

Appendix: Item 12

FISH'N'TRIPS

The Logistics Issues Faced by the Scottish Aquaculture Industry

Report by SYSTRA and Imani Development

On behalf of HITRANS and HIE

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EXECUTIVE SUMMARY

The Scottish aquaculture industry

The Scottish Government defines aquaculture as “the farming or culturing of fish, molluscs, crustaceans, and seaweed”¹. The aquaculture industry is one of the most important in Scotland, worth around £1.8bn to the Scottish economy and supporting around 8,800 jobs² in the production and processing of finfish, shellfish and seaweed products. Growth estimates vary, but “Aquaculture Growth to 2030”³, published by Scotland Food & Drink in 2016, identifies the potential for industry turnover to as much as double to around £3.6bn in the next twelve years.

This review has sought to identify evidence of transport and logistics issues that are faced by the industry, and in particular where these issues may constrain future growth. To do this, we have reviewed published data and also engaged with key stakeholders in both aquaculture and logistics sectors in order to gather information about both current and anticipated future issues.

Finfish production accounts for a large proportion of the aquaculture industry, and salmon is the most widely produced finfish (accounting for 95% of Scottish finfish production in 2015). Other species produced include rainbow trout, halibut, and sea trout⁴. Scottish salmon production has fluctuated over the years, but was nearly 190,000t in 2017, the highest ever level of production recorded in Scotland. Production takes place at sites throughout the north and west coast of Scotland, and the northern and western isles, whilst processing takes place at more than a dozen key locations, including some well away from production locations. It is estimated that around 60% of Scottish salmon is consumed in the UK and 40% exported⁵.

The shellfish species currently cultivated in Scottish waters are mussels, pacific oysters, native oysters, queen scallops and scallops, though the industry is dominated by the production of mussels. Total mussel production in 2017 was just over 8,000t for the table, and nearly 4,500t for on-growing⁶. Over 80% of Scottish mussels are produced in Shetland.

The seaweed industry is currently small in Scotland, and no total production data for the industry is available, though substantial opportunities for growth are foreseen. There is currently no fully commercial aquaculture production of seaweed in Scotland; but small to medium scale harvesting takes place in various locations around the country. Scotland, and in particular the west coast, has excellent conditions for cultivating the types of seaweed that have high commercial value for use in a wide range of products, including food, pharmaceuticals, cosmetics, biofuels and fertilisers.

Aquaculture routes and flows

There are many links in the aquaculture supply chain, where the industry relies on the movement of product or equipment. Both routes and flows of aquaculture products in Scotland are constantly in flux. Significant variances in flows occur in the course of normal production (variances in total production levels by year and by area, of where products are landed, of which supplier feed is purchased from, etc). Furthermore, some consultees were reluctant to provide detailed information about their logistics requirements on the grounds of commercial confidentiality. As such, reliably quantifying the routes and flows of aquaculture logistics is challenging, but key information is summarised below.

¹ Scottish Government (2017) *Aquaculture*. [online] Available at: <http://www.gov.scot/Topics/marine/Fish-Shellfish> [Accessed 30.08.2017].

² Marine Scotland (2013), *An Assessment of the Benefits to Scotland of Aquaculture*.

³ <http://scottishsalmon.co.uk/wp-content/uploads/2016/10/aquaculture-growth-to-2030.pdf>

⁴ MAXiMAR: Maximising the Marine Economy in the Highlands and islands, ekosgen, Imani Enterprise Ltd., and HIE, 2018

⁵ Marine Scotland Topic Sheet Number 40, *The Value of Aquaculture in Scotland*

⁶ *The Scottish Shellfish Production Survey 2017*

Salmon

The primary input for salmon production is feed; by volume and value it is by far the most significant input for the sector. There are three currently main fish feed suppliers serving the industry in Scotland, and exporting further afield:

- EWOS in Bathgate;
- Skretting in Invergordon; and
- BioMar in Grangemouth.

In 2016, an estimated 195,000t was transported from the three feed-producing nodes to Scottish salmon farms. Most is taken firstly by road to Kishorn, Aberdeen, Mallaig, Oban or Stornoway (by road/ferry), where it is loaded onto chartered boats for delivery to the farms.

The development of a new feed production site at Kyleakin, due to open soon, is anticipated to have a substantial impact on the logistics of sourcing feed for the salmon farms, including a much higher proportion of transportation being made entirely by boat.

In 2017, just over 46 million smolts (young salmon) were produced in Scotland, by 24 companies operating over 79 different sites, with a comparatively small number of ova and smolts being imported and exported each year.

The smolts are typically transported from the hatcheries in water tanks on flatbed trucks by public road to ports, then by wellboat to farms. Generally, wellboats are under hire within the industry, though in some cases they form part of companies' own integrated supply chains. Relative to the volumes of feed and processed fish transported, smolts transport is a relatively minor part of the logistics system: it involves multiple origins and multiple destinations, generally short distances, and has no reliance on commercial ferry operators.

There are two primary steps in salmon processing. First is the harvest and gutting, and then the filleting and secondary processing. Salmon are typically taken by wellboat to harvesting stations where they are then killed and gutted (though much of Marine Harvest's production relies on harvesting in Mallaig then road transport to Fort William for gutting). Once harvested, they are generally moved to another plant for the secondary processing; these plants are in various locations across the Scottish mainland and islands, some being well away from the production or harvesting sites. Virtually all processed fish is then taken to the DFDS Logistics centre at Larkhall, where fish and shellfish from almost all producers is consolidated into shipments bound for different destinations.

Mortalities, or morts, are a by-product of fish production, and regulations mean that most necessitate lengthy journeys by truck (including ferry from island production sites) for disposal. There are two types of mortality: routine mortalities, which tend not to cause major transportation problems, and incident-based mortalities, which are unexpected, and can vary between very low numbers and many thousands of tonnes in any given year. The latter has the potential to place high short-term demands on the transport network.

The view within the industry, as asserted by the Scottish Salmon Producers' Organisation, is that the medium-term future will see aquaculture production move towards fewer but larger production sites, with greater support and infrastructure requirements. Aquaculture hubs will play a larger role: Mallaig, Fort William, Inverness, Oban, Kyleakin, etc. The trend towards increasing use of seaborne transport will tend to ease pressure on the remote rural road network, though there may be a risk of intensifying congestion in ports and harbours, especially if tourism and wet fish catch continue to grow.

Shellfish

The logistics of the shellfish production cycle is simple to map, as shellfish require minimal equipment and no feed.

After mussels have been harvested, they are landed in bulk bags on a suitable local quayside, from where they are taken by lorry for onward dispatch; those from Shetland almost entirely reliant on the Lerwick – Aberdeen NorthLink ferry, and many on inter-island Shetland ferries to reach Lerwick. Almost all mussels produced in Scotland are then taken to Bellshill, Lanarkshire for processing. Many are then moved to Larkhall for onward distribution with other aquaculture products by DFDS Logistics, though major supermarkets will also collect direct from Bellshill. Fish and shellfish are commonly transported together from processing plants to final markets, as they are consolidated according to destination, rather than by type of product.

The shellfish sector aspires to increase production by over 60% by 2030, to around 20,000t. The increase in freight flow is relatively modest when set in the context of the aspiration to produce in the range of 300,000 to 400,000t of finfish and, consequently, the net impact of the transport network in future will not be so significant. But if, as expected, Shetland wishes to retain its dominance of mussel cultivation, this industry growth will rely on expanded use of inter-island ferries and the Lerwick – Aberdeen ferry service, and onward connections to the Central Belt (assuming that processing remains consolidated there).

Seaweed

Seaweed in Scotland is largely harvested off-shore, generally in remote areas, before being taken by truck to a factory for drying and milling. The biggest input required for seaweed production is wood; this is used for the drying process, and is presently transported by truck and/or boat. Final product is currently modest in volume, and transport by truck or van.

Current and future issues and constraints

Harbours and piers

Aquaculture is very reliant on harbours and piers at several stages in the production cycle. Consultees in the main were satisfied with the harbour infrastructure that was available, though some areas of concern were raised.

The capacity of harbours on the west coast is reported to sometimes be a problem, with it being hard to access appropriate quay space at times. The maximum size of available berths was reported to be an issue, especially for wellboats; the Scottish industry is not able to utilise such large wellboats as in some other locations, because no suitably large harbours are available; this poses challenges for efficient growth in aquaculture production.

Growth in the industry without growth in harbour capacity could create or exacerbate capacity problems, though we recommend considering pier and harbour infrastructure in more detail once the full effects of the opening of the Marine Harvest feed production plant in Kyleakin have become apparent. Some consultees expressed disappointment that the government had not committed to providing a deep water ro-ro ferry terminal as part of the Nigg Bay development (which would avoid the need for road vehicles to travel into Aberdeen to get to the ferry).

Road transport

Many strategic and local transport links are essential for the effective operation of different aquaculture sites. But those that are of particular importance to the industry are:

- A90/M90 – Aberdeen – Central Belt;
- A830/A82 – Mallaig – Fort William – Central Belt;
- M74/M6, etc – Central Belt to English and European markets and Heathrow.

For the main part, road transport in Scotland is not seen to be a problem for the aquaculture industry or for hauliers. Consultees identified few systemic problems with the Scottish Trunk Road network. Journey times on it were generally felt to be reasonable, and reasonably reliable; though some

pinchpoints were identified, most notably the route from Aberdeen Harbour to the A90 and congestion around Fort William.

Hauliers have more concerns about roads in England, which are experiencing increased congestion, and may reach a point where this affects the ability to reach major markets within a driver shift of the Larkhall and Bellshill processing plants.

Both hauliers and aquaculture producers expressed nervousness about the risk that Brexit could result in long delays to freight traffic. The impacts of this on the value of Scottish aquaculture produce and on the availability of transport services could both have a significant impact on the industry.

Ferries

All the main island – Scottish mainland ferry routes are essential to current aquaculture production.

Various issues around the Northern Isles ferries have raised been in the course of the consultation. These include that the timetabling and routing of sailings does not always suit aquaculture producers and concern over the delayed introduction of the Road Equivalent Tariff (RET). Some consultees also noted concerns with the timings of Shetland inter-island ferries. But the biggest concern raised was regarding capacity of the Aberdeen ferries; though NorthLink report that there is significant spare space over the course of the year as a whole, some ferries do operate at capacity, which can cause problems for aquaculture products. Problems tend to be worse later in the year (when aquaculture production tends to be highest) and if major construction projects on the islands are creating demand for deck space. Aquaculture producers on the islands also express concern that Brexit could lead to increased landings of wet fish there, which would be competing for the same ferry capacity.

West coast ferries pose fewer challenges to the industry at present; the main challenge noted by consultees in relation to them is of sailings being cancelled or delayed due to bad weather. Sailings are reported to often be cancelled too late for the hauliers to make alternative routing arrangements. However, whilst capacity challenges appear to be largely manageable at present, there was widespread agreement amongst consultees that the current provision of service could not accommodate any substantial increase in aquaculture production in the Western Isles, exacerbated by an increase in car traffic following the introduction of RET.

In the course of the business engagement exercise, many businesses and organisations highlighted the issue of the unresolved Freight Fares Review. There are concerns that the review will create clear 'winners and losers'. One aquaculture industry spokesperson says that uncertainty over freight fares is holding back development.

Rail

At present rail plays no significant role in aquaculture freight in the UK; in terms of interchange, and the practicalities of transferring freight in suitably adapted containers, it is not seen as a viable option.

Air

Almost all air-freighted Scottish aquaculture produce currently leaves the UK from Heathrow. Consultees were generally content with the broad reach of international markets that Heathrow offers, although there was a view amongst consultees that once a critical mass of production is reached, then air freight services from Scotland would become economically viable, and indeed could offer considerable benefits in terms of saved time and reduced haulage costs.

Summary and implications for the industry

Overall, logistics issues do not currently cause major problems for the Scottish aquaculture industry, though delays to transportation when they occur do significantly reduce the value of the product.

Looking ahead, logistics issues are not anticipated to be as significant a brake on potential growth of aquaculture as some other factors including the availability of suitable production sites, of planning constraints and environmental considerations. But, nevertheless, there are logistics issues which have the potential to hamper the industry's plans.

The evidence gathered from this review has identified the following as being the most important:

- **Harbour capacity for wellboats:** the largest wellboat berth in Scotland is at Mallaig, and enables access for vessels of up to 1,800m³ capacity. Yet some Norwegian harbours enable boats of up to 3,000m³. Enabling larger vessels to dock in Scotland would facilitate more efficient growth of larger fish farms;
- **Capacity at other ports:** lack of capacity for transhipment from road to sea-going vessels at other ports could place a constraint on growth. We note, however, that the on-going development of a new finfish feed production site at Kyleakin could result in more deliveries of feed directly by boat to the farms, so reduce the need for port transhipment; the resulting situation should be monitored before investment decisions are made;
- **Ferries:** across the year as a whole, there is reported to be spare capacity on all Scotland's ferry services. But some peak-time sailings are full, and ferry capacity could be a constraint to growth of aquaculture in the islands. This is of particular importance if growth in other industries results in them generating more demand for ferry freight traffic, which could squeeze out aquaculture produce. Finalisation of the Ferries Review would also enable hauliers and aquaculture producers to plan for island investment with more certainty than they are currently able. The recent Audit Scotland Ferries Review recommends that Transport Scotland should (amongst other notable actions) develop a Scotland-wide, long-term strategy for its network of subsidised ferries as part of its Strategic Transport Projects Review;
- **Airports:** better facilities for handling freight at Scottish airports (including provision for handling chilled goods which they currently lack) provides a potential option to enable faster access to international markets for aquaculture produce and fewer UK road miles. But, given Heathrow's access to a much wider range of destinations and its much more comprehensive freight handling service, the demand for airfreight from Scotland remains to be tested;
- **Trunk Road delays:** consultees report a generally high level of satisfaction with the Scottish Trunk Road's ability to cater for aquaculture traffic, though reducing delays in Fort William and Aberdeen would reduce haulage costs. But delays on the routes south to access English and European markets are reported to be increasing, and posing some risk to the carefully-designed supply chains that place the main distribution centres at Bellshill and Larkhall within a driver's shift of the main Boulogne-sur-Mer northern European fish market;
- **Haulage industry capacity and efficiency:** there is potential that a significant growth in demand for aquaculture road haulage, without reductions in demand from other sectors, could result in a capacity constraint in terms of numbers of drivers available, especially locally in rural Scotland. Improvements in communications network coverage would potentially aid driver recruitment and also enable hauliers to respond more effectively to unplanned changes in demand or operational difficulties.

1. INTRODUCTION

1.1 Context

The aquaculture industry is one of the most important in Scotland, worth around £1.8bn to the Scottish economy and supporting around 8,800 jobs⁷ in the production and processing of finfish, shellfish and seaweed products.

But it is also one that sees good opportunities for growth. Estimates vary, but “Aquaculture Growth to 2030”⁸, published by Scotland Food & Drink in 2016, identifies the potential for industry turnover to as much as double to around £3.6bn in the next twelve years. The strategy outlines that achieving this growth requires wide-ranging improvements to:

- regulation;
- leadership;
- innovation;
- skills;
- finance; and
- infrastructure.

Within the last category, the strategy states that “Growth in aquaculture in Scotland will require – but also facilitate – investment in infrastructure such as ports and piers and innovation in the design of vessels and vehicles. Scottish producers and supply chain have the capacity and expertise to develop the logistics, vessels and infrastructure required to support a flourish[sic] industry in 2030. However, a number of developments are critical to the industry’s sustainable growth.”

It recommends “a sectoral mapping exercise to determine aquaculture’s current transport and logistical constraints and future requirements to 2030, in terms of roads, ports, harbours and ferry services. This should be used to inform future investment plans in infrastructure improvement in Scotland.”

This report represents the output of that sectoral mapping exercise. It is intended to provide evidence to inform forthcoming transport investment decisions, including the emerging National Transport Strategy and Strategic Transport Projects Review.

1.2 This review

This review has sought to identify evidence of transport and logistics issues that are faced by the Scottish aquaculture industry, and in particular where these issues may constrain future growth. We have sought to take a holistic view of the whole industry, yet also to identify those matters that are relevant to particular parts of aquaculture production, or which are relevant to specific areas of Scotland.

Our work has been based on evidence provided by key players in both the aquaculture production/processing and transport/logistics sectors, complemented by published information and previous reviews. As the first stage of the expansion of the evidence base, the research team engaged in a series of face-to-face meetings. These discussions and our review of published information were used to help develop structured interviews which were used in in-depth research though one-to-one telephone surveys with a range of transport, aquaculture, local authority or third sector businesses and organisations. The purpose of these interviews was to drill down in the current and anticipated routes and flows of the inputs and outputs of the aquaculture production processes, and explore current and anticipated issues and constraints. Over 30 organisations have contributed to this research.

⁷ Marine Scotland (2013), An Assessment of the Benefits to Scotland of Aquaculture.

⁸ <http://scottishsalmon.co.uk/wp-content/uploads/2016/10/aquaculture-growth-to-2030.pdf>

The main sources of published information are listed in footnotes alongside the text and in the bibliography in Appendix A. The consultees that have helped provide evidence and insight to inform this review are listed in Appendix B.

Within this document, we first provide an overview of the Scottish aquaculture industry, then outline the main routes and flows of aquaculture supplies and products, before a summary of the evidence about issues and constraints. Key findings and implications for the industry are provided at the end of the report.

This report was commissioned by HITRANS (the Regional Transport Partnership for the Highlands and Islands of Scotland) and Highlands & Islands Enterprise.

The work was led by SYSTRA, supported by Imani Development.

2. THE SCOTTISH AQUACULTURE INDUSTRY

The Scottish Government defines aquaculture as “the farming or culturing of fish, molluscs, crustaceans, and seaweed”⁹.

The aquaculture industry is a key sector in Scotland’s plans for growth and is an asset both nationally and regionally, particularly in coastal and rural areas. It is the largest sub-sector targeted in Scotland’s Food & Drink Strategy and is an industry that has been earmarked by the Scottish Government to drive economic growth.

Scottish aquaculture is dominated by salmon production, with mussels a distant second along with trout (increasingly farmed in cages using similar techniques and technology to those for salmon).

The Scottish aquaculture industry has seen significant growth in recent decades, owing largely to having the right climate, geography (i.e. suitable sites and loch systems) and high-quality water for growth of both finfish and shellfish. In addition, aquaculture in Scotland has high sustainability credentials, for example high feed conversion ratios, good protein yields, and low CO₂ emissions and water usage compared to land-farmed animals.

A report published by Marine Scotland in 2014, *An Assessment of the Benefits to Scotland of Aquaculture*, examined production output data for 2012 and found that, when direct production values are aggregated with turnover and GVA across the supply chain, including processing and other suppliers, the finfish and shellfish industries (seaweed was not included) were estimated to contribute as much as £1.4 billion turnover and 8,000 thousand jobs to Scotland, and £1.8 billion turnover and 8,800 to the whole UK. This included (in addition to salmon) rainbow trout produced in the marine environment plus small volumes of halibut and sea trout. However, a report for Highlands and Islands Enterprise and Marine Scotland, *The Value of Aquaculture to Scotland*, produced in 2017¹⁰, stated that the estimated employment impact is higher than quoted in the Marine Scotland 2014 report, and estimated the full time equivalent employees in industry to be 12,000 jobs in 2015 (see table 1).

⁹ Scottish Government (2017) *Aquaculture*. [online] Available at: <http://www.gov.scot/Topics/marine/Fish-Shellfish> [Accessed 30.08.2017].

¹⁰ Available at <http://www.hie.co.uk/regional-information/economic-reports-and-research/archive/value-of-aquaculture-2017.html>

Table 1. Value of the Scottish aquaculture industry¹¹.

SUB-SECTOR	FTES	EARNINGS (£M)	GVA (£M)
Salmon	10,340	271.0	540
Rainbow Trout	472	12.3	25
Other finfish	61	1.7	3.5
Shellfish	1,054	25.9	5.0
Industry Organisations	95	3.1	4.5
TOTAL	12,022	314	620

The figures in the table above represent direct impacts only, not the supply chain and induced impacts.

Whilst aquaculture contributes significantly to the UK and Scottish economies, it is also important for other reasons. The industry supports some of Scotland’s fragile rural communities, where there can be limited alternative economic opportunities. Equally, there are processing jobs elsewhere in Scotland in areas with higher levels of unemployment and social deprivation (including in the Strathclyde area and Fife).

2.1 Production volumes and locations

Finfish

Finfish production accounts for a large proportion of the aquaculture industry, and salmon is the most widely produced finfish (accounting for 95% of Scottish finfish production in 2015).

Other species produced include rainbow trout, halibut, and sea trout¹². Other finfish, such as wrasse, are also being bred as ‘cleaner’ fish to help tackle sea lice in salmon farms.

Production of salmon is dominated by five big players (Marine Harvest, Scottish Seafarms, The Scottish Salmon Company, Cooke Aquaculture and Greig Seafood); in total they provide around 93% of total production.

97% of total Scottish salmon production takes place in the Highlands and Islands. Figure 1 shows where, by Scottish marine region, salmon are produced. This shows that production occurs throughout almost all of the west and north coast and the islands.

¹¹ Source: Value of Aquaculture to Scotland report

¹² MAXiMAR: Maximising the Marine Economy in the Highlands and islands, ekosgen, Imani Enterprise Ltd., and HIE, 2018

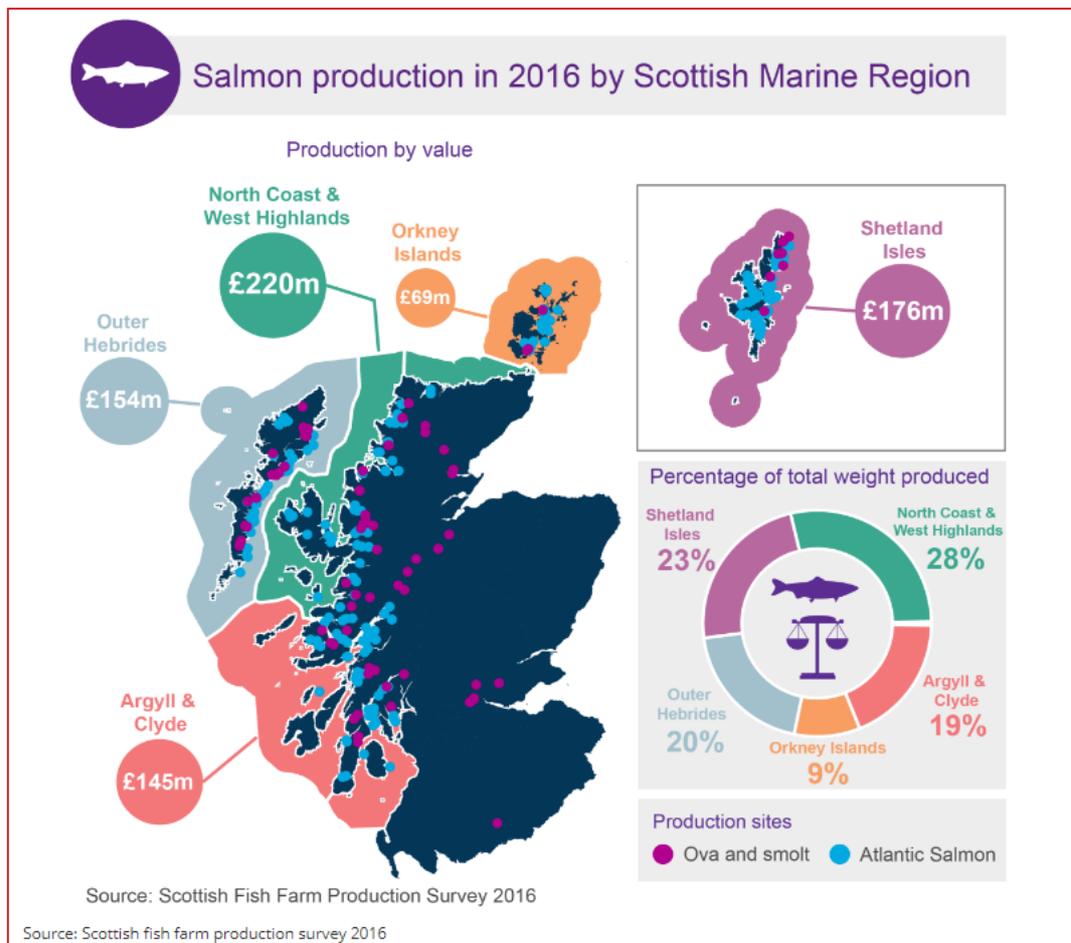


Figure 1. Salmon production in 2016 by Scottish Marine Region¹³

Scottish salmon production has fluctuated over the years, but according to fish farm survey data gathered by Marine Scotland has grown overall from 130,000t in 2007 to nearly 190,000t in 2017¹⁴. This latest figure is the highest ever level of production recorded in Scotland.

Processing takes place in selected locations across Scotland, including in non-production areas (Central Belt, North East Scotland). Almost all processed salmon, from all suppliers, passes through a DFDS distribution hub in Larkhall, South Lanarkshire.

The total production of rainbow trout in Scotland was around 7,600t. Production of rainbow trout is shared between 23 companies; two larger producers and diverse, smaller ones. Production sites are mainly located in the Argyll & Bute and Perth & Kinross regions, as well as at locations in Dumfries & Galloway, with a few in the Highlands and Central Belt, though none in the islands.

Other finfish that are farmed in Scotland accounted for relatively small volumes.

Shellfish

The shellfish species currently cultivated in Scottish waters are mussels, pacific oysters, native oysters, queen scallops and scallops; though the industry is dominated by the production of mussels. Additionally in 2017 there was cultivation of whiteleg shrimp and common periwinkle; however this was done at a very small scale, to the extent that Marine Scotland has not provided production information, on grounds of commercial sensitivity. Total mussel production in 2017 was 8,232t for the

¹³ Source: <https://digitalpublications.parliament.scot/ResearchBriefings/Report/2018/2/13/Salmon-Farming-in-Scotland#How-much-Salmon-is-produced-in-each-region->

¹⁴ The production tonnages given for salmon and trout in this report refer to the wet weight (i.e. weight of live fish) at harvest.

table, and 4,437t for on-growing¹⁵. There were just over 5 million pacific oysters produced in 2017, a substantial increase on previous years (42% up on 2016).

The largest producing area for mussels is Shetland (81% of 2017 Scottish mussel production occurred there), with the remainder of production spanning the West Coast and Western Isles.

Shellfish production is characterised by a large number of smaller, often artisanal, operators. In 2017 there were 132 shellfish businesses operating in Scotland. The Scottish Shellfish Marketing Group, a cooperative marketing platform, plays a significant role in processing, marketing and distribution, and most of Scotland's mussels pass through their facility in Bellshill, North Lanarkshire.

Seaweed

The seaweed industry is currently a small player in Scotland, though substantial opportunities for growth are foreseen. The global seaweed industry is valued at £4 billion per year. At present, 96% of seaweed comes from Asia, but Scotland, and in particular the west coast, has excellent conditions for cultivating the types of seaweed that have high commercial value for use in a wide range of products, including food, pharmaceuticals, cosmetics, biofuels and fertilisers.

There is currently no fully commercial aquaculture production of seaweed in Scotland. Small to medium scale harvesting takes place in several locations, notably the Western Isles and Orkney, with small scale collection of seaweed for specialist high value products taking place in various locations including Fife and Argyll.

There are four relatively well established small seaweed harvesting businesses:

- Hebridean Seaweed produce simple seaweed products (i.e. dried/ground) for use in the animal feed supplement, soil enhancement, alginate, cosmetics and nutraceutical industries. They also produce a liquid seaweed extract fertilizer.
- Uist Asco was acquired by Acadian Seaplants in 2017. It specialises in the harvesting and processing of *Ascophyllum nodosum*.
- Just Seaweed, Isle of Bute, collect a range of seaweed species at low tide and prepare for the deli/online health food market.
- Mara Seaweed, based in Edinburgh and source mainly from Scottish and UK coastline. They market a range of seaweed condiments and food additives primarily in the form of seaweed flakes.

The Scottish Seaweed Industry Association (SSIA) reported that there are no production figures available as this data is not collected at present; and likewise no production targets. The SSIA expects this sector to grow over the next few years.

2.2 Markets

It is estimated that around 60% of Scottish salmon is consumed in the UK and 40% exported¹⁶.

But the demand for salmon within the UK exceeds Scottish supply, so UK consumption often includes imported Norwegian salmon to meet needs, while the higher premium Scottish product is either sold in the UK or exported.

Salmon is Scotland's number one food export. HMRC data released earlier this year reveals the highest ever value for Scottish salmon exports: during 2017 they were valued at £600 million, an increase of 35% compared to 2016. The volume of salmon exported also increased during 2017 by 26% on 2016.

¹⁵ The Scottish Shellfish Production Survey 2017

¹⁶ Marine Scotland Topic Sheet Number 40, The Value of Aquaculture in Scotland

According to Marine Scotland, the value of farmed salmon exports had already increased by 150% between 2006 and 2016, to nearly £500 million in 2016, suggesting sustained strong growth¹⁷.

Scottish salmon is exported to over 65 countries; the top five export destinations are:

- USA (sales worth £193M);
- France (£188M);
- China (£69M);
- Republic of Ireland (£34M);
- Taiwan (£16M).

Germany, Poland, Canada, Belgium and the Netherlands make up the next five export destinations¹⁸.

China in particular is a growing market: China's annual seafood consumption increased from 11.5kg per head in 1990 to 25.4kg in 2004, and estimates suggest it is continuing to rise.

Currently, all processed produce of finfish and shellfish is transported from processing plants to UK and most European markets by truck. That for more distant destinations is flown as airfreight, almost all leaving the UK from Heathrow.

Scottish producers have explored direct flights to international markets, with produce being flown from Glasgow to Dubai, and, recently, Marine Harvest flew produce from Edinburgh to Beijing, but as yet these have been small-scale trials.

Rope grown mussels are mostly sold as a fresh, live product to local markets, and the bulk of Scottish production is marketed by SSMG, which distributes live mussels throughout the UK and processes for many multiple retailers and foodservice companies. There is also an expanding market for on-growing, in which part-grown mussels are exported, in large part to Ireland.

In 2017, the combined value of shellfish in Scotland, according to the Scottish Government's most recent Scottish Shellfish Farm Production Survey, was £12.4 million, £10.1 million of which was accounted for by mussels (for the table and for on-growing), and £2 million of which came from Pacific oysters.

The impacts of Brexit may influence export destinations but, especially in the context of 'undersupply' of Scottish salmon for the UK market, it is reasonable to expect that market demand will be available into the future.

It is important that aquaculture produce can reach its markets quickly. As a guide, the Scottish Salmon Producers' Association (SSPA) estimates that cargoes of fresh salmon can lose up to 30p per kilo in value per day. For a fully-loaded lorry of 22t payload this equates to £6,600 of lost value trailer for each day of delay, plus the knock-on costs of and increased haulage costs.

2.3 The main supply chain links

There are several links in the aquaculture supply chain, where the industry relies on the movement of product or equipment. The most significant of these movements are listed below, and the most commonly used current modes also stated (note that 'truck' includes ferry for island production and vans for some smaller production sites):

For finfish production:

- equipment for the establishment and maintenance of farms: **truck, boat**;
- smolts (young salmon) from hatcheries to the off-shore farms: **truck, wellboat**;
- fish feed from suppliers to the farms: **truck, boat**;

¹⁷ Marine Scotland Topic Sheet Number 40, The Value of Aquaculture in Scotland

¹⁸ <http://scottishsalmon.co.uk/salmon-exports-reach-record-600m/>

- salmon from the farms to harvesting stations: **wellboat**;
- morts (dead fish) to handling sites: **boat, truck**;
- harvested salmon to production and processing sites (for gutting, filleting and preparation): **road tanker, truck**; and
- processing sites to markets: **truck, some air**.

For shellfish production:

- shellfish from farms to processing sites: **truck**; and
- processing sites to markets: **truck, some air**.

For seaweed:

- supplies of wood for drying the harvested seaweed: **truck, boat**;
- seaweed from harvesting sites to drying facilities: **truck**;
- dried seaweed to processing sites: **truck**;
- processing sites to markets: **truck**.

We expand on these links a little further in the text below.

Equipment

There are a number of suppliers in Scotland that provide equipment and services to producers: for example, fish farm pens, diving equipment, Remote Operating Vehicles (ROVs), and boat maintenance. By *volume* scale, these are not significant compared to feed and product movements, though they can entail irregular items (machinery, fabricated sections of pens, etc.).

No problems with the movement of equipment were noted by either the equipment suppliers or purchasers, and the volume of movements is small in comparison with other aquaculture flows, so this issue is not considered further within this review.

Smolts

Smolts (young salmon) are largely transported to fish farms via specialised vessels (wellboats) under hire within the industry, or in some cases using a company's own supply chain. Public roads are used to transport the smolts from production units in water tanks on flatbed trucks with large water tanks to access a port suitable for the wellboat.

In order to maximise available sea farm capacity, salmon production companies are looking at growing smolts in tanks for longer before transferring to the sea. This may improve overall operational efficiency, but may require an increasing transportation requirement (because the fish will be larger when they are moved to the farms).

Feed

The feed conversion ratio for Scottish salmon is generally in the region of 1:1.2; that is, to produce 1kg of salmon requires 1.2kg of feed. There will be some variation in this ratio according to water flow, temperature etc. which will affect the energy required for the fish to develop, but feed supply is in close proportion to the volume of output by region.

There are three main suppliers of feed, based in Bathgate and Grangemouth in the Central Belt, and Invergordon in the Highlands. Feed is currently transported from these production sites by road (and ferry to the northern isles) and then from harbours to the farms by chartered boats.

The largest salmon production firm, Marine Harvest, is building a feed new plant in Kyleakin (with production expected to commence in early 2019) from which feed inputs will be supplied and outputs distributed by boat to the company's sites. In the short term, this will displace shipments from the existing suppliers and is likely to reduce the amount of feed being moved by road.

Product

Fish are usually bought to shore in wellboats, before being harvested, then transported for processing (sometimes at the landing station, sometimes elsewhere) and later to market. All transportation post-landing on shore is by truck (including ferries from the islands), with the exception of some air freight to distant markets.

Morts

Morts are bought on shore from farms, then transported by truck to specialist processing sites.

Shellfish production

Mussel production does not require large volume inputs like salmon, since the mussels derive most of their nutrients from the water. Transportation requirements are therefore almost exclusively reserved for the product being moved to processing plants and onto customers.

Seaweed

Seaweed production relies on wood to be transported to drying plants, for the local transportation of harvested seaweed to the same plants, and then of the dried product for processing and to markets. Volumes are small, and the industry commonly makes use of vans for transportation. Ferry services are important for many of the movements.

2.4 Anticipated changes in the Industry

Looking ahead, there are some key issues that the aquaculture industry faces, and which will be relevant to its logistics requirements. Key amongst these are

- **Consolidation:** the industry is becoming increasingly vertically integrated. In salmon, production is highly concentrated within five companies. In trout, the biggest growth is delivered by producer Dawnfresh, which in many respects follows the 'salmon production model'. In shellfish, while there is a very large number of producers, in fact the vast majority of production is concentrated within a small number of firms supplying into one processing operation.
- **Importance of the natural capital of a site:** producers look at the natural capital when choosing a site, meaning that logistics, labour supply and other inputs are of secondary importance must follow suit. Regulators are also required to balance other considerations such as impact on wild fish, ecosystem impact, other water resource uses etc.
- **Moving further offshore:** some in the industry foresee a move to more exposed, further offshore, sites for salmon production, and pilot schemes are underway in Norway. This could require on-shore movement of supplies and products to more remote ports and harbours or, conversely, might facilitate the development of fully-offshore production facilities, which may require little to no on-land transport until processed fish are landed. These offshore sites would facilitate larger farms, and could be a key factor for growth in the industry.
- **Markets:** the demand for salmon in the UK exceeds Scottish supply, and often includes imported Norwegian salmon to meet needs, while Scottish product is either sold in the UK or exported. Brexit will likely change export destinations, but in the context of 'undersupply' of Scottish salmon, it is reasonable to expect that market demand will be available into the future.
- **A relatively new industry:** the sector is still young, at around 40 years old. It is rightly and often compared to thousands of years of agriculture, since our acceptance of terrestrial farming, understanding of our landscape and environment, and rural culture, are influenced by this history. Like wind farms, aquaculture is yet to be fully understood in the same way. At an operational level, historic processing capacity on islands, sub-optimal sites, changes in scale and ownership, all mean that the industry is not yet fully stable and rationalised.

- **Feed Conversion Ratios:** feed is a large cost (up to 40-50%) of salmon production, meaning that efficiencies can yield big improvements. Equally, the scale of feed movements in salmon (and to a proportionate extent, trout) has a large impact on the logistics aspects of aquaculture. Reducing the costs of feed by improving feed conversion ratios and finding alternative, cheaper, protein sources is a core topic of research for the aquaculture industry and may result in reduced transportation requirements.

2.5 Achieving growth to 2030

The Aquaculture Growth Strategy suggests that by 2030, sustainable growth in aquaculture production, the wider supply chain and the value-adding sectors in Scotland could double the sector's contribution to the economy. Although this is a promising prospect in relation to the economic contribution this could generate, there are a number of challenges that have been highlighted that need to be overcome in order to achieve this. Other studies have been more restrained in their forecasts for the industry; for example, *The Value of Aquaculture to Scotland* report looked at internal and overseas market development; growth capacity at existing sites; potential new production sites; potential growth in productivity; and potential constraints, etc, and concluded that a 50% increase in production across the aquaculture sector might be more likely. The report also highlighted that there are a large number of factors which could have significant positive or negative influences on growth across the sector and its value chains.

Scotland has the potential to maintain its position as one of the leaders in aquaculture as the importance of farming Scotland's seas goes beyond economic considerations. It has a particularly important position to maintain regarding a niche market for high quality and internationally recognised salmon.

However, while the growth potential for Scottish aquaculture is promising and achievable for Scotland, in a global perspective it could be quite different. The recent MAXiMAR report for Highlands & Islands Enterprise (Maximising the Marine Economy) stated that the production growth for salmon in Scotland has been lower than competitor countries. This can be partly attributable to regulatory constraints that has seen the global share go from 10% in 2005 to less than 7% in 2017.

In order to capture the full potential value from Scottish Aquaculture, the report states, Scotland must maintain and extend its already strong position and exploit new technology to drive productivity. Scotland has significant potential to expand its market share as there remain large areas of untapped resource, for example in shellfish farming and in diversifying to other finfish species. There are also opportunities to increase the scale of salmon farming and boost production volumes.

The work identified that improving the supply chain infrastructure is a required condition for growth to be achieved, but is of lesser priority than some other factors that will also be necessary.

The most urgent areas for attention for the industry include monitoring volume versus value to ensure stable growth; managing the risks and costs of sea lice and other diseases; remaining alert to international competition; and ensuring that licensing and regulation of the industry does not put a stranglehold on growth.

Taking all these factors into account, it is not possible to predict in comprehensive detail how the forecast growth in the aquaculture industry will affect demand for transport across the entire network, through there are some specific areas where impacts can be predicted. We do know that total volumes will increase, and that the logistics must be in place to support industry growth. The next chapters explore current and anticipated future demand in more detail.

3. AQUACULTURE ROUTES & FLOWS

This chapter outlines what is known about the routes and flows of the inputs and outputs of the production of finfish, farmed shellfish and seaweed, both today and as anticipated in the future.

The research undertaken included a mixture of desktop research, attempting to capture and synthesise what is already known on this subject, and also engagement with production and haulage businesses, and other industry representatives.

The exercise to drill down into the sector to determine routes and flows encountered a number of challenges. These are informative in themselves, but demonstrate the difficulty of ascertaining routes and flows with any confidence.

Some feed producers and haulage businesses were reluctant to provide information on the volumes and destinations of feed, and number of trucks deployed per week, etc, because of commercial confidentiality.

But we have also identified significant variances in flows in the course of normal production (variances in total production levels by year and by area, of where products are landed, of which supplier feed is purchased from, of the numbers of morts, etc). As such, reliably quantifying the logistics requirements of the whole sector is challenging.

Nevertheless, much relevant information is available, as summarised below.

3.1 Current requirements: finfish

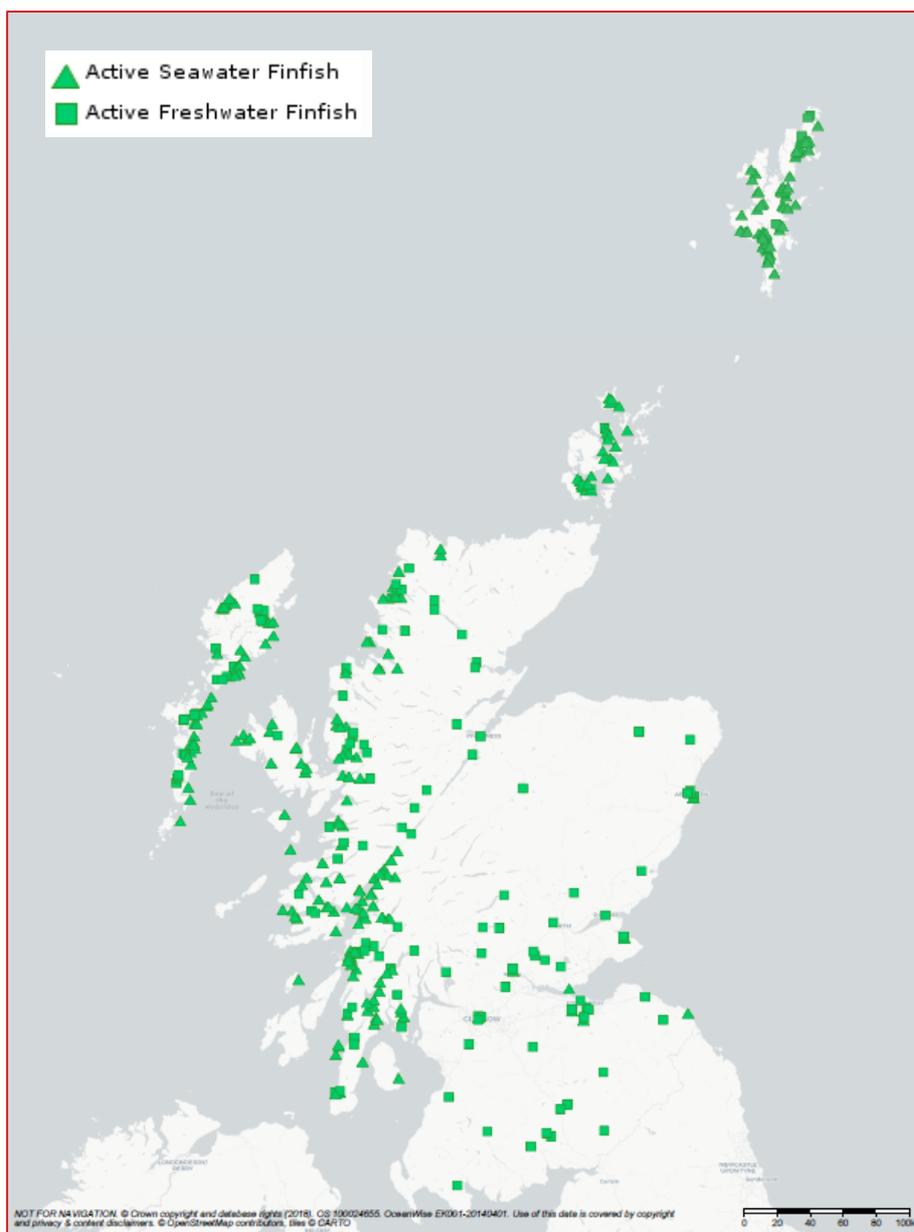
According to the Scottish Fish Farm Production Survey for 2017, a total of nearly 190,000t of Atlantic salmon was produced from 133 active farms by eight companies. There is a trend towards concentrating production in larger sites.

A total of 7,600t of rainbow trout was produced in 2017.

Given the relative quantities concerned, and the availability of data, the remainder of this section focuses only on salmon.

Salmon is produced at sites across much of west and north Scotland, and the islands. Figure 3 shows the locations of active finfish farms, highlighting their widespread distribution, mostly in remote areas.

Figure 2. Finfish production sites (source: Marine Scotland)



Feed

The primary input for salmon production is feed; by volume and value it is by far the most significant input for the sector. There are three main fish feed suppliers serving the industry in Scotland:

- EWOS in Bathgate;
- Skretting in Invergordon; and
- BioMar in Grangemouth.

These supply the fish farms in Scotland, and also export feed to Norway and sometimes elsewhere. One issue that has made determining flows with any accuracy is the changing commercial situation. The major salmon producers re-tender their feed contracts annually (or in one or two cases, biennially), with the result that the volumes and flows of feed from each of the three big feed producers can vary significantly from year to year.

In 2016, an estimated 195,000t was transported from the three feed-producing nodes to Scottish salmon farms. Most is taken by road to Kishorn, Aberdeen, Mallaig, Oban or Stornoway (by road/ferry), where it is loaded onto chartered boats for delivery to the farms.

EWOS have a time-chartered vessel berthed at Mallaig, which is their principal mode of transport to salmon farms throughout the west coast and Western Isles, taking 5,000t at a time, but they will put trucks on the passenger ferry to the Western Isles if top-up deliveries are needed. The company reports that around 23 trucks deliver to Mallaig every week. Feed is also delivered by truck to Aberdeen every week; a small amount to Orkney (5,000t per annum), and 52,000t per annum split between Shetland and Norway. The company will serve Orkney via the Scrabster ferry if deliveries are required outwith the NorthLink freight service to Kirkwall, but avoid this if possible.

Similarly, BioMar UK deliver to Orkney and Shetland from Aberdeen; and operate a vessel out of Oban to serve the west coast and islands.

Invergordon, where Skretting's plant is based, is 90 miles away from Scrabster, and 125 miles from Aberdeen, and so is well positioned to make use of the two routes to the Northern Isles; and is approximately 68 miles via the A890 from Marine Harvest's current feed distribution point at Kishorn, from where farms throughout the west coast and Western Isles are served by boat.

However, added to this is up to an estimated 52,000t of feed for export. At least some of this feed leaves for Scandinavia via Aberdeen, but the research team did not manage to obtain full information about routes and flows of feed for export.

In total then an estimated 250,000t of finfish feed is being transported per annum, moving on the Scottish road network between production sites and main maritime nodes, then onward by boat. This equates to around 10,500 loaded lorry movements around Scotland for feed per annum (based on 24t payload per vehicle).

Current routes and flows: feed

Volumes: approx 250,000t per annum, moved on approximately 10,500 lorry movements from production sites to harbours, then by boat to farms

Key links:

- M90/A90 – Central Belt – Aberdeen
- A82/A830 – Central Belt – Mallaig
- A82/A85 – Central Belt – Oban
- A832/A890 – Easter Ross – Kishorn
- Aberdeen – Lerwick/Kirkwall ferry
- Chartered boats for delivery to farms

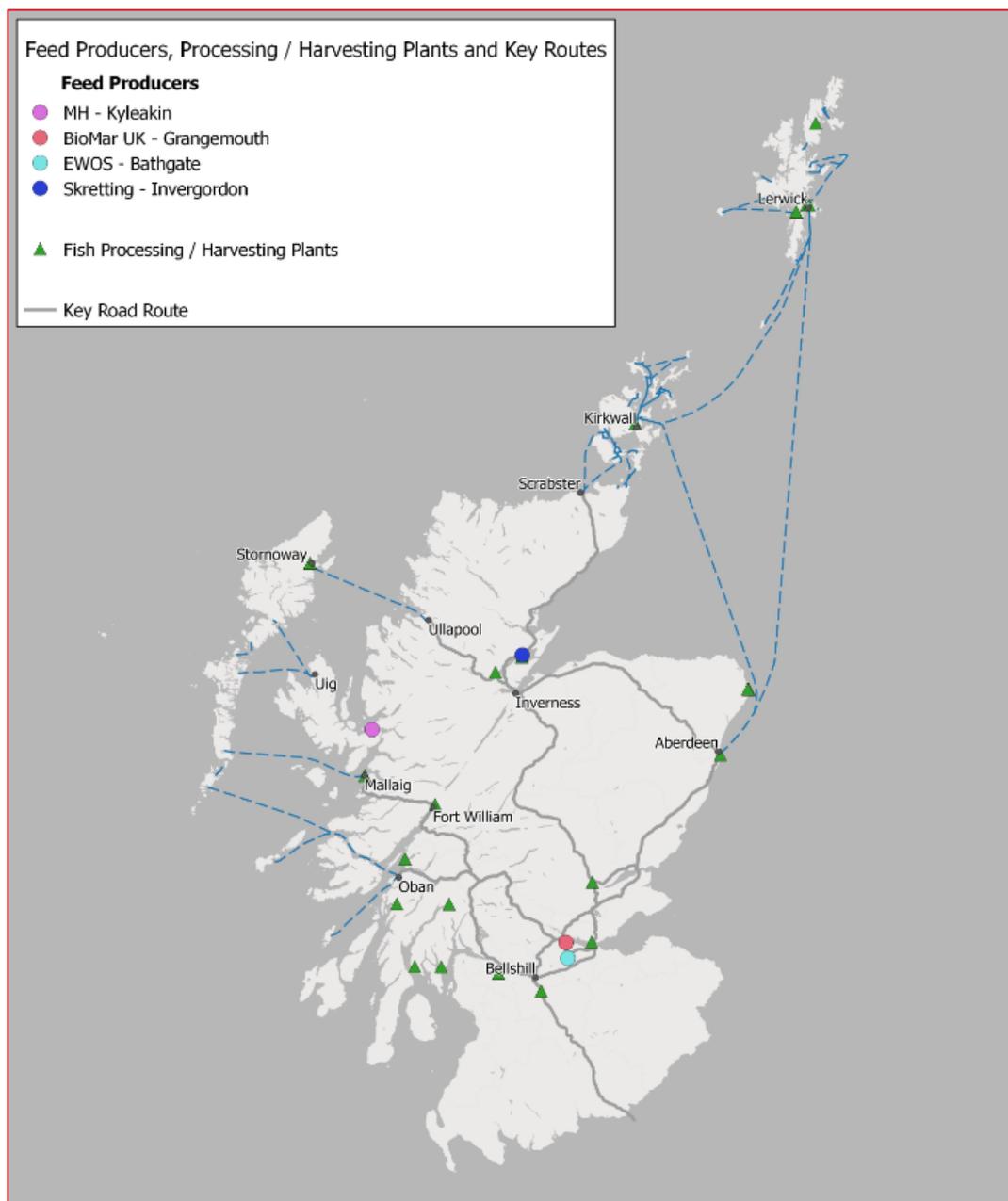
Key nodes (production):

- Grangemouth
- Bathgate
- Invergordon

Key nodes (transshipment):

- Kishorn
- Mallaig
- Oban
- Aberdeen

Figure 3. Feed production nodes, distribution nodes, processing / harvesting plants and connecting trunk roads
 Contains OS data © Crown Copyright and database right 2018



Smolts

In 2017, just over 46 million smolts were produced in Scotland, by 24 companies operating over 79 different sites, shown in the figure below. A comparatively small number of ova and smolts are imported and exported each year.

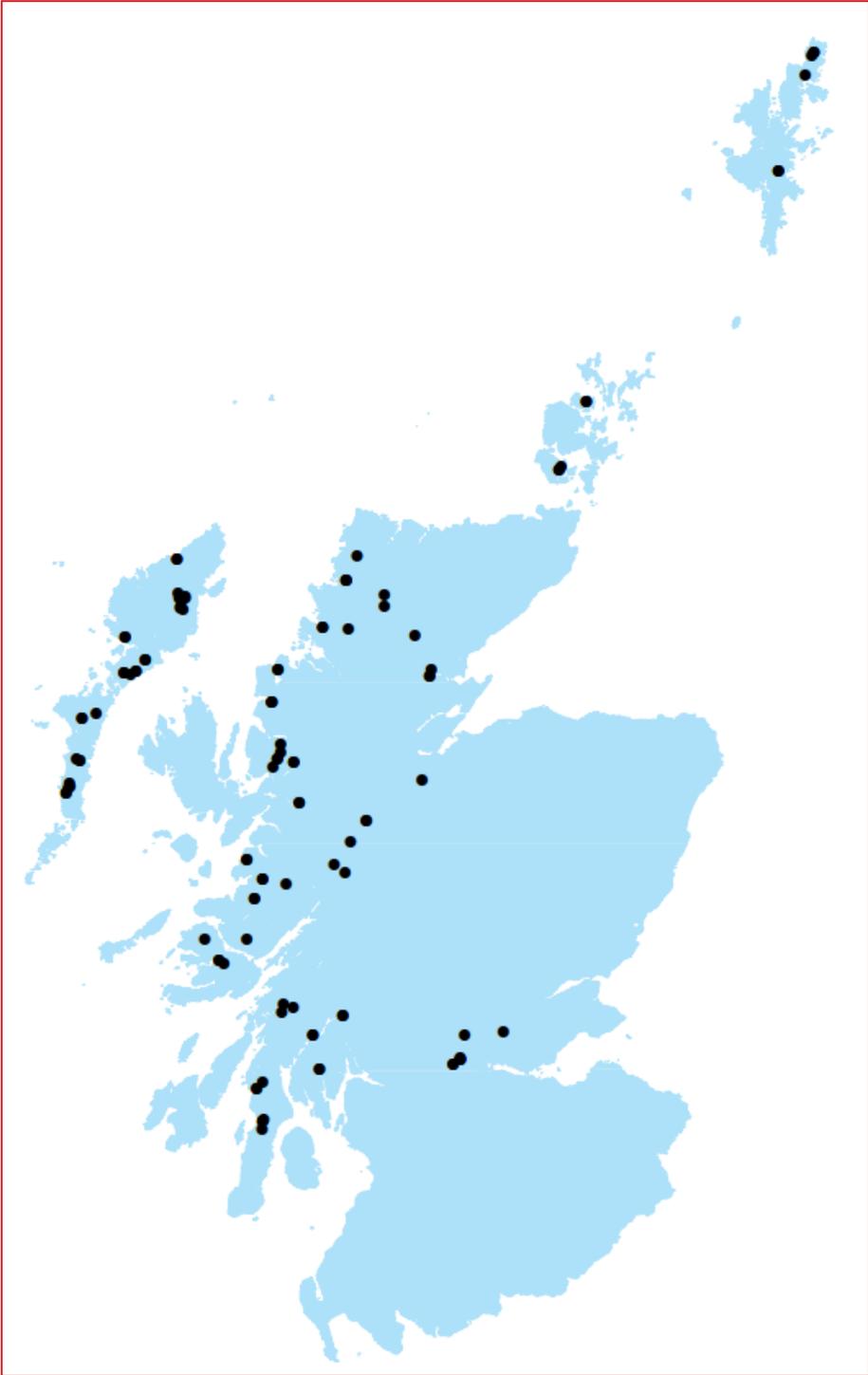
The smolts are typically transported from the hatcheries in water tanks on flatbed trucks by public road to ports, then by wellboat to farms; though in some areas smolts can be transported by helicopter. Generally, wellboats are under hire within the industry, though in some cases they form part of the company’s own integrated supply chain.

Scottish Sea Farms are developing a major new freshwater hatchery in Barcaldine, north of Oban, which will have deep water access. This will impact on current lorry movements in the region by reducing the volumes of smolt transported by road.

However, relative to the volumes of feed and processed fish transported, smolts transport is a relatively minor part of the logistics system: it involves multiple origins and multiple destinations;

generally short distances; and has no reliance on commercial ferry operators. None of the consultees engaged in this study raised the transportation of smolts as a concern.

Figure 4. The distribution of active Atlantic salmon smolt sites in 2017, Scottish Fish Farm Production Survey 2017



Current routes and flows: smolts

Volumes: approx 46M smolts transported, first by road then wellboat

Key links:

- None specific (relies on links from many production sites to many harbours, then onward transportation by wellboat or helicopter.)

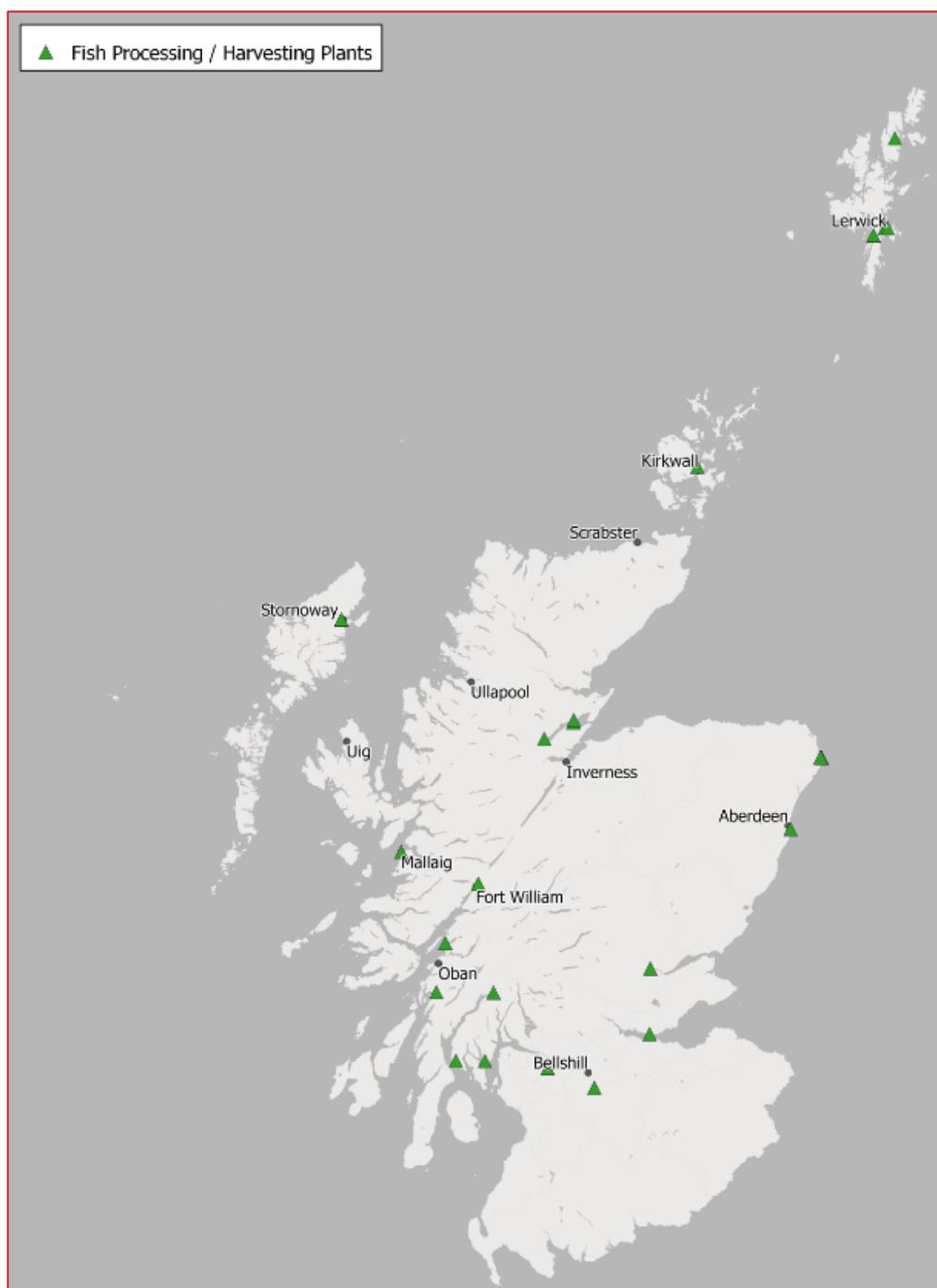
Salmon processing

There are two primary steps in salmon processing; first the harvest and gutting, and then the filleting and secondary processing.

Salmon are typically taken by wellboat to harvesting stations where they are then killed and gutted (though much of Marine Harvest's production relies on harvesting in Mallaig then road transport to Fort William for gutting). Once harvested, they are generally moved to another plant for the secondary process.

According to data provided by SEPA, there are 24 salmon processing plants in Scotland, as shown in the figure below. It is thought, however, that this data is not exhaustive, as it did not include the large secondary processors known to be based at Rosyth and Lanarkshire. Unlike the fish farms themselves, processing plants are usually situated near a ferry port, or trunk road – as soon as fish has been harvested, it becomes a matter of urgency to get the fish processed, and the product to market as soon as possible.

Figure 5. Processing / harvesting sites in Scotland (source: SEPA Registry) Copyright Scottish Government, Contains OS data © Crown Copyright and database right 2018



All stages of the logistics operations for Scottish salmon once they are landed on shore from the wellboats are undertaken by road (including trailers carried on ferries from the islands). Some road transportation is by food-grade tanker (including the Mallaig – Fort William haul for Marine Harvest), but the majority of product is transported in refrigerated trailers.

Almost all processed fish is taken to the DFDS Logistics centre at Larkhall, where fish and shellfish from all producers is consolidated into shipments bound for different destinations. The volumes of flow are considered confidential.

DFDS Logistics made the decision to site their distribution centre at Larkhall for the reason that it is within one driver shift driving distance of the Boulogne-sur-Mer fish market. (DFDS keeps 'rescue' drivers on standby in France to relieve any driver who may have been delayed and therefore in danger

of breaching driver hour limits.) For this reason, DFDS are concerned about any potential delays on the route, as it could easily prove very disruptive to its carefully timed operations.

DFDS Logistics is heavily involved in logistics operations both to and from Larkhall, and reported no major issues with the Scottish road network; and indeed commented that Transport Scotland were effective at communicating and co-operating with them. They noted some problems with the English road network, as set out in the next chapter

There is a lucrative market for fish gut waste, which is rich in Omega-3 and other nutrients. During primary processing, the guts are removed, and then ensiled, macerated and acidified. They are then taken by road tanker to either Greenock or Lanarkshire where they are converted into fish oils, etc, for animal feeds.

Cooke Aquaculture, which produces roughly 15% of all Scottish salmon, reported that they send five tankers (which carry around 27t each) a week from Orkney and Shetland to Rossyew in Greenock for processing to oils. This suggests that approximately 45,000t – or about 1,700 trucks – per year of fish waste are moving on the Scottish road network.

Current routes and flows: salmon

Volumes: approx 190,000t in 2017, moved from farms to shore by wellboat, then on approximately 10,000 lorry movements (including ferries from the islands) from harbours to processing sites, and later a similar number of lorry movements to markets

Key links:

- Wellboats for delivery to shore
- Lerwick – Aberdeen ferry
- Orkney – mainland ferries
- A90/M90/A9 – Aberdeen – Central Belt
- A830/A82 – Mallaig – Central Belt
- M74/M6 and onwards for access to English and international markets

Key nodes:

- Mallaig
- Lerwick/Aberdeen
- Fort William
- Rosyth
- Larkhall

Morts

Mortalities, or morts, are a significant by-product of fish production. There are two types of mortality: routine mortalities, which tend not to cause major transportation problems; and incident-based mortalities, which are unexpected, and can vary between very low numbers and many thousands of tonnes in any given year. The latter has the potential to place a high short-term demand on the transport network.

There are varying estimates on the level of mortality: a recent Scottish Parliament Information Centre report suggests that over the past 30 years there has been around 20% mortality of farmed salmon throughout the production cycle, but that this has been increasing recently¹⁹. It has also been estimated that there are around 10,000t of morts from an average annual production²⁰.

¹⁹ Salmon Farming in Scotland, Kenyon and Davies, SPICe, 2018

²⁰ Finfish Mortalities in Scotland, Zero Waste Scotland, 2016

Previously, farmed fish producers in remote areas had a derogation which permitted the disposal of morts in approved landfill sites; but from 2016 a change in the interpretation of regulations has meant this is no longer possible, resulting in a change in morts logistics.

The majority of morts from Scotland's aquaculture farms are transported, first by boat to local harbours, then by road (including by ferry in some instances) to the SecAnim incineration centre in Widnes. Some Shetland morts are disposed of locally, but others are transported by ferry/road to Widnes.

Assuming a 16t average payload, based on general haulage payloads and the anticipated part-loads of some movements, the 10,000t typical average results in around 600 lorry loads from Scotland to Widnes per annum, with a one-way journey distance of between about 350 and 400 miles, depending on where in Scotland the morts are landed.

Current routes and flows: morts

Volumes: approx 10,000t per annum, moved from local harbours on approximately 600 lorry movements, mostly to Widnes in Cheshire

Key links:

- Scottish trunk roads to Central Belt
- M74/M6

3.2 Current requirements: shellfish

The logistics of the shellfish production cycle is simple to map, as shellfish require minimal equipment and no feed.

The highest volume of outputs originates in Shetland. Mussels and oysters are also produced on the west coast, the Western Isles and Inner Hebrides. Orkney has potential to produce both but does not currently do so.

After the mussels have been harvested, they are landed in bulk bags on a suitable local quayside, from where they are taken by lorry for onward dispatch, in most cases on the Lerwick – Aberdeen NorthLink ferry.

Almost all mussels produced in Scotland are then taken to Bellshill, Lanarkshire for processing. Many are then moved to Larkhall for onward distribution with other aquaculture products by DFDS Logistics, though major supermarkets will also collect direct from Bellshill. Fish and shellfish are commonly transported together, as they are consolidated according to destination, rather than by type of product.

Because oysters are valued individually, they are counted as numbers of shells rather than by volume weight, though the total Scottish output in 2017 was 420t. The vast majority of the 3.8 million Pacific oysters produced in 2017 came from Argyll and the Western Highlands, with Argyll producing 2.8 million shells in 2017, and the West Highland 1.8 million shells (the remainder coming from other areas).

Being a live product, it is important that oysters are able to be distributed rapidly. According to the Association of Scottish Shellfish Growers, often this may be to relatively local outlets such as hotels; though increasingly oysters are moved to central dispatch centres for distribution to the multiple retail sectors. Transportation of oysters is typically in Light Goods Vehicles rather than lorries.

The West Highlands region includes the Inner Hebridean islands of Skye, Raasay, Eigg, Rum and Canna; and the Argyll region includes the islands of Mull, Tiree, Islay, Jura and Colonsay; the ASSG has

highlighted the importance of a regular and frequent ferry service to the smaller inner isles to ensure rapid distribution, either locally, or to Bellshill and beyond.

Current routes and flows: shellfish

Volumes: approx 12,600t annum of mussels (around 81% of which originate in Shetland), plus relatively small volumes of other shellfish moved on approximately 820 lorry movements from production sites to processing, mostly in the Central Belt

Key links:

- Shetland inter-island ferries
- Lerwick – Aberdeen ferry
- Inner Hebrides ferries
- A90/M90 or A9/M80 – Aberdeen – Central Belt
- A82/A830/A9/A85 – Highlands – Central Belt
- A82/A83 – Argyll – Central Belt
- M74 – Bellshill – Larkhall
- M74/M6 and onwards for access to English and international markets

Key nodes (processing):

- Bellshill

Key nodes (transshipment):

- Larkhall

3.3 Current requirements: seaweed

Seaweed is harvested off-shore, generally in remote areas, floated to shore in barges, and then taken by truck to a factory, where it is dried and milled.

The biggest input required for seaweed production is wood; this is used for the drying process. The research team spoke with Uist Asco, a North Uist producer taken over last year by Acadian Seaplants Ltd, who reported that 1/3 tonne of wood was required for every tonne of finished seaweed product. In the case of Uist Asco, most of the wood is taken on a chartered vessel from Corpach, with some coming on lorries that travel to the factory via the Uig – Lochmaddy ferry. Once processed, the seaweed is taken by lorry to Grangemouth, where it is shipped to international market in containers.

Current routes and flows: seaweed

Volumes: total volumes unknown, but small in comparison with finfish and shellfish. Product carried in vans/lorries. Lorries/ferries and chartered boats used for the transportation of wood used for drying

Key links:

- Western Isles ferries
- Trunk roads from west coast to Central Belt and onwards to markets

3.4 Anticipated changes to routes and flows

As reported in Aquaculture Growth to 2030: “[Aquaculture] contributes £1.8bn annually to Scotland’s economy and sustains the economic and social fabric of the Highlands and Islands in particular. But the potential contribution of farming Scotland’s seas is far greater. Research points to a potential annual contribution of £3.6bn or more by 2030. The number of jobs supported by the sector could reach 18,000.”

Any substantial increase in the value of the sector would require a considerable step up in the levels of production across the various types of aquaculture, and a concomitant impact on the transport network would be expected.

Salmon

The view within the industry, as asserted by the SSPO, is that the medium-term future will see aquaculture production move towards fewer but larger production sites, with greater support and infrastructure requirements. Aquaculture hubs will play an increasing role: Mallaig, Fort William, Inverness, Oban, Kyleakin, etc.

Marine Harvest is building a new fish feed production plant in Kyleakin which will become operational in January 2019. The plant will have total capacity of around 170,000t per year, with the potential for further expansion. At this site, Marine Harvest will be producing feed to supply to their own farms and, although not part of their core business strategy, they are open to supplying competitors. This could potentially impact on all three existing feed suppliers in Scotland, which adds to uncertainty of flows for feed.

Marine Harvest take all feed to their farms by boat. Currently this is all from Kishorn, taken there by road, but when their new feed production facility at Kyleakin is on-line Marine Harvest will require hardly any road transport for feed deliveries.

More widely, the trend towards increasing use of seaborne transport will ease pressure on the remote rural road network, though there may be a risk of increasing congestion in ports and harbours, especially if tourism and wet fish catch continue to grow. Agriculture can also offer competition for temperature controlled transport.

In order to maximise available sea farm capacity, and reduce the level of disease and therefore of morts, producers are considering growing smolts for longer in tanks before transferring to the fish farms in the sea.

This would increase the transport requirement for smolts, as their larger size will reduce the number that can be transported in any given lorry- or ship-load, but we foresee transportation continuing in a localised manner from many origin points.

The industry as a whole is looking at a way to reduce the proportion of morts, and the main aquaculture producers are looking at solutions to make the disposal of morts more efficient and sustainable.

However, an increase in the scale of finfish production would be expected to be accompanied by an increase in morts volumes, but this will always remain an unplanned and unpredictable factor which introduces additional cost and complexity into the production cycle. There is, perhaps, potential for an increased number of morts in Scottish aquaculture to lead to the development of more local processing facilities, hence reducing net transportation requirements.

Changes in the production methods of salmon could impact on both routes and flows.

Some producers are experimenting with larger farms, further off-shore, which may provide a healthier environment for fish and be easier to develop.

Offshore fish farms are likely to necessitate the sea-borne transport of feed, equipment, medicines, etc; and fish would potentially be landed for processing in much greater quantities. There is therefore likely to be demand for larger supply boats and wellboats, and potentially increased demand, and increased density of demand (more product being taken to/from a relatively small number of ports) for land-based transport.

Shellfish

The shellfish sector aspires to increase production by over 60% by 2030, to around 20,000t. The increase in freight flow is relatively modest when set in the context of the aspiration to produce in the

range of 300,000 to 400,000t of finfish, and, consequently, the net impact of the transport network in future will not be so significant.

Around three-quarters of all shellfish comes from Shetland, and there is no indication that this will change in the medium-term future. We anticipate this industry growth therefore relying on expanded use of the Lerwick – Aberdeen ferry service, and onward connections to the Central Belt (assuming that processing remains consolidated there).

As at present, the provision of a regular and frequent inter-island service will be important to shellfish growers, and the guarantee of space on the NorthLink ferry to the mainland.

Seaweed

In 2017 the Scottish Government published its first policy guidelines for the commercial cultivation of seaweed. The guidelines have the objective of providing clarity over where seaweed may be harvested, along with what kinds of development will be approved.

The Scottish Association of Marine Science has two experimental seaweed farms. One farm, at Port a' Bultin near Oban, is used for upscaling studies. The Association is conducting research that would support an industry to develop: identifying the most advantageous species to farm, developing cultivation and harvesting techniques, exploring how to identify and control seaweed pathogens and the policies needed to manage such an industry.

Future scenarios: feed

Feed transportation requirements will increase approximately proportionally with the growth of the industry. Looking ahead, and as outlined in chapter 3, the logistics requirements for feed are likely to be significantly disrupted by the new feed production facility at Kyleakin, with more deliveries to farms being made solely by boat, reducing the need for road transport.

Future scenarios: smolts

Increasing requirement for the transportation of smolts, both because of the growth in the industry and a trend towards moving smolts when they are larger. Land transportation requirements may be partially offset by an increase in coastal smolt production.

Future scenarios: salmon

The requirement for transportation of salmon, both pre- and post-processing, are likely to increase substantially in coming years. It is anticipated that these could be landed in larger batches, from larger wellboats if facilities were available. The growth could be accompanied by changes to the locations of processing and/or distribution centres.

Future scenarios: morts

The aquaculture industry is making efforts to reduce the proportion of morts, but the total volume is likely to increase if total salmon production increases significantly. There is potential for increased volumes to result in the creation of sites in Scotland that can process morts.

Future scenarios: shellfish

Growth in the shellfish industry is anticipated to result in proportional growth in current logistics requirements, with notable increase in demand for use of the Lerwick – Aberdeen ferry. But major changes to logistics could arise if that growth resulted in changes at which shellfish are processed.

Future scenarios: seaweed

Transportation requirements are anticipated to increase approximately proportionally with the growth of the industry. As stated earlier, there is little to no cultivation of seaweed for commercial purposes, but Uist Asco, a wild seaweed harvesting company, has plans for expansion. The Scottish Seaweed Industry Association also anticipates strong growth in this sector in the medium term.

4. ISSUES AND CONSTRAINTS

In this section, we outline first the current constraints on the aquaculture issues that the transport system provides, then provide an overview of where these constraints may hinder further growth.

The information provided in this chapter draws heavily on the information provided by industry consultees.

4.1 Harbours / Piers

Aquaculture is very reliant on harbours and piers for several stages in the production cycle. Consultees in the main were satisfied with the harbour infrastructure they used, though some areas of concern were raised.

Lerwick Harbour was considered effective, with good infrastructure and facilities in place. Lerwick Harbour is a deep-water port, situated in a sheltered aspect with minimal tidal effects, with two entrances. It handles around 5,000 vessels annually, offering vital support to the oil and gas, fishing, and agriculture and aquaculture industries.

In Aberdeen Harbour, the NorthLink passenger service has exclusive use of the Jamieson's Quay terminal. The Commercial Director at Aberdeen Harbour reported that aquaculture logistics passed through the harbour "very smoothly and very efficiently". He reported that the Harbour has a good relationship with NorthLink, who have reported no issues; and that the harbour has more than sufficient capacity to accommodate substantial growth.

Several businesses in the Northern Isles, however, have expressed disappointment that the plans for the £350 million Nigg Bay development to the south of Aberdeen Harbour did not include provision for a roll-on, roll-off ferry terminal, as this would have provided the opportunity for road traffic heading to/from the ferry to avoid city congestion.

Producers on Orkney have said that Kirkwall Harbour has been becoming busier in recent years due to increased traffic from tourism, leisure, fishing and aquaculture sectors, and so is close to capacity. Cooke Aquaculture reported that unloading is sometimes difficult here, due to congestion.

Stornoway Port is the principal port and gateway for the Western Isles. It has been identified in the National Planning Framework as one of the six "key ports" in Scotland, and is the hub for the aquaculture sector in the Western Isles. The primary operator at the Port is The Scottish Salmon Company. Their fish are landed and harvested at Arnish, then trucked to their Marybank plant for processing and shipping, via the Stornoway – Ullapool ferry. To support the new ferry, infrastructure at the terminal was improved in 2014, and the terminal now has a larger car and truck marshalling area, dedicated trailer drop area, and an elevated covered passenger access facility. The Inner Harbour offers a fish market and ice plant, and there is a slipway where workboats and wellboats can be maintained and repaired.

Stornoway Port Authority is progressing plans to develop a deep water port by 2021 as part of its 20-year Masterplan. It also has a medium-term plan to promote development of the aquaculture supply chain.

Mallaig Harbour has increasingly become a key hub for the aquaculture sector in recent years. Marine Harvest is an anchor tenant at the harbour, where it operates its harvesting facility, with a designated berth for wellboats, and infrastructure for pumping fish directly from the vessel into the harvesting station. According to the Mallaig Harbour Masterplan, produced in 2017, approximately 220t of salmon are brought in for harvesting, six nights per week. As mentioned earlier, Marine Harvest then trucks the fish Fort William for secondary processing.

According to the Masterplan, 40,000t of fish feed per year is currently distributed to fish farms off the west coast via Mallaig Harbour. Scottish Sea Farms use Mallaig Harbour as an operational base for their three Loch Nevis farms, while the Scottish Salmon Company use Mallaig as a back-up for unloading harvested salmon. Aquaculture companies view the ice plant as a 'back-up' source of ice.

The harbour has identified the potential loss of traffic as a risk arising from the new Marine Harvest feed facility in Kyleakin. It aims to develop the harbour to be able to accommodate larger well boats in the medium term to safeguard aquaculture activity in Mallaig, and Fort William. To do this, it will be necessary to dredge the harbour's seabed of loose deposits and rock in order to provide adequate depth for a new deep water quay. The harbour sits within the proposed Inner Hebrides and the Minches Special Area of Conservation (pSAC), and supports a population of porpoises, so any activities such as underwater blasting, dredging and piling would need to be evaluated.

One operator said that facilities in Oban Harbour – such as the provision of power for working ships – could be improved.

But there is a wide variety of other smaller ports and harbours that are also used for more localised servicing of offshore aquaculture sites. In most cases, these are seen to be fit for purpose in terms of facilities and access by road and ship, but some companies report problems with capacity; that there are times when they are unable to find suitable berths at or close to their preferred locations.

Similarly, the maximum size of available berths was reported to be an issue, especially for wellboats. The largest harbour facility in Scotland currently is at Mallaig, which is able to accommodate an 1800m³ wellboat. Marine Harvest currently operates the Ronja Challenger, which is 70m long and has a gross tonnage of 1753t. But one aquaculture producer reported an aspiration to run much larger vessels in order to serve larger farms more efficiently, and has an aspiration to run boats of up to 3000m³ capacity, as are in use in Norway.

4.2 Road haulage

For the main part, road transport is not seen to be a problem for the aquaculture industry or for hauliers. The business consultation exercise threw up few complaints about the design and quality of the Scottish network.

The previous chapter outlines the key strategic road links that are of importance to aquaculture, but many local roads across Scotland are essential for the servicing of individual sites.

Scottish Trunk Roads

Consultees identified few systemic problems with the Scottish Trunk Road network. Journey times on it were generally felt to be reasonable, and reasonably reliable.

The pinchpoints identified through the consultation were:

- The route from Aberdeen Harbour to the A90, as arriving from the Northern Isles at 0700 necessitates travelling through Aberdeen during peak hours;
- Fergusons and the Road Haulage Association both reported frequent and sometimes severe congestion around Fort William, and unreliability of journey times on the A82 between there and the Central Belt, both of which can have an adverse impact on haulage drivers' working hours / shift patterns²¹;
- The A830 Mallaig – Fort William road can experience high volumes of traffic, including tourist traffic, causing some congestion and delay;
- The A85 / A82 route between Oban and Glasgow can similarly experience congestion and delay.

²¹ Hitrans is presently leading a review into options to improve regional connectivity in Fort William.

It was noted that Transport Scotland were generally prompt and effective in issuing notifications of planned works to the trunk road network, and unexpected disruptions. It was also noted that BEAR is proactive in maintaining the A830 Mallaig – Fort William road, and in keeping it open at night to ensure that tanker movements can continue to get through.

Winter maintenance on Scottish Trunk Roads was noted to have improved in recent years to a generally good standard, though long delays in reopening roads following crashes cause frustration.

One haulier reported that the opening of the Queensferry Crossing has eased the journey considerably; and that the opening of the AWPR should facilitate drivers making their way south from Aberdeen Harbour.

Local Scottish Roads

Argyll and Bute Council signposted the research team to their recent research report, Argyll and Bute Transport, Connectivity and Economy. Argyll and Bute is home to the Scottish Sea Farms Plan in South Shian, Loch Fyne Oysters in Cairndow, and Islay Crab Exports, on Islay. Argyll and Bute's key roads are:

- A82 – from Glasgow to Inverness, via Loch Lomond and Crianlarich;
- A83 – from Campbeltown to Tarbert, through the heart of Argyll, via Lochgilphead and Inveraray;
- A85 – from Oban to Perth, via Dalmally, Tyndrum and Crianlarich; and
- A828 – from South Ballachulish to Connel where it meets the A85.

The report also identifies the limitations and quality of the road network, resulting in low average speeds on some key routes, including parts of the A85, A816 and B836/A8003. Challenging terrain, poor road alignment and carriageway width, volumes of HGV traffic and reduced speed limits when passing through settlements can all affect journey times. Due to the importance of tourism to the area, the roads generally see a significant uplift in traffic levels in the summer.

The A816 Oban to Lochgilphead route is also identified as an important road for aquaculture transportation in the area, due to the presence of smolt and finfish production sites near this road. Argyll and Bute Council already considers the A816 a priority route for future investment, and has previously estimated costs in the region of £40m for improving road alignment and width to a modern standard.²²

The roads in both the Western Isles and Northern Isles were generally not an issue for the hauliers and producers consulted. It was noted, however, that there could be delays in the tourist season, due to the higher numbers of cyclists and recreational vehicles; and that in recent years the tourist season on the Western Isles had drawn out from June to September to run from Easter until October.

In winter there is bad weather; in summer there are tourists. It was ever thus.

Haulage firm manager, Western Isles

The remote and rural nature of the islands was generally accepted by the hauliers consulted, and there was no strong demand for single track roads to be double-tracked.

However, the Director of Technical Services at Comhairle nan Eilean Siar said that there was a problem with lots of roads being poorly founded, estimating that only 10-15% of roads in the Western Isles are well constructed, and many of the rest having been built up over farm tracks. Any increases in heavy traffic on these roads might increase damage to them.

²² Argyll and Bute Transport, Connectivity and Economy, page 60.

Roads in England and cross-Channel traffic

DFDS and other hauliers have reported that roads south of the border are experiencing increased congestion, and can cause delay. Also, DFDS Logistics reported that there is a tendency for Highways England to arrange short notice roadworks, particularly on the A66 and the M6, and particularly overnight.

Some hauliers have also reported that the severe winter weather in some recent years, including 2018, has caused delays when driving through the Borders, and the north of England, winter maintenance in these areas often being worse than further north in Scotland.

Hauliers do not commonly experience delays in crossing the Channel to access European export markets, but both hauliers and aquaculture producers expressed nervousness about the risk that Brexit could result in long delays to freight traffic. The impacts of this on the value of Scottish aquaculture produce and on the availability of transport services (if lorries journeys take longer, there is concern that the logistics industry will not have enough capacity to meet demand) could both have a significant impact on the industry.

4.3 Ferries

Northern Isles

NorthLink operates two passenger vessels, MV Hjalmland, and MV Hrossey, between Aberdeen, Kirkwall, Orkney and Lerwick, Shetland. There is one sailing every day each way between Lerwick and Aberdeen, with a journey time of between 12 hours and 12.5 hours. Three or four days per week, these sailings go via Kirkwall, when the journey time increases to between 13.5 hours and 14.5 hours. The passenger ferries offer 18 spaces for temperature-controlled trailers.

NorthLink also runs one passenger vessel, MV Hamnavoe, between Scrabster and Stromness in Orkney. Off peak and at weekends, there are two sailings per day each way; in peak months this rises to three sailings per day. Sailings take 90 minutes.

In addition, MS Hildasay and MS Helliar are used for freight and livestock, and sail between Aberdeen, Kirkwall and Lerwick. There are five sailings weekly between Lerwick and Aberdeen (some via Kirkwall); five sailings between Aberdeen and Lerwick; between two and three sailings weekly between Kirkwall and Aberdeen; and between three and five sailings between Aberdeen and Kirkwall.

Producers report preferring to ship processed salmon on the sailings that go direct between Lerwick and Aberdeen. This is partly because the earlier sailing time of 1730 via Orkney sharply curtails the working day for fish processing plants, which are based in Yell and Unst. To check in for the 1730 sailing from Lerwick, producers on Yell and Unst need to load up the trucks by around 1330. On the other hand, Cooke Aquaculture on Orkney benefit from a 2300 sailing time, which leaves more time for processing.

There is seen to be little reported demand for movement of aquaculture products between Lerwick and Kirkwall; to Shetland producers, Kirkwall is seen as an unnecessary detour and delay; one consultee suggested that the two routes should be split, with the additional capacity this would create.

Scottish Sea Farms take their salmon by wellboat from Orkney to Shetland for harvesting and processing, leaving Cooke Aquaculture as the only major producer processing salmon in Orkney, at a plant near Kirkwall, where it is then shipped to Aberdeen on one of the NorthLink ferries for onward travel.

Orkney benefits from a greater choice of ferries and routes than Shetland. Pentland Ferries operate three sailings each way per day from Gills Bay near John o' Groats to St Margaret's Hope on Orkney, with sailings taking one hour.

From the business engagement exercise, it seems that producers and hauliers will avoid crossing by the Pentland Firth unless business needs demand it. The Kirkwall – Lerwick route cuts out a significant amount of road miles: the journey from Scrabster to Larkhall via the A9 is around 284 miles, whereas the journey from Aberdeen to Larkhall via the A90 is approximately 152 miles.

There are conflicting perspectives as to whether or not the current provision of service meets demand. Fish UK, JBT and Lerwick Harbour all reported that on occasion some product had not found space on the ferry, and had been left in Lerwick. But NorthLink report that there is significant spare capacity throughout the year as a whole, and that it is only a few sailings that are full.

One producer reported that the October, November and December period was particularly challenging, as there was conflict with agricultural sales; increased demand for more and bigger salmon in the run-up to Thanksgiving and Christmas; and more likelihood of delayed sailings due to adverse weather.

NorthLink noted peaks in demand, some of them being seasonal, but also arising from construction projects in Shetland which can, from time to time, generate substantial amounts of freight traffic that can conflict with their more regular loads.

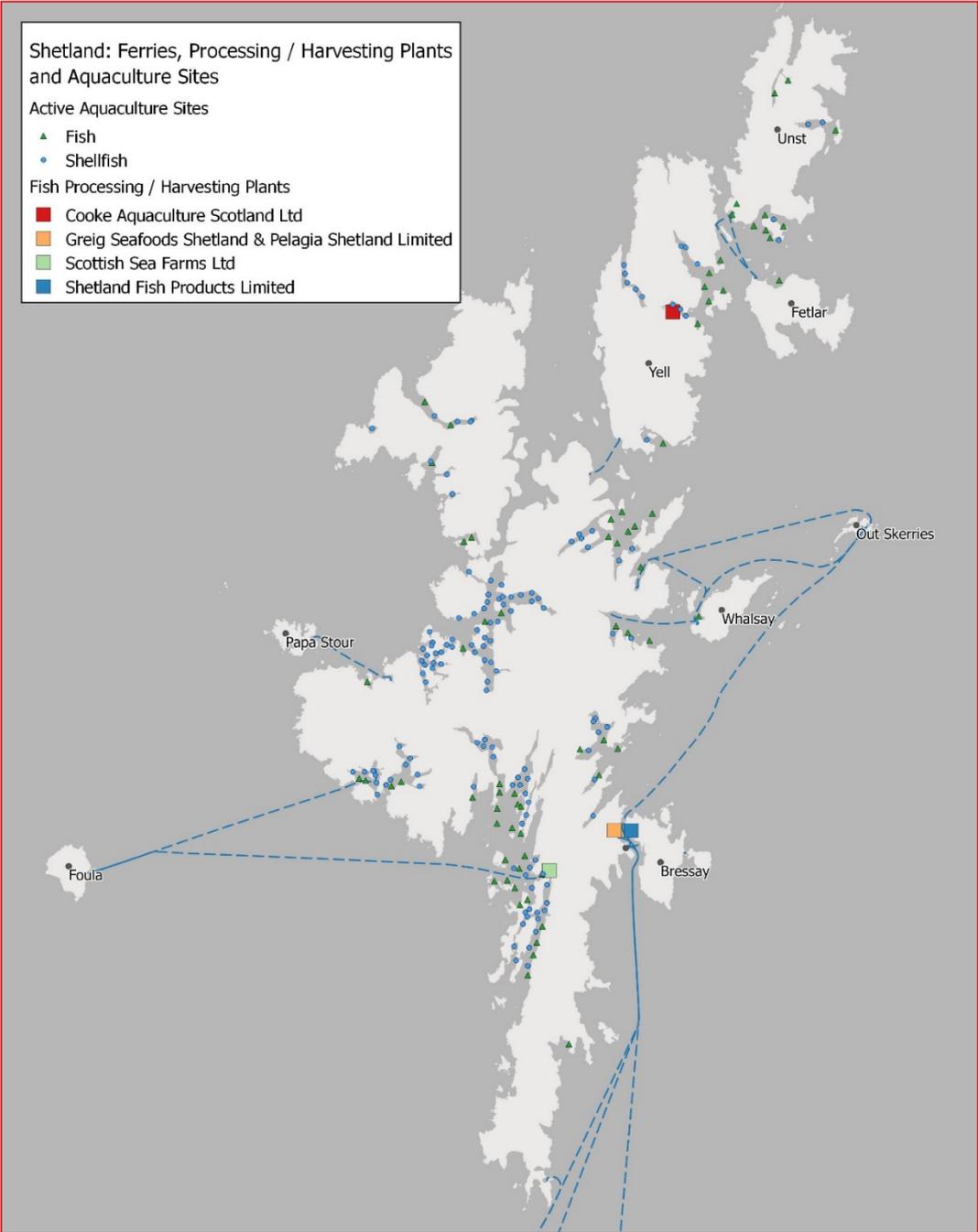
Cancellation of a sailing does of course create significant problems for aquaculture customers. In the year to June 2018, NorthLink reported that 2.3% of their Lerwick – Aberdeen sailings were cancelled²³.

It should be noted that some in the aquaculture industry recognise that NorthLink makes valiant efforts with its passenger vessels to meet deadlines to ensure that seafood shipments are not compromised during periods when freight vessel sailings are disrupted or cancelled.

Some consultees also noted problems with the Shetland inter-island ferries, namely variations to the timetable throughout the week; capacity constraints, and severe problems in the spring when the ferry is taken off for maintenance and replaced by a ferry that is ‘too small and not fit for purpose’. The services between Unst and Yell, and Yell and mainland Shetland, are particularly sensitive for producers, as shown in the figure below.

²³ <http://www.northlinkferries.co.uk/information/publications/statistics/>

Figure 6. A map of the main aquaculture activity sites on Shetland (Contains information from Scottish Government (Marine Scotland) licensed under the Open Government Licence v3.0. Copyright Scottish Government, Contains OS data © Crown Copyright and database right 2018)



Western Isles

CalMac operates a fleet of 31 ferries over a network of 51 ports connecting 23 Scottish islands and six mainland destinations. Although the aquaculture industry has a lesser presence in the Hebrides than Shetland, each of the direct connections between the Western Isles and the mainland is used for aquaculture logistics.

The main challenge noted by consultees in relation to the west coast ferries is that of sailings being cancelled or delayed due to bad weather. Sailings are reported to often be cancelled too late for the hauliers to make alternative routeing arrangements.

There is a higher proportion of cancellations of CalMac’s sailings than NorthLink, with the rate on the main routes used by aquaculture shown in Table 2.

Table 2. Summary of selected CalMac performance data (year to June 2018)²⁴

CALMAC ROUTE	SCHEDULED SAILINGS	CANCELLED	% CANCELLED
Ullapool – Stornoway	2017	68	3.4%
Uig – Tarbert / Lochmaddy	2188	105	4.8%
Oban – Castlebay / Lochboisdale	826	60	7.3%
Mallaig – Castlebay / Lochboisdale	478	99	20.7% ²⁵

The potential for conflict between growing numbers of tourists (often in recreational vehicles) and hauliers was also noted. Outer Hebrides Tourism, however, said that from a tourism perspective, it was found that hauliers usually cross on the weekday ferries, while the bulk of tourists cross between the mainland and the islands on the weekend sailings. From their perspective, the capacity strain is worse on the inter-island ferries than the ferries connecting to the mainland, and hauliers tend not to use inter-island ferries on the west coast.

The ferries have got a lot busier since the introduction of RET, so it can be difficult to get bookings. But the HGVs don't benefit – we pay high charges. It's £500 for a 45-minute sailing – you can take the Channel Tunnel three times for that price! And it doesn't take much for the ferry to be cancelled.

Argyll based haulier

The ferry services identified in the business engagement as suffering from at least occasional capacity constraints were the Lochmaddy – Uig service, and the Stornoway – Ullapool service. One North Uist seaweed producer reported that a dedicated overnight freight service between Lochmaddy and Uig would be very helpful for logistics. One of the Argyll bases hauliers reported that the Oban – Mull ferry was a pinchpoint.

CalMac confirm that some sailings do operate at capacity (especially on summer Fridays and Saturdays). They report that they are unable to formally prioritise between user types, but that understand the needs of hauliers of perishable goods and will work to accommodate them as much as they are able. They also offer flexibility to hauliers in terms of enabling block-booking of sailings, which benefits regular customers, but are having to make efforts to ensure that this flexibility is not abused by people overbooking and then cancelling later.

While capacity challenges appear to be largely manageable, there was widespread agreement amongst consultees that the current provision of service could not accommodate any substantial increase in aquaculture production in the Western Isles.

The Freight Fares review

The Scottish Ferries Plan 2013 – 2022, published in December 2012, stated the Government's intention to undertake a review of large commercial vehicle fares, to develop a policy for freight fares across the entire ferry network. The objective is to deliver a freight fares structure for Scottish Government subsidised ferry services, which is "simple and transparent, and importantly does not advantage one part of the network over any other part. Any future fares structure will also need to balance the wellbeing of communities against the public sector cost."²⁶

A research report was published in 2015; and it was decided that further analysis was required to consider how options should be compared and how options should be fine-tuned in terms of specifying

²⁴ Source: CalMac website

²⁵ Affected by repairs to the MV Clansman

²⁶ Scottish Ferry Services Ferries Plan (2013-2022)

fixed and variable charges and distance bands. This new freight fares structure has not yet been revealed, nor has any indication yet been made for a timescale for introduction.

In the course of the business engagement exercise, many businesses and organisations highlighted the issue of the unresolved Review. There are concerns that the review will create clear ‘winners and losers’, and fears that hauliers on the Aberdeen – Lerwick route will be particularly badly hit.

One aquaculture industry spokesperson says that uncertainty over freight fares is holding back development: the aquaculture producers will not invest in new or expanded sites in Shetland until they know the extent of the costs they will have to absorb from hauliers passing on the increased freight fares.

The ferry freight fares review is a poisoned chalice. It’s going to make the Lerwick to Aberdeen sailings much more expensive, and the Pentland Firth crossings much cheaper. People are terrified of it.

Shetland transport operator

4.4 Rail

At present rail plays no substantial role in aquaculture freight in the UK; in terms of interchange, and the practicalities of transferring freight in suitably adapted containers, it is not seen as a viable option.

In Norway, where much of the fish is produced in northern parts of the country, there is sufficiently long distance to the main European markets to make intermodal transport, including rail, a viable option²⁷. We have, however, uncovered no evidence that this model is being considered as appropriate for adoption in Scotland.

4.5 Air

Air freight services are important for some Scottish aquaculture products to reach international markets. The HMRC Overseas Trade statistics for seafood exports does not distinguish between caught and farmed shellfish and finfish, so we do not have exact figures for the level of aquaculture exports from Scottish airports.

In 2016, 4,140t of both caught and farmed seafood was exported from Glasgow, Edinburgh and Aberdeen, almost all of it from Glasgow, and this represented around 8.2% of total seafood exports from the UK. But consultees reported that almost all air-freighted aquaculture produce currently leaves the UK from Heathrow, having been taken there from Scotland by truck. We estimate that more than 100t of Scottish aquaculture produce is flown from Heathrow daily. Glasgow does export some volumes of seafood on long haul passenger services to Asia, particularly China, which is a growing market. Hainan Airlines opened up a direct route between Edinburgh, Dublin and Beijing in the summer of 2018, and Marine Harvest have been trialling exporting consignments of salmon on the service.

Most businesses consulted were satisfied with the current arrangement, and that flying from Heathrow worked well. Heathrow has effective facilities and processes, and has the broadest reach for accessing international markets of any UK airport.

In the course of the study, the research team contacted Aberdeen, Edinburgh, Glasgow and Prestwick International Airports, and Highlands and Islands Airports, for comment.

Highlands and Islands Airports Ltd has recently undertaken a study into the air freight market currently being served in the Highlands and Islands, potential unmet demand for air freight among Highlands

²⁷ Generalized transport costs in intermodal freight transport; Hansseen, Mathison and Jørgensen, 2012.

and Islands services, and the prospects for more air freight through Inverness airport in particular. With regard to seafood, the study found that producers are by and large satisfied with the status quo. Current road transport is 'tried and tested' and fairly cost effective. Producers felt that introducing additional air stages could result in a more fragile logistics chain, and there is no real impetus to do this.

Prestwick Airport reported that they are not planning to develop any chilled / cold transport logistics at present; however, if a commercial proposal were to come along we would consider building the required infrastructure if the business case was favourable. The Airport does on occasion handle temperature-controlled goods but they are collected immediately after the flight arrives by refrigerated trucks. The main barriers to development would be cost and premises as a dedicated facility for refrigeration would be required.

Edinburgh Airport confirmed that they had seen an increase in the movement of seafood cargo through Edinburgh Airport; and advised that Working Group is currently looking at the whole cargo market, including those products that require temperature controlled facilities, with a view to considering what development and investment might be delivered.

However, the Scottish Salmon Producers Organisation considers that exporting direct from Scotland could become a real option: all it would take is for production and export demand to reach a critical mass and it will become economically viable. Similarly, Cooke Aquaculture felt that any barriers to flying from Scotland were easily surmountable, and that the potential benefits in terms of saved time and reduced road haulage costs were considerable. At present, though, no Scottish airport has facilities for the storage of chilled goods; a challenge that would need to be overcome to maximise use of more direct flights.

4.6 Communications

Some hauliers identified the lack of mobile phone coverage as an issue in rural and remote parts of Scotland. Whilst some companies make use of telematics, through which they can track the lorries and contact the fish farms and processing plants from headquarters, not all haulage firms have this, and it can create added complexity if drivers are running late, or there is a change in the order.

One manager reported that poor mobile phone and Wi-Fi coverage was additionally causing recruitment and retention problems within the industry; workers had often moved far from friends and family to take up employment, but the lack of communications coverage meant that they could not access internet telephony, social media platforms, etc.

My drivers deliver to Iceland, Ireland, Norway, Spain and the Faroe Islands. They have complete mobile phone coverage in all these places – even in Iceland where there's about 300,000 people – but not in Scotland. We really are bottom of the league here, and there's no excuse.

Manager of a haulage firm

This need for better digital connectivity has already been identified in Aquaculture Growth to 2030, which recommends that "the Scottish Government's plan for digital connectivity in terms of area coverage and broadband speeds take account of the planned industry footprint to 2030. Specifically, a Spatial Plan produced by Marine Scotland [...] should be considered when digital coverage is being planned and in line with Scottish Government commitments, all aquaculture shore-based properties should have superfast broadband by 2021."²⁸

²⁸ Aquaculture Growth to 2030, p14

4.7 HGV drivers – recruitment and retention

Across the UK, there is a driver shortage for HGVs. Figures for the shortage are estimated by the RHA at around 45,000 – 50,000 drivers, but this is particularly acute in remote and rural parts of Scotland. The average age of a truck driver in the UK is around 56. It is considered that the strictness and severity of legislation (fines and penalty points); poor working conditions that include long periods away from home and disruptive shift patterns; unappealing facilities for washing, eating and sleeping; and the high skill of the job relative to the remuneration are all factors which deter people from a career as a truck driver.

Some haulage companies consulted as part of this work are being proactive in encouraging more drivers to join the industry, but the lack of drivers could be a constraint to the future growth of the logistics industry in Scotland, be it for hauling aquaculture or other products.

4.8 Anticipated future issues and constraints

In this section, we summarise evidence we have identified as to likely future challenges and constraints for logistics as the aquaculture industry seeks to grow.

Ferries

There is a consensus amongst all haulage businesses and producers consulted in the Northern Isles that capacity on both the Shetland and Orkney lines is going to become more and more constrained, and that, in the words of one producer “a situation that is already very challenging is going to become a crisis. Shetland is already at a critical stage”.

The ability for the NorthLink ferries to cater for increased aquaculture traffic depends as much on demand from other sectors as from aquaculture itself. Major construction projects on the islands are already reported to create significant short-term peaks in demand, and the ferry operator does not often have detailed insight into these peaks in advance.

A more direct impact on aquaculture logistics could come from Brexit and its potential to increase the volumes of white fish being landed in Scotland and, in particular with reference to ferries, notably in Lerwick. Some consultees have estimated that the total amount of landed catch could double, and this would then be competing with the same capacity in refrigerated trailers and for ferry deck space as aquaculture produce.

NorthLink state that there remains significant capacity across the year as a whole, but that some peak-time sailings are full. Unless mechanisms can be found to manage demand to make use of off-peak capacity (which could be difficult for both fishing and aquaculture sectors, as they rely on rapid transportation), or create additional capacity (either on ferries or by transportation of aquaculture produce on chartered boats to the Scottish mainland for processing), then there is a significant risk that aquaculture growth in the islands will be constrained by ferry capacity.

Piers / harbours

The industry reports that lack of capacity at some ports and harbours already disrupts aquaculture supply chains. Growth in the industry without growth in dock capacity could exacerbate these problems, though the development of the feed plant at Kyleakin might mitigate this to an extent by reducing the need for road/ship transshipment; we recommend reconsidering this in more detail once the full effects of Kyleakin have taken place.

But the lack of deep water harbours in Scotland is constraining the maximum size of wellboat that can be used by the Scottish aquaculture industry; some in Norway are 40% larger than those in Scotland, and the industry there is reaping efficiency benefits as a result.

Air

Airfreighting aquaculture produce straight from Scotland, rather than transshipping via Heathrow, provides theoretical benefits of reduced road miles and higher product values (if it is fresher on reaching final markets).

Scottish airports currently lack the facilities to store chilled goods, and this places a constraint on this market. There may be potential for such facilities to facilitate growth in high-value exports of Scottish aquaculture produce. We note caution around this issue, though; the industry generally reports satisfaction with the current arrangement and, whilst there are relatively few long-haul destinations served directly from Scotland, it may be that Heathrow continues to provide a convenient option.

Rail

Rail is largely not currently used by the Scottish aquaculture industry and this review has not uncovered any evidence that the industry can foresee a situation where rail freight provides an attractive option for local or longer-distance movements. We do not therefore foresee that any rail issues place a hindrance to growth; though there are opportunities for making more use of the Caledonian sleeper to transport shellfish from Inverness to London. This would likely be relatively small quantities of oysters; though the cost of transport could be an issue.

Road

Although there are locations at which delays frequently occur to aquaculture traffic (as noted above), the Scottish road network is not currently seen to place significant constraints on the growth in aquaculture.

If, however, delays on the English trunk road network continue to increase and it becomes more time consuming to access European markets, then this could affect the distribution (and, potentially, processing) elements in the aquaculture supply chain.

A shortage of HGV drivers is not yet a significant constraint on road haulage capacity, but companies in the industry have identified the risk and are working to overcome it. There is potential, however, that unless there is a more significant intervention to improve training and recruitment, then a lack of drivers could potentially become a constraint on haulage in Scotland; which industries would then suffer as a result will depend on the willingness of each to pay for what would be increased haulage costs.

Brexit

While not dominating the consultation exercise, Brexit was cited by several stakeholders as an area of severe concern. The main area of concern is the ongoing lack of clarity and information from the Government, meaning that it is now too late for producers to implement a strategy to respond to changed circumstances.

Hauliers are fearful that Brexit could result in lengthy delays for customs checks, and concomitantly, severe congestion on the approaches to the Dover ports and the Channel Tunnel. Longer journey times will incur significantly higher costs, and also risk lowering the market value of finfish, which, as mentioned elsewhere, is acutely time sensitive. DFDS Logistics sited their operations centre at Larkhall specifically because a driver can generally drive Larkhall to Boulogne-sur-Mer in a single shift; delays will mean that this is no longer possible, and two drivers will be required. The Managing Director of DFDS Logistics advised that among options being considered was the creation of a new logistics hub in England.

It's a desperate situation now [regarding Brexit]. There's no information coming back to us as to what's going to happen. If there are checks on every truck going to Europe – which there will be – then the south of England is going to be a car park.

Cooke Aquaculture

Some within the fishing industry feel that one consequence of Brexit could be a relaxation in restrictions, resulting in an increase in the volume of fish landed. If this is the case, this could lead to heightened competition for space on the Northern Isles ferries.

Also, both fish processing and road haulage often use migrant labour, and Brexit restrictions on migration may have an impact on availability, and recruitment. The extent to which processing can be mechanised, or alternative labour arrangements can be found, is currently unknown. However, this combined with changing market access to Europe versus alternatives (e.g. China, UK) may also change the processing requirements.

5. FINDINGS AND IMPLICATIONS FOR THE INDUSTRY

This review has considered the logistics issues facing the Scottish aquaculture industry, and particularly whether logistics might act as a constraint on the industry's significant plans for growth.

Our work, through a review of published evidence and engagement with industry stakeholders, has not been able to build up highly precise estimates of the logistics requirements, in part because of data confidentiality and in part because of frequent changes in the locations at which supplies are moved or shipping routes.

Aquaculture production occurs throughout the west and north coasts of Scotland, and in all the main island clusters. In addition, many on-shore facilities are of importance to the industry, notably:

- Feed production facilities at Bathgate, Grangemouth and Invergordon;
- Processing plants in many locations, with the largest being in Fort William and Rosyth; and
- Distribution centres in Larkhall and Bellshill.

The finfish industry is reliant on chartered vessels for the delivery of feed and other consumables to offshore facilities, and on wellboats for the transportation of live fish to and from farms.

Land-based transport is entirely by road vehicle (including on ferries from the islands), with the exception of some processed produce being airfreighted to final market, mostly from Heathrow.

The most important ports for transshipment are at Mallaig, Kishorn and Oban, though many other ports and harbours are also used by the industry.

Many strategic and local transport links are essential for the effective operation of different aquaculture sites. But those that are of particular importance to the industry are:

- Shetland – Aberdeen ferries;
- Orkney – Aberdeen ferries;
- Western Isles – mainland ferries;
- A90/M90 – Aberdeen – Central Belt;
- A830/A82 – Mallaig – Fort William – Central Belt;
- M74/M6, etc – Central Belt to English and European markets and Heathrow.

Logistics issues do not currently cause major problems for the aquaculture industry, though delays to transportation when they occur do significantly reduce the value of the product. Problems that were identified include:

- A small proportion of peak-time ferries are full, meaning that produce is sometimes unable to get away from island production sites, and the timing of ferry departures reduces production flexibility;
- It is sometimes challenging for operators to find suitable berths at ports for transshipments;
- There is nowhere in Scotland that the largest wellboats can berth, meaning the maximum capacity is restricted in comparison with operations in some other countries;
- The road network was generally felt to operate well, though delays occur frequently around Fort William and Oban, in Aberdeen, and on routes south through England.

Many stakeholders are concerned about the potential impact of Brexit on aquaculture logistics, citing potential delays to cross-Channel freight traffic and also the potential for a significant increase in white fish landings, especially in Shetland, to compete with aquaculture produce for the same refrigerated trailer and ferry capacity.

Looking ahead, logistics issues are not anticipated to be as significant a brake on potential growth of aquaculture as some other factors including the availability of suitable production sites, of planning constraints and environmental considerations. But, nevertheless, there are logistics issues which have the potential to hamper the industry's plans. The evidence gathered from this review has identified the following as being the most important:

- **Harbour capacity for wellboats:** the largest wellboat berth in Scotland is at Mallaig, and enables access for vessels of up to 1,800m³ capacity. Yet some Norwegian harbours enable boats of up to 3,000m³. Enabling larger vessels to dock in Scotland would facilitate more efficient growth of larger fish farms;
- **Capacity at other ports:** lack of capacity for transshipment from road to sea-going vessels at other ports could place a constraint on growth. We note, however, that the on-going development of a new finfish feed production site at Kyleakin could result in more deliveries of feed directly by boat to the farms, so reduce the need for port transshipment; the resulting situation should be monitored before investment decisions are made;
- **Ferries:** across the year as a whole, there is reported to be spare capacity on all Scotland's ferry services. But some peak-time sailings are full, and ferry capacity could be a constraint to growth of aquaculture in the islands. This is of particular importance if growth in other industries results in them generating more demand for ferry freight traffic, which could squeeze out aquaculture produce. Finalisation of the Ferries Review would also enable hauliers and aquaculture producers to plan for island investment with more certainty than they are currently able. The recent Audit Scotland Ferries Review recommends that Transport Scotland should (amongst other notable actions) develop a Scotland-wide, long-term strategy for its network of subsidised ferries as part of its Strategic Transport Projects Review;
- **Airports:** better facilities for handling freight at Scottish airports (including provision for handling chilled goods which they currently lack) provides a potential option to enable faster access to international markets for aquaculture produce and fewer UK road miles. But, given Heathrow's access to a much wider range of destinations and its much more comprehensive freight handling service, the demand for airfreight from Scotland remains to be tested;
- **Trunk Road delays:** consultees report a generally high level of satisfaction with the Scottish Trunk Road's ability to cater for aquaculture traffic, though reducing delays in Fort William and Aberdeen would reduce haulage costs. But delays on the routes south to access English and European markets are reported to be increasing, and posing some risk to the carefully-designed supply chains that place the main distribution centres at Bellshill and Larkhall within a driver's shift of the main Boulogne-sur-Mer northern European fish market;
- **Haulage industry capacity and efficiency:** there is potential that a significant growth in demand for aquaculture road haulage, without reductions in demand from other sectors, could result in a capacity constraint in terms of numbers of drivers available, especially locally in rural Scotland. Improvements in communications network coverage would potentially aid driver recruitment and also enable hauliers to respond more effectively to unplanned changes in demand or operational difficulties.

APPENDIX A: BIBLIOGRAPHY

Both aquaculture and transport bodies have produced research and reports that were directly relevant to the scope of this study. In addition, Marine Scotland and the Scottish Government provide useful geographic data and production statistics that were also useful in building an overview of the current state of the sector.

Many sources are listed as footnotes throughout, but below is a list of the main documents consulted by Imani and the SYSTRA research team in the course of preparing this report:

- An Assessment of the Benefits to Scotland of Aquaculture, Imani Enterprise Ltd, SRSL 2014.
- Aquaculture Growth to 2030, Scotland Food and Drink, year unknown
- Argyll and Bute Transport, Connectivity and Economy, 2016
- Audit Scotland Ferry Services Report, 2017
- Fort William Strategic Transport Study, HITRANS, 2018
- Finfish Mortalities in Scotland, Zero Waste, 2016
- Generalised transport costs in an intermodal freight transport, Hanssen et al, EWGT, 2012
- How Scotland's Transport Network Supports the Growth Sectors, Transport Scotland, year unknown
- Mallaig Harbour Masterplan, Fisher Associates, 2017
- MAXiMAR: Maximising the marine Economy in the Highlands and islands, ekosgen, Imani Enterprise Ltd., and HIE, 2018
- Oban Bay Harbour Masterplan Phase 1, Fisher Associates, 2014
- Salmon Farming in Scotland, SPICe briefing, February 2018
- Scottish Ferry Service Ferries Plan, Transport Scotland, 2012
- Skills Review for the Aquaculture Sector, ekosgen and Imani Enterprise Ltd, 2018
- Stornoway Port Authority – Port Masterplan, Fisher Associates, 2017
- The Value of Aquaculture to Scotland, Westbrook, S., and Imani Enterprise Ltd 2017
- Transport Scotland Ferries Plan, 2015

APPENDIX B: CONSULTEES

As the first stage of the expansion of the evidence base, the research team engaged in a series of face-to-face meetings. These discussions and our review of published information were used to help develop structured interviews which were used in in-depth research through one-to-one telephone surveys with a range of transport, aquaculture, local authority or third sector businesses and organisations. The purpose of these interviews was to drill down in the current and anticipated routes and flows of the inputs and outputs of the aquaculture production processes; and explore current and anticipated issues and constraints.

The stakeholders we consulted are listed in the table below. We thank all of those that helped us with this study for their time.

- Aberdeen Harbour
- Alsop Transport
- Aquaculture Industry Leadership Group
- Argyll & Bute Council
- ASSG
- Biomar UK
- Comhairle nan Eilean Siar
- Cooke Aquaculture
- Dawnfresh
- DFDS Logistics
- Edinburgh Airport
- Fish UK
- GaelForce
- Highlands & Islands Enterprise
- HITRANS
- JBT
- Karen McLeod
- Lerwick Harbour
- Mallaig Harbour
- Marine Scotland
- Northwards Transport & Distribution
- Orkney Islands Council
- Outer Hebrides Tourism
- Road Haulage Association
- Scottish Sea Farms
- Serco / NorthLink
- Shetland Islands Council
- Sinclair Haulage
- Scottish Salmon Producers' Organisation
- Stornoway Port Authority
- Uist Asco