear evidence from consultees of a reliance on overseas workers in the aquaculture sector and the extent of this varies in different areas of the industry. One consultee from a large producer that undertakes its own processing noted that a large proportion of processing employees in the industry are overseas workers (in some cases 60% or more), most often from the EU. Thus Brexit has serious implications for employers, if the supply of EU workers is reduced.

5.60 In contrast to production, processing sites are often closer to centres of population. While there may be a sizeable potential local workforce, attracting local workers to available roles as processing operatives or hatcheries workers can be a challenge and so the skills shortages are met through overseas recruitment.

5.61 The impact of Brexit is already being felt with employers reporting increasing difficulty in recruiting staff from the EU. The issues presented are illustrated by these quotes from employers:

> "There are a number of jobs that employ people from Eastern Europe, mainly processing. The UK and Scots don't seem to want to do these jobs and I don't know why. The industry is reliant on Europeans who may or may not be able to stay. This is an area of concern for the industry – they are not sure if they will be able to find other workers."

> "Last year we found it a lot harder to recruit Eastern Europeans in the processing plants which is probably down to the effect of Brexit. About 70% of the processing workers are Polish or Latvian. And we have found that they are less flexible and less eager to take the jobs as they were before."

> "Brexit threatens skills availability. If skills are lost, it will have a large impact on the sector, same as in other sectors dependent on EU labour."

5.62 Whilst this is perhaps most acute in processing it is also an issue in other areas of the sector. Many EU graduates work in aquaculture in Scotland in more technical, specialist jobs, e.g. fish veterinary specialists. One large finfish producer noted that around 50% of its hatchery workforce was from elsewhere in the EU:

> "We can get EU graduates [currently], so we are worried about Brexit, especially in the hatchery [where there are] degree-educated EU graduates."

5.63 Brexit will also potentially impact negatively on the supply of graduates into the sector as a proportion of Masters and PhD graduates from Scottish universities are from EU countries (around 12% as identified in Chapter 4, though this varies by institution). One stakeholder stated that there is often a challenge to recruit students to study, and that this is increasingly difficult. There is a concern that Brexit will reduce the number of EU students undertaking postgraduate study – and then working – in Scotland, as one HEI stakeholder noted:

> "In any given year, there are 50 students, and up to 25 nationalities… [It is] very difficult to recruit students and staff, and getting harder."

> "There is a strong academic community in Europe that produces quality graduates that end up doing postgraduate studies in Scotland. This will necessarily fall if Brexit happens."

5.64 If the supply of overseas skills decreases significantly, there are likely to be implications for meeting the skills requirement of the aquaculture sector and so realising the ambitions for 2030. With the increase in demand for protein as a food source globally as identified in Chapter 3, ensuring the research and development skills are in place to work in this field and deliver a quality product for the end consumer is a key consideration for aquaculture producers.

CURRENT WORKFORCE SKILLS ISSUES

5.65 Employers participating in the research report comparatively few skills gaps in their existing workforce. This reflects the fact that they tend to address any gaps with internal training and development. Gaps in understanding and basic skills required to undertake jobs within aquaculture are often addressed by companies developing and delivering in-house training.

Workforce development

5.66 Whilst not a skills gap in the strictest sense, employers across all types report a lack of sectoral knowledge in new entrants. In some instances, this is understanding of company- or industry-specific approaches or procedures. There is a broad recognition that new employees cannot be expected to have a deep understanding of the sector but a broad understanding would be helpful and reflect an interest.

5.67 Currently, internal company training is combined with short courses (e.g. boat handling certificates) as required, but skills are not uniformly supplied outside this system. Larger employers are able to provide in-house training and induction to provide a basic level of understanding of the sector for new entrants, and to provide certification for any mandatory training. Consultees highlighted that the production of internal training manuals is often expensive. Training is delivered by a mix of internal provision and external training providers.

5.68 Statutory training and other required certificates for on-site operatives such as Health & Safety and boat handling is a gap in the existing workforce that currently must be addressed by employers through induction courses and ongoing in-house training. For example, one large employer detailed their comprehensive induction process:

> "[We] have a two-day company induction that everybody has to complete before being able to go on site. This covers everything from health and safety, awareness, chemical handling, PPE, working over water, etc. We make sure they have the safety training before they go out."

5.69 However, such training is not universally available, or accessible to all producers and employers, particularly smaller ones. This is compounded by a lack of locally available training provision. Whilst some short courses, e.g. Health & Safety, are delivered by NAFC Marine Centre, this is not accessible to all employers. Bringing in trainers from other areas or sending employees to training provision further afield is costly and time consuming, as reflected by the following comments:

"There is a lack of [external] training, especially in the more rural areas, but this is something that we just have to accept."

"Boat masters' courses and HACCP training [Hazard Analysis and Critical Control Points, food safety course] need to be itinerant, rather than sending people to the mainland."

"We look to hire people that already have the training because they can get straight on the boats…it can take six months to get on a course. There is a lack of courses locally…more frequent and accessible courses are needed, in terms of location too. There is nothing unless you go to Aberdeen or the Central Belt."

5.70 As employers, particularly within finfish, are often providing their own in-house training, there is a lack of consistency in training across the sector. There are many examples of employers providing good quality, highly valued in-house training with supporting resources and manuals. For example, there is an employer in the Highlands and Islands that has developed an excellence framework to guide career progression. Despite good examples, the lack of consistency presents some issues. For example, it means that training can often be repeated if an employee moves from one company to another. Ultimately, this represents a significant cost in terms of time and resource to re-train employees. One stakeholder commented that:

"In-house training is often not transferable between companies. If it's accredited, then employees can transfer [qualifications], but this is not guaranteed. Mobility of qualifications is important, and it is not clear how standardised CPD is amongst aquaculture companies."

5.71 There is a perception that a sizeable proportion of employees are reluctant to undertake accredited training, for example for fear of how not successfully completing the training may impact on their employment. This reinforces the lack of consistency in the training undertaken by staff. This finding is reinforced by the high proportion of college enrolments that lead to no qualification as discussed in Chapter 4. As an employer commented:

"Employees don't want to do accredited courses because there is a lot of pressure and they are worried about passing courses, and the implications on their jobs, salaries, promotion, etc. They are happy to do non-accredited courses that are provided by the companies."

Skills gaps in the current workforce

5.72 The shortage of business management, leadership and commercial skills were discussed earlier in the chapter, but these skills are also lacking in parts of the existing workforce (a skills gap). Whilst this is identified amongst both finfish and shellfish companies, consultation findings suggest that is more an issue amongst the latter. Given the way that the industry has evolved, the relatively young age of the sector, and with many of the pioneers still working, it is perhaps unsurprising that there is a perceived lack of business management and commercial expertise.

5.73 Strong leadership and clear decision-making in companies will be critical to achieve the transformational change that the aquaculture sector is pursuing. This includes improving strategic planning, and developing a more proactive approach to issues that face companies, and the sector as a whole. These skills are not consistently available in the current workforce, reflected by the following view put forward in the research by one producer:

"There is a lack of foresight, and business management understanding is needed for small business models."

5.74 Recognising this, some employers are working to build leadership capacity by participating in leadership development training; for example, through HIE business support including the Entrepreneurship Development Programme.[59] One supply chain company stated:

> "[We are] considering some MIT courses which is new for us but this isn't aquaculture specific. Mainly for business skills."

5.75 Though adaptability and flexibility to changes within the sector are considered as essential *current* skills, they are also identified as *future* skills requirements. Innovation, and the rate of change to date in aquaculture has seen substantial change in a relatively short space of time. Employers therefore see an ability to keep pace with future technological change, and adapt to the rapidly changing demands of job as also being essential in future.

Gender balance and the aquaculture workforce

5.76 There is a significant gender imbalance in the aquaculture workforce (both producers and supply chain), and this is an issue that is recognised by employers and stakeholders. Evidence from employer consultations and online survey indicates that only 16% of the aquaculture workforce is female. Whilst there is some evidence from consultations to suggest that the gender balance in the sector is improving, females are still significantly under-represented. If more women could be attracted into the sector, it would widen the available workforce and skills, with greatest opportunity most likely in remote and rural locations.

5.77 Evidence from consultations indicates that there is horizontal segregation in the sector, i.e. clear division of males and females in the types of roles that they undertake. Females tend to work in support roles e.g. administration, HR, finance, etc. Employers attribute this to persistence of gender segregation and historic employment patterns.[60] Roles in aquaculture have traditionally been quite manual, which may have meant that women either self-exclude and also, that employers may have consciously or unconsciously been biased in their recruitment between men and women. Further, the culture in the sector may be off-putting to women and that women's choices, and indeed men's, are heavily influenced by family, friends, schools and careers advisers. One employer noted that despite efforts to attract women into roles traditionally dominated by males, there has been little uptake:

> "We provide women with the opportunities on sites and try to get them involved, but they prefer not to. It's a personal choice."

5.78 However, innovation and adoption of technology and automated systems means that aquaculture roles are now, or are becoming, less labour-intensive. This may make it more attractive to a wider pool of workers, including women. As an employer commented:

> "With things changing, [the work] is becoming less manual and more techy, so there are more opportunities [for females]."

5.79 As well as horizontal gender segregation, there is a high degree of vertical segregation (gender division based on occupational levels) in the aquaculture sector. Evidence from consultations also shows that women are under-represented in managerial positions, and there is some indication that this is also the case with senior management teams and company boards, though anecdotal evidence suggests that this may be improving. Conversely, women are over-represented in low-skilled manual roles, for example in processing. This is an untapped

[59] The Entrepreneurship Development Programme (EDP) is a key component of HIE's Entrepreneurship Support Programme, delivered in conjunction with Scottish Enterprise. The EDP is a week-long, high level, intensive residential executive education course teaching skills for high impact entrepreneurship. It is designed for highly ambitious entrepreneurial individuals within businesses who have the potential for international growth. It is held on-site at the MIT Sloan School of Management in Boston in January each year.

[60] ekosgen's recent work on occupational segregation in the Highlands and Islands identifies the critical barriers and implications of gender segregation in the workforce, in sectors such as aquaculture. Available at: http://www.hie.co.uk/regional-information/economic-reports-and-research/archive/occupational-segregation-in-the-highlands-and-islands.html

resource that could have a significant impact on skills shortages across the sector, and the roles within it. Women could also play a key role in addressing succession planning and leadership challenges. As one stakeholder observed:

> "[There is a] clear impact on skills in terms of tapping into potential skills supply."

EDUCATION AND QUALIFICATION PROVISION FOR AQUACULTURE

5.80 The FE and HE institutes in Scotland that provide education qualifications, and skilled entrants, for the aquaculture sector are generally considered by consultees to be of a good quality. Stirling University's Institute for aquaculture and NAFC Marine College were specifically cited by employers for the quality of their graduates although overall the quality of students coming through education providers is perceived as being very high. Masters graduates from Scottish institutes are considered by businesses to be:

> "focused, driven and business-ready".

5.81 However, businesses report that the pipeline of graduates from colleges and universities entering aquaculture is insufficient to meet the sector's growth ambitions. There is a perception that there are not enough graduates to be able to fill the technical roles needed. Also, employers report that the courses provided to students could be more specific. For example, there is evidence to suggest that wider availability of undergraduate aquaculture degrees – and graduates – would be valued by employers in the sector, rather than more general courses such as marine biology which can then lead into more specialist postgraduate study. This reflects the desire for more specialist degrees to align the needs of the role and of the employer and the more niche roles that are emerging. An example put forward is combined study, e.g. aquaculture and Chemistry. This reflects the changing nature of the sector, and the increase in technical specialism, currently in finfish production in particular.

5.82 A small number of stakeholders perceive that the supply of people with postgraduate degrees outstrips need, and that staff can be over-qualified for the roles they are in. Conversely, many employers believe that better qualified staff, but with the right specialisms, would benefit the sector and help realise growth ambitions; it was pointed out that many Norwegian farm managers have PhDs, in contrast to Scottish farms.

5.83 However, it is increasingly important to consider the competition from providers outside Scotland, as well as from other sectors. Increasing numbers of aquaculture courses are being provided by established institutions such as Plymouth University, as well as development of new courses such as those at Harper Adams and the formation of a National aquaculture Centre in Grimsby. Such courses can offer a potential skills supply, if graduates are able to be attracted to the aquaculture industry in Scotland. Equally, they can serve to attract Scottish learners away, which may ultimately lead them to work in aquaculture elsewhere in the UK, or indeed globally.

EDUCATION CHALLENGES

5.84 As discussed previously, one of biggest challenges regarding the provision of higher education in support of the aquaculture sector is ensuring that degree-level qualifications provide industry-relevant skills in graduates. It is arguable that this is not currently the case. Employers often have to provide training to graduate entrants to meet their own, and industry, requirements. There is also qualitative evidence that workers/learners can find it difficult to progress from FE into HE. Whilst employees can undertake FE qualifications and complete Apprenticeships whilst in work, consultees consider that there is no equivalent opportunity to gain a degree while they are working. Though some companies provide for career progression in their training offer, this could potentially act as a barrier to moving into management for some employees. A degree with a considerable practical work element would help to address this, and there is an appetite for this in the sector. For example, one stakeholder said the following:

> "It would be amazing to get a degree with a large work-based component."

5.85 The recently launched Technical Modern Apprenticeship, delivered at NAFC Marine Centre is seen as very positive. It helps to address the demand for more vocational training at degree level. More generally, vocational training through Apprenticeships is highly valued by employers. As highlighted by *Scottish aquaculture: a view to 2030*, there is increasing demand for more vocational training in order to address the skills gaps that the sector is currently faced with. However, the geographical pattern of provision is not adequate for employers, and is not located close to their operations. Some vocational qualifications are available through Inverness College and other UHI colleges in the Highlands and Islands, but much of the vocational training delivery is provided through NAFC Marine College. This acts as a barrier for employers and employees to access vocational training, but also for students and prospective employees to tap into available education resources. Many courses including the aquaculture Modern Apprenticeship are delivered remotely and employers believe that students require more hands-on support.

5.86 Employers and stakeholders broadly agree that course content and education does not, generally, reflect the pace of innovation and change in the sector and so there is a lag in the currency of what is being taught and what is actually happening in the workplace. Industry is at the forefront of technological change and so it is difficult for education providers to keep up. An example is that the equipment used to teach students is no longer used in industry so employers are having to fill this gap in knowledge and skills when graduates enter the workforce. The increasingly diverse and technical range of jobs in aquaculture mean that its workforce will need to have access to a wide range of opportunities for training and skills development if they are going to meet the needs of the industry.

ADDRESSING SKILLS PRIORITIES

5.87 There is clear demand for engineering skills, and increased levels of technical skills across the sector. Leadership and management skills are also in demand. These skills are needed currently and in the short-term future. There is no set time frame within which an increase in these skills needs to be realised. However, their need is pressing. Given the rate of innovation and technological change and the adoption of automated systems in the sector, technical skills will also be needed in the medium- and long-term future. Challenges in fish health and nutrition will also demand appropriate fish biology and veterinary skills. Further, if the prospect of using more remote sites further offshore for aquaculture production becomes a reality, then there will also be increased demand for engineering. Additionally, efficiency gains are expected so that as production increases, technological gains that enable this will mean jobs, proportionately, sit more in the supply chain than in farm production.

5.88 There is a recognition that there are a series of macro socio-economic challenges that affect the Highlands and Islands, Scotland, aquaculture and the economy overall. Addressing the demographic challenges of out-migration, an ageing population and low population density in remote areas would contribute to addressing the key skills supply challenge of ensuring enough suitably skilled workers. Evidence from ekosgen's research for HIE into the attitudes and aspirations of young people from the Highlands and Islands[61] suggested that there is a considerable cohort of young people willing to return to work and live in the region. Working to provide the right incentive to achieve this is a key strategic priority, not just for aquaculture.

5.89 Employers suggested that previous efforts to attract skilled workers to the Highlands and Islands may work again, if done in a more targeted way. For example, some companies noted that they had previously hosted graduate placements and interns, something that was seen as relatively successful. Anecdotal evidence suggests that even where positions were not available in one company at the end of a placement, graduates were encouraged to apply elsewhere with other companies, helping to retain skills within the sector and the region.

[61] ekosgen, Reference Economics, Whitewall / HIE (2015) Our Next Generation | Young People and the Highlands and Islands: Attitudes and Aspirations, June 2015, http://www.hie.co.uk/regional-information/economic-reports-and-research/archive/young-people-and-the-highlands-and-islands--attitudes-and-aspirations-research.html

5.90 As an example, a relocation incentive scheme operated by Argyll and Bute Council is an interesting approach. The Rural Resettlement Fund provides grants for businesses and new residents to relocate to the area.[62] Argyll and Bute suffers particularly acute out-migration challenges and the incentive scheme was in response to this. However, such an approach may not be appropriate or viable in other areas.

5.91 Ensuring adequate provision of infrastructure and services is key to retaining and attracting talent in more remote areas of the Highlands and Islands and one important aspect is digital infrastructure and broadband coverage. There is evidence from the employer consultations to suggest that remote working – and living – can be more attractive if workers and their families can remain connected through social and other media. Given the increased use of technology in the sector, digital infrastructure is increasingly critical for fish farm sites and is an important consideration more widely.

5.92 As discussed, access to services and amenities such as schools, healthcare and leisure amenities, also helps to attract and retain people in an area. These infrastructure issues are largely outside the control of employers and the sector. There is an opportunity for aquaculture companies to engage with local authorities and development agencies at the operational, local level to identify ways of addressing such challenges on a joint basis, in a similar fashion to the provision of housing that some employers are undertaking. However, this will form part of a much wider strategic approach that considers the development of the Highlands and Islands as a whole, and the role that the development of the aquaculture sector and the plans for this to 2030 plays in this. Regional development priorities, as well as the local development plans of local authorities, need to take cognisance of the growth priorities of the sector. Likewise, the sector should identify where and how it can contribute to these plans.

5.93 Qualitative evidence points to a demand for changes to HE provision for the sector, to reflect the changing skills and expertise required as the sector evolves and grows. This should cover more varied provision by HEIs, as well as the inclusion of a greater work-based component and a work-based degree where this is appropriate. Similarly, there is clear demand for provision of more vocational training at an FE level. This is not just in terms of volume, but also in geographical reach of the education provided. This would help to make education in the region a more attractive proposition, and meet the changing skills needs of the sector. There are some very good examples of joint working between industry and education, e.g. through SAIC, but there is scope for this to be enhanced, for example through collaboration on skills needs as well as industry-focused and applied research projects.

5.94 There is an identified need for better promotion of the sector, and work to raise awareness of it both generally and specifically in relation to the career opportunities available. This will require joint working between all partners across industry, education and the public sector. The aim would be not just to educate the public, but also to inform key influencers, such as careers advisers, parents and schools and so on, to act as champions to promote careers in the sector. There is a wide range of work being delivered as part of Scottish Government and SDS work on developing and promoting STEM skills, and the aquaculture sector should ensure that it is engaged with and able to benefit from this. Part of this should be ensuring effective industry engagement with schools and colleges. Both will help to raise awareness of aquaculture as a valid and rewarding career choice, but may also help to identify opportunities for work placements.

[62] https://www.argyll-bute.gov.uk/rrf

6 KEY MESSAGES, CONCLUSIONS AND RECOMMENDATIONS

INTRODUCTION

6.1 The preceding chapters set out the analysis of the evidence about skills requirements and supply in the aquaculture sector, including the supply chain. The report identifies the factors that have, and are, driving changes in the sector and the skills responses that will be required. This chapter sets out the conclusions drawn from the analysis to inform future skills planning and resourcing for this important sector in the Highlands and Islands and Scotland. It provides recommendations for the future development of skills.

KEY FINDINGS

The aquaculture industry and workforce

6.2 The aquaculture sector is important to the Highlands and Islands and to Scotland as a whole. Our seafood produce has a worldwide reputation for quality which provides us with a competitive advantage. From its current position, it has the potential to grow, enhance productivity and contribute even more to Scotland's economy. It has an important role to play in rural and fragile economies, providing employment and generating income in more remote parts of Scotland. However, its impact is not confined to the Highlands and Islands, across Scotland it supports processing, distribution and export operations. It contributes and has the potential to contribute further across the Scottish Government's Economic Strategy, in particular to the internationalisation and inclusive growth agendas.

6.3 There are essentially two sub-sectors in aquaculture, finfish and shellfish. Whilst there are many similarities, there are also some key differences in their structures, processes and to some extent, skills requirements.

6.4 Finfish is characterised by a relatively small number of larger producers (87 businesses operate in this sub-sector although there may be some double counting where a business farms more than one species). Conversely, with 138 producers, shellfish is still predominately based around a larger number of smaller operators. Whilst there are more shellfish businesses than finfish in the Highlands and Islands, the volume and value of finfish production in 2016 (171,000 tonnes with a GVA of £569.5 million) far exceeded that of shellfish (8,000 tonnes with a GVA of £50 million). Over recent years there has been consolidation in finfish businesses but this has not been reflected to the same degree in shellfish, though large volume growth is from a relatively concentrated number of firms.

6.5 Unsurprisingly, the aquaculture supply chain includes a wider business base across a number of subsectors such as: equipment supply (including technology), processing and preserving; feed manufacture; wholesale supply; retail; freight and transport; and veterinary and health activities.

6.6 There is a clear concentration of aquaculture businesses in the Highlands and Islands although the actual number of businesses in the region has fallen since 2010 but at the same time has increased in other parts of Scotland, albeit by a small number. However, this is the number of businesses, rather than volume of production. Finfish and shellfish production have both grown over the past decade, and despite a decrease in production for finfish in 2016, production is expected to increase again in 2017.

6.7 Employment in the sector has grown by 355 jobs or 18%. This has been largely driven by a growth in the Atlantic salmon workforce which saw a 40% growth between 2010 and 2016, accounting for 400 new jobs. Conversely, the shellfish workforce declined in the same period, by 21%, representing 84 jobs. Although the actual numbers in shellfish may seem small, given the remoteness of the areas in which it tends to be located, even a small number of job losses can have a significant impact.

6.8 The workforce is gender imbalanced with many more men working in it than women. However, there are some parts of the industry where women are more prevalent, in particular, processing. In terms of levels, women are severely under-represented in management roles, most acutely in senior management.

6.9 The size of the workforce in the wider supply chain has remained fairly stable in the period from 2009/10 although there was a slight decline up to 2012, before it then started to rise again.

Drivers of change

6.10 There are a number of factors that are driving the changes in the aquaculture sector, some of these present opportunities whilst others are challenges that must be addressed if Scotland is to realise its ambitions for the sector's growth. The sector has a significant contribution to make to the objectives of Scotland's Economic Strategy (2015) across the four priorities of Investment, Innovation, Inclusive Growth and Internationalisation. It can contribute to the economic health of the nation, and has a particularly important role in the Highlands and Islands.

6.11 The *Scottish aquaculture: a view towards 2030* roadmap and the *Aquaculture Growth to 2030* strategy set out the ambitions for the sector over the next 12 years, identifying the key innovations and priorities to support the sector's growth.

6.12 In common with many other sectors, technological developments in aquaculture have and will continue to have an important impact on the sector. There has been a move towards more automation of processes and the application of technology to enhance production and productivity. This has in turn, meant that different skills are required in the workforce and these are likely to continue to evolve. There is also a symbiotic relationship between changes in the sector and in the supply chain, for example there are innovations in equipment and systems in response to issues identified by industry, that then flow back into aquaculture businesses in terms of new processes and ways of working.

6.13 The demand for seafood is global and is growing. In particular, the volume of salmon that is produced worldwide is insufficient to meet the growing demand. Sitting alongside this, Scotland's share of that market in terms of volume has been declining. A balance must be struck between retaining the provenance and quality of Scotland's salmon but also responding to and benefiting from the growth in demand. Currently, we are in danger of continuing to lose market share to competitors such as Norway, Canada and Chile. Despite increasing automation, growing production is likely to require an increased workforce, as well as the new skills that will be required to reflect changing roles and skills around fish health, environmental management and research and development.

6.14 Sea lice is a high-profile issue for the sector, impacting not only on production and quality, but on market, and importantly, consumer perceptions. Effective management is crucial and there has been significant investment to improve sea lice control through management practices, treatments and innovative technologies. Other diseases also disrupt production and require careful monitoring, control and management. Fish health, welfare and environmental stewardship are seen as a priority for the industry the Strategic Farmed Fish Health Framework, being driven by the Scottish Government, will focus on this area. The issues are driving the need for scientific and technical skills to research and evidence the problems and impacts, find solutions, and then apply them in production.

6.15 There is pressure on the marine environment as an asset from a number of different users. Coupled with the growth potential of aquaculture, there is a need for the sector to look at the potential of expanding in to new sites. However, availability of inshore sites is constrained meaning that the sector is increasingly looking to more exposed sites located further offshore. The environment and conditions in more exposed sites may drive up production costs and will certainly mean that processes and equipment will need to be adapted to cope with the conditions, for example wave movement, deeper water and wind. This will have implications for the skills required and potentially, recruitment and retention if working conditions are deemed less attractive.

6.16 Responding to some of the drivers of change will require investment from businesses, in addition to the investment required to develop and grow. Access to finance can be an issue, particularly for shellfish producers. The industry does not tend to fit neatly in to how financial institutions assess and value business assets and this has driven companies to seek finance from overseas banks, for example, Norwegian banks which cater for and are used to dealing with aquaculture businesses. This lack of access to finance is very likely to inhibit growth if it is not

addressed. There is scope to develop the leadership and strategic management skills in the sector which will help businesses to develop their cases to access finance and funding.

6.17 There remains fairly limited knowledge sharing between the sub-sectors and indeed, across the marine economy as a whole both in terms of research and innovation and industry knowledge. Work is already underway on more collaboration, particularly in relation to common issues such as sea lice, as solutions would benefit the entire sector. There is also some evidence of research clustering and alignment between research and industry but this could be enhanced and there is an appetite in the sector and across education and the public sectors to increase this collaboration. However it takes time and investment and for industry in particular, if it is to be worthwhile, it must bring benefits in the short to medium term, and be seen by industry to do so. Understanding the benefits of collaboration and being able to build effective partnerships is part of the leadership skill set that must be enhanced within the aquaculture sector.

6.18 There is currently work under way that is examining the science, research and innovation assets in the marine economy which includes aquaculture. This 'Science and Innovation Audit has the potential to lead to enhanced research capacity and application, and potentially clustering that will benefit aquaculture and its supply chain.

6.19 The potential impact of Brexit on aquaculture is an issue for the sector and one that is likely have serious implications, however we cannot be clear about the extent of these at this stage. Exporting into Europe may be affected and its impact on recruiting and retaining workers from the EU will have implications for aquaculture. A challenge at this stage is that planning for Brexit in businesses and also, the public sector and education is largely taking place in a vacuum as there is no clarity on what the specific outcomes will be in terms of trade agreements, migration and the legal framework. If skills cannot easily be brought in from outside of the UK, then a planned approach to developing and attracting them locally will be crucial.

The skills pipeline for aquaculture

6.20 While the number of entries and passes in subjects relevant to aquaculture has declined in recent years, the number of college enrolments has increased, although the majority of these enrolments are for courses not leading to a qualification. MA starts in aquaculture have fluctuated over the last three years, but it is important to note that the apprenticeship family offering is expanding for example with the introduction of the Technical Modern Apprenticeship in Aquaculture Management. University provision in aquaculture-related subjects has remained broadly constant overall; however, the number of students studying in specific aquaculture degrees has decreased, whilst provision in marine biology and marine zoology has increased. Overall, this is a mixed picture in terms of the skills pipeline for aquaculture, but the research suggests that current levels of skills supply are not sufficient to meet demand from the industry.

6.21 Vocational training in particular is concentrated, even within the Highlands and Islands. Most enrolments are at Shetland College/NAFC. Though delivery of FE training from here is peripatetic, this nevertheless poses a potential barrier for FE access. Employers often perceive that training is not available in their area.

6.22 The introduction of the Technical Modern Apprenticeship in Aquaculture Management begins to address the demand for more vocational training. However, evidence from employer consultations indicates a need for further vocational education and training provision and key areas include health and safety and boat skills. There may be scope here for a cross-sectoral approach to providing this type of training in local areas.

Skills challenges

6.23 There are a number of challenges facing the sector in terms of the skills that are and will be required going forward, and their need is pressing, both now and in the future. There is a need for more engineering skills in the aquaculture workforce as well as the supply chain but there is strong competition for these skills from other sectors in the economy.

6.24 Boat skills are key across aquaculture and its supply chain and there is an unmet demand in the workforce and the pipeline. This covers boat piloting as well as a range of boat handling and boat-based skills. The introduction of a Diploma in Maritime Studies: Workboats as part of the Maritime Occupations Modern Apprenticeship Programme, as well as the recent launch of the SVQ in Boat Building and repair, is indication that this issue is receiving attention, however more development is required in this area. The industry and supply chain is also struggling with provision of statutory training for boat handling and availability of companies and instructors providing sufficient courses to cope with demand as the sector grows.

6.25 There are gaps in leadership, management and wider business skills in the current aquaculture workforce and addressing these will be important going forward, particularly where businesses grow in size and complexity. Linked to this is the challenges of succession planning that is facing aquaculture, in particular, shellfish as its existing workforce ages. The lack in management skills extends from assistant managers through to more senior managers and mangers across specialist functional areas such as finance, marketing and HR. The introduction of the SVQ Level 4 Modern Apprenticeship in aquaculture Management qualification, building on existing levels 2 and 3, has been well received by industry, however, there is a need for it to be expanded to accommodate more learners and for a wider range of locations providing the training.

6.26 Reflecting the importance of fish health and disease control, the aquaculture sector needs people who are skilled in up-to date approaches to fish husbandry, fish health, feeding and biology. Again, these are lacking in the current workforce and will be increasingly important for the future, sustainable development of the sector. This is particularly the case for finfish, but is becoming an increasing concern in shellfish companies as they innovate and adopt innovative and technical approaches.

6.27 As a cross cutting theme, there is a need for high quality R&D skills to be attracted and retained in aquaculture and the supply chain. If the sector is to respond to the challenges and maximise its growth potential it will be important to develop new technologies and innovate in terms of equipment, product and process. R&D takes place in industry, in academic institutions and in research centres and institutes. If the commercial benefits of R&D are to be realised, then there needs to be good collaboration across these and so there must be the skills and capabilities to do that, alongside the research capacity.

6.28 As well as the more tangible, technical skills that are required, there is an industry wide need for more people with soft, transferable skills and skills that enable them to adapt and continue to adapt the changing work environment and new systems and processes. This covers team working, career management, digital skills, relationship building and the skills required to be a valuable and effective worker. There is an over-riding sense that aquaculture businesses can find it difficult to recruit for these skills although it is a challenge faced in many other parts of the economy. Certainly, the need for the workforce to continually develop their knowledge and skills is a thread running throughout the Scottish economy.

6.29 Aside from competition from other sectors for skilled workers, the particular characteristics of aquaculture can make it challenging to recruit and retain staff. The perception of the sector as a physical, challenging and sometimes lonely environment in which to work can deter people from considering it as a career option. It is recognised that there can be challenges in recruiting and retaining talent across a range of sectors in the Highlands and Islands. Arguably, the locations of aquaculture operations, particularly production, makes it even more difficult to recruit the skills required. These more remote areas have small local populations to draw on and often lack the infrastructure and opportunities that workers and their families look for.

6.30 Where people work in aquaculture, they frequently move between employers in the sector and this churn can disrupt the workplace and mean that investment in training is lost to the employer, albeit that it is retained in the sector. Compounding this, training provided in-house by aquaculture employers is not always transferable or recognised by other employers in the sector which means employees may repeat some training and it is potentially an inefficient use of resources.

CONCLUSIONS

6.31 It is clear that aquaculture has enormous potential and there is a remarkable set of opportunities for its development and growth. It is an increasingly large scale and technological industry that contributes to inclusive and economic growth in Scotland. The produce enjoys a premium postion in the global market, recognised as producing high quality products within Scotland's Food and Drink offer.

6.32 It provides important employment opportunities across a wide range of skills areas and has a strong R&D base which provides high quality jobs which are important to the region. However, a sizeable proportion of the higher value-added activities and business ownership sits outside of Scotland which is potentially detrimental to achieving its full potential in terms of economic development and skills.

6.33 The sector faces challenges in terms of the skills it needs now, and the skills it will need to fuel its development and growth. All stakeholders must be proactive in identifying these skills needs and putting in place the measures to make sure they are fulfilled. Ensuring that what is taught in FE and HE aligns with the workplace and the needs of industry will be key.

6.34 In common with many sectors, its workforce is ageing and there is therefore not only a skills issue in terms of expansion demand, but also replacement. There is a need to upskill and reskill the existing workforce as well as ensure the pipeline of people with the skills, attitudes and aptitudes flows into it and is retained. Coupled with this, a key challenge for the Highlands and Islands is retaining and attracting talent and it is an issue for the majority of sectors in the region. Local infrastructure is crucial so that there are not only jobs, but that areas are attractive as places to live, work and learn.

6.35 As well as more people, aquaculture will need a resilient and agile workforce that can adapt quickly to a constantly changing sector. This will require planning on the part of employers but also from other stakeholders in education, training and economic development. Skills and economic development are inextricably linked and over the last decade there has been an increasing drive for an integrated approach, illustrated by the Enterprise and Skills review. Effective communication and working across the range of relevant policy and strategic areas at national, regional and local levels will be important to achieve consistent integration of skills and economic development in aquaculture. There is already work underway to develop the 'Blue Economy' of which aquaculture is a key component. Taking this wider 'economy' approach presents scope for more cohesion and collaboration.

RECOMMENDATIONS

6.36 Based on the evidence from the qualitative and quantitative research, ekosgen and Imani Development have developed the following set of six recommendations, which relate directly to the actions required for skills development that are needed by the aquaculture sector. Reflecting wider challenges and issues, some of the recommendations are similar to actions required for other sectors in Highlands and Islands as identified in current Skills Investment Plans. However, there are particular areas of focus for the aquaculture sector which should be considered to ensure the skills required are available to the industry now, and in future.

6.37 The development of aquaculture will require a number of organisations, sectors and interested bodies to work together and take a planned approach to ensure there are the right skills in the right places at the right time, but also to address the wider challenges and harness the greater opportunities for the sector.

6.38 Overarching all of this is the need to continue to build on the work and expertise of the aquaculture ILG and the research and intelligence that already exists and is underway relating to the sector.

Recommendation 1: Promoting the sector as a career destination

Aquaculture is a very positive career destination. It is a growing sector that is developing in new and exciting ways. There are varied roles within the sector and its supply chain and progression opportunities in terms of skills and role development. There are also opportunities around leadership and succession planning in finfish and shellfish. However, there is a lack of awareness and understanding about modern processes, working conditions and visibility of career opportunities and pathways.

To attract people into aquaculture, the sector and the roles within it must be clearly communicated and reinforced amongst potential recruits, people and organisations that influence career decisions. The profile of the sector must be raised and it should be promoted as fast growing and technology driven. It must be acknowledged that at this stage, this is more reflective of finfish rather than shellfish but in both there is undoubtedly scope to raise and alter sector profile.

Promoting the sector as a career destination should be at all qualifications and skills levels, as well as for all types of jobs. This will mean promoting the sector to younger people including school leavers as well as graduates, post graduates and other potential recruits. Whilst there is a need to promote the sector to people who could fill a wide range of roles, there would be particular merit in the short term in raising awareness to attract more engineers in to aquaculture and the supply chain.

Recommendation 2: Develop leadership, management and business capacity

There are a number of programmes and initiatives available in the Highlands and Islands and other parts of Scotland that are designed to develop leadership and management skills in business leaders and future leaders. Some aquaculture businesses have already benefited from these but there is scope to extend the reach more widely in to the sector and target leadership and management development support, along with wider business skills at aquaculture and supply chain businesses. Barriers to participation should be explored and tackled where they exist; for example, financial barriers, time commitment and attitudinal barriers. This will be a key requirement if the industry is to reach its potential and should be addressed in the short to medium term.

There is increasing interest in, and commitment to, leadership development being built into education and learning cutting across subject areas, for example through internships and other programmes and initiatives. This is important for the future of the Scottish economy as a whole and for specific sectors. Going forward, learners in aquaculture-related subjects should have the opportunity to develop leadership and business skills as part of their study at under-graduate level and post-qualification. This should be explored and introduced as soon as is practical, recognising the range of partners who would be involved.

Recommendation 3: Consistency and transferability of training and education

To address skills gaps in the current workforce and in new recruits, many employers provide in-house induction and skills training. Whilst this is very positive and proactive, the downside is that training and skills across the sector is not consistent and because it is largely not accredited, there is a lack of industry wide quality assurance. The advantages to employers is that their staff are trained in the specific skills and working practices of that firm but, when employees move to other employers, they frequently have to undertake new training rather than port across.

Whilst employers may resist sharing and aligning their in-house training, ultimately this would benefit both employers and employees. Employees benefit as their training would be recognised by a wider range of employers which may enhance their access to career progression opportunities and provide greater mobility. Employers benefit as there is a significantly reduced need to provide bespoke training for each new entrant to the businesses, saving time and unnecessary training investments and improving productivity. Overall this could retain more people in the sector and in time grow the labour pool. This could potentially be achieved through accreditation and could deliver efficiencies at sector level as well as a greater degree of consistency and

transferability across the industry. Whilst employers may worry that it would make it easier for staff to move between employers, it may serve to retain more people in the sector as a whole and build the skills capacity rather than skills development being a 'revolving door' where employees repeat training each time they move.

Recommendation 4: Developing a digitally enabled workforce

Digital skills are increasingly important in every sector in the Scottish economy and have changed how we expect to work, live and receive services. Aquaculture is no different and IT and digital skills are critical for many roles in the workforce. This will continue to develop and change as technology advances.

Staff in, and entering the sector must have the skills to enable them to use digital technology, and looking to the medium to longer term, have the ability and confidence to continue to learn and upskill as they adapt to new changes in technology. There is no doubt that the technology and skills required now will look very different in a decade and certainly, by 2030. To embed this digital capital in the workforce, digital literacy should be a key component of training and learning across the aquaculture skills pipeline. In addition, aquaculture businesses should be directed to initiatives and support to help develop the digital skills of their existing workforce, for example through Skills for Growth. Updating digital skills and responding to technological changes will be an on-going requirement and it is one that should be tackled in the short term to keep abreast of developments and maximise productivity.

Recommendation 5: Enhance provision of work based learning and vocational training

Work-based learning is highly valued by employers as providing skills development for staff in the workplace that is considered to be more effective and aligned to working practices. It also, with the right delivery structures, makes it more accessible to a wider population who may not be able or willing to relocate or travel to participate in learning. There is scope to expand the provision of work-based learning including for higher level qualifications at SCQF Level 9 and above.

Consideration should be given to expanding the provision of undergraduate level aquaculture courses in line with industry need and ensure that undergraduate courses comprise an element of work placement. Underpinning the provision of training and education is that it should be accessible to learners whether they are full time learners or in employment. This means expanding the number of places as well as the locations in which it is delivered. Location is a particular issue for aquaculture given the dispersed geography of operations.

Opportunities for work-based learning and vocational training should be actively promoted in the sector and in communities with aquaculture producers. Where these are available on an outreach basis and in local areas, it should be clearly promoted. This is a high priority area of work that will take some time to achieve but exploratory work and planning should start in the short term.

Recommendation 6: Widen the recruitment pool

The aquaculture workforce is largely male and is ageing. Diversifying the workforce is an important objective, and it would help to widen the pool of potential recruits by broadening it out to more women and younger people. This will include awareness raising about career opportunities and learning and education in the sector, and taking consideration of the factors that will attract more young people and women into the sector, and retain them.

Support could be provided to employers to review and develop their recruitment processes. Businesses could also be provided with guidance and encouragement to put in place more flexible working practices and importantly, the internal culture to support take up. This would help to remove some of the real and perceived barriers to working in the sector, in particular for women who tend to have the main caring responsibilities in households. Again, flexible working is a key tool for retaining staff. Achieving this will likely rely on drawing and building on existing work in the Highlands and Islands to tackle occupational segregation and encourage more diversity in the workforce including people with shared protected characteristics.

APPENDIX 1: SECTOR DEFINITION AND DATA LIMITATIONS

DEFINING THE SECTOR

Aquaculture refers to the breeding, rearing, and harvesting of plants and animals in all types of water environments including ponds, rivers, lakes and the oceans. It includes the production of seafood from hatchery fish and shellfish which are grown to market size in ponds, tanks, cages or raceways and produces a range of products. Some plant species that are farmed are used in a range of food, pharmaceutical, and biotechnology products.[63]

SIC code definition

In terms of the 'top-down' approach to defining the sector, aquaculture can be captured according to the following Standard Industrial Classification (SIC) codes:

aquaculture sector

- 03210 Marine aquaculture
- 03220 Freshwater aquaculture
- 10200 Processing and preserving of fish, crustaceans and molluscs

Capturing the scale of employment in and the business base of aquaculture, and its immediate processing supply chain, through SIC Codes is relatively straightforward, since most data is available through BRES.

In terms of the wider supply chain, the following SIC codes are of relevance to the aquaculture sector, but it should be recognised that much of this is a wider, shared supply chain that services other sectors in addition to aquaculture. Therefore only a proportion of this employment will form part of the aquaculture value chain.

SIC codes encompassing the wider (shared) supply chain

- 10890 Manufacturing of other food products, not elsewhere classified
- 10910 Manufacture of prepared feeds for farm animals
- 46380 Wholesale of other food including fish, crustaceans and molluscs
- 47230 Retail sale of fish, crustaceans and molluscs in specialist stores
- 49410 Freight transport by road
- 75000 Veterinary activities

Scottish Government definition

However, the definition of aquaculture used by Scottish Government and Marine Scotland is simpler, and is defined as "the farming or culturing of fish, molluscs, crustaceans, and seaweed".[64] Through its annual surveys, data is gathered from companies actively involved in the production of:

Finfish: Rainbow trout, Atlantic salmon (ova and smolts, and production), other finfish such as Brown trout, Halibut and cleaner fish (Lumpsucker and Wrasse); and

Shellfish: Mussels, Pacific oyster, native oyster, queen scallop, scallop.

[63] NOAA – National Oceanic and Atmospheric Administration (2017) *aquaculture: What is aquaculture?*, at: http://www.nmfs.noaa.gov/aquaculture/what_is_aquaculture.html
[64] Scottish Government (2017) *aquaculture*, at: http://www.gov.scot/Topics/marine/Fish-Shellfish

DATA LIMITATIONS

There are a variety of different jobs that are undertaken throughout the aquaculture industry. These are diverse and range from office work, to laboratories, to on-site. Onsite roles include fish health, husbandry, engineering, environmental science, and business management[65] and smolt (baby salmon) production. There are also significant opportunities within the value chain such as employment in feed production, vets, regulation and so on.

However, these roles are not adequately captured through SIC codes for aquaculture, or Standard Occupational Classification (SOC) codes. Only a small number of SOC codes are immediately relevant to the aquaculture sector (e.g. *1213 Managers and proprietors in forestry, fishing and related services*), but these extend to cover other industries, such as fishing, forestry, agriculture etc. As these codes are already at the 4-digit level, further granularity is not available, and it is not possible to disaggregate any further.

[65] Scotland Food and Drink (2017) *aquaculture Growth to 2030: A strategic plan for farming Scotland's seas*

APPENDIX 2: STAKEHOLDERS CONSULTED

Organisation
Argyll and Bute Council
Association of Scottish Shellfish Growers (ASSG)
British Trout Association
Comhairle nan Eilean Siar
Highland and Islands Enterprise
Institute of Aquaculture (University of Stirling)
Marine Scotland
NAFC Marine Centre
SAMS
Scottish Aquaculture Innovation Centre
Scottish Salmon Producers Organisation (SSPO)
Scottish Seaweed Industry Association
Sea Fish Industry Authority
Shetland Islands Council
Skills Development Scotland
The Crown Estate

APPENDIX 3: EMPLOYERS ENGAGED IN THE RESEARCH

Employer	Type
AKVA Group Scotland	Supply chain
Aqua Pharma Ltd	Supply chain
Aquascot	Supply Chain
ATLAS Arts	Producer (Shellfish)
Caledonian Oyster Company Ltd	Producer (Shellfish)
Cooke Aquaculture	Producer (Finfish)
Cribba Sound Ltd	Producer (Shellfish)
Dawnfresh	Producer (Finfish)
Ewos	Supply Chain
FAI Aquaculture	Supply Chain
Firth of Forth Lobster Hatchery	Producer (Shellfish)
Fusion Marine	Supply chain
Gael Force	Supply chain
Grieg Seafoods	Producer (Finfish)
Hatch Blue Ltd	Supply chain
Howietoun Fishery	Producer (Finfish)
Isle of Barra Oysters	Producer (Shellfish)
Isle of Lewis Oysters	Producer (Shellfish)
Isle of Mull Oysters	Producer (Shellfish)
Isle of Mull Scallops	Producer (Shellfish)
Johnson Marine	Supply chain
Kames	Producer (Finfish)
Knox Marine	Supply chain
Landcatch Natural Selection Ltd	Producer (Finfish)
Loch Duart	Producer (Finfish)
Loch Eishort Mussel Culture	Producer (Shellfish)
Lochfyne Langoustines Ltd	Producer (Shellfish)
Marine Harvest	Producer (Finfish)
PHARMAQ	Supply chain
Sainsburys	Supply chain
Scottish Sea Farms	Producer (Finfish)
Shetland Mussels	Producer (Shellfish)
Shian Fisheries Ltd	Producer (Shellfish)
Skretting	Supply chain
Solway Transport Ltd	Supply chain
Unst Shellfish	Producer (Shellfish)
Vaki Scotland Ltd	Supply chain
Wester Ross Fisheries	Producer (Finfish)

APPENDIX 4: HE HESA/JACS CODES

The following HESA/JACS codes were agreed with the project steering group, and are considered as 'core' HE subject areas for aquaculture.

C – Biological Sciences, and specifically:

C150 Environmental biology; Relates animals and plants to their terrestrial and marine habitats.

C160 Marine/Freshwater biology; The study of aquatic biology.

C161 Marine biology; The study of saltwater and oceanic biology.

C162 Freshwater biology; The study of freshwater and estuarine biology.

C300 Zoology; The scientific study of all aspects of animal biology: their reproduction, development, physiology, behaviour, mechanics of locomotion, diseases and interactions with the environment.

C310 Applied zoology; Zoological topics of commercial or social importance, e.g. animal disease and eradication.

C350 Marine zoology; The biological study of animals in seawater environments.

D – Veterinary Sciences, Agriculture and related subjects; specifically:

D430 Fish farming; The study of the most efficient way to use an area of water to rear fish for commercial sale.

D431 Fish husbandry; The study of fish in their environment for fishing or fish farming.

D432 Freshwater fish; The study of fish generic to unsalted ponds, streams, rivers and lakes, their habits, breeding pattern and the unique effects of their environment.

D433 Saltwater fish; The study of fish generic to seas, oceans and salted estuaries, their habits, breeding patterns and the unique effects of their environment.

D435 Aquaculture; The study of the cultivation of water resources, both plant and animal, for human consumption or use.

D463 Organic fish farming; The study of the most efficient way to use an area of water to rear fish for commercial sale, without the use of artificial chemicals.

F – Physical Sciences, and specifically:

F140 Environmental chemistry; Concerned with environmental issues related to the chemical sciences.

F141 Marine chemistry; Topics in the chemical sciences concerned with understanding the marine environment.

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