Report

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Contingency Planning for Fish Mortalities in Scotland

Project Code: RC06-0002

HERIOT WATT UNIVERSITY
NAFC Marine Centre University of the Highlands and Islands
FishVet Group
SRSL
enscape ENVIRONMENTAL & DEVELOPMENT SERVICES

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Acknowledgments

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Glossary of Terms

Anaerobic Digestion (AD)	Process of controlled decomposition of biodegradable materials under managed conditions where free oxygen is absent, at temperatures suitable for naturally occurring mesophilic or thermophilic bacteria that convert the inputs to biogas and digestate.
Animal and Plant Health Agency (APHA)	The aim of the organisation is to safeguard animal and plant health for the benefit of people, the environment and the economy. It is an executive agency sponsored by the Department for Environment, Food & Rural Affairs, and also works on behalf of the Welsh Government and the Scottish Government. It is responsible for inspecting Animal By-Product processing facilities in Scotland.
Animal by-products (ABPs)	Animal by-products are materials of animal origin that people do not consume. They are controlled by the Animal By-Products Regulations (EC) 2009 (142/2011), transposed into Scottish law through The Animal By-products (Enforcement) (Scotland) Regulations 2013. This controls the collection, transport, storage, handling, processing and use or disposal of animal by-products in Scotland, including catering wastes.
Aquaculture Scotland	A website resource developed by Marine Scotland (Scottish Government), Food Standards Scotland, SEPA and the Crown Estate – providing access to a range of information about aquaculture in the country.
Biodiesel	A fuel that is made from natural elements such as plants, vegetables and animal-by products, including a range of waste streams.
Code of Good Practice (CoGP)	First published in 2006, the result of an agreed industry action arising from the 2003 Strategic Framework for Scottish Aquaculture. An evolving document, it is regularly reviewed to incorporate elements of change in legislation and emerging priorities in environmental management and the sustainable development of the industry.
Contingency Plan	A plan used by the fish farming companies, or policy-makers which sets out how Event Mortalities can be managed in a safe, sustainable and responsible manner.
Disease Management Areas (DMAs)	Established in January 2000, based on separation distances around active farms, taking into account tidal excursions and other epidemiological risk factors. Farms with overlapping separation distances will usually be within the same disease management area.
Energy from Waste (EfW) plant	Facilities which incinerate waste to generate energy in the form of electricity and/or heat.
Ensiling	A low energy method for storing fish which eliminates the need for controlled storage and transportation facilities. The macerated fish are mixed with formic acid at 3.5% to acidify it. The pH is kept at 4 or below.
Event Mortalities	These are significant, non-routine mortality events which fall into the Level 1 to 5 categories defined in this report.
Fish Health Inspectorate (FHI)	The main aim of the Scottish Government FHI is to prevent the introduction and spread of listed and emerging fish and shellfish diseases in Scotland. It does this by undertaking statutory inspection and sampling programmes, providing advice to stakeholders and implementing regulatory functions in accordance with the current aquaculture and aquatic animals health regulations.
In-vessel composting (IVC)	A term used to describe a wide range of composting systems where the composting feedstock is contained in a purpose-built structure for the sanitisation phase of composting, allowing a higher degree of process control and compliance with ABPR requirements. Many IVC sites incorporate an element of windrow composting for maturation of the material following the sanitisation phase.

Pollution Prevention Control (PPC) permit	This is a permit is granted by the regulator allowing the operation of a regulated facility subject to certain conditions. Some activities are exempt from permitting or waste management licencing provided they meet certain conditions. Further information is available on the SEPA website: www.sepa.org.uk
Renderer	A company which takes ABPs, processes them and produces usable materials such as lard, tallow, etc.
Scottish Environment Protection Agency (SEPA)	SEPA is Scotland's principal environmental regulator. It works with the Scottish Government and Zero Waste Scotland to achieve the objectives and targets of the Zero Waste Plan, published in 2010. It has a wide range of responsibilities including regulating waste management activities such as landfills, incinerators and the export of waste, administering the producer responsibility schemes for packaging, WEEE and batteries, collecting and interpreting waste data and tackling environmental crime.
Scottish Salmon Producers Organisation	A member organisation for Scotland's salmon farming industry, with the aim of giving the industry a voice and promoting best practice.

Executive Summary

Overview

Building on the Zero Waste Scotland 2016, *"Zero Waste Report - Fish Mortalities in Scotland"*, this report assesses the industry's current ability to deal with mortality events at the farm, disease management area (DMA), regional and national levels. This is considered in terms of removal, transport, storage and processing, where significant tonnages of Animal By Product (ABP) material are required to be managed in a short timescale. By identifying potential bottlenecks, this assists the industry plan for the future. This project focussed on seawater production sites, where fish are grown to harvest size.

The objective of the project was not to highlight individual site or company behaviour, but to focus on waste management processes (not fish husbandry). Other groups are currently looking at fish health, the sizes of fish, the causes of mortalities etc.

The Code of Good Practice (CoGP) for Scottish Finfish Aquaculture incorporates a reporting system where for different sizes of fish, the occurrences of mortalities above specified percentages should be reported to Marine Scotland's Fish Health Inspectorate (FHI). For example, for fish in exceedance of an average site weight of 750 grammes, the maximum 5-week rolling mortality is 4% before the FHI is to be informed (1% is the maximum weekly mortality for such reporting to occur).

This report refers to significant, non-routine "Event Mortalities", these being equal to/above 5%, as measured from the monthly reports submitted to SEPA. These are sub-divided into a number of different categories, as follows: Level 1: ≥5 to <10%; Level 2: ≥10 to <20%; Level 3: ≥20% to <40%; Level 4: ≥40%; and Level 5: 100%.

Quantitative and qualitative data/information was gathered and assessed from different sources, including finfish operators in Scotland. The data was considered in terms of the category levels indicated above:

- Individual farms.
- Marine Scotland Disease Farm Management Areas (DMAs).
- National and regional.

This report collates the information gathered and assesses the ability and capacity of the sector, and its supply chain, to deal with scaled ABP volumes occurring from Event Mortalities.

Data on Fish Morts

Mortality from year to year varies. The total level of fish mortalities in Scotland, in 2017 was 25,737 tonnes, with levels increasing steadily as production levels have also changed (figure below).

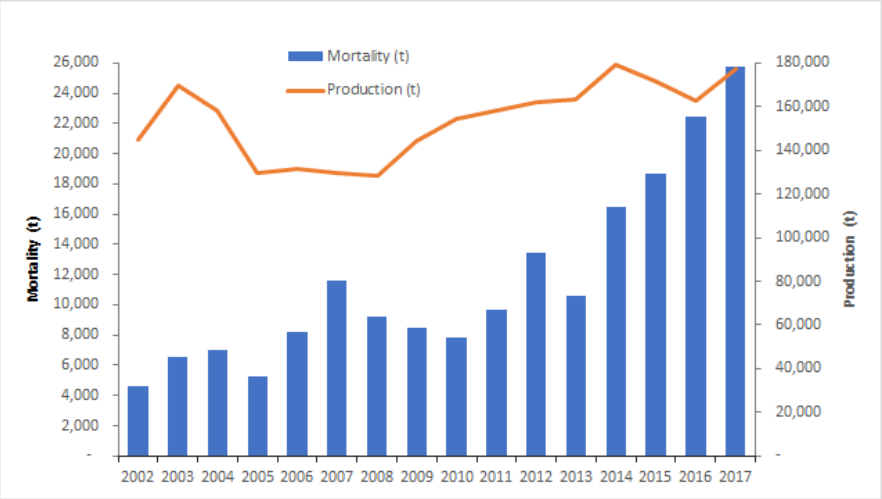

Figure 1. Annual Scottish marine fish farm mortalities & production (Atlantic salmon)

This project, which considered in detail approximately one-third (75) of the fish farm sites registered, has analysed the quantities and percentages of mortalities for each of these sites, classifying them into the different Event Mortality ranges mentioned previously. In the period 2008 to 2017, the percentage of all mortalities, as a percentage of average annual biomass, has changed from 4.9% in 2008, to more than 14% in 2017. Event Mortalities over the same period increased from 1% of average annual biomass to just under 7%. Event Mortalities, as a percentage of all mortalities, also grew from 21% to 48% in the same period i.e. the occurrence and scale of such mortality events has been increasing significantly in this time period.

Seasonality was considered in the data analysis, which is important because of the potential for Event Mortalities to take place over a short period. An analysis of historical data (2010 to 2017), indicated that there is a significant peak in mortalities during the period August to November inclusive. This requires particular consideration for Shetland, since this co-incides with the busiest time of the year in terms of freight movements (there is little additional capacity during this time).

Fish Farm Companies

In terms of fish farm contingency plans information provided by the operators indicated that existing infrastructure and processes would be used to manage Event Mortalities.

Road haulage on the Western Isles, particularly in summer, is challenging. There are also significant issues in terms of ferry capacity and in the context of Event Mortalities these issues will be exacerbated, for both the Western Isles and Northern Isles.

There is currently no significant licensed processing infrastructure (beyond maceration/ensiling) in any of these regions, except for the Western Isles, where the level of additional capacity for fish morts is small (2,500 tonnes per annum). A facility is being built on Shetland which will have the capacity to process routine mortalities, but would not be able to manage events more significant, from a tonnage perspective, than Level 1. The vast bulk of fish mortalities are currently hauled to the central belt of Scotland, or further south.

A number of points and opportunities were brought out from the engagement:

- Regarding the lack of regional processing infrastructure, a number of companies indicated their support for the establishment of processing infrastructure in each of the five fish farming regions. This represents a business opportunity, although for such facilities to be sustainable would require them to accept fish morts and waste from a number of companies (to ensure consistency of supply).
- Having processing infrastructure near ports would be a positive development.

There is interest in developing collaborative approaches, with a number of the operators interested in working together to realise industry-led solutions.

Mortality Processing Capacity

All of the licensed processing companies operating in Scotland were contacted, plus others in the rest of the UK (rUK) and Scandinavia, allowing the extent of current and *additional* capacity to be understood.

Considering Scotland, the rUK and wider afield (Scandinavia) there is sufficient capacity, using currently ***licensed*** facilities, to manage Level 1 to 4 Event Mortalities, on the basis of 2017 levels of production. This is also the case for the scenario where there is growth in production of 30%, e.g. up to the year 2030. With 50% growth the capacity is sufficient for managing Level 1 to 3 events. Adding ***potential*** future processing infrastructure to the licensed facilities will give options in terms of there being sufficient capacity to manage and process a 100% Event Mortality (on the basis of 2017 production/mortality tonnages).

For Scotland alone, licensed plus ***potential*** processing capacity is sufficient to manage 2017 mortality tonnages up to Event Mortality level 2. The position then worsens significantly when production growth rates of 30% and 50% up to the Year 2030 are considered.

Additional, licensed capacity, in addition to what is currently being used in Scotland, is estimated to be circa 38,000 tonnes per annum. The majority of this additional capacity lies with one rendering company while just under 13,000 tonnes is available at AD and IVC companies. The addition of new capacity, on Shetland and the Western Isles (the latter uncertain) may add a further 9,000 tonnes.

Further capacity was also considered with respect to future, new municipal, Energy from Waste (EfW) facilities at four locations, three of which are in extremely close proximity to harbour infrastructure (Aberdeen, Dundee and Dunbar). On the basis of assumptions concerning the percentage of feedstock that fish morts would be limited to, such facilities were estimated to be able to provide circa 25,000 tonnes per annum of additional processing capacity. Discussions would be required to understand the issues that the operators may have for these facilities, in taking fish morts, when there are currently no plans to have these as feedstocks.

The total ***potential***, additional processing capacity in Scotland is therefore circa 72,000 tonnes per annum (38K by rendering, 9K by AD/IVC and 25K by EfW) – this total capacity could be made available over a number of months.

Further, additional capacity, licensed and available now, could be secured, processing morts in rUK and Scandinavia. Discussions identified 67,500 tonnes of additional processing capacity in the former and 38,000 tonnes per annum for the latter.

The additional (licensed + potential) processing capacity is summarised in the table below.

Table 1. Summary of additional licensed and potential processing capacity

Additional, existing licensed capacity	Tonnage
Scotland	37,835
rUK	67,500
Scandinavian capacity	33,800
Sub-total	**139,135**
Potential capacity, Scotland	**Tonnage**
EfW Facilities	25,173
Drying	3,000
Rendering/biodiesel	6,000
Sub-total	**34,173**
Total	**173,308**

A further increase in processing capacity would require significant infrastructure developments in Scotland and/or the identification of further capacity outwith the country.

Estimates of processing capacity should be considered carefully because they are based on snapshots of an industry at any given time, and capacity utilisation is likely to change. There is also difficulty accessing information or assessing capacity in any given week because this depends on how busy processing facilities are. There are seasonal peaks in process operations as there are with mortality levels and unexpected, significant Event Mortalities will require capacity to be available at that moment in time, which may not be prove to be the case.

Haulage capacity – land and sea

Discussions with a number of key players indicate that Scotland has a significant level of additional capacity in terms of land haulage, which can be mobilised in response to Event Mortalities. Engagement with this sector identified additional, licensed haulage capacity not currently being used to haul fish morts, and which could be deployed if required e.g. a large scale haulier, for one of the regions, indicated that it is not currently licensed for this service, but commented that it would be happy to go through the required steps to become licensed and provide a service.

There may be value in further understanding the benefits that could be realised by such companies being able to provide additional capacity, in particular in those regions where bottlenecks in terms of road haulage have been identified.

More bottlenecks potentially exist for future Event Mortalities when seagoing capacity is considered. Only one independent company was engaged with that provides this service in Scotland, while another, larger-scale, haulage and processing company from Scandinavia was also engaged. However, an additional service company located in Scotland, was identified, with significant capacity, which would be interested in providing a fish morts service if requested by clients. The analysis indicates that a significant Event Mortality occurring over one region could be managed by the current seagoing capacity. However, if there were significant events occurring across the country as a whole (across multiple regions) at the same time, the capacity would be insufficient to manage beyond a Level 3 Event Mortality (this assumes that the vessels considered would be available at that time).

In terms of ferry capacity, the fish farming companies have indicated that there are challenges at times, particularly in summer for the Western Isles. Discussions with the operator of the service have identified the potential to charter evening ferries, in addition to timetabled services, which would provide significant additional freight opportunities. The peak periods for freight movements on ferries from Shetland are June to December, which overlaps with the peak period for mortalities (from the historical analysis carried out in this project). Analysis of the data provided by the ferry operator, in terms of the quantity of salmon being shipped for human consumption, indicates that this makes up a significant percentage of the overall freight movement. As such, if there is a significant Event Mortality, the quantity of product for human consumption would be reduced and there may be the potential for the space usually allocated for this to be substituted by fish morts.

In terms of regional bulk storage facilities, fish farm companies were more focussed on the need for regional processing infrastructure than storage infrastructure. However, the latter was of interest to three of the logistics/processing companies engaged with, who felt that this represented a significant opportunity to add value to the industry.

Recommendations

(a) Feedback from fish farm companies is that there would be great value to the industry, in having regional processing infrastructure and there may be value in Zero Waste Scotland, Marine Scotland, the SSPO and companies getting together to discuss this in more detail, and to identify if there are ways in which support and facilitation can be provided to make this happen. Interest from logistics/processing companies engaged with, to establish regional bulk storage facilties should be explored at the same time as considering processing infrastructure. Further work could consider the scale and locations of such infrastructure, as well as the financial implications and the potential for support. This could consider infrastructure such as AD or similar being established on the quayside.

(b) There may be value in understanding how Zero Waste Scotland and the Scottish Government, the SSPO etc could work to understand how the capacity at existing processing facilities, in particular AD, could be increased. An important element of this involves the recipes of feedstocks, with concerns that adding fish morts beyond a specified percentage will lead to digester failure. Work which develops a more detailed understanding of the minimum and maximum levels of feedstocks such as fish morts that achieve effective digestion could provide AD facility operators with the confidence to accept larger tonnages/percentages of morts.

(c) Data collation and analysis should move forward in addition to current reporting and Code of Good Practice thresholds through Scotland's 10 Year Farmed Fish Health Framework, to assist the industry in the significant efforts it is making to improve understanding of the causes of mortalities, and to identify trends, where there are present.

(d) Further work is required to map out the detailed options for Shetland and Orkney, to understand ferry capacity,and the the contingency measures that are required to manage significant mortality events that could occur at peak periods.

(e) The opportunities to effectively add further road haulage capacity on the Western Isles should be explored, to overcome the increasing constraints being experienced, associated with growing tourist numbers. This could be considered along with how seagoing vessel capacity could be maximised, to take fish morts off the roads. There would be value in understanding how other operators with land and seagoing vehicles, not active or licensed to collect/move fish morts could potentially play a part, to provide additional capacity for significant mortality events.

1 Introduction

Aquaculture is a growing industry in Scotland with the finfish sector being composed almost entirely of farmed Atlantic salmon (a member of the finfish family) which is the largest food export from Scotland, accounting for around 40% of total value[1]. A consequence of finfish farming is fish mortalities. These fish morts are normally classed as Category 2 animal by-products (ABPs) and must be disposed of in a safe and environmentally responsible manner in accordance with the Animal By-Product (Enforcement) (Scotland) Regulations 2013 (ABP(E)(S)). Examples of suitable disposal options are incineration, rendering, in vessel composting or anaerobic digestion, all of which must take place in plants approved under the ABP(E)(S) regulations or the Waste Incineration Directive.

Finfish production sites are widely dispersed throughout remote parts of Scotland, presenting logistical difficulties in terms of mortality (Animal By-Product material) collection and transport to disposal outlets. These logistical difficulties in turn make the safe removal, storage, collection and transport of ABP material very costly.

This can be further complicated in the case of sudden and significant event mortalities – while routine mortalities can be reasonably predicted year on year, event mortalities are unpredictable by their nature and can be confined to a single farm or group of farms.

The objectives of this report and the work done were:

- To assess the ability of the industry to deal with significant mortality events at farm, disease management area (DMA) and regional levels.
- Where issues are identified above, suggest alternative and cost effective contingency removal, transport, storage and disposal pathways per region.
- Consider the industry's future ABP material disposal requirements and whether current disposal capacity and infrastructure can meet this effectively.

Building on the 2016 *"Zero Waste Report - Finfish Mortalities in Scotland[2]"*, this report assesses the industry's current ability to deal with a mass mortality event at the farm, disease management area (DMA) and regional level, in terms of removal, transport, storage and disposal, where large volumes of ABP material are required to be processed in a short timescale. By identifying potential bottlenecks, this will also help the industry plan for the future. This project focussed on seawater production sites, where fish are grown to harvest size and large quantities (kg) of mortalities may be required to be disposed of. The project and research undertaken was focussed on waste management processes rather than fish husbandry. Other groups are currently looking at fish health, the sizes of fish, the causes of mortalities etc.

The sector in Scotland has adoped the Code of Good Practice (CoGP) for Scottish Finfish Aquaculture. This incorporates a reporting system where for different sizes of fish, mortalities above specified percentages should be reported to Marine Scotland's Fish Health Inspectorate (FHI). For example, for fish in exceedance of an average site weight of 750 grammes, the maximum 5-week rolling mortality is 4% before the FHI must be informed (1% maximum weekly mortality). This report refers to significant, non-routine "Event Mortalities" above 5% (as measured from the monthly reports submitted to SEPA).

The data and analyses are focussed on salmon, with marine trout excluded, the latter representing a very small percentage (circa 1%) compared to salmon production[3]. However, the industry perspective, with regards to marine trout aquaculture was sought through the stakeholder engagement work carried out.

Quantitative and qualitative data/information was gathered and assessed from different sources, including finfish operators in Scotland. The data was considered in terms of the following category levels:

[1] Available online at: http://scottishsalmon.co.uk/exports/
[2] Available online at: https://www.gov.scot/Topics/marine/Fish-Shellfish/FHI/healthpractice/ZeroWasteMort
[3] From the 2016 "Zero Waste Report – Finfish Mortalities in Scotland".

- Individual farms
- Marine Scotland Disease Management Areas (DMAs)
- National
- Regional:
    - Western Isles
    - Northwest
    - Shetland
    - Orkney
    - South West

The data and information relates to mortality removal and disposal for small, medium and large scale events at fish farm facilities, as well as how, historically, unexpected mortalities have been dealt with.

Toxic algal blooms can cause high mortality on several farms in an area almost simultaneously. There is therefore a requirement to assess disposal routes at this scale (100%). Outbreaks of notifiable diseases, such as Infectious Salmon Anemia (ISA) or Viral Hemorrhagic Septicemia (VHS), may require rapid depopulation. In some cases, where fish are not showing signs of clinical disease, fish may still be processed for human consumption (therefore 100% ABP material disposal will not always be required).

Other environmental and/or biological events can affect individual cages or different cage groups. In the last two years treatments for complex gill disease and sea lice have resulted in large losses at some sites over a short period of time. Other disease events (other than those requiring rapid depopulation) may have a lower mortality rate, over an extended period of time.

The industry has gone through rapid change in the last 40 years, including changes to farm management and biosecurity practice. To keep the report relevant, only mortality disposal issues of note since the last infectious significant Notifiable Disease outbreak in 2008-09 have been considered (i.e. the report covers the period 2008 to 2017 inclusive). The report specifically considers approaches to removal, transport, storage and disposal of ABP material arising from such event mortalities. This report collates the information gathered and assesses the ability and capacity of the sector, and its supply chain to deal with mass mortality events for the different category levels. This report has also identified issues and gaps in the information available, and provides evidence and recommendations in terms of the following:

- Historic problems encountered by individual farm sites and companies and consideration of the potential for these to reoccur in the future.
- Current ability to deal with different scales of mortalities with alternative and cost effective contingency pathways identified where appropriate/possible.
- Future ABP material disposal requirements for the industry describing where existing disposal capacity and infrastructure can meet this effectively. This also factors in future increase in production of a) 30% and b) 50% to 2030, in two-year projection increments (i.e. one production cycle).
- The requirement for future bulking and ensiling stations (as referenced in the "*Fish Mortalities in Scotland*" report) are also covered.
- The different logistics and processing pathways, in terms of removal, transport, storage and disposal.

Timing factors are also considered for the above stages, i.e. how quickly can requirements reasonably be carried out at different event scales. The Contingency Plans described in this report signpost the bottlenecks and management options for the aquaculture industry in Scotland for different scales of event, referring to historical data to inform these options, and incorporating feedback from engagement with the fish farm companies and subsequent supply chain employed to deal with mortalities.

The figure over the page illustrates the various ways in which morts can be taken, stored, hauled and processed, all of which are considered in this report. The processing infrastructure shown is not actually located at the quayside, however, where this was to prove to be the case there could be significant advantages in terms of speed of response, reduced costs, local economic benefits etc.

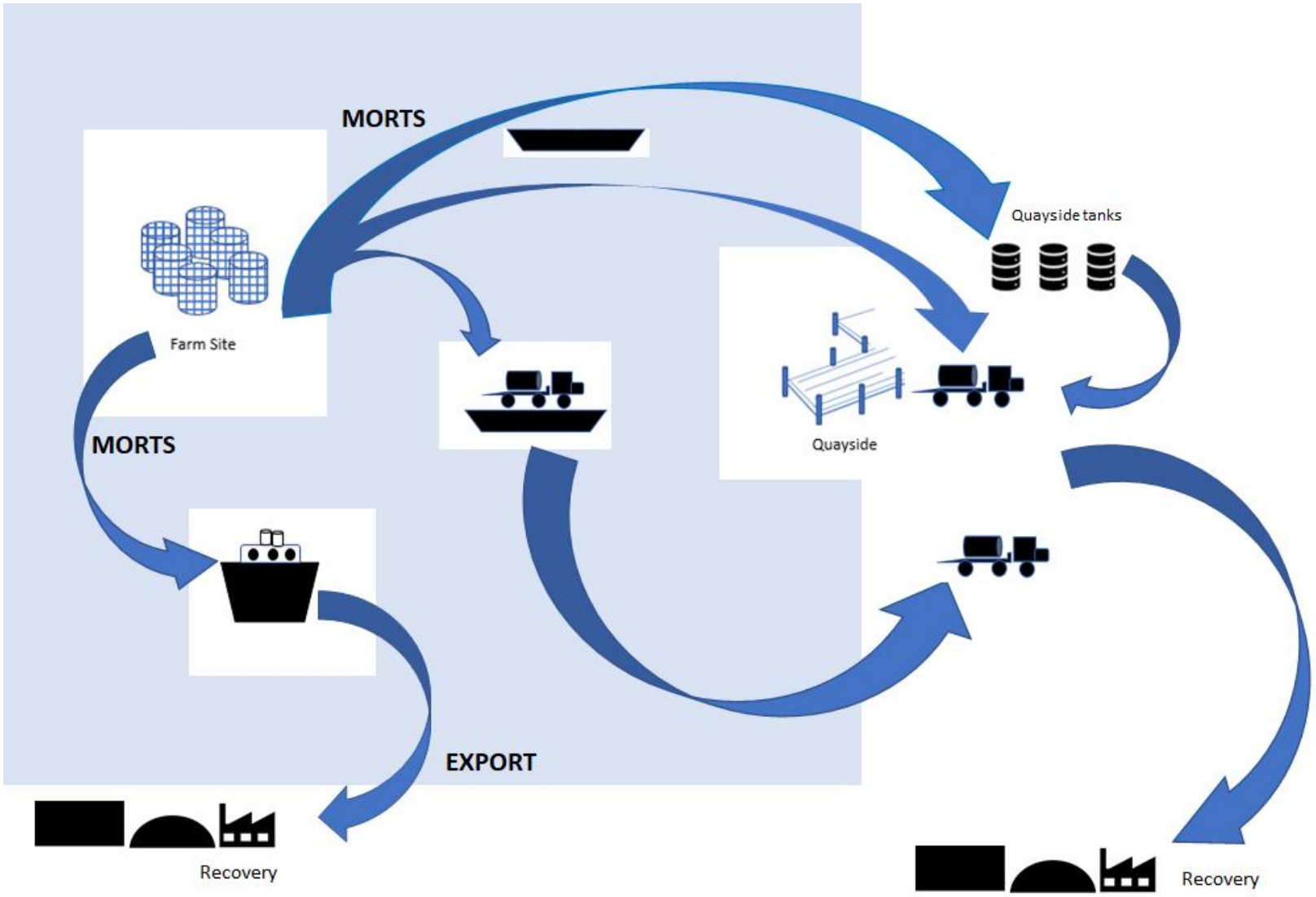

Figure 2. Schematic illustrating the potential logistics pathways for morts

2. Fish Mortalities, Animal By-products and the Regulatory Context

The Scottish Government's guidance on ABP from aquatic animals is categorised into one of three groups[4] which it states are according to the nature of the hazard/risk which they could pose. The government's position, in terms of the classification of animal by-products is summarised below.

Category 1 (few aquatic animals would fall into this category):

- Aquatic animals containing certain prohibited substances above specified levels or unacceptable levels of environmental contaminants (for example fish contaminated with fuel from an oil spill or fed contaminated feed)

Category 2 (mortalities would fall into this category):

- Fish or aquatic animals which die from a notifiable disease - such as infectious salmon anaemia (ISA)
- Aquatic animal products containing unacceptable levels of residues of veterinary drugs and higher than specified minimum levels of certain contaminants.
- Fish or parts of fish that die, other than being slaughtered for human consumption, including fish killed for disease control purposes. This includes all mortalities occurring during the production cycle in aquaculture, including fish that die from disease.
- Third country imports that fail to comply with veterinary requirements for their importation into the Community.

Category 3 (processing waste would fall in to this category):

- Carcases (heads, frames) and parts of slaughtered fish, which are fit for human consumption but are not intended for human consumption for commercial reasons.
- Carcases and parts of slaughtered fish, which are unfit for human consumption, but derive from carcasses that are fit for human consumption i.e. viscera; internal organs containing parasites.
- Carcases and parts of carcases of slaughtered fish, which are rejected as unfit for human consumption, but which do not show signs of disease communicable to humans or animals.
- Fish or other sea animals, except sea mammals, caught in open sea for the purposes of fishmeal production or bait.
- By-products from fish plants manufacturing fish products for human consumption.
- Shells from shellfish that contain soft tissue or flesh.

Where the product is made up of more than one category, the highest category applies (category 1 being the highest).

3. Review of Data on Mortality Levels

3.1 Methodology

3.1.1 Overview

Publicly-available data has been taken at an individual farm/site level, collated in Excel databases, with tonnages and causes of mortality shown (based on FOI data in 2015, 16 and 2017) at a regional and national level.

[4] http://www.gov.scot/Topics/marine/Fish-Shellfish/FHI/healthpractice/ZeroWasteMort

3.1.2 Data Sources

Sources of data on salmon production and mortalities, forming part of the analysis to produce options, in terms of contingencies, is provided online via the sources summarised in the table below.

Table 2. Summary of the data sources

Data sources	Type of data provided	Comments in terms of potential of data
Aquaculture Scotland	Monthly return data provided to SEPA	Excel databases with data which can be provided at individual site level, stating monthly, production, biomass and mortality levels etc over the course of a year. Data can be organised and structured to show site, Disease Management Area (DMA) and regional levels.
Marine Scotland Fish Health Inspectorate (FHI)	Publication of Case Information	A list of all cases reported/conducted, summary of case inspections and outcomes per region – for the period 2015 to 2017 inclusive.*
Scottish Government Scottish Fish Farm Production Survey, 2016	Data collected from all 15 companies actively involved in Atlantic salmon production, farming 253 active sites.	This data in the report represents the entire industry operating in Scotland, but only shows stock levels, not mortalities.
Scottish Government	Disease management area maps	52 disease management areas split across the code numbers 1 to 21 – for the regions North West Scotland, Orkney, Shetland, South East Scotland, South West Scotland, Western Isles.

*This was the period over which case inspection data was available in a collated format.

3.1.3 Site Selection

An analysis was undertaken on a sample of marine fish farm sites in Scotland, with 75 proposed and agreed, representing around a third of active sites. The analysis was provided for each of the years from 2008-09 up to 2017.

DMAs which incorporate only one site were excluded, otherwise the fish farm company and site associated with this area would be identifiable – this means that a total of 16 DMAs were excluded at the outset. (The objective of the project is not to highlight individual site or company behaviour).

The 2018 revision of the DMA maps and site listing identifies a total of 231 sites. Analysing 75 sites means that around one third (32.5%) of these were considered in detail in this project. With respect to the DMAs selected:

- The size/ number of sites was chosen to represent a regional balance.
- Where a DMA was chosen, all sites were included for analysis.

Taking forward the above methodology involved some iteration. For example, the following table provides a summary of the sites selected initially, which amounted to a total of 90. However, a number of these proved to have no data records (not active) and once active sites with full datasets were identified, this left 74 sites. The table summarises this, indicating the % split of sites per region, along with the distirbution of those chosen for the detailed analysis.

Table 3. Summary of site selection criteria

	% of No. of Sites Per Region	No. of Sites/Datasets for Project?	Sites Selected for Initial Analysis	Sites Actually Available with Monthly Data
Shetland	27%	20	25	19
Orkney	10%	7	9	6
North West	18%	14	23	18
Western Isles	16%	12	13	13
South West	29%	21	20	18
TOTAL	**100%**	**75**	**90**	**74***

**A further site from within Orkney was chosen to increase the number of sites with datasets to the target 75.*

This methodology and split is not based on the biomass or number of fish at specific sites/areas/regions or on data identifying areas where there appear to be particular issues in terms of mortalities.

Taking the Western Isles as an example, to demonstrate how a proportionate number of sites in a region was identified for analysis, the selection of DMAs 5c and 6a provided 13 sites with datasets available (close to the 12 sites indicated in the table).

3.1.4 Classifying the Event Mortalities

"Scotland's Aquaculture website" was interrogated for mortality and biomass data, on a site by site basis, for the period 2008 to 2017. The information considered from this database was the monthly SEPA return data for individual farms, which was subsequently organised into DMAs and consolidated nationally, and on the basis of five regions – Shetland, Orkney, Western Isles, North West (mainland) and South West (mainland).

In terms of classifying and quantifying mortalities the following terminology was adopted, indicating the significance of Event Mortalities, on a site-by-site and month-by-month basis – for all 75 targetted sites.

Table 4. Classification of event mortalities

Event Mortality Level	Weight of Mortalities as a % of Monthly Biomass Weight (for the Year Considered)
1	5 to <10%
2	10 to 20%
3	>20% and <40%
4	>40%
5	100%

The methodology used to identify Level 1 to 5 mortalities at a site level was as follows:

- The percentage of monthly mortalities was calculated for each site - by dividing the weight of mortalities by the biomass reported for the same month.
- Where Event Mortalities then fell into the categories defined by Level 1 to 5, the tonnages for each event were recorded. This provided a tonnage for each of the levels, for each site, each DMA, region and nationally – on an annual basis.
- The number of month-incidents were also recorded, showing the number of months where Event Mortality tonnages fell into Levels 1 to 5.

To show annual trends, from a DMA perspective, regionally and nationally, in terms of Event Mortalities, requires them to be expressed in percentage terms. As a result, mortalities were expressed as a percentage of average annual biomass ("biomass" tonnages were used because production tonnage

data is not provided within the SEPA monthly return datasets). Doing so allows a detailed analysis to be undertaken in a way which means that the levels of commercial farm activity can be considered. It should be noted that "average annual biomass" for a specific year and site, in this context is calculated as follows:

- The biomass tonnages for each of the 12 months are used to produce an average monthly tonnage for the year in question. This is referred to as the "average annual biomass" tonnage.
- The Event Mortality tonnages are then divided by this "average annual biomass" tonnage, providing data on an annual basis on a DMA, regional and national basis – to allow comparisons to be made.

3.1.5 Analysing the Causes of Event Mortalities

Detailed descriptions for the causes of reported mortalities have been provided by the Scottish Government Fish Health Inspectorate (FHI) for part of 2015 and all of 2016 and 2017. The data on causes of mortality for incidents is organised as follows:

- SEPA site reference and operator name.
- Quantity/number of fish affected.
- Description of mortality event and any listed/notifiable disease.

This FHI dataset was combined with Marine Scotland's Aquaculture database referred to previously to assist with the data analysis process.

3.2 Total Mortality Levels for All Sites in Scotland

The total, national picture, for mortality levels across all sites is as shown in the table below.

Table 5. Summary of total mortalities (tonnes) in Scotland from 2010 to 2017

Location	2010	2011	2012	2013	2014	2015	2016	2017
South West	924	2,164	1,746	2,059	1,972	1,972	4,746	4,761
North West	1,371	1,519	2,508	2,429	3,767	3,767	4,357	7,798
Western Isles	1,306	1,218	2,230	2,005	6,372	6,372	7,377	4,649
Orkney	538	504	880	708	703	703	964	1,471
Shetland	3,103	4,266	6,065	3,396	3,665	3,665	5,035	7,058
Scotland	**7,846**	**9,671**	**13,429**	**10,598**	**16,480**	**16,480**	**22,478**	**25,737**

The following section indicates that for the 75 sites selected for detailed analysis (around one-third of the sites) the tonnage associated with these amounts to 44% (11,285 tonnes) of the total mortality tonnage for Scotland in 2017.

3.3 Results for Scotland

The following table provides a summary of how Level 1 to 5 mortalities have changed for all of the 75 sites, across the five regions, considered over the period 2008 to 2017. It should be be noted that the same information is also available for each of the regions, and is provided in Appendix A. Section 3.4 discusses the data, from a national and regional perspective.

Table 6. Scotland - description of mortality levels

Year	Ave Annual Biomass, Tonnes	Total - All Mortalities	% All Mortalities of Ave Biomass	% Level 1-5 Mortalities of Ave Biomass	% Level 1-5 Mortalities of All Mortalities
2008	33,413	1,644	4.92%	1.05%	21%
2009	45,427	2,205	4.85%	1.21%	25%
2010	38,394	2,348	6.12%	2.66%	44%
2011	49,747	2,542	5.11%	1.72%	34%
2012	36,714	2,916	7.94%	1.43%	18%
2013	51,161	3,421	6.69%	1.90%	28%
2014	44,869	5,144	11.47%	5.02%	44%
2015	56,227	5,526	9.83%	4.54%	46%
2016	47,122	7,878	16.72%	6.92%	41%
2017	79,080	11,285	14.27%	6.87%	48%

Table 7. Scotland - description of mortality within different levels

Year	Tonnes, Level 1 to 5 Mortalities Reported							% of Mortalities		% of Ave Biomass		No. of Month-Incidents, Event Mortalities					
	5-<10%	10-20%	20%-<40%	≥40%	100%	Total	3 Yr Ave	Annual	3 Yr Ave	Annual	3 Yr Ave	5-<10%	10-20%	20%-<40%	≥40%	100%	Total
2008	186	138	25	0	0	350	n/a	21%	n/a	1.0%	n/a	9	3	1	0	0	13
2009	442	60	48	0	0	550	n/a	25%	n/a	1.2%	n/a	13	3	2	0	0	18
2010	224	0	0	0	799	1,022	641	44%	30%	2.7%	1.6%	10	0	0	0	2	12
2011	219	539	96	0	0	854	809	34%	34%	1.7%	1.9%	9	7	2	0	0	18
2012	246	147	52	81	0	525	801	18%	32%	1.4%	1.9%	12	3	2	1	0	18
2013	322	267	355	26	0	971	783	28%	27%	1.9%	1.7%	16	5	4	3	0	28
2014	638	619	782	213	0	2,252	1,249	44%	30%	5.0%	2.8%	25	12	5	2	0	44
2015	835	742	687	289	0	2,553	1,925	46%	39%	4.5%	3.8%	22	8	4	2	0	36
2016	1,331	866	660	405	0	3,261	2,689	41%	44%	6.9%	5.5%	32	11	8	4	0	55
2017	2,132	1,484	917	903	0	5,436	3,750	48%	45%	6.9%	6.1%	40	13	9	3	0	65

3.4 Results & Discussion Points on the Data

3.4.1 The National Picture

Analysis of the data for Scotland has indicated that, taking the 75 sites targeted across the country, Event Mortalities (Levels 1 to 5) amounted to 5,436 tonnes in 2017 compared to 350 tonnes in 2008. Total mortalities (i.e. including those less than 5%) for all of the Scottish sites amounted to 11,285 tonnes in 2017, compared to 1,644 tonnes in 2008. (in 2017 the total level of mortalities, for all sites, was more than 25,000 tonnes).

A number of key points, for Event Mortalities, for the 75 target sites across the country are summarised below

- Total mortality tonnages for the target sites, as a percentage of average annual biomass, were 1.7% in the period 2008-2013 and averaged 5.8% in the period 2014-2017.
- The increase in average biomass tonnage since 2008 has been accompanied by increasing levels (percentage and tonnage) of total mortalities. For example, total mortalities for the target sites in 2008 represented 4.9% of the average biomass for that year. This percentage increased to 14.3% in 2017.
- Event Mortality tonnages, as a percentage of total mortalities for the target sites, averaged 28.3% in the period 2008-2013 and 44.9% in the period 2014-2017.

3.4.2 Regional Comparisons

From a regional perspective, a number of key points for Event Mortalities are summarised below for analysis carried out on the target sites:

- Event Mortality tonnages, as a percentage of average annual biomass in 2017, were 18% South West, 14.7% North West and 19% for the Western Isles. This compares to 7.17% for the Shetlands and 0.28% for Orkney.
- Event mortality tonnages, as a percentage of total mortalities for the target sites in 2017, were 63% South West, 45% North West, 56% Western Isles. This compares to the much lower levels of 33% for Shetland and 3% for Orkney.

Graphs describing the above are shown in the following two figures.

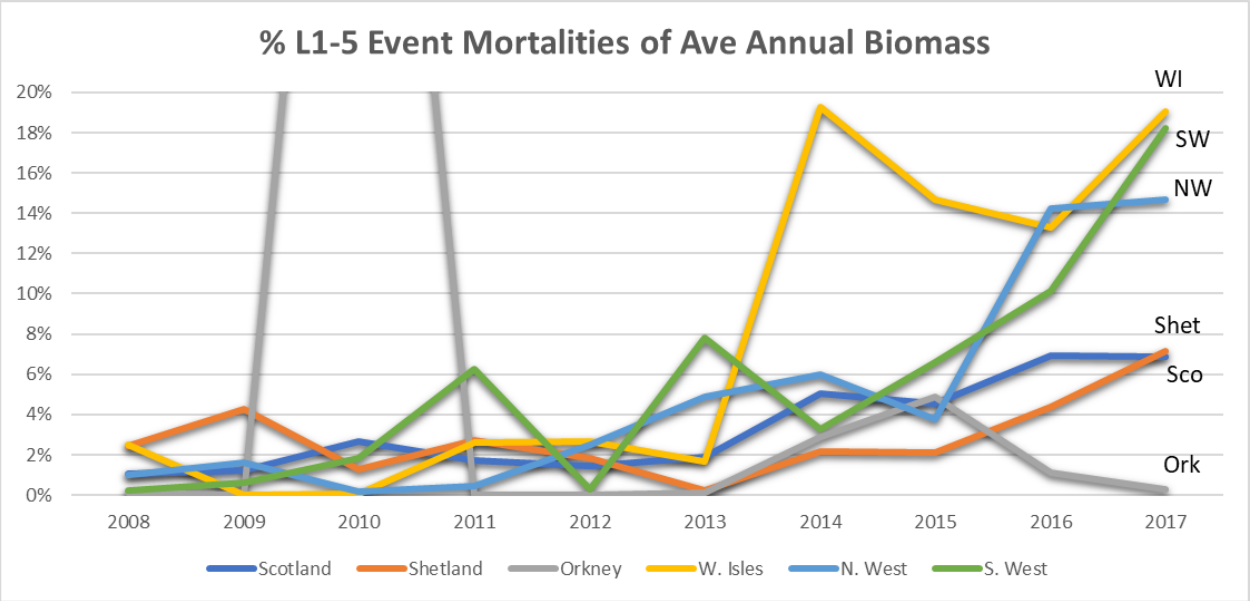

Figure 3. National and regional event mortalities as % of ave annual biomass

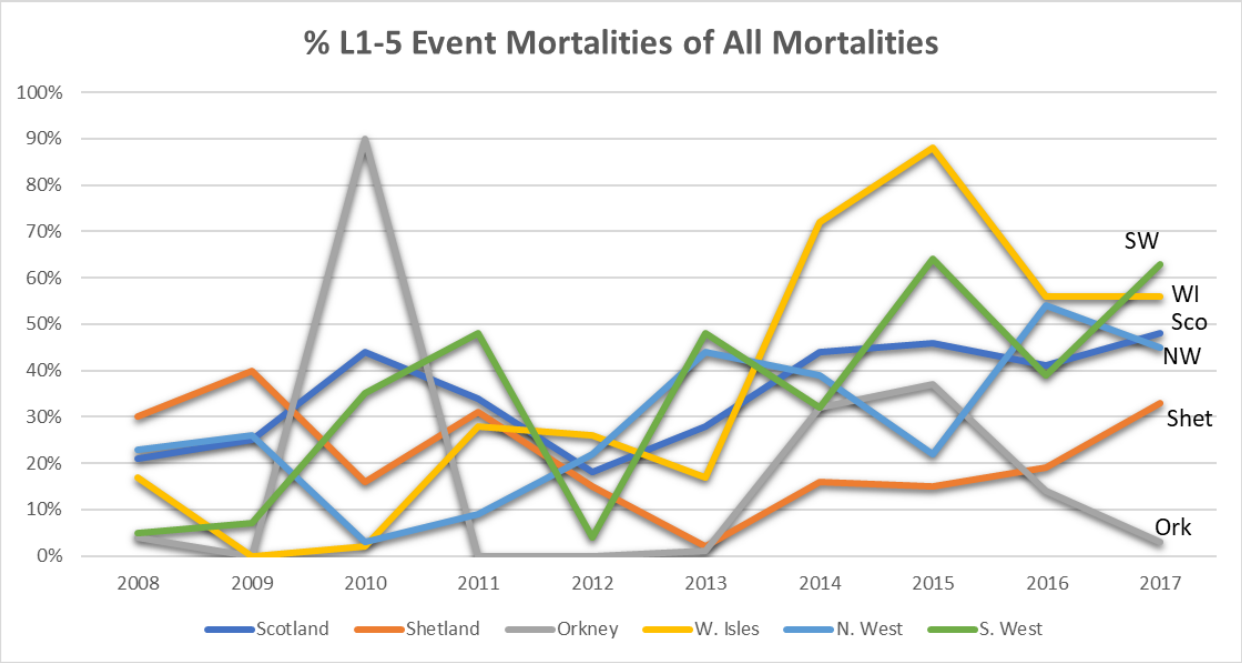

Figure 4. National and regional event moralities as percentage of all mortalities

The following figure also shows the rising trend in terms of how the total level of mortalities at the target sites has increased over the period considered, 2008 to 2017:

- In 2008 , for all all of the regions considered, the total mortalities as a percentage of average annual biomass, was less than 10%. In 2017 this had grown to between 29% and 30% for the Western Isles, North and South West regions.
- Orkney saw a one-off major increase in 2010.
- As a whole, the data for Orkney shows a significantly lower mortality rate, compared to the other regions, although it has also seen a significant level of growth in the period (1.7% to 10.2%).
- Shetland's total mortality rate in the period grew from 8% to 22%.

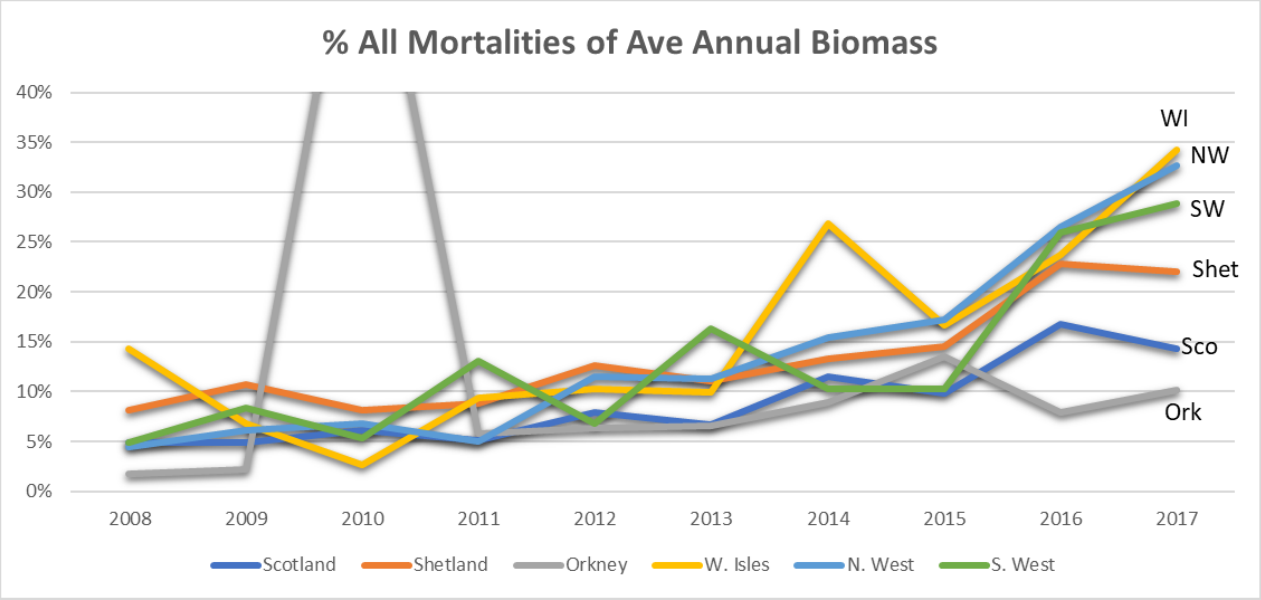

Figure 5. National and regional overview of % of all mortalities of ave annual biomass

3.4.2 National and Regional Position with Respect to Month-Incidents

The data shows a significant growth in the number of month-incidents (i.e. the number of months where Event Mortalities are within the Level 1 to 5 ranges). For the country as a whole, in 2008 there were 12 month-incidents for Level 1 to 3 and 1 month incident for Level 4 to 5. In 2017 this had increased to 53 month-incidents for Level 1 to 3, and 12 month-incidents for Level 4 to 5.

In addition, the average tonnages of mortalities for each of the Event Mortalities has increased over time. For example:

- 2008: for Level 1 (5 to 10%) the average weight per month-incident was 21 tonnes.
- 2018: for Level 1 the average weight per month incident was 53 tonnes.

There are similar increases to the above for the other levels considered in this report. However, it should be noted that the majority of the increases per month-incident has occurred in the three years covering 2015 to 2017 (inclusive).

The increases referred to above therefore required additional logistics infrastructure, with two or three road vehicle movements required for example, where previously only one was needed (assuming haulage capacity of 20 to 25 tonnes per vehicle).

To understand the above in more depth, the data for the period 2008-2017 period thas ben considered nationally and regionally, in terms of the number of month-incidents per 1,000 tonnes of average annunal biomass. The results are shown in the following table and graph.

Table 8. No. of incidents per 1,000 tonnes of average annual biomass

Year	Scotland	Shetland	Orkney	W. Isles	N. West	S. West
2008	0.4	0.9	1.0	0.7	0.2	0.4
2009	0.4	1.2	0.0	0.0	0.6	0.4
2010	0.3	0.8	1.5	0.2	0.2	0.3
2011	0.4	0.8	0.0	0.3	0.4	0.9
2012	0.5	0.5	0.0	0.6	1.2	0.2
2013	0.5	0.2	0.3	0.7	2.5	1.2
2014	1.0	1.0	2.1	1.6	1.4	1.8
2015	0.6	0.7	0.7	1.3	1.3	0.7
2016	1.2	0.9	1.4	2.0	2.2	2.0
2017	0.8	1.5	0.6	1.5	2.7	1.3

The reported data for the target sites, and the number of month incidents (expressed per 1,000 tonnes of average annual biomass) suggests that:

- The number of month-incidents for Scotland has doubled, from 0.4 to 0.8.
- The largest growth has been in the North West and South West, where the numbers have increased significantly in recent years, by more than a factor of 10 for the former and factor of approximately 3 for the latter (when compared with 2008). The number has approximately doubled in the Western Isles over the same period.
- In terms of Shetland and Orkney the data does not clearly indicate any similar trend when compared to the other regions,

The following figure illustrates the above more clearly.

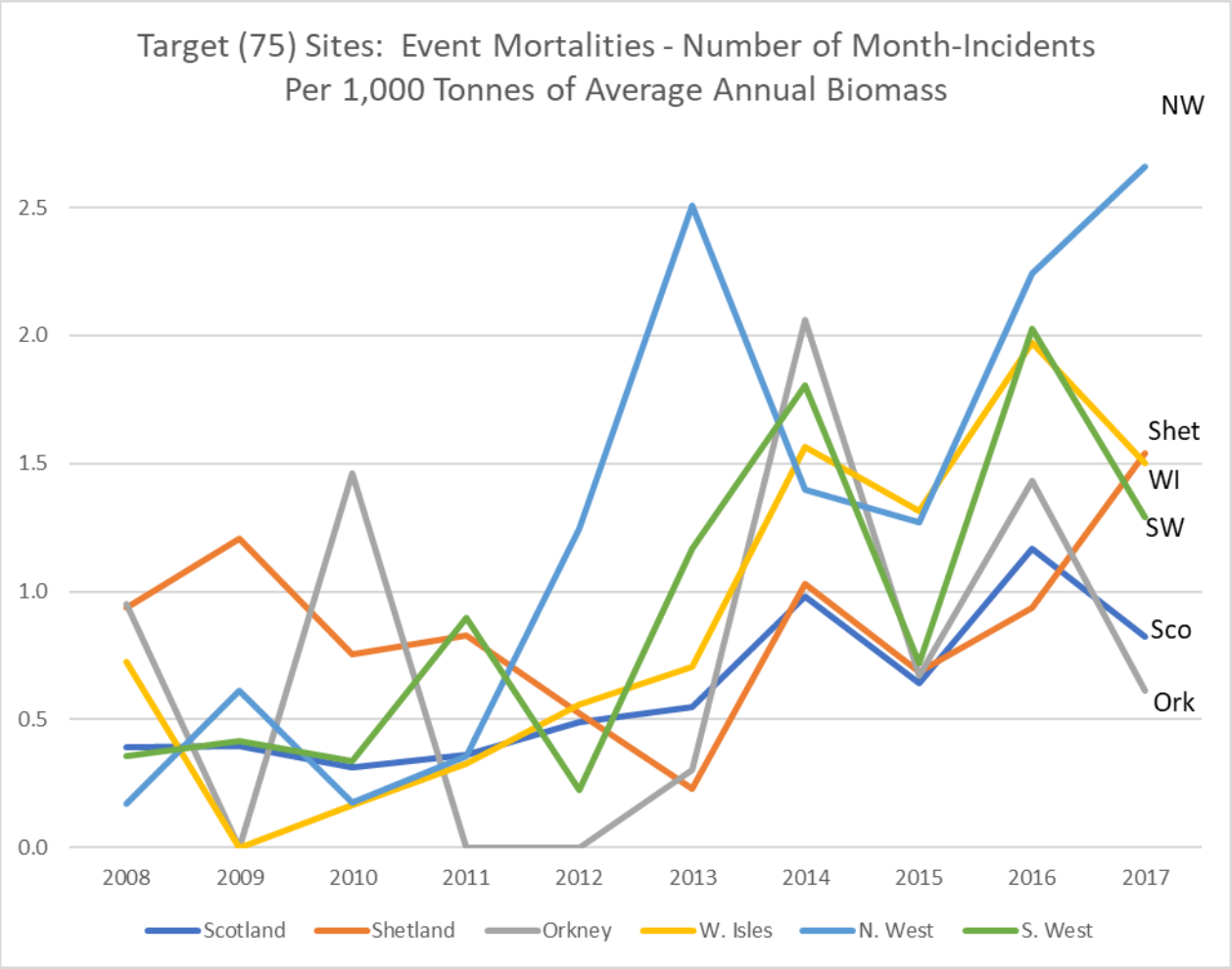

Figure 6. Target sites event mortalities – no. of month-incidents per 1,000 tonnes of ave annual biomass

4. Fish Farm Company Engagement and Views

4.1 Objectives

The overall aim of engaging with the fish farm companies, in face to face meetings, was to understand the following:

- The contingency plans that they use to deal with different scales of mortality events.
- To have their views on what the data is indicating, in terms of the different scales of mortality event and how these change when considered over time.
- To understand their views on which is required in the future to manage different scales of mortality events.

The following eight companies were identified and approached, with the aim of having face to face meetings, to cover the topics above.

- The Scottish Salmon Company
- Cooke Aquaculture Scotland
- Wester Ross Salmon
- Dawnfresh
- Marine Harvest Scotland
- Grieg Seafood
- Loch Duart Ltd
- Scottish Sea Farms

Meetings were held with 7 of the 8 companies above, in the North West, on Orkney and the Shetlands. One company did not respond to the contacts made.

Regional managers were engaged with, giving complete coverage in terms of the five regions of interest. The questions covered in the meetings are shown in Appendix B, covering the following:

- Views on historic mortality data
- How morts are dealt with
- Regional variations
- Waste management infrastructure
- Significance of the scale of events
- Views on managing increasing levels of Event Mortalities
- Contingency plans
- The development of regional infrastructure
- The barriers and opportunities

The results are summarised in the following sections.

4.2 Results

4.2.1 Views on Historic Mortality Data, 2008 to 2017

A summary of the data analysis undertaken, described in Section 3, was presented to the companies prior to discussing the questions. One company commented that although there has been an increase in the tonnage of mortalities recently, measures are/have been taken to reduce these. The expectation is that as a result, these numbers will return to normal (pre 2014 levels). A 5-10% mortality event is large for the industry. 1% is the notifiable level for Marine Scotland.

A different company commented that it did not think that the categories of Event Mortalities used for the analysis were useful as they do not match Marine Scotland (the Fish Health Inspectorate's) reporting criteria (as defined in the Code of Good Practice).

Two companies commented that they did not use percentages as part of their management and planning processes, with another stating that different industry players will have larger or smaller numbers of mortalities according to their practices and the scale of their operations.

In terms of the data itself, after some clarification about the methodology and sample size, there were no comments indicating whether the data was realistic or unrealistic. One company mentioned that in terms of a 40% Event Mortality, the tonnages generated will not occur over a short period of time, usually taking up to six months for this.

Finally, one of the companies believed that it was likely to have lower levels of mortalities of salmon than for the industry as a whole because of the regional conditions and management techniques applied.

4.2.2 How Morts are Dealt with (including Event Mortalities)

All of the companies commented that they are using mainstream hauliers (four specifically named – all engaged with as part of the logistics company consultation) to haul morts from the North West and South West mainland to AD facilities in the central belt (two specific facilities mentioned). It was mentioned that one of the hauliers takes morts to a renderer in the south of the country when AD facilities do not have spare capacity.

One fish farmer indicated that morts generated in the Western Isles are taken to a disposal facility on North Uist. Another, referring to the Western Isles again highlighted the issues of road and ferry infrastructure which can prove to be extremely challenging in removing morts to the mainland. Once there, it was mentioned that road haulage becomes the key consideration.

One company is generating a low enough level of morts to allow it to store them in a storage tank prior to being hauled to the central belt.

Another company is typically ensiling on site, and once this capacity is exceeded, skips are used. In terms of the Northern Isles, morts are hauled and shipped to AD facilities on the mainland, the central belt and north east. This is happening on a routine basis, with one of the companies indicating that it does not have the same challenges as experienced in other regions.

At one site, where mortalities generated are less than 5 tonnes (in a short-medium period) they are incinerated on site.

4.2.3 Regional Variations

Three of the seven companies engaged with only operater in one region, or mainly in one region, and therefore the question is not relevant to them – nothing more is said about these companies in this section.

Of the remaining four companies, one stated that there were variations in how morts were handled, on a regional basis. This company indicated that different methods for the treatment of mortalities were related to the availability of processing infrastructure in one region and the unavailability of this in another region. In the case of the latter, morts are ensiled, in the former they are placed untreated into lorries and transported directly to the nearest biogas plant. The disposal options adopted do no change according to the cause of mortality.

The three remaining companies operating across different regions stated that there were no variations in mort treatment. The comments of two of them are provided below.

One company indicated that rather than regional variations there are differences in how the morts could be used according to the variables that caused the mortality events. For example, there was a jellyfish bloom over 10 years ago which caused an Event Mortality and because the fish were not diseased, a fishmeal manufacturer was able to collect (directly from the pens) the mortalities and use them in their product. This company has raised the question that it would be beneficial to know what the time constraints are for these types of businesses – i.e. do they need to collect within 24/48 hrs? It would also be good to have more firm guidance on how Category 2 waste which is not diseased (e.g. from jellyfish blooms) can be used. This company also pointed out that if there is a jellyfish bloom, there will be protracted mortality, where some of the fish might not die immediately, but will contract other diseases as a result of injuries from the jellyfish. The company also commented that individual sites have blips, which means that there is not a consistent quantity of morts per site/region per annum, which has implications in terms of waste management infrastructure (see below).

Another company commented that the disposal of morts does not seem to change according to the cause of mortality. The level of event will determine disposal methods, apart from the type of disease causing an event, where biosecurity issues might present particular constraints.

4.2.4 Waste Management Infrastructure

Continuing from the final point in the previous section, the same company commented that any new processing facilities targeting morts would need to accommodate the waste of several companies to ensure consistency of supply. This is seen as an opportunity.

A different company had looked at in-house incineration and ensiling but the health and safety issues, costs of employing more personnel, and acknowledgement that it might not be looked upon favourably by their neighbours meant the idea was rejected. The life-span of such a small facility would be short as well. This company commented that the SSE AD facility in the central belt takes all categories of waste which makes it easy for this company. All of their morts use that route, regardless of cause of mortality.

4.2.5 Significance of the Scale of Events

Mortalities above 10% would present significant concerns for one of the companies, with another indicating that it is set up to deal with mortalities up to this level. Another indicated that, generally speaking, it considers the scale of mortalities as follows (for a single event):

- 0-10% - normal
- 10-40% - significant
- 40-100% - mass mortality

The latter company felt that its waste contractor would be able to manage an Event Mortality e.g. up to around 30%, as experienced in 2017, after which alternative arrangements may be required (the service was at full capacity at this point.

A different company commented that in recent years it did have to employ the services of a Norwegian company, for the use of a seagoing vessel, to deal with a significant event that was too large for local infrastructure to manage (at the same point in time that landfill had just stopped as a disposal option). This was not done in collaboration with any other organisations.

4.2.6 Views on Managing Increasing Levels of Event Mortalities

A range of diverse views were expressed in terms of managing increasing levels of Event Mortalities, and these are summarised below:

- Need to develop contingency plans to cope with the increasing size of the industry. Also, government support to grow third party companies that can assist with this.
- Complex gill health is the main issue, but aware that environmental factors outwith their control could result in future mass mortality events
- Production growth plans are being matched by the company's investment in waste disposal capacity (e.g. boats).
- The focus has to be on the development of increased capacity to manage this on the Northern Isles.
- Increased collaboration required with other companies to manage Event Mortalities.
- Focus should be on measures to reduce mortality levels.

One company commented that they were not experiencing increasing levels of Event Mortalities and therefore this issue was not applicable to them.

4.2.7 Contingency Plans

Most of the consultees commented that they had contingency plans in place. One company stated that it has plans for all scales of mortalities, going on to say that it is not a problem to remove morts from pens, however, for island sites they are dependent on ferry services and on the mainland on good transportation options, the lack of which often results in delays. Another explained that the biggest risk is the outbreak of disease.

It was commented, by one of the companies, that they have their contingency plan in place, but it has not had to be put into practice yet. A concern of theirs is what happens if there is a Chile-type/scale event, when the infrastructure might then be overwhelmed - Scot Gov assistance would be needed in this circumstance.

One consultee emphasised that its contingency plan is in place at a national level, rather than there being specific regional plans. Another commented that its plan is to stabilise production level, with the management of morts supported by the development of regional processing infrastructure.

Final comments, from two other companies were:

- Their contingency plans cover everything except transportation to a processing (AD) facility.
- They have protective measures in place, however, their emphasis is on reducing mortality levels.

4.2.7 The Development of Regional Infrastructure

A number of the responses related to the potential of regional infrastructure were similar in nature to those discussed under "Regional Variations" (Section 4.2.3), however for completeness responses under the infrastructure heading are summarised below:

- Need to have regional disposal facilities that can manage all morts within the region. Also, having sites near ports would be positive. Concerns about a dedicated vessel servicing multiple sites, because of biosecurity risks.
- Mortality ship servicing all sites would not be an approach that is welcomed. Regional AD, e.g. in the Inverness area would be positive development.
- Development of regional AD facilities, generally, would be welcomed.
- One company is considering their own biogas facility as a value-added development.
- Another company's preference is for the development of a biodiesel facility, that uses fish morts as a feedstoch and where they can buy back the diesel.
- It is important to have options on the Northern Isles, and to have a facility that can take both Cat 2 and 3 morts. Costs are high here, and there should be a facility able to take both Cat 2 and Cat 3 morts.

4.2.8 The Barriers and Opportunities

One of the consultees stated that it is important to view fish mortalities, although undesirable, as a valuable commodity that can be used beneficially ("as in other countries"). It was stated that government support is needed to improve their recovery.

Three companies indicated that the development of regional AD on the mainland is an opportunity that should be exploited, with one commenting that the way morts are classified is a barrier (in terms of the potential for their recovery).

From a logistics perspective, one company stated that the availability of skips and tankers (transportation infrastructure) is an issue, across the country – that the management/disposal of morts is more difficult than getting morts out of pens.

The unavailability of suitable waste management infrastructure for morts on the Northern Isles was described by a number of companies as a significant barrier and therefore a large business development opportunity. More collaboration is also needed here, including the shipping of morts.

5. Engagement with Processing and Logistics Infrastructure- AD and IVC Facilities

5.1 Objectives

The IVC and AD infrastructure has been examined by engaging all of the operators licensed to manage fish mortalities, with nearly all of the organisations being the same as those engaged with for preparation of the 2016 *"Zero Waste Report - Finfish Mortalities in Scotland"* project.

5.2 Method

A set of questions was developed to guide discussion with operators. Questions looked to update information from the 2015-16 project mentioned above.

Operators of all 10 ABP registered IVC facilities in Scotland were initially contacted by email or telephone, as shown below:

- Billy Bowie
- Dalinlongart, Shanks
- Keenan Recycling
- Levenseat Organics

- Lochgilphead, Shanks
- GP Plantscape
- Gray Composting Services Ltd
- Moleigh, Shanks
- Earnside Energy
- AH Tucker

Short interviews were conducted by telephone with follow up emails to confirm information provided.

All eight ABP registered AD facilities based in Scotland were contacted. In addition, two further facilities in the process of development were included. The companies are shown below:

- Deerdykes
- Energen
- Fife Council
- John Rennie & Sons
- Buchan Biogas
- SSE Generation Ltd
- Earnside Energy
- Western Isles Council
- Edinburgh/Midlothian Councils, Millerhill
- Aberdeen City Council

As well as considering specific issues around fish mortalities, discussions were held around wider fish waste reprocessing. Questions were asked on the following:

- Pasteurisation process
- Facility capacity
- Gate fee
- Current status on acceptance of fish processing waste and fish mortalities and quantities
- Additional fish processing waste and mortalities capacity
- Limitations/concerns of fish waste as a feedstock for specific facilities
- Preference for macerated and ensiled or whole fish mortalities
- Appetite/interest in a regional bulking station

The eighteen operational ABP registered AD and IVC facilities were initially contacted by email/telephone. Short interviews were conducted by telephone or face-to-face meeting with follow up emails to confirm information as required.

5.3 Results

5.3.1 In Vessel Composting (IVC)

A summary of key results can be found in Table 9.

Three of the facilities continue to be operated as PFI contracts. These facilities are restricted from taking commercial wastes both contractually and due to ABP categorisation which is limited to catering waste only. The PFI contracts have seven years still to run after which the facilities are expected to be handed over to the respective councils for operation. Another facility would be interested in taking fish waste as a feedstock as the operators recognise it as a good material to complement other feedstocks. However, there is significant concern about odour from fish waste and therefore reluctance to take this type of feedstock.

There are three other facilities currently take fish processing waste and fish mortalities - an increase on the situation in 2015. Further, one facility has significantly increased its capacity in the intervening period. The facilities all have additional capacity to take fish mortalities.

The Pollution Prevention Control (PPC) limit on storage of untreated waste was raised by one IVC operator as an issue for taking large quantities in a short period of time. Discussion with SEPA indicated that potential isolated fish mass mortality events could be considered as exception to the rule in respect of maximum storage times for untreated material. In such an event, longer storage times may be acceptable as long as controls on odour emission could be upheld either through the nature of the material (e.g. ensiled material with low odour) or additional control measures (e.g. chilling of feedstock onsite).

The remaining two facilities take fish waste with one of these taking fish mortalities and the other is not interested in additional fish waste material.

Of the five facilities currently taking fish mortalities, three of these had a preference for whole fish rather than macerated+ensiled (M+E). The reason for this was due to the comparative ease of handling of whole fish on concrete pads when mixing with other feedstocks.

5.3.2 Anaerobic Digestion (AD)

A summary of key results can be found in Table 10, which shows that there are six operational 'wet' based and two 'dry' based AD facilities in Scotland. One wet facility did not respond to telephone or email requests and so only information known to still be correct from the 2015 project has been left in.

All six wet based facilities are all fully ABP cat 3 facilities (as a minimum) with pasteurisation processes of a minimum 70 °C for 60 minutes. One facility is listed on the ABP register as category 1+2+3, however, the category 1 registration is limited to taking glycerine derived from category 1 material in line with an amendment to the EU ABP implementation regulation (EU No 142/2011).

All five operational 'wet' AD facilities engaging with the project take fish waste with a limit around 25 to 30% of feedstock tonnage being appropriate to maintain reactor health. Three of these facilities have capacity to take additional fish waste (mortalities); however, there is a limit on season for one and limit on batch size for all three. The batch size limit relates in part to PPC permit restrictions for sites designed to minimise odour (as covered in the IVC engagement section).

Contamination of feedstock was not an issue for any operator showing an improvement in the quality of this feedstock from our 2015 engagement.

Several wet AD operators prefer fish waste ensiled – the reason for this is that it can be fed directly into the process rather than needing to be shredded, which has additional handling, the need for bunding and mixing with other wastes to manage. Ensiled waste also reduces odours.

In comparison to the 'wet' facilities, neither of the two operational 'dry' facilities currently accepts fish mortalities. One facility is ABP Cat 3 approved and the challenge for this operator is the balance of feedstocks with limited complementary materials available locally.

The other facility is ABP Category 3 and could take fish waste. The plant is at capacity between May-October generally but there is availability out with this period. As a council facility, however, the focus is on processing the council's own co-mingled organic waste collections and there is no appetite currently to take commercial wastes.

Table 9. ABP registered in vessel composting (IVC) sites in Scotland (correct at time of data collation)

Description	A	B	C	D	E	F	G	H	I	J
Listed ABP	2+3	3CW	3CW	3CW	3	3	3	3CW	3	2+3
Fish waste	Yes	no	no	No	Yes	Yes	Yes	no	Yes	Yes
Fish morts	Yes	no	no	No	Yes	Yes	Yes	no	Yes	No
Fish waste (t/year)	420	0	0	0	Tbc	~7,200	360-840	0	2,080	1,300
Additional morts capacity (t/y)	780-1,040	0	0	0	Yes	500-1,000	120-240[2]	0	Yes	0[3]

Table 10. ABP registered anaerobic digestion (AD) sites in Scotland (correct at time of data collation)

Description	A	B	C	D	E	F	G	H	I	J
Listed ABP*	3	2+3	3	2+3	1+2+3	3	2	2+3	Pending – cat 3	Pending – cat 2
Fish waste	Yes	n/d	No	Yes	Yes	Yes	Yes	No	No	n/a
Fish mortalities	No	n/d	No	No	No	Yes	No	No	No	n/a
Fish waste (t/year)	Not confirmed	n/d	0	5,200	0	6,240-8,320	0-400	n/a	n/a	0
Additional morts capacity (t/y).	3,120	n/d	0	0 – Max output to grid	1,456-4,368	1560	2,500-3,000	~600 (Summer)	Yes	0

6. Engagement with Rendering and Incineration Infrastructure

6.1 Objectives

The objective was to engage, briefly, with a target of 10 organisations providing rendering, incineration and other capability consulted for the 2016 *"Zero Waste Report - Finfish Mortalities in Scotland"* project, as well as to identify whether there are new and additional plant and operators able to add value and capacity.

6.2 Method

A set of questions was developed to guide discussion with operators who were initially contacted by email or telephone. Short interviews were conducted by telephone with follow up emails where required.

The operators of the following ABP registered rendering, biodiesel and processing companies were contacted by email and/or telephone, as shown below:

Scotland

- Dundas Chemicals
- Argent
- Shetland Heat & Power

rUK & Wider

- SecAnim
- Leo Group
- Hordafor

In addition, the following, companies/organisations were engaged with, to understand their plans, and the potential for future management of ABPs (future infrastructure, currently going through procurement, construction or feasibility):

Rendering, Drying etc

- TWMA
- Whiteshore Cockles Ltd

Energy from Waste (EfW)

- MVV/Dundee City Council
- Aberdeen City Council

The following questions were asked:

- Are they able to take fish mortalities with and without notifiable/listed diseases?
- What capacity do they have for each kind of mortality and with what frequency i.e. daily, weekly, monthly?
- What gate fee would they charge?
- Will they take both macerated/ensiled and whole fish? If there are exclusions/restrictions, what are they ad how do these impact on the questions above?
- What conditions would be placed on potential future shipments of mortalities?

6.3 Results

The following table provides a summary of the discussions with organisations, structured as follows:

- A, B and C: Organisations/facilities in Scotland, licensed to process Cat 2 and 3 fish morts.
- D & E: Organisations/facilities in the north of England, licensed to process Cat 2 and 3 fish morts.
- F: Scandinavian company licensed to haul/process Cat 2 and 3 fish morts.
- G, H, I & J, not currently operational:
    - Facility being built, due to be operating in 2018, for Cat 2 & 3 fish morts.
    - Potential facility (under discussion for several years) – Cat 2 and 3 fish morts.
    - Energy from waste facilities under construction or going through the procurement phase, to be licensed for municipal waste only.

Table 11. Summary of rendering and EfW additional capacity per annum

Description	Organisation Reference IDs									
	A	B	C	D	E	F	G	H	I	J
	Rendering	Biodiesel	Heat & Power	Rendering	Heat & Power	Rendering	Biodiesel	Drying (Potential future facility)	Municipal EfW	Municipal EfW
Additional, available, annual capacity for Cat 3 & 2 morts	>21,000 to 25,200 T	1,300 to 2,600 T	0	25,000 to 50,000	30,000	33,380 (Est.)	6,000 T	3,000	2,600 to 5,200 T	TBC
Weekly capacity for morts	500 T	25 – 50 T	0	500 – 1,000 T	250 T		200 – 400 T	112 T	50 to 100 T	TBC
Max. daily capacity	250 – 300 T	3.5 – 7 T	0	250 T	50 T		250 T	16 T	50 T	TBC

Colour Key:

No colour:	Operating currently in Scotland
	Operating currently in rUK
	Scandinavian company
	Not operational yet and/or licened for fish morts

6.4 Key Outcomes

6.4.1 Implications in terms of fish mortalities with and without notifiable/listed diseases?

Issues associated with Cat 2 fish mortalities, as a result of notifiable disease, are discussed in the above-mentioned 2016 report. The ABP registered organisations described above are licensed to accept all Cat 2 and 3 fish mortalities. The rendering and biodiesel production companies are also licensed to accept Cat 1 waste.

6.4.2 Additional Capacity Available

The additional capacity available, and associated with the organisations listed in the previous tables, can be described as follows:

- Facilities in Scotland: Between 22,300 and 27,800 tonnes per annum.
- Facilities in rUK: Between 55,000 and 80,000 tonnes per annum
- Facilities outside UK (Scandinavia): Estimate of 33,800, on the basis of 26 shipments by boat to end-facility, taking 1,300 tonnes per trip.
- Energy from Waste facilities: The following table indicates a potential for 25,173 tonnes of additional capacity, if each of the four facilities (not currently operating – in procurement/construction etc) were able to take fish waste, as a maximum of 3.5% of the feedstock at any time.

Table 12. Breakdown of EfW capacity potential

	POTENTIAL TONNAGE RANGES, EACH FACILITY				
	Dundee EfW *2,600 to 5,200*	Aberdeen EfW *3,544 to 7,090*	Edinburgh Millerhill EfW *3545 to 7,090*	Dunbar EfW *3545 to 7,090*	**TOTAL**
Potential Tonnages (mid-point)	**3,900**	**5,318**	**5,318**	**10,636**	**25,173**

Discussions with the APHA and Scottish Government have not identified mechanisms that would map out a process for municipal EfW facilities to take Cat 2 or 3 fish morts under a derogation. The APHA have indicated that if the EfW facilities have the technical specification to process fish (temperature requirement) then the process should be one that follows a standard methodology. It is understood, though would need confirmation, that the EfW facilities will provide the required level of treatment.

The above does not include the proposed 3,000 tonnes per annum facility that could result on North Uist, which is still in a speculative position at the time of writing. Potential associated with this is, however, referred to later in the document (Section 8), when considering future scenarios and processing capacity.

6.4.3 Gate Fee

Indicative gate fees have been provided by a number of the companies engaged with, and for those where information has been secured, the options described in this report are, on a tonnage basis, appear to be available on a competitive basis. However, the situation, environment and market at the time of a major event could be significantly different.

6.4.4 Conditions placed on potential future shipments of mortalities

Only one company has indicated that its capacity and process would require ensiled fish as a condition for being accepted. The impact of this on the overall capacity is limited.

7 Engagagement with Haulage Sector

7.1 Objectives

The objective was to engage with 5 hauliers consulted for the 2015-16 project to identify whether there was new and additional infrastructure able to add value. 8 companies were actually engaged with, as described later. The company names/details are anonymised with the exception of the ferry companies providing services to the Hebridean islands and Northern Isles.

7.2 Methodology

Questions were developed to guide discussions with the operators:

- What are the constraints and opportunities that they have in terms of capacity to haul mortalities?
- How responsive can they be, in terms of timescales, to remove and move mortalities?
- What suggestions could they make, in terms of improving the logistics of storing and hauling Event Mortalities?
- What alternative opportunities for storing, hauling and processing Event Mortalities are they aware of?

7.3 Results

The results of the engagement are provided in a summary form table over the page, with more detailed comments provided in the section after this. The companies are anonymised, with the exception of the ferry operators, who are sole operators for the regions involved.

Table 13. Summary of results from engagement with hauliers

Site name	Company One, Calmac	Company 2, NorthLink Ferries	Company Three	Company Four	Company Five	Company Six	Company Seven	Company Eight
Potential Operation Range	West Coast - Hebrides	Northern Isles	All Scotland	All Scotland,	All Scotland	All Scotland	All Scotland	Mostly W. Isles
Fish mort operation?	Yes, as part of mainstream sailings.	Yes, as part of freight sailings only.	Yes	No	Yes	Yes	Yes	No.
If not, interested in fish mort haulage?	n/a	n/a	n/a	Yes. Have boats with significant capacity	n/a	n/a	n/a	Yes, incl. bulk storage opportunity
Destination of morts	Central belt	North East & Central Belt	Central belt and south west	N/A	Norway	Central belt	Central belt & south west	n/a
Land haulage capacity								
100 T	n/a	n/a	0.5 days	n/a	2 days	1 – 2 days	1 day	1 – 2 days
1,000 T	n/a	n/a	2 – 3 days	n/a		4 weeks	10 days	1 – 2 weeks
Marine haul tonnage capacity:								
100 T	See next section	See next section	2 days sailing, 1 vessel	2 days sailing, 1 vessel	Likely to be too small to be economic	n/a	n/a	n/a
1,000 T			2 days sailing, 3 vessels to match this capacity	2 days sailing, 3 vessels to match this capacity	2 days sailing to match this capacity	n/a	n/a	n/a
Interest in Regional Bulk Storage	n/a	n/a	Yes, at multiple locations	Never considered	Available already through vessel capacity, inc. ensiling.	Never considered	No	Yes, in Stornoway

7.4 Constraints and opportunities in terms of capacity to haul mortalities

7.4.1 Ferries

Northern Isles

Ferry restrictions for the Western Isles and Northern Isles were identified by the fish farm companies as a constraint in terms of how able they are to quickly and efficiently have morts managed.

Northlink Ferries only allow fish mortalities to be hauled on freight ferries, which can carry 65 trailers, and which in turn have a maximum capacity of circa 25 tonnes each. This means that these ferries can carry 1,625 tonnes of freight. However, there are restrictions, as summarised as follows:

- Vehicles with tarpaulin-covered tops (i.e. unsealed) are allowed to only carry a maximum of 15 tonnes of fish morts, treated with lime (to stabilise and alter viscosity) to avoid spillage during voyages.
- The number of trailers/vehicles able to be ferried off the island is dependent on the space available, which is significantly reduced for the peak seasons. The off-peak and peak seasons are described below:
  - Off-peak: Period 1 to 5 (Jan to May inclusive)
  - Peak: Periods 6 to 8; 11 to 12 (June to Aug; Nov & Dec)
  - Peak livestock: Periods 9 & 10 (Sep and Oct)

Period 11 and 12 is a peak period because of the festive season and the increase in consumption/demand for salmon. As a result, in terms of freight utilization of the available capacity during the above periods, indicatively these are:

- Off-peak: 50% full capacity
- Peak period: 75% full capacity
- Peak period - livestock: 80 to 90% full capacity

The number of sailings associated with each of the above are:

- Off-peak: 3 southbound departures per week to Aberdeen, one southbound to Aberdeen via Orkney.
- Peak: 5 southbound departures from Shetland per week, 3 from Orkney

“Off-peak” is where there is most scope for additional freight movements. There could be two additional sailings per week from Shetland, with one additional sailing per week from Orkney in the off-peak season.

During the peak livestock season there would be zero/negligible additional capacity. In the peak season there could be one additional sailing from Shetland via Orkney to Aberdeen. However, it should be noted that salmon processed for human consumption is one of the main freight items on the dedicated freight ferries and if there are large mortality events then there is less movement of product, therefore more capacity for moving mortalities.

Information from NorthLink is summarised in the table below.

Table 14. Salmon product & fish waste moved on NorthLink ferries – from Northern Isles in 2017

Item	Tonnage	Comments
Salmon, human consumption	58,445	NorthLink data
Seafood Waste	9,431	NorthLink Data
Total	**67,876**	

The NorthLink data can be compared with the data in following table, as stated elsewhere in this report.

Table 15. Tonnages of salmon product and fish waste move on NorthLink ferries from the Northern Isles in 2017

Item	Tonnage	Source
Salmon production	52,900	Production Survey data
Mortalities	8,529	SEPA monthly return data
Total	**61,429**	

Significant Event Mortalites impacting the Northern Isles would reduce the tonnage of salmon for human consumption being shipped. This would create space on the ferries for the movement of mortalities. Contingency planning should incorporate an agreed position and strategy to allow for a managed approach where capacity is stretched.

Pentland Ferries also carry freight and would be able to provide capacity across the Pentland Firth, between Orkney and the mainland. The challenge would be most significant during peak periods, which coincide with the time of the year that mortalities have historically been highest. NorthLink Ferries also operate a service across the Pentland Firth, between Stromness and Scrabster, but that the same restrictions apply on the passenger vessel on this route as from Lerwick and Kirkwall

Hebrides

There is an increasing challenge now, particularly in summer, with respect to accessing timetabled ferries, with visitor numbers reducing the places/space available for freight.

The use of sealed tankers avoids issues with leakages, which can result from using vehicles with unsealed containers. For Event Mortalities, there will be a need for haulage capacity which exceeds that available with tankers.

Calmac has been providing a night ferry service for the MOD when required, and this is a model which may work best for situations involving significant levels of mortalities. The MOD typically provide 8 weeks' notice when there is a requirement for a night ferry, with a new crew taking over after the normal/timetabled service is finished.

The potential to charter boats from Calmac is summarised below:

- Stornoway-Ullapool- Loch seaforth- 24hour operation- no capacity for chartering
- Uig Triangle- Hebrides-deadweight 624T -available to charter
- Lochboisdale- Mallaig- Lord of the Islea-deadweight- 389T-available to charter
- Barra- Oban- Isle of Lewis- DW-787T-available to charter
- Coll Tiree Colonsay- Clansman-DW- 644T-available to charter
- Oban Craignure-Isle of Mull-460T-available to charter
- Islay- Kennacraig- Finlaggan 750T-available to charter

In terms of the minimum time-period to mobilise a night ferry for fish morts collections a key factor is that Calmac would be likely to have to provide an additional crew due to the length of working days. As an estimate 1 week may be a workable notice period. The cost of a night ferry will be based on vessel costs, crew requirement, fuel and harbour dues.

7.4.2 Seagoing capacity to service the farms

Marine capacity is provided by a range of third parties to the fish farm companies, three of which have been engaged with in this project.

One of these is currently active in terms of fish morts movements, with vessels going out to all regions of the country. In terms of their capacity, an example of this is that if there was a 1,000 tonne incident on the Western Isles they would be on-site and removing the morts within 48 hours of the commercials being agreed. In terms of the Shetlands, it is a 36 hour sail from the mainland base. The company has developed a system that allows tankers to be loaded onto marine vessels, with morts taken directly from pens, dewatered and placed into the tanker (on the vessel, at the pen). They can process 12 tonnes per hour this way, with tankers having a 20 tonne capacity. The company will, in 2018, have six such tanker systems in place.

Another company, with significant capacity in terms of marine vessels, is currently focussed on harvesting healthy fish, however, could provide morts management capacity when/if requested by clients, or in response to a major incident.

The company based in Norway can be on site anywhere in Scotland within 48 hours of the commercial aspects being concluded, and will be able to take fish in any condition. The capacity of their vessels exceed 1,000 tonnes, and therefore costs can be considered from this perspective.

7.4.3 Land haulage from the quayside

One of the companies engaged with has 70 tractor units with a number of rigid vehicles and has new, modular tankers that can go onto seagoing vessels, straight to the pens, mitigating against smell issues, and using a clam-shell grab can take salmon directly out of the pens. These tankers hold 20 tonnes (24,000 litre capacity), they have two operating now, with another four on order. They can manage 12 tonnes per hour, which compares to 12 tonnes per day at many sites. In terms of their skip capacity these are 4-6 tonnes and 10-12 tonnes. For future large events, it was commented that a development which would greatly assist their effectiveness would be the potential to operate over 24 hours.

Companies were asked if they were still hauling morts to the same facilities identified in the 2016 Zero Waste Report – Finfish Mortalities in Scotland, when a significant tonnage was hauled to a facility in England. One of the significant suppliers to this facility commented that this has changed significantly, with virtually all of the morts collected now going to the four AD facilities in the central belt of Scotland (e.g. SSE, Bin Farm, Deerdykes and Energen). This company continues to service the whole of Scotland. In terms of their capacity for dealing with Event Mortalities, the example of an event in Lewis and Harris in 2017 was highlighted, where they had tankers (do not use skips) taking three loads (sometimes four) of morts per week. In terms of the tonnages of fish that such tankers haul, these were described as being in the range:

- Macerated – 20 to 25 tonne payloads
- Whole fish (4 or 5 Kg) – 15 to 18 tonnes.

Tankers with a 6-inch diameter suction hose are able to take ensiled and whole salmon (most common), doing so as follows:

- Top loading boom system
- Goes straight over tub/IBC, if there is access to do so on the site
- Sucks from either the tubs or IBCs

This company is currently operating one vehicle per week at the moment for fish morts. Using the example of a 1,000-tonne mortality event, this would require 60 uplifts in a month. i.e. 2 loads per day. They could gear up for this without any issues, with their challenge being the logistics at the receiving sites (processors). An example was given in terms of one processor, which is only allowed to receive fish mortalities in the evening because of the risk of odours, and proximity to housing. The ferries need some planning which, although an issue, they have been able to work around capacity/availability issues to date. Ferries become more of an issue in summer, because of increasing numbers of tourist. As a result, the later ferries to the Western Isles are a more practical option. These tend to be quieter, and then allow the tankers to be at the site first thing next morning. A shunting vehicle can assist to reduce space on the ferries, with only the trailer/tanker being shunted on, then moved off at the other end. In terms of response times, fish farm companies will get in touch and enquire about the potential to be on

site in 4 to 5 days' time, and this is a timescale which is no problem to them. For a mass event, with more pressure, they can respond much quicker.

Another company commented that it provides a service throughout Scotland. In the case of an Event Mortality, the majority of fish are whole, rather than ensiled (ensiling capacity is exceded), for which they have 30 specially sealed skips that can be used. The skips have a total capacity of 420 tonnes i.e. 14 tonnes each. They also have 7 air mover suction tankers, which hold 10-16 tonnes each. Whilst their infrastructure is typically in use, they can react quickly to an emergency and redirect. The company indicated that it could realistically manage approximately 100 tonnes per day. So an incident involving 1,000 tonnes could be managed across 10 days, or 50 days for 5,000 tonnes – their experience is that they can transport the fish as fast as the fish farms could get them out of the water. If the fish were ensiled, they also have a further 120 tankers capable of dealing with this (the tankers have between a 15 – 30 tonne individual capacity). With regards to times, if the event happened south of Fort William, they could probably pick up and transport morts to the end destination within 24 hours, which is typically in Dumfries & Galloway. If further north than Fort William this would become 48 hours. If a major event occurred on the Western Isles, Shetland or Orkney, they would be able to provide a service, but would be more reliant on getting booked on to a ferry. For large tonnages there may be a need for government support with this. They would anticipate a 3 day turnaround for individual vehicles in this circumstance (ferry permitting). They can take fish in any condition – this would not pose problems logistically (although it was acknowledged that it would be an odour problem for the farms). It was mentioned that a significant way of assisting with a future major event would be if the Scottish Government relaxed drivers' working hours and how this is enforced from legislation. If there was the abliity to drive for longer periods to get the fish to the end destination they would be able to respond more effectively. It was commented that with emergencies for Scottish Water recently drivers were able to ignore the tackograph legislation for 24 hours (provided they could still drive safely). They understand that the Scottish Government has the power to relax this for a stated period of time, e.g. to support industry.

Additional Information

Two further companies, engaged with in this project initially from the perspective of understanding their processing capacity, would be able to provide suitable, licensed logistics capacity to move tens of thousands of tonnes of fish morts by land, if required. One of these has a haulage fleet consisting of 150 trailers, 100 articulated lorries, 1,000 roll-on/off skips and 7 tankers. The other has a significant haulage fleet based in England which could be mobilised if a significant mortality event arose.

Another company, operating on the Western Isles has a significant haulage capacity and storage infrastructure. They do provide services to the aquaculture industry, but do not haul or store morts. They would be interested in providing this service if customers enquired about it and/or there was a need for it.

7.4.4 Regional Bulk Storage

One of the hauliers engaged has never considered bulk storage, in any regions, and were not sure if this was a viable option or not – capital cost implications. Another company indicated that regional bulking facilities were not their preferred way forward, because it would involve double handling and increase the costs. Their preference would be to get the fish to the end destination where they could be treated.

One haulier has strongly advocated for the development of regional, bulk storage infrastrucuture, for example able to hold 1,000 tonnes of morts. There could be merits in having 5 such sites, although the company has identified three preferences, on the mainland, in terms of Argyll, Mallaig and Kishorn. Another haulier, not currently servicing fish farm mortalities, expressed its interest in providing bulk storage on the Western Isles and using existing facilities/sheds would, if there was demand, be able to set up facilitie to store circa 155 tonnes of fish morts (if approved to do so).

Another company which is both a processor and haulier would be very much supportive of efforts to develop regional bulk storage infrastructure, a development which it believes would support more sustainable waste management and cost effective haulage movements.

It was commented that there are many occasions when loads of three or four tonnes are moved hundreds of miles, which must result in extremely high costs to the fish farm companies.

As indicated previously, a number of fish farm companies expressed their support for the development of regional infrastructure, although this has tended to be associated with added value processing, such as anaerobic digestion or biodiesel production.

8. Assessment of the Quantitative and Qualitative Datasets

8.1 Overview

The stakeholderholder engagement work that has focussed on processing capacity is combined with the data analysis in terms of the tonnages of morts arisings. The total mortality level for 2017 was 25,737 tonnes, as stated at the beginning of this report. With landfill banned, it is assumed that this therefore represents the tonnage of morts processed by infrastructure across Scotland and the rUK. This is referent to as the "Current Processing Baseline" in the tables and following sub-sections.

This report provides contingency planning outputs on the basis of the different levels of mortality, indicating how logistics and processing infrastructure can be employed to provide effective management options. However,this section specifically presents data on the basis of the following:

- Mortality tonnages are shown for Levels 1 to 5, for Scotland, on the basis of 2017 data - then increased by 30% and 50% to match potential growth in the aquaculture sector up to 2030.
- The capacity of different types of processing infrastructure is compared against the mortality levels, indicating the extent to which different processes/technologies are able to provide a solution for different scales of event in the future.

The mid-points of Levels 1 to 4 are used, while Level 5 is used at 100%, to show representative tonnages against which the processing capacities can be compared.

8.2 Results on Processing Capacity and Growth

The results of the above are summarised in the following four tables, which provide processing capacities on the basis of different growth rates to manage level 1 to 5 mortalities for:

- Scotland, rUK and wider afield (e.g. Scandinavian countries)
- Scotland and rUK
- Scotland
- Scotland + POTENTIAL processing capacities

The potential processing capacities referred to above are the following:

- Future municipal EfW facilities, currently going through procurement/build phases, without licences or intent to manage fish mortalities, but which would have the technical ability to process such waste.
- A planned biodiesel facility being built on Shetland.
- A potential drying facility being discussed for North Uist, Western Isles

It should be noted that apart from the AD facility on Lewis (with additional 2,750 tonnes of capacity), and the small Heat Energy & Power plant in Lerwick, with circa 1,000 tonnes of capacity (no further capacity for fish morts) there is currently no more installed, licensed processing infrastructure at a regional level in Scotland (in terms of how regions are defined within the aquaculture industry).

For the following tables and analysis it should be noted that it was assumed that the level of fish morts generated in 2017 was approximately the same as the capacity of the processing sector in Scotland to manage this – 25,737. (This may be an over-estimate since there have been movements of morts to locations/facilities which are not processing in Scotland.)

Table 16. Scotland, rUK and wider processing capacities, including future, potential capacity, on basis of different growth rates to manage Level 1 to 5 mortality events

Year and Mortality Levels	Tonnages of mortalities	ADDITIONAL CAPACITY AND SHORTFALL/EXCESS (TONNES)					
		CURRENT PROCESSING BASELINE	IVC	AD	Render / Biodiesel	Municipal EfW	TOTAL SHORTFALL / EXCESS
2017							
Level 1 (8%)	15,220						**183,824**
Level 2 (15%)	30,441						**168,604**
Level 3 (30%)	60,882	25,737	1,843	10,942	135,350	25,173	**138,163**
Level 4 (70%)	142,057						**56,987**
Level 5 (100%)	202,939						**-3,894**
2030, 30% growth							
Level 1 (8%)	19,787						**179,258**
Level 2 (15%)	39,573						**159,472**
Level 3 (30%)	79,146	25,737	1,843	10,942	135,350	25,173	**119,899**
Level 4 (70%)	184,674						**14,370**
Level 5 (100%)	263,821						**-64,776**
2030, 50% growth							
Level 1 (8%)	22,831						**176,214**
Level 2 (15%)	45,661						**153,383**
Level 3 (30%)	91,323	25,737	1,843	10,942	135,350	25,173	**107,722**
Level 4 (70%)	213,086						**-14,041**
Level 5 (100%)	304,409						**-105,364**

Table 17. Scotland ONLY, Licensed + *POTENTIAL processing capacities on basis of different growth rates to manage Level 1 to 5 mortality events

Year and Mortality Levels	Tonnages of mortalities	BALANCE ON A TECHNOLOGY BY TECHNOLOGY BASIS - ADDITIONAL CAPACITY THAT CAN BE UTILISED PLUS POTENTIAL FUTURE CAPACITY (TONNES)					
		CURRENT PROCESSING BASELINE	IVC	AD	Render / Biodiesel	Municipal EfW	TOTAL
2017							
Level 1 (8%)	15,220						**82,524**
Level 2 (15%)	30,441						**67,304**
Level 3 (30%)	60,882	25,737	1,843	10,942	34,050	25,173	**36,863**
Level 4 (70%)	142,057						**-44,313**
Level 5 (100%)	202,939						**-105,194**
2030, 30% growth							
Level 1 (8%)	19,787						**77,958**
Level 2 (15%)	39,573						**58,172**
Level 3 (30%)	79,146	25,737	1,843	10,942	34,050	25,173	**18,599**
Level 4 (70%)	184,674						**-86,930**
Level 5 (100%)	263,821						**-166,076**
2030, 50% growth							
Level 1 (8%)	22,831						**74,914**
Level 2 (15%)	45,661						**52,083**
Level 3 (30%)	91,323	25,737	1,843	10,942	34,050	25,173	**6,422**
Level 4 (70%)	213,086						**-115,341**
Level 5 (100%)	304,409						**-206,664**

Table 18. Licensed Scotland, rUK and wider processing capacities, on basis of different growth rates to manage Level 1 to 5 mortality events

Year and Mortality Levels	Tonnages of mortalities	ADDITIONAL CAPACITY AND SHORTFALL/EXCESS PER ANNUM (TONNES)					
		CURRENT PROCESSING BASELINE	IVC	AD	Render / Biodiesel	Municipal EfW	TOTAL SHORTFALL / EXCESS
2017							
Level 1 (8%)	15,220						**149,652**
Level 2 (15%)	30,441						**134,431**
Level 3 (30%)	60,882	25,737	1,843	10,942	126,350	0	**103,990**
Level 4 (70%)	142,057						**22,815**
Level 5 (100%)	202,939						**-38,067**
2030, 30% growth							
Level 1 (8%)	19,787						**145,085**
Level 2 (15%)	39,573						**125,299**
Level 3 (30%)	79,146	25,737	1,843	10,942	126,350	0	**85,726**
Level 4 (70%)	184,674						**-19,802**
Level 5 (100%)	263,821						**-98,949**
2030, 50% growth							
Level 1 (8%)	22,831						**142,041**
Level 2 (15%)	45,661						**119,211**
Level 3 (30%)	91,323	25,737	1,843	10,942	126,350	0	**73,549**
Level 4 (70%)	213,086						**-48,214**
Level 5 (100%)	304,409						**-139,537**

Table 19. Licensed Scotland ONLY processing capacities on basis of different growth rates to manage Level 1 to 5 mortality events

Year and Mortality Levels	Tonnages of mortalities	ADDITIONAL CAPACITY AND SHORTFALL/EXCESS PER ANNUM (TONNES)					
		CURRENT PROCESSING BASELINE	IVC	AD	Render / Biodiesel	Municipal EfW	TOTAL SHORTFALL / EXCESS
2017							
Level 1 (8%)	15,220						**48,352**
Level 2 (15%)	30,441						**33,131**
Level 3 (30%)	60,882	25,737	1,843	10,942	25,050	0	**2,690**
Level 4 (70%)	142,057						**-78,485**
Level 5 (100%)	202,939						**-139,367**
2030, 30% growth							
Level 1 (8%)	19,787						**43,785**
Level 2 (15%)	39,573						**23,999**
Level 3 (30%)	79,146	25,737	1,843	10,942	25,050	0	**-15,574**
Level 4 (70%)	184,674						**-121,102**
Level 5 (100%)	263,821						**-200,249**
2030, 50% growth							
Level 1 (8%)	22,831						**40,741**
Level 2 (15%)	45,661						**17,911**
Level 3 (30%)	91,323	25,737	1,843	10,942	25,050	0	**-27,751**
Level 4 (70%)	213,086						**-149,514**
Level 5 (100%)	304,409						**-240,837**

8.3 The National Picture

8.3.1 Scotland, rUK and wider afield (e.g. Scandinavian countries)

Table 18 indicates that there is sufficient capacity, using currently ***licensed*** facilities, to deal with Level 1 to 4 Event Mortalities on the basis of 2017 levels of production. This is also the case for the scenario where there is growth in production of 30%. With 50% growth the capacity is sufficient for Level 1 to 3 events.

Table 16 indicates that, adding ***potential*** future processing infrastructure to the licensed facilities above will give options in terms of capacity to manage and process a 100% Event Mortality (Level 5), - on the basis of 2017 production/mortality tonnages. This additional capacity is described in Section 0 of this report. As a total, these provide the potential for managing just under 200,000 tonnes per annum, 3,989 tonnes short of the Level 5 total. It is highly likely that the shortfall could be met by the processors identified, or with others on continental Europe. (e.g. the 2016 "Zero Waste Report – Finfish Mortalities in Scotland" report highlighted a suitable AD facility in Denmark and there has been subsequent interest expressed by a Danish AD operator in taking fish morts from Scotland).

Considering the licensed plus potential infrastructure, if mortalities continue apace with production up to 2030, growth levels of 30% and 50% would mean that there would be shortfalls in capacity for a Level 5 Event Mortality. e.g. 64,776 tonnes for 30% and 105,364 tonnes for 50% growth.

8.3.2 Scotland Only

Table 17 includes Licensed plus ***potential*** processing capacity. To recap, the table shows the mid point for the different Event Mortality levels, with the range for Level 3 being 20 to 40%. For the upper range the tonnage of morts significantly exceeds the current (2017) licensed + potential capacity as indicated. The position then worsens significantly when production growth rates of 30% and 50% are considered.

9. Assessment of the Information in Relation to Notifiable Diseases

9.1 Overview

The Code of Good Practice[5], with respect to Managing Mortalities and Disease, describes key areas to considered, in terms of:

- Hazard Analysis Critical Control Points
- Guidelines for Veterinary Health Plan (VHP) and Biosecurity Plan for Fish Health
- Disinfection Procedures
- Minimising Risks in Wellboat Operations
- National Strategy for Sea Lice Treatment Control
- Procedures and Standards for Holding Facilities
- Legislation

Various chapters of the Code refer to thresholds for mortalities, and with respect to Seawater Lochs (Chapter 4) describe the level of fish mortalities, where exceeding the threshold(s), shown below, this should be notified to Marine Scotland's Fish Health Inspectorate and the veterinary surgeon who has the fish under his/her care. An example of how this is defined is shown in the following table.

[5] SSPO, 2015, "Code of Good Practice". Web source: http://scottishsalmon.co.uk/cogp/

Table 20. Extract from the Code of Good Practice showing the thresholds for notification

Ave. Weight (g)	Max. weekly mortality (%)	Max. 5-week rolling mortality (%)
Under 750	1.5	6
750+	1	4

Annex 3 of the Code, "Risk Assessment Protocol for Fish Health" provides information on the general management procedures, disease control measures, biosecurity, monitoring, recording and control, probability of disease establishment, and consequences (following an assessment process) – the latter in terms of high, moderate, low or negligible significance. The risk evaluation matrix then allows this to be understood with some clarity.

In the disinfection guide (Version IV) the Code describes how, during harvesting, there is a:

> *"high risk of spread of disease associated with the slaughter of farmed fish. Containment of fish and fish products, including blood, is recommended at all on-site slaughtering operations and is mandatory at sites within a Control or Surveillance Zone for a List I or List II notifiable disease."*

In terms of managing mortalities, with regards to processing, ensiling is described as:

> *"inactivating ISA virus and many other fish pathogens, however does not, for example inactivate Infectious Pancreatic Necrosis (IPN) virus. Consequently, ensiled waste should not be regarded as free from risk with respect to disease transmission."*

In the disinfection guide, the following is stated with regards to the disposal of dead fish (Section 6):

> *"Subject to safe operating conditions, mortalities should be removed on a daily basis and should be disposed of by an approved method in accordance with Regulation (EC) 1774/2002. Local authorities have responsibility for waste disposal."*

The risk evaluation matrix shown below is extracted from the Code of Good Practice (Annex on Risk Assessment), with evaluation to be performed in respect of the major categories of commercially significant diseases of Scottish salmon (Amoebic Gill Disease, Viral myopathies [pancreas disease, cardiomyopathy syndrome and heart and skeletal muscle inflammation] and bacterial diseases).

Table 21. Extract from the Code of Good Practice annex - risk evaluation matrix

		Significance of Consequences →			
		Negligible (N)	Low (L)	Moderate (M)	High (H)
Probability of Establishment ↑	High (H)	Yes	No	No	No
	Moderate (M)	Yes	No	No	No
	Low (L)	Yes	Yes	No	No
	Very Low (VL)	Yes	Yes	Yes/No	No
	Negligible (N)	Yes	Yes	Yes	Yes

For information, the meanings of Yes/No used in the table are:

- Yes = the risk is acceptable.
- No = the risk is unacceptable and should not be taken without further risk management.
- The terms used to describe the probability of an event occurring can be explained as follows:
- High: Event would be expected to occur
- Moderate: There is a less than even chance of the event occurring

- Low: Event would occur occasionally
- Very Low: Event would occur very rarely
- Negligible: Chance of event occurring is so small it can be ignored.

Box 3 of the Code's Annex on risk assessment describes the significance of consequences, for example moderate consequences would be those:

> *"Associated with diseases that have less pronounced biological effects. Such effects may harm economic performance at an enterprise/regional level. These diseases may be amenable to control measures at a significant cost, or their effects may be temporary. They may affect the environment, but such harm would not be irreversible."*

In defining how future contingency plans would have managed historical events, we consider the risk assessment methodology described above and articulate the level of risk, along with proposed mitigation measures.

9.2 Notifiable Disease

Salmonids are susceptible to the following UK notifiable diseases :

- Bacterial Kidney Disease (BKD)
- Gyrodactylosis due to Gyrodactylus salaris
- Infectious Haematopoeitic Necrosis (IHN)
- Infectious Salmon Anaemia (ISA)
- Viral Haemorrhagic Septicaemia (VHS)
- Epizootic haematopoietic necrosis (EHN)

Government controls on Notifiable Diseases range from control of movement of fish and equipment (BKD) to compulsory slaughter (ISA). The currently notifiable diseases that have been identified in seawater in Scottish Aquaculture since 2009 are BKD, ISA and VHS.

ISA is a viral disease which has occurred on 2 occasions in Scotland (1998/99 and 2008/09). Estimated cost to industry of the first outbreak was £30 million. The mortality rates of infected salmon are highly variable, ranging from 2 to 50 per cent over a single production cycle. Infected farms in Scotland are subject to compulsory slaughter orders in order to eradicate the disease. Strict movement controls are applied to suspect farms. Farms in the vicinity of an outbreak are placed under surveillance. In Shetland in 2009 (Shetland Times) it was estimated that £20 million was lost from the Shetland salmon farming's value through control of the disease. The main costs were associated with culling of fish and prolonged fallowing of sites.

BKD is a chronic bacterial disease of low prevalence in trout and salmon farms in Scotland. It can occur throughout the year but is more often associated with increasing water temperatures in the spring. 12 cases of BKD were recorded in the period 2009 to 2016 (the date of the last recorded case). 8 out of the 12 recorded cases occurred between the months of April and June. BKD has a significant impact on cultured salmonids with chronic losses ranging from 5–40%. Fish can carry the bacterium from freshwater to the marine phase with latent infection emerging months after seawater transfer. Stressful conditions may increase the rate of mortality.

Viral Haemorrhagic Septicaemia (VHS) historically occurs in farmed rainbow trout in freshwater in Europe, but outbreaks have been recorded in the marine environment in farmed turbot in Scotland and mainland Europe. The presence of VHS virus was confirmed, in wrasse used as cleaner fish at six aquaculture sites in Shetland in 2012/2013. Atlantic salmon are not listed as a species susceptible to the disease and all Atlantic salmon populations tested negative for VHS at the affected marine pen aquaculture sites.

9.3 Disease Risk

The main diseases in seawater production of salmon in Scotland have been assessed as to their likelihood of occurrence. Likelihood of occurrence has been judged as ranging from negligible to high.

Bacterial diseases have been grouped together, recognising similar likelihood of occurrence, apart from SRS (Salmonid Rickettsial Septicaemia) and Furunculosis which in recent times has been less prevalent. The use of vaccination has significantly reduced the likelihood of occurrence in the case of Furunculosis, Infectious Pancreatic Necrosis and Pancreas Disease.

Recognising that disease alone is not the sole cause of fish mortality, the causes of mortality including disease and other factors have been listed along with the significance of the consequences of the disease. The consequences have been judged as ranging from negligible to high.

The terms under which likelihood of occurrence and significance of consequences have been applied are listed in the tables below.

Table 22. Descriptions of likelihoods of occurrences

Term	Likelihood of Occurence
HIGH	Disease or event would be expected to occur
MODERATE	There is a less than even chance of disease or event occurring
LOW	Disease or event would occur occasionally
NEGLIGIBLE	Disease or event is unlikely to occur or occur very rarely

Table 23. Description of significance of consequences

Term	Significance of consequences
HIGH	Associated with fish pathogens that would have serious biological effects (high mortality or morbidity). Such effects would be expected to be felt for a prolonged period and would not be amenable to control measures. Such diseases would be expected to result in significant economic losses or may cause serious harm to the environment
MODERATE	Associated with diseases that have less pronounced biological effects. The diseases may be amenable to control measures at a significant cost or their effects may be temporary. They may affect the environment, but such harm would not be irreversible
LOW	Associated with diseases that have mild biological effects and would normally be amenable to control measures. Effects on the environment would be minor or temporary
NEGLIGIBLE	Associated with diseases that have no significant or only transient biological effect. Such diseases may be readily amenable to control measures. Effects on the environment would be insignificant

The categories of disease are listed in the following table, with the likelihood of occurrence indicated. It should be noted that the colour-scheme used for emphasis is chosen to correspond with the Lind et al, 2015[6], matrix referred to in detail later.

Table 24. Main diseases in seawater production and their likelihood of occurrence

Disease	Likelihood of Occurrence				Comment
	High	Moderate	Low	Negligible	
Sea Lice					
Amoebic Gill Disease (AGD)					
Complex Gill Disease (CGD)					
Pancreas Disease virus (PDV)			Vaccinated		Likelihood of occurrence has been significantly reduced through widespread use of vaccine
Infectious Pancreatic Necrosis virus (IPNV)				Vaccinated	Likelihood of occurrence has been significantly reduced through widespread use of vaccine
Heart Skeletal Muscle Inflammation (HSMI)					
Cardiomyopathy Syndrome (CMS)					
Infectious Salmon Anaemia virus (ISAV)					On a national level across the period of the report clinical ISA has occurred infrequently.
Bacterial Infection (e.g. Aeromonas; Moritella; Pasteurella; Piscirikettsia; Renibacterium; Tenacibaculum; Vibrio; Yersinia)					

[6] [6] Lind CE, Dana GV, Perera RP and Phillips MJ. 2015. Risk analysis in aquaculture: A step-by-step introduction with worked examples. WorldFish, Penang, Malaysia. Manual: 2015-08.

Table 25. Causes of mortality and the significance of their consequence

Mortality Cause	Significance of Consequences	Comment
Sea lice and sea lice treatment	Moderate	Sea lice treatment can be a significant cause of mortality, due to losses associated with the handling of fish. Mortality associated with parasitic infection are not as significant.
Amoebic Gill Disease (AGD) & AGD treatment	Moderate	The outcome of any gill disease is an impact on a fish's respiratory capacity. Fish with a reduced respiratory capacity are more likely to die during treatment handling
Complex Gill Disease	Moderate	
Pancreas Disease Virus (PDV)	Low	Widespread use of PD vaccine has reduced the consequences of clinical PD
Infectious Pancreatic Necrosis Virus (IPNV)	Negligible	Widespread use of IPN vaccine has significantly reduced the consequences of clinical IPN
Heart Skeletal Muscle Inflammation (HSMI)	Low	Increasing significance on a local level, but on a national level scores 'Low'
Cardiomyopathy Syndrome (CMS)	Low	Increasing significance on a local level, but on a national level scores 'Low'
Infectious Salmon Anaemia Virus (ISAV)	High	Notifiable disease with significant consequences
Bacterial Infection (e.g. Aeromonas; Moritella; Pasteurella; Piscirikettsia; Renibacterium; Tenacibaculum; Vibrio; Yersinia)	Low	The consequences of bacterial infection can be highly significant on a local level but of low significance on a national level.
Harmful Algal Blooms	Moderate	
Zoo Plankton	Moderate	
Environmental (Low Dissolved Oxygen)	Moderate	
Predator damage	Low	
Transportation & Grading	Low	

The risk of mortality occurring has been quantified using a 'risk evaluation matrix' adapted from Lind et al 2015[7], the combination of the likelihood and consequence scores is the risk (risk = likelihood x consequence).

[7] Lind CE, Dana GV, Perera RP and Phillips MJ. 2015. Risk analysis in aquaculture: A step-by-step introduction with worked examples. WorldFish, Penang, Malaysia. Manual: 2015-08.

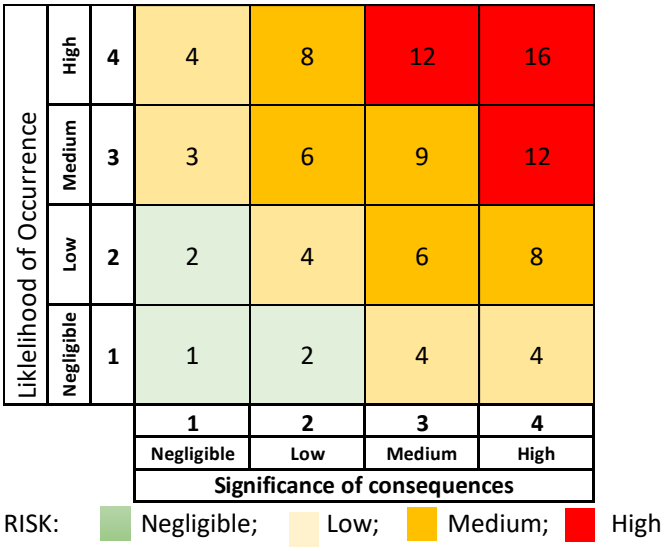

Figure 7. Risk evaluation matrix example/template

The risk of mortality occurring due to a particular cause has been evaluated using the above matrix/template, as shown in the following table.

Table 26. Risk assessment matrix

Mortality Cause	Likelihood of Occurrence	Significance & Consequence	Risk
Sea lice and sea lice treatment	4	3	12
Amoebic Gill Disease (AGD) & AGD treatment	4	3	12
Complex Gill Disease	4	3	12
Pancreas Disease Virus (PDV)	2	2	4
Infectious Pancreatic Necrosis Virus (IPNV)	1	1	1
Heart Skeletal Muscle Inflammation (HSMI)	2	2	4
Cardiomyopathy Syndrome (CMS)	2	2	4
Infectious Salmon Anaemia Virus (ISAV)	2	4	8
Bacterial Infection (e.g. Aeromonas; Moritella; Pasteurella; Piscirikettsia; Renibacterium; Tenacibaculum; Vibrio; Yersinia)	2	2	4
Harmful Algal Blooms	2	3	6
Zoo Plankton	2	3	6
Environmental (Low Dissolved Oxygen)	2	3	6
Predator damage	1	2	2
Transportation & Grading	1	2	2

The results of this analysis identify the highest risk of mortality occurring as a result of the following conditions:

- Sea lice and sea lice treatment
- AGD and AGD treatment
- Complex gill disease.

9.4 Guidelines for Veterinary Health Plan (VHP) and Biosecurity Plan for Fish Health

9.4.1 Biosecurity Management and Important Considerations

Overview

Biosecurity management at a farm site, DMA and regional level are key to reducing the mortality risks associated with any infectious disease. Best practice guidelines are described within the Code of Good Practice and within the requirements for operators of an Aquaculture Production Business (http://www.gov.scot/Topics/marine/Fish-Shellfish/FHI/authorisation/apb/bmp). A VHP and Biosecurity Management Plan should cover disinfection procedures and wellboat operation risks.

Disease control measures must both prevent the occurrence of disease on site and minimise the effect of any disease event. Snapshos of these are provided below under a range of headings.

Moribund and Dying Fish

Moribund and dying fish are a significant source of fish pathogens. Rapid removal of mortality and moribund fish including biosecure handling, storage, transport and disposal of mortality is a fundamental part of the process to reduce disease related mortality.

Mortality Removal Systems

A range of mortality removal systems are available, eg air lift, dead sock, hand removal by divers. In the event of infectious disease, daily mortality removal significantly reduces the risks. Biosecurity Measures Plans must also include guidance for secure transport, storage and disposal of mortality.

Bottlenecks

Potential bottlenecks within this process exist where farm sites are under resourced in terms of either equipment or staff. Where farm sites are unable to employ the mechanical mortality retrieval systems, daily removal is less likely.

Locational Pressures

Where a significant mortality occurs in more than one location, there is significant pressure on the existing available equipment. Delay in removal of mortality from pens affected with infective disease is likely to have an impact on the prevalence and duration of the disease.

Classification

Fish farm mortalities, including Notifiable Disease related mortality are categorised under the Animal By-Products (ABP) Regulation as Category 2. Category 1 would only apply to fish given an illegal treatment/substance or a legal treatment/substance at a level that exceeds permitted levels.

9.4.2 Equipment for Mass Culling/Compulsory Slaughter

Where a Confirmed Disease Notice has been issued under Aquatic Animal Health Scotland Regulations, the Competent Authority may require the slaughter or killing of fish in cases where the disease must be eradicated.

Killing large numbers of fish humanely is not a simple task. Commercial harvesting equipment has been designed for humane killing of market sized fish. Throughput is limited by the number or capacity of stunning machines or the volume of pipework. Percussive stunning equipment would not be suitable for use on fish below market size. Electrical stunning offers a potential humane solution regardless of size of fish. When the correct electrical parameters are applied, the size or condition of fish does not impede effective stunning.

9.4.3 Transport and Storage

Overview

The ability to destroy and dispose of all of the fish stock on an entire farm site, while minimising the risk of the spread of the disease presents a range of logistical problems. If the fish are not suitable for human consumption, there is an immediate requirement for transport, storage and disposal facilities to cope with a high tonnage.

Transporters and storage facilities for Animal By-Products (ABPs) need to register (no need for full approval) from the Animal and Plant Health Agency (APHA). Guidance can be found at:

https://www.gov.uk/guidance/transporting-animal-by-products
https://www.gov.uk/guidance/animal-by-product-categories-site-approval-hygiene-and-disposal

The APHA, from June 2019, are charging for new approvals, not for registrations. However, those who are registered under the ABP Regulations may have a follow on inspection which will be chargable.

It should be noted that the Scottish Government issues approvals and registrations in Scotland although the APHA does much of the work on the ground and recommends if a site should be approved. One registration from a haulier would cover all vehicles and depots.

Transport & Constraints

Movement of ABPs must be in secure, covered, leakproof containers. The different categories of mortalities must be separated (e.g. Category 2 from Category 3) in any transport movement. Such movements must take place in a vehicle or vessel suitable for the purpose. Vessels and vehicles must be cleaned and disinfected before and after each movement. Transporters must provide commercial documentation with each load and must include:

- A detailed description of the contents including the ABP category and quantity of the load.
- The address of the origin and destination of the load with contact details for each location.
- The approval and registration numbers of the vehicle and the sites of origin and destination (wastes must be delivered to an approved site).
- The date of transport.
- Signature of person responsible for the load in transit.

Compulsory slaughter in the event of a notifiable disease could put significant strain on the logistics infrastructure in the country, with the movement of a significant fish kill by vehicle transport from island regions facing the challenges associated with ferry capacity. Currently there is one UK independent vessel operator with approval for mortality transport, using vessels which have a potential capacity of circa 400 tonnes. A Norwegian operator also has significant capacity, with the potential to be in the country within two days of commercial agreements being reached. The potential for concurrent event mortalities or notifiable disease events could mean unacceptable delays in removal of potentially infective material from farm sites. More about this is discussed, in detail, in the following section.

Full disinfection of vessels (Disinfection Guide Stage III) would be advised after carriage of mortalities from a site with notifiable disease. A stage III disinfection requires the vessel to be dry docked for external hull disinfection. Dry dock locations are limited and the capacity to handle vessels over 50 m limits the available locations further.

Storage & Constraints

Storage containers must be weatherproof, secure, leakproof and must be able to be cleaned and disinfected easily. They must be sited on suitable ground and capable of full drainage. Provision must be in place to prevent or contain any spills or leaks.

Approval is required for a tank storage facility where fish waste is coming from more than one origin. Additional permissions would be required from SEPA and Highland Council. The approval process requires details of Standard Operating Procedures (SOPs) for training, hygiene, segregation of wastes,

maintenance, operation of the plant and biosecurity. Operators should have a risk identification and assessment process in place, as well as suitable records of their operations.

In terms of potential constraints, the requirements for Scottish Government approval is more complex for storage facilities. There are no approved bulk storage facilities, but potential interest in establishing such facilities have been identified through engagement with a number of parties in the aquaculture/logistics supply chain.

10. Comparison of Future Contingency Planning with Historical Events

10.1 Overview

The key issues in terms of historical events are described and summarised from both a commercial and notifiable disease (risk management) perspective. The contingency plans described in Section 11 then build on this in terms of the following:

- How the future plans would address historic problems, from both a commercial and notifiable disease perspective.
- The provision of data related to geographical locations to manage different scales and types of events appropriately.
- Areas of weakness, bottlenecks to be identified, along with the mitigation measures required.

10.2 Seasonality and Mortality Trends

The potential to identify seasonal trends associated with mortalities is discussed in this section and in various tables and graphs is correlated and discussed against the rising production levels since 2010, as indicated in the table below.

Table 27. Summary of production output since 2010

Region	2010	2011	2012	2013	2014	2015	2016	2017
South West	27,751	37,157	26,850	34,924	34,976	35,911	31,022	37,981
North West	47,353	41,656	50,987	43,320	50,873	54,741	46,917	53,834
Western Isles	24,233	37,343	29,682	36,817	33,775	27,210	32,662	32,487
Orkney	9,388	6,369	11,694	11,479	13,029	11,074	14,752	14,288
Shetland	45,439	35,493	43,010	36,694	46,369	42,786	37,464	38,612
Production total (t)	**154,164**	**158,018**	**162,223**	**163,234**	**179,022**	**171,722**	**162,817**	**177,202**[8]

The following figure plots the total mortalities, for all sites and regions of Scotland over the period 2010 to 2017, doing so on a monthly basis. This indicates that the period during which the majority of mortalities appear is the four months from August to November inclusive (with some exceptions) – important in terms of future contingency planning purposes. It should be noted that the increasing levels of mortalities also occurs over a period when production has been increasing, as indicated earlier in this report.

[8] This is an estimated production total for 2017 – actual tonnage not available at time of writing.

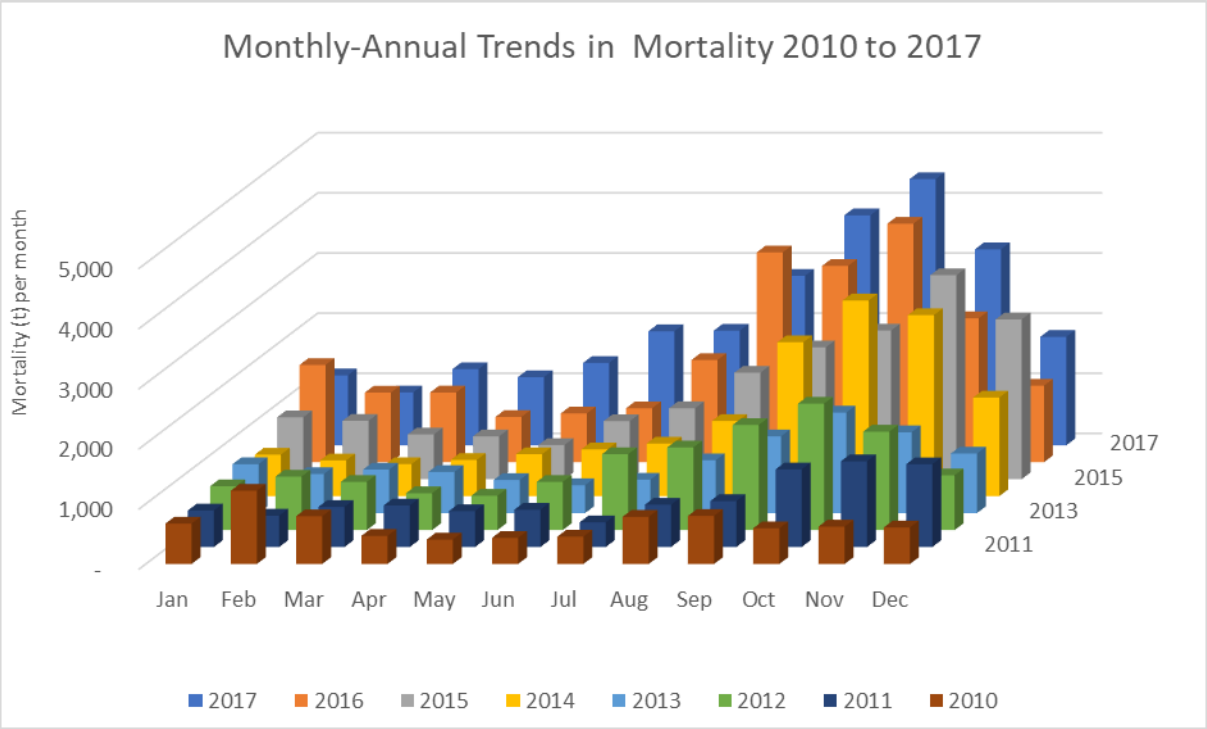

Figure 8. Monthly – annual trends in all mortalities for Scotland (all regions)

The following table shows the annual growth in mortalities since 2010, grouped for the month periods shown, to indicate the extent to which mortalities in a year appear in the August to November period of the year.

Table 28. Mortality tonnages – seasonal trends

Year	Jan-Jul & Dec	Aug-Nov	Total
2010	5,049	2,797	7,846
2011	5,489	4,182	9,671
2012	6,571	6,858	13,429
2013	5,428	5,170	10,598
2014	6,408	10,072	16,480
2015	8,825	9,824	18,649
2016	9,367	13,111	22,478
2017	11,413	14,324	25,737

The data shown in the table above is represented in the following figure, which clearly shows that the trend is for mortality tonnages to be increasing for all months over the years in question (as has production). However, from 2010 it can be seen that the growth over the months of August to November has exceeded that for the months of Jan-Jul & Dec.

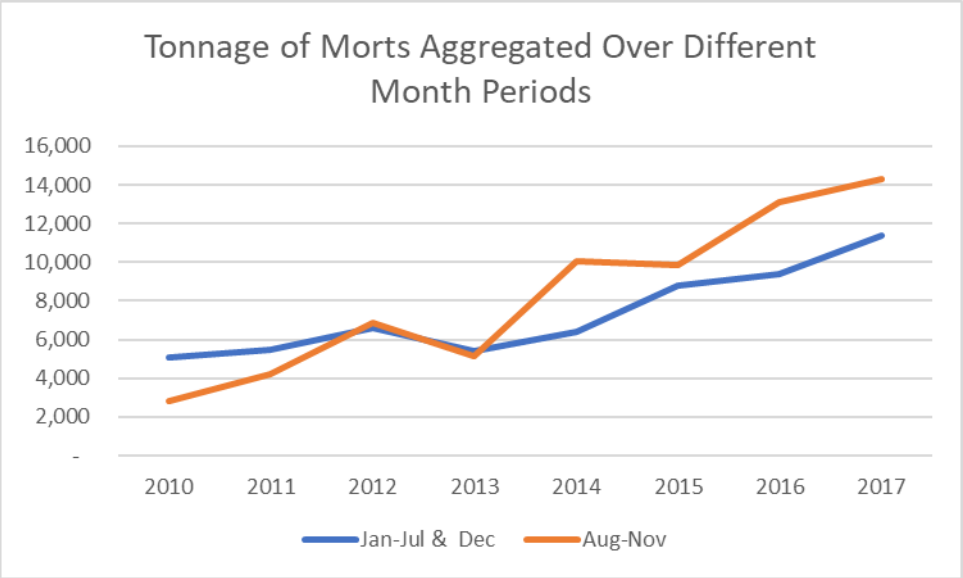

Figure 9. Graph showing trend in seasonal levels of morts

The growth in mortalities during the August to November period is not only in tonnage terms, but has, in the main, increased as a percentage of the total mortalities over the 2010-17 period, as shown in the table below. The years 2013 and 2014 were outliers in this respect.

Table 29. Seasonal summary of mortality percentages

Year	% of Total Morts Per Year	
	Jan-Jul & Dec	Aug-Nov
2010	64%	36%
2011	57%	43%
2012	49%	51%
2013	51%	49%
2014	39%	61%
2015	47%	53%
2016	42%	58%
2017	44%	56%

The tonnage of mortalities for all of the regions considered in this report has been plotted and is shown in the following figure.

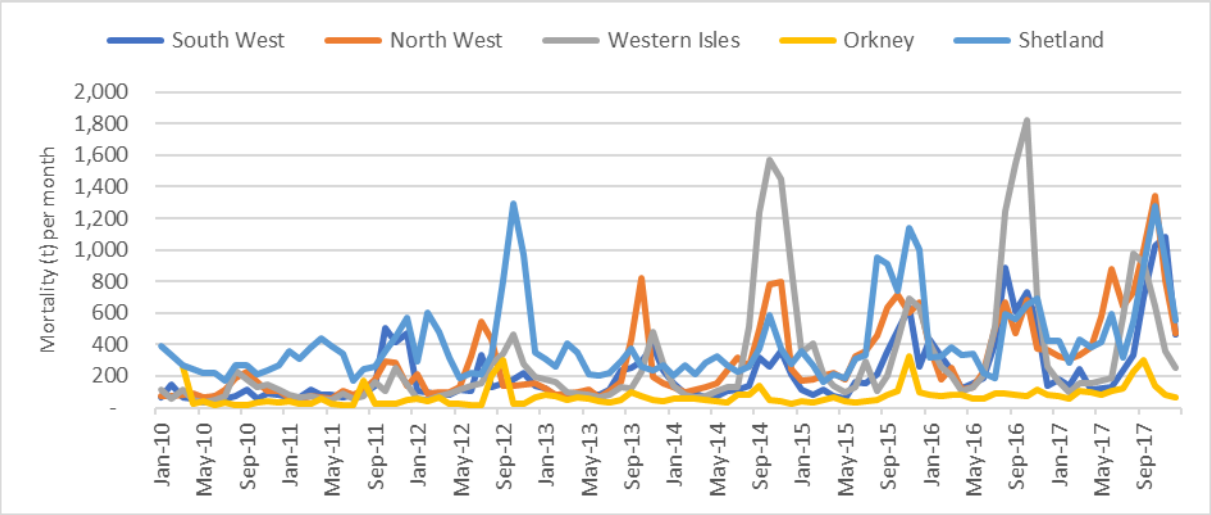

Figure 10. Monthly mortality (all mortalities) by region across the period 2010 to 2017

The figure highlights seasonal trends in mortality and indicates an increased pressure on the available facilities to handle, transport, store and dispose of mortality during the September to November period.

Likely causes can be attributed to peak temperatures occurring in September, which will have an impact on the speed of disease process. Peak sea temperatures also result in more challenging environmental conditions (lower oxygen) and potentially poorer gill health as a result of cumulative plankton challenges during April to September. In addition to greater challenge from external irritants, the load of certain gill microsporidia and bacteria (while present year-round in fish with good gill health) has been shown to peak in early autumn (Gunnarson, 2017) consistent with greater gill immunosuppression around this time. Further to this general decline in gill health around peak water temperatures, the risk of event-type mortality due to severe blooms of harmful gelatinous zooplankton or certain phytoplankton species also increases with water temperature. Ectoparasites such as sea lice and gill amoeba grow faster in warmer water, necessitating more frequent treatments to maintain compliance with health and regulatory requirements. All of these factors lead to a potential peak in mortality during late autumn period.

The above is then plotted in the graph below, for Scotland, to show more clearly how both the tonnage of mortalities has been growing, but also how the spike over the period August to November has been contributing to this level of growth.

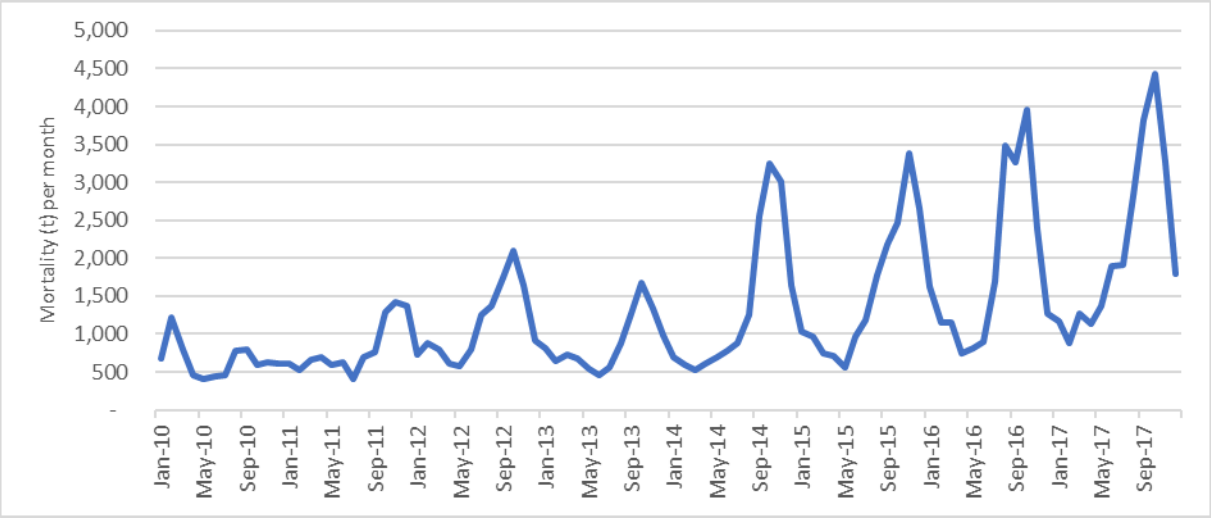

Figure 11. Monthly mortality (all mortalities) across the period 2010 to 2017

The period August to November is when mortality levels are at their highest, peaking in October.

10.3 Causes of Mortality and Trends

10.3.1 Analysis Based on DMAs Targetted

The data clearly shows that the number of Level 1 to 5 events has been increasing over the period analysed in detail (2008 – 2017). This section discusses the causes of mortalities as presented through data available.

There can be one or more disease processes acting on a fish at the time of death, such as parasitic infection, viral myopathies or bacterial infection. The outcome of these diseases may not necessarily cause the death of the fish in “normal” conditions, but when additional factors are also present, such as the handling of fish, environmental stressors, the presence of predators, then the outcome is more likely to be fatal.

Gill health is a broad term covering a complex suite of gill diseases and conditions. Gill diseases include bacterial, viral and parasitic fish pathogens, all of which can have a marked effect on the gill’s ability to function efficiently. Gill function and therefore the respiratory capacity of fish can be reduced by the presence of harmful algal blooms and harmful zooplankton. The ability of fish to survive basic husbandry operations such as crowding, grading, transportation or bath treatment is severely compromised by poor gill health.

Classification of cause of death during routine mortality removal can be inaccurate. Gross physical signs present at the time of death can be indicative of a number of causes. Suspicious or significant rises in mortality must be investigated and where suspicion of Notifiable Disease exists, or when mortality levels rise above the thresholds agreed by the Fish Health Working Group, farms must notify Marine Scotland's Fish Health Inspectorate. FHI’s data from routine inspections and Event Mortality notifications have been used to examine the impact of gill health on regional and total mortality.

Information on mortality cause was extracted from the FHI database, based on:

- Voluntary reporting by fish farmers to FHI during mortality events; and
- Data obtained by FHI during routine surveillance inspections during the period 2015 to 2017.

For the purposes of this report the mortality cause data recorded by FHI has been assigned into one of 2 groups depending on whether gill health could be implicated in the root cause of the fish mortality or not, based on the categories described in the following table.

Table 30. Descriptions of gill and non-gill mortality events

Categories	Examples of event mortality
Gill or Gill related	AGD; AGD treatment; Proliferative Gill Disease (PGD); Complex Gill Issues; Gill Pathology; Algal bloom; ‘Environmental’; Handling
Unlikely to be gill related or not gill related	Sea lice; unspecified 'treatment'; Cardiomyopathy syndrome (CMS); Pancreas Disease; Heart Muscle Skeletal Inflammation (HMSI); Physical Damage; Seal predation; Grading; Transport

The table below presents the results of an analysis of the causes of mortality using the above categories, for the sites within the DMAs targeted in this project and for which FHI case reports were generated.

Table 31. Summary of FHI case data for DMAs analysed – tonnage data

Causes of Mortalities	FHI Cases Reported within the DMAs Covered					
	2017		2016		2015	
	No. Cases	Tonnes	No. Cases	Tonnes	No. Cases	Tonnes
Gill + Likely Gill-Related	51	1,281	10	324	3	142
Not + Unlikely Gill-Related	24	186	23	254	7	122
% Gill Related	68%	87%	30%	56%	30%	54%

Table 32. Summary of FHI case data for DMAs analysed – % data

Causes of Mortalities	FHI Cases Reported within the DMAs Covered					
	2017		2016		2015	
	% of All Morts	% of Level 1 to 5 Morts	% of All Morts	% of Level 1 to 5 Morts	% of All Morts	% of Level 1 to 5 Morts
Gill + Likely Gill-Related	11%	24%	4%	10%	1%	15%
Not + Unlikely Gill-Related	2%	3%	3%	8%	2%	5%

10.3.2 Analysis Based on Full Regional and National Datasets

The following datasets analyse the full FHI case data for all of the regions and Scotland, to provide a wider set of data on gill and non-gill causes of mortality. Data was derived from taking every seawater case for which FHI had recorded mortality as a number of fish. Average weights were used when provided to estimate tonnages. In cases where no average weight was provided the weight was estimated based on age of fish (date of event - when they were transferred to sea). The results are summarised on a regional and national basis in the table below.

Table 33. Summary of FHI case data – full regional/national dataset – tonnage data

Location	Tonnages of FHI Case Data		
	2015	2016	2017
South West	232	1,496	1,298
North West	910	843	2,682
Western Isles	572	2,722	1,417
Orkney	73	157	319
Shetland	869	948	1,791
SCOTLAND	**2,655**	**6,167**	**7,506**

Analysis of the above, and differentiating them again into causes, with respect to gill and non-gill mortalities, is summarised in the table below.

Table 34. Summary of FHI case data – full regional/national dataset – tonnage data

Location	Gill Mortality (t)			Non-Gill Mortality (t)		
	2015	2016	2017	2015	2016	2017
South West	-	1,342	876	232	154	422
North West	487	368	1,789	423	475	893
Western Isles	205	2,079	1,244	367	643	173
Orkney	61	102	313	12	55	6
Shetland	836	136	543	33	812	1,248
Scotland	**1,589**	**4,028**	**4,765**	**1,066**	**2,139**	**2,741**

It should be noted that the 4,756 tonnes of gill related mortalities in 2017 make up 64% of the FHI Event mortalities (7,506 tonnes in total).

The above data has been divided by the production + mortality total, to provide percentages which may be indicative of how gill and non-gill mortalities vary across the regions. These percentages are summarised in the table below. It should be noted that this is not done for 2015, since the FHI case reports were only carried out for part of this year (the year that data started to be collated in this way).

Table 35. Summary of FHI case data – full regional/national dataset – % data

Region	Gill Mortality (GM) %			Non-Gill Mortality (NGM) %			Avge of %s, 2016 + 2017	
	2015	2016	2017	2015	2016	2017	GM %	NGM %
South West	-	3.8%	2.0%	-	0.4%	1.0%	2.9%	0.7%
North West	-	0.7%	2.9%	-	0.9%	1.4%	1.8%	1.2%
Western Isles	-	5.2%	3.3%	-	1.6%	0.5%	4.3%	1.1%
Orkney	-	0.7%	2.2%	-	0.4%	0.04%	1.5%	0.2%
Shetland	-	0.3%	1.2%	-	1.9%	2.7%	0.8%	2.3%

The above table indicates that, taking both 2016 and 2017 together, gill related causes of mortality are lowest around Shetland, and highest in the Western Isles and South West. However, covering two years only means that this is a snapshot and data over a longer period of time will provide more robust evidence of trends.

The following figure shows the months over which gill event mortalities occur, again covering the August to November period discussed previously. It should be noted that this graph and others, plotting Event Mortalities on a tonnage basis, in terms of causes, should not be used for quantitative purposes, and rather show general trends. The tonnages are based on reporting on the basis of the CoGP referred to at the beginning of this report, which for 2015 was based on only a part of the year. Reporting and participartion levels have been increasing since the introduction of the CoGP, however, these levels are also variable across sites.

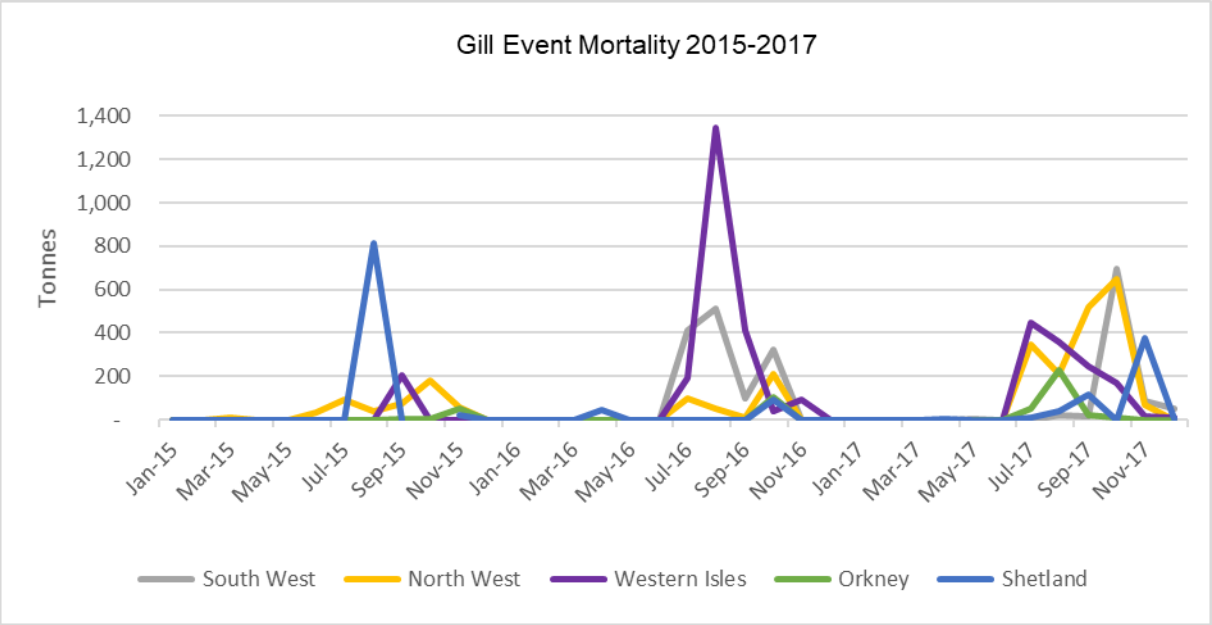

Figure 12. Gill event mortalities by region – showing seasonal trends

Looking at the distribution of mortality on a monthly basis across the 5 regions gill mortality events occur concurrently in a number of regions.

The figure below looks at the same regions and time periods for non-gill related mortalities.

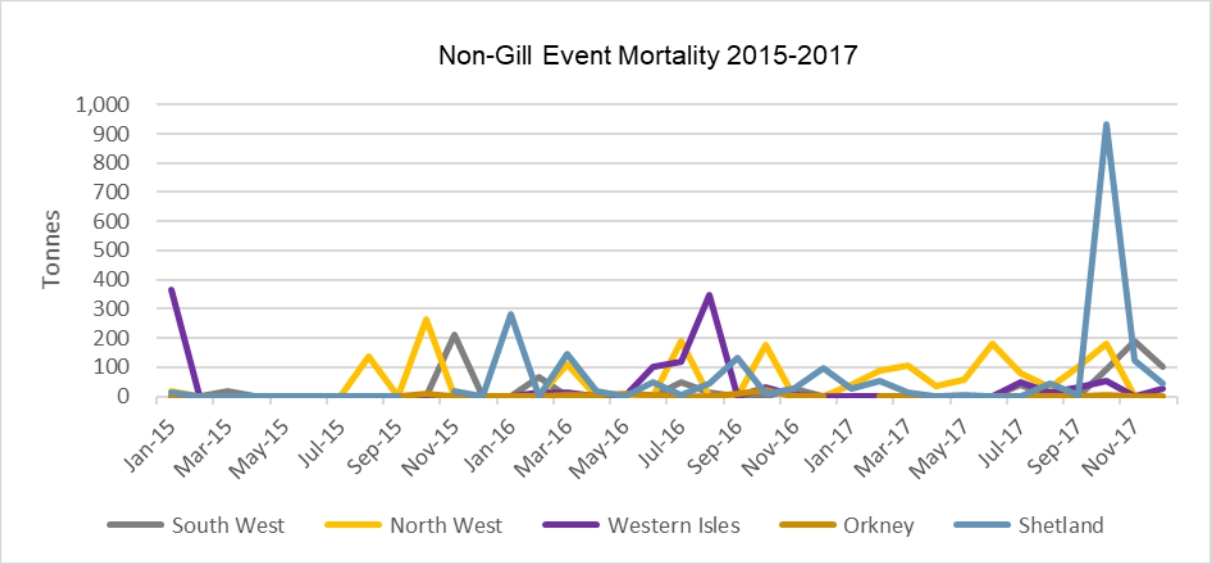

Figure 13. Gill event mortalities by region – showing seasonal trends

The above indicates that are peaks in non gill related mortalities, but trends in this respect are more difficult to pinpoint.

For clarity, the following figure provides the total tonnages of mortalities, for Scotland, together with the gill and non-gill related mortalities.

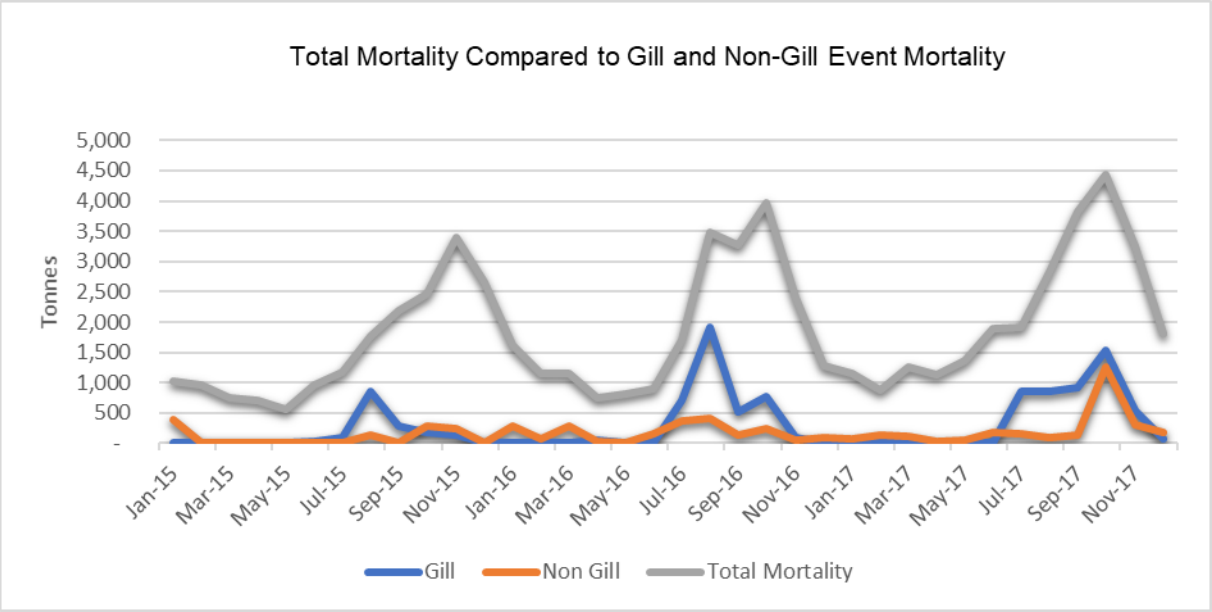

Figure 14. Comparison of seasonal trends of total mortalities, with gill and non-gill event mortalities

The figure above further highlights that fluctuating levels of mortality put additional pressure on the capacity for transporting, storage and management of mortalities.

11. National & Regional Contingency Plans - Logistics

11.1 Overview

The data generated in this report has been used to develop regional contingency plans which are a combination of:

- Guidance, provided in this section of the report
- Risk Assessments, provided in Appendix D.
- Flowcharts, provided at the end of this section

The contingency plans are underpinned by the data model produced, which considers the following, at a regional, Scotland and wider level (Scotland + rUK + Scandinavia):

- Seagoing capacity - morts removal from pens.
- Bulk storage capacity of morts.
- Ferry capacity, to take morts to the Scottish mainland (from the Hebridean Islands and the Northern Isles, using Calmac and NorthLink respectively)
- Land haulage capacity
- Processing capacity

Data on the above is provided for each of the five regions targeted in this report, as well as at a national level. rUK and wider afield (Scandinavia) are also considered, in terms of the bulk storage, haulage and processing capacity, in particular, that can be provided.

The data model developed for this project considers Level 1 to 5 Event Mortalities described for the 75 selected sites described in this report. However, to provide meaningful contingency plans the total mortality tonnages for the regions and country are provided, derived from Level 1 to 5 events taking place across all of the sites within a region, or the country as a whole. These tonnages are presented against the capacity of the logistics and processing infrastructure, to show where there are capacity constraints, shortfalls and bottlenecks.

Where engagement with the sector has indicated that there is potential, the logistics requirements to support the management of a Level 5 (100%) mortality event are indicated. This applies to road and ferry haulage, although there are significant challenges associated with this, in particular with regards to ferry movements (as described in the following sections).

It should be noted that the capacity options highlighted in red font are for hypothetical infrastructure, with the potential and interest in terms of providing this, but not currently licensed to do so.

11.2 Seagoing Capacity – Morts Collection

The table below describes the level of seagoing capacity, excluding timetabled ferry services (covered separately) identified for removing and hauling morts directly from pens. Company 2 is not currently authorised to haul fish morts, however, would be able to provide support if there were client drivers to do so, and approvals were in place from the Scottish Government.

Table 36. Summary of vessels licensed or with potential to be licensed, for seagoing transfer

	Company		
	1	2	3*
Status	Approved	Potential	Approved
Vessels	3 vessels	3 vessels	1 vessel
Load	Cum. 260 tonnes	Cum. 1,250 tonnes	1,300 tonnes

*Sourced from Scandinavia

The following table summarises the number of haulage movements in a year that would result in the shortfall or excess of capacity described in the tables shown in Section 11.6.

Table 37. Seagoing capacity – number of haulage movements providing the stated capacity

Year / Growth	Scotland *Company*		
	1	2*	3
2017	52	52	52
2017 + 30%	70	70	70
2017 + 50%	78	78	78

*Only for the scenario describing *potential* capacity (i.e. not licensed)

The companies providing the licensed seagoing capacity are effectively the same for any region or the country as a whole, since vessels can be provided to any region, if capacity permits. The level of commitment shown above would be dependent on the utilisation of vessels at any point in time and these haulage movements are therefore described for indicative purposes.

The seagoing capacities shown for the regions are based on lower numbers of movements than those shown nationally. For licensed facilities at a national or regional basis, the number of movements is based on providing enough capacity to allow morts to be removed from up to the scale of a Level 3 event. To go beyond this would need the operator shown above (Company 2) to become licensed and provide this service.

11.3 Bulk Storage

Fish farm companies presently use a limited range of routine storage options, such as ensiling on site (i.e. maceration and acidification) followed by storage either in a tank on site, a tanker vehicle on-site or in Intermediate Bulk Containers (IBC) of 1 m3 volume. Generally, farms have a licence from SEPA to store a maximum of 10 such IBCs on site. There will be occasions when this storage capacity is exceeded (during mass mortality events) in which case whole fish are moved off site as quickly as the logistics can be arranged.

There is currently no large-scale (e.g. more than 100 tonnes), bulk storage facility available on land in Scotland. However, included in this analysis is the collection and storage of large tonnages of fish morts in seagoing vessels of the kind that are used in Scandinavia and which have been chartered for use in Scotland on occasions.

The stakeholder engagement work referenced previously in this report, has identified interest from a number of parties in providing bulk storage facilities and these are reflected by Companies 1, 2 and 3 in red font in the table below.

Table 38. Summary of potential and actual storage capacity

	Company 1	Companies 2 & 3	Company 4
Status	Potential, W. Isles	Potential	Approved
Container	Four 4.2m dia, 4 m high tanks for bulk storage – 154 tonnes	5 x 1,000 tonne capacity – one per region	1 boat, 1,300 tonne capacity
Frequency, if applicable	Turned over 24 times e.g. twice per month. Then 30 and 36 for growth	Turned over 24 times (e.g. fortnightly) per annum	12 times pa then by growth rate

The potential excess/shortfall capacities summarised later are derived from using the above infrastructure and turning this over (emptying and refilling) the number of times shown in the following table.

Table 39. Summary of turnover of storage capacity considered

Mortality Level	No. of Times Bulk Storage Turned Over Per Annum					
	N. West, S. West, Shet & Ork			W. Isles		
	1	2 & 3	3	1	2 & 3	3
2017 level	n/a	24*	12	24	24*	12
2017 + 30%	n/a	30	16	30	30	16
2017 + 50%	n/a	36	18	36	36	18

The bulk storage approaches identified as being of interest to companies 2 & 3 would give 1,000 tonnes of storage for each region. Turnoved over 24 times per annum, this means, 120,000 tonnes storage capacity for Scotland, and 24,000 tonnes for each region.

11.4 Road Haulage

The following table summarises the haulage capacity modelled, in terms of managing different levels of mortality events. Companies 1 to 3 were engaged with in detail during this project.

Table 40. Summary of haulage capacity considered

	Companies			
	1	2	3	4 to 10
Licence Status	Potential, W. Isles*	Approved	Approved	Approved**
No. of vehicles	80 trailers	70 Trucks	30 sealed skips/trailers + >100 tankers	7 companies used as the basis for further capacity

**Additional, unlicensed capacity potentially available on W. Isles.*
***Reflects a number of additional haulage companies able to provide authorised capacity*

The table below shows the **monthly** summary of capacity used in the analysis, for considering the potential for hauling morts at a national and regional level, with the requirement growing to match the growth projections for the industry of 30% and 50%

Table 41. Summary of monthly haulage capacity considered to manage mortality events

Year / Growth	Scotland	Shetland	Orkney	W. Isles	N. West	S. West
2017	18,000	4,200	1,500	3,600	5,100	3,600
2017 + 30%	24,280	5,460	1,950	5,560	6,630	4,680
2017 + 50%	27,400	6,300	2,250	5,800	7,650	5,400

The capacity described below can be provided by the companies that were engaged with in this project and in effect results in the following level of haulage movements (Scotland and North West used as examples):

- Scotland: 10 companies, 1,800 tonnes per month each, or 346 tonnes per week. i.e. 14 haulage movements per week, per company, carrying 25 tonne loads.
- North West: 10 companies, averages at 510 tonnes per month, or 118 tonnes per week. i.e. 5 haulage movements per week, potentially, carrying 25 tonne loads.

11.5 Ferry Transport

11.5.1 Western Isles

Calmac's chartering potential has been described earlier in this document. To cover a Level 5 mortality event on the Western Isles, where the full tonnage of morts needs to be moved to the mainland, there would be a requirement for 65 ferries to be chartered e.g. just over once per week if spread across a year or, depending on the timing of an event, this would be equivalent to four boats, chartered for 16 occasions each.

The above would then need to increase to 85 then 100 charters to match the growth of 30% and 50% respectively from the 2017 figures.

11.5.2 Shetland & Orkney

As described previously, the freight ferries have a 65-trailer capacity (1,625 tonnes). To manage a Level 5 mortality event, where, for simplicity, all of the morts would need to be taken to the mainland, there would be a requirement for 52 sailings, with 40 of the 65 trailer capacity hauling fish morts i.e. 60%

utilisation of the freight ferry for morts (or various combinations giving the same effective haulage capacity)[9].

A Level 5 event on Orkney requires, for indicative purposes, 52 sailings carrying 14 trailers (20% of capacity), or a combination of fewer sailings carrying more morts, with capacity increasing by 30 & 50% to match growth.

11.6 Logistics and Processing Capacity – Summary Tables

The following tables provide a summary of where there are shortfalls or excess capacity in term of the logistics and processing capacity for:

- Scotland, rUK & Wider, With Licensed Processing Capacity
- Scotland, With Licensed Processing Capacity

Appendix C provides the same level of detail at a regional level, for the following:

- Shetland, with Potential Processing Infrastructure
- Orkney
- Western Isles + Potential Processing Infrastructure
- North West
- South West

The potential processing infrastructure is included in the tables for Shetland and the Western Isles because of the specific opportunities identified, one of which is, at the time of writing, going through the construction phase.

[9] Processing infrastructure is being developed on Shetland, though it not yet operational at the time of writing.

Table 42. Scotland, rUK & wider, with licensed processing capacity

		Morts		AVAILABLE CAPACITY (-VE = SHORTFALL) FOLLOWING MORTS EVENTS INDICATED									
				Seagoing		Storage		Land Haulage		Ferry*		Processing	
		Annual	*Monthly*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*
2017													
8%	Level 1	15,220	1,268	111,400	9,283	-820	-68	200,780	16,732			149,652	12,471
15%	Level 2	30,441	2,537	96,179	8,015	-16,041	-1,337	185,559	15,463			134,431	11,203
30%	Level 3	60,882	5,073	65,738	5,478	-46,482	-3,873	155,118	12,927			103,990	8,666
70%	Level 4	142,057	11,838	-15,437	-1,286	-127,657	-10,638	73,943	6,162			22,815	1,901
100%	Level 5	202,939	16,912	-76,319	-6,360	-188,539	-15,712	13,061	1,088			-38,067	-3,172
2030, capacity with 30% growth in production/mortalities													
8%	Level 1	19,787	1,649	144,819	12,068	-1,067	-89	261,013	21,751			145,085	12,090
15%	Level 2	39,573	3,298	125,033	10,419	-20,853	-1,738	241,227	20,102			125,299	10,442
30%	Level 3	79,146	6,596	85,460	7,122	-60,426	-5,036	201,654	16,804			85,726	7,144
70%	Level 4	184,674	15,390	-20,068	-1,672	-165,954	-13,830	96,126	8,010			-19,802	-1,650
100%	Level 5	263,821	21,985	-99,215	-8,268	-245,101	-20,425	16,979	1,415			-98,949	-8,246
2030, capacity with 50% growth in production/mortalities													
8%	Level 1	22,831	1,903	167,099	13,925	-1,231	-103	376,769	31,397			142,041	11,837
15%	Level 2	45,661	3,805	144,269	12,022	-24,061	-2,005	353,939	29,495			119,211	9,934
30%	Level 3	91,323	7,610	98,607	8,217	-69,723	-5,810	308,277	25,690			73,549	6,129
70%	Level 4	213,086	17,757	-23,156	-1,930	-191,486	-15,957	186,514	15,543			-48,214	-4,018
100%	Level 5	304,409	25,367	-114,479	-9,540	-157,265	-23,567	95,192	7,933			-139,537	-11,628

*Ferry capacity is discussed in the body of the report

Table 43. Scotland, with licensed processing capacity

		Morts		AVAILABLE CAPACITY (-VE = SHORTFALL) FOLLOWING MORTS EVENTS INDICATED									
				Seagoing		Storage		Land Haulage		Ferry*		Processing	
		Annual	*Monthly*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*
2017													
8%	Level 1	15,220	1,268	111,400	9,283	-820	-68	200,780	16,732			48,352	4,029
15%	Level 2	30,441	2,537	96,179	8,015	-16,041	-1,337	185,559	15,463			33,131	2,761
30%	Level 3	60,882	5,073	65,738	5,478	-46,482	-3,873	155,118	12,927			2,690	224
70%	Level 4	142,057	11,838	-15,437	-1,286	-127,657	-10,638	73,943	6,162			-78,485	-6,540
100%	Level 5	202,939	16,912	-76,319	-6,360	-188,539	-15,712	13,061	1,088			-139,367	-11,614
2030, capacity with 30% growth in production/mortalities													
8%	Level 1	19,787	1,649	144,819	12,068	-1,067	-89	271,573	22,631			43,785	3,649
15%	Level 2	39,573	3,298	125,033	10,419	-20,853	-1,738	251,787	20,982			23,999	2,000
30%	Level 3	79,146	6,596	85,460	7,122	-60,426	-5,036	212,214	17,684			-15,574	-1,298
70%	Level 4	184,674	15,390	-20,068	-1,672	-165,954	-13,830	106,686	8,890			-121,102	-10,092
100%	Level 5	263,821	21,985	-99,215	-8,268	-245,101	-20,425	27,539	2,295			-200,249	-16,687
2030, capacity with 50% growth in production/mortalities													
8%	Level 1	22,831	1,903	167,099	13,925	-1,231	-103	305,969	25,497			40,741	3,395
15%	Level 2	45,661	3,805	144,269	12,022	-24,061	-2,005	283,139	23,595			17,911	1,493
30%	Level 3	91,323	7,610	98,607	8,217	-69,723	-5,810	237,477	19,790			-27,751	-2,313
70%	Level 4	213,086	17,757	-23,156	-1,930	-191,486	-15,957	115,714	9,643			-149,514	-12,459
100%	Level 5	304,409	25,367	-114,479	-9,540	-282,809	-23,567	24,392	2,033			-240,837	-20,070

*Ferry capacity is discussed in the body of the report

11.7 Discussion Points on the Logistics and Processing Capacity

11.7.1 Overview

The data from the previous tables, and from those in Appendix C (on a regional basis) is illustrated in the following figures to show the situations where there is excess or shortfalls in capacity. The data is illustrated on a **monthly** basis (dividing previously stated annual totals by 12).

The graphs are also presented on the basis of a Level 3 Event Mortality of 30% (mid-point of the 20 to 40% range), for the following scenarios:

- On the basis of current (2017) production/mortality levels
- 30% growth in production/mortality levels
- 50% growth in production/mortality levels

The graphs indicate whether there is sufficient or insufficient capacity on the basis of licensed infrastructure for seagoing haulage, storage, land haulage and processing of mortalities, doing so for:

- Scotland, rUK and wider - licensed
- Scotland - licensed
- Shetland: licensed plus potential processing capacity (expected to be in place in 2018)
- Orkney: licensed
- Western Isles: licensed plus potential processing capacity (in the short-term on North Uist)
- North West: licensed
- South West: licensed.

It should be noted that Section 8.3 covers processing capacity at a national level, and therefore the discussion points below touch on this, but do so with the aim of providing context in terms of the regional descriptions.

It should also be noted that the graphs and data used in the following section, show capacity on the basis of maintaining infrastructure able to manage a minimum of Level 3 (30%) Event Mortalities. For the scenarios involving 30% and 50% growth in the aquaculture sector this is done so by increasing the frequency of uplifts (seagoing vessels or land-based haulage) or turning over stored mortalities, to the levels shown in Sections 11.1 to 11.5.

11.7.2 Capacity Overview on a Regional Basis

The figure below, based on 2017 production/mortality levels, indicates that there is 224 tonnes per month of excess processing capacity (2,690 tonnes per annum) for licensed facilities in Scotland. Processing infrastructure is currently (2018) located in regions outwith those as defined for the aquaculture sector i.e. even with expected (late 2018) and potential (short-term) processing infrastructure on the Shetlands and Western Isles respectively, none of the aquaculture section regions will have succifient capacity to deal with an Event Mortality of this level. A 30% Event Mortality generates 60,882 tonnes per annum (5,073 tonnes per month) and this can therefore be considered the limit of licensed Scottish processing capacity in the short term. Beyond this, the potential for additional capacity in Scotland, the rUK and wider (Scandinavia) has been discussed in an earlier section of this report.

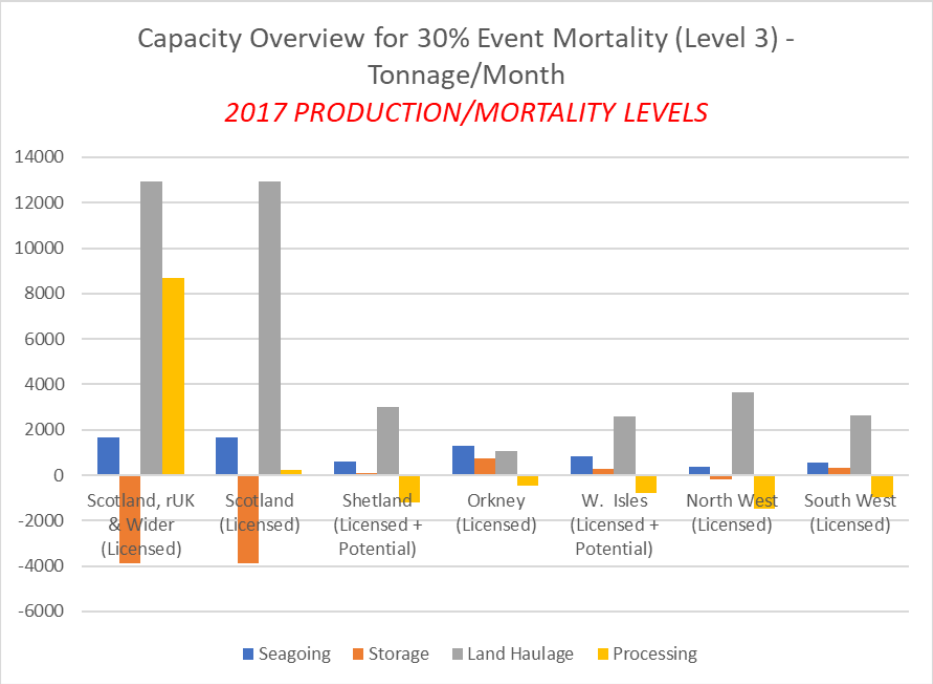

Figure 15. Capacity overview

In terms of seagoing capacity, to manage higher Event Mortality Levels (i.e. Levels 4 and 5) increased frequencies of uplifts, and/or additional seagoing infrastructure would be required. An example of one company with the interest and infrastructure to become licensed and provide this capacity has been discussed earlier in this report.

With regards to storage, there is currently no licensed, *land-based* capacity for this in Scotland (outwith small-scale fish farm storage). The storage capacity referred to in the figure relates to large vessels from Scandinavia providing mobile/seagoing storage. Fluctuations in capacity shown are based on varying frequencies of vessel movements (as described earlier). If these vessels are not available as modelled then the capacity will be reduced in line with this.

The figure indicates that there is sufficient road haulage capacity.

If the growth rates of 30% and 50% are considered, in terms of production levels up to the year 2030, increased frequencies of uplifts using seagoing vessels, land-based vehicles etc would be required as described in Sections 11.1 to 11.5 – to maintain capacity for managing Level 3 Event Mortalities. However, this is not applicable in the context of processing infrastructure, and for the additional levels of mortalities associated with these, the additional infrastructure described previously in this report, involving the rUK and wider (Scandinavia) would be required.

11.8 Contingency Planning Guidance

11.8.1 Overview

This section provides an overview of the following:

- Flowcharts which give a high level overview of the steps that could be followed when taking forward contingency plans to deal with mortality events.
- Options Guide – a collation of information provided within this report, to give an overview of the management options at a regional level.

11.8.2 Flowcharts

The flowchcharts provided in this section:

- Point to a Risk Assesment, Appendix D, covering disease transfer
- Indicate the tables in this report that can be referred to for indicative information on capacity constraints.
- Highlight where there is further information (referred to as “Options Guide”) on the regional/national context in terms of support infrastructure.

Flowcharts are provided separately in the following figures for the island and mainland regions covered in this report.

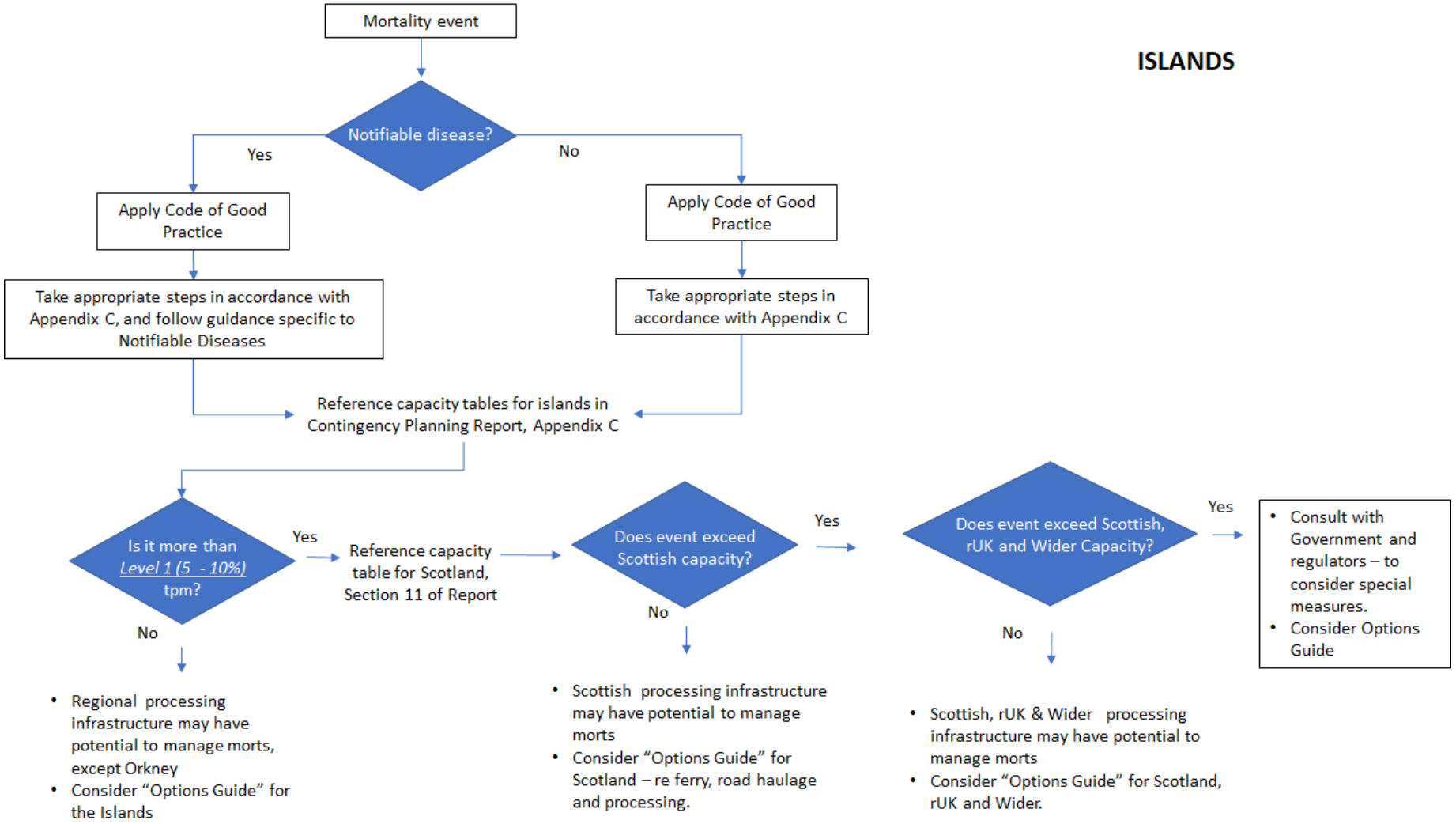

Figure 16. Contingency planning flowchart for the islands

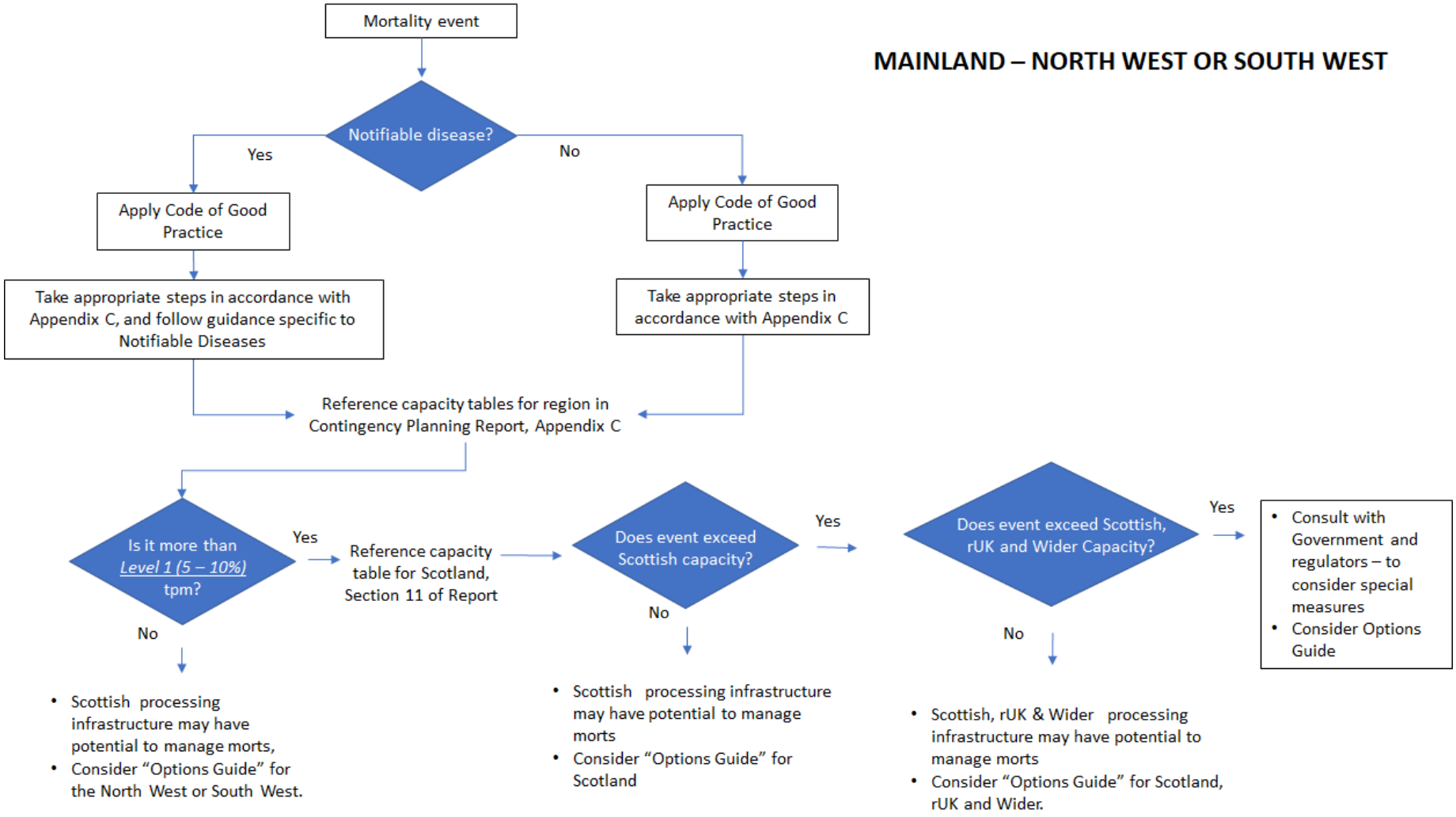

Figure 17. Contingency planning flowchart for the mainland (north west or south west)

11.8.3 Options Guide

Overview

This section provides a short summary of the capacity issues and opportunities associated with the following geographical areas, in terms of their potential capacity to support the management of significant mortality events.

- Scotland, rUK and Wider (Scandinavia)
- Scotland
- Western isles
- Shetland
- Orkney
- North West & Soth West

*This category, “Scotland, RUK and Wider (Scandinavia)” is included because of the additional processing infrastructure available, which provides a significantly higher level of capacity to deal with major mortality events.

Each of the above are taken in turn, with descriptions of boundaries and opportunities.

Scotland, rUK and Wider (Scandinavia)

There is sufficient additional capacity, if phased across a number of months, for licensed infrastructure to provide haulage and processing capacity for a Level 4 event affecting Scotland. In terms of processing infrastructure, two major processors in England/rUK were engaged with during this report, and the potential, additional capacity for taking fish morts discussed and understood. These two companies alone provide the opportunity to take and process an additional 67,500 tonnes of fish morts per annum.

The potential to bring in large seagoing vessels from Scandinavia/Norway provides, in effect, short-term mobile storage, haulage, intermediate processing on the vessel, prior to being processed on land. The potential capacity associated with this would be dependent on the availability of vessels, however, based on the need for support during significant mortality events, the capacity used, 33,800 tonnes in a year, is based on a number of movements that is equivalent to one vessel servicing Scotland every fortnight.

Scotland

There is sufficient additional capacity, if phased across a number of months, for licensed infrastructure to provide haulage and processing capacity for a Level 3 event affecting the country. Beyond this, the capacity would need to be increased by engaging contractors outwith Scotland. Another potential opportunity, not available at the time of writing, is to use forthcoming municipal EfW facilities in extremis, if changes to their proposed licensing regimes are made – to incorporate fish morts. This has the potential to add a further, circa, 25,000 tonnes of processing capacity. The tonnages modelled are based on discussions with an EfW facility operator, where it was considered possible that up to 5% of the feedstock being comprised of fish morts would be manageable (indicative – would need to be confirmed).

There are no land-based bulk storage facilities in Scotland at the time of writing. If there are developments that result in such facilities being installed they should be considered for use because of the opportunity they present for overcoming Event Mortalities that occur over a short period of time.

Western Isles

At the time of writing this report the only licensed processing facility for managing morts on the Western Isles is the Creed AD facility at Stornway, with additional/spare capacity for 2,500 tonnes per annum of fish morts. Another facility, for drying morts, has been under discussion for a number of years on North Uist. If this does come to fruition then it is is anticipated that it will provide a further capacity of circa 3,000 tpa. For events exceeding Level 1 morts it is anticipated that morts will need to be moved off the Western Isles, and this can involve using local seagoing capacity, chartering ferries from Calmac and/or

bringing in capacity from Scandinavia,. Information related to the latter is provided in some detail previously in this report, where there are a number of options in terms of the potential to charter night ferries.

There is also the potential to develop a bulk storage facility specifically on the Western Isles, associated with the existing storage space available through a local company. This is relatively small-scale compared to the regional storage potential described earlier.

Shetland

At the time of writing this report there are no licensed processing facilities for managing morts on the Shetland Islands. It is understood that a facility is being constructed, with plans for this to be operational in 2018, taking fish morts to produce biodiesel. If this does become operational then it is is anticipated that it will provide a further capacity of circa 6,000 tpa. For events exceeding Level 1 morts it is anticipated that morts will need to be moved off the Shetlands, and this can involve bringing in capacity from Scandinavia, using local seagoing capacity, or buying capacity on the NorthLink freight ferries. Information related to the latter is provided previously in this report.

A particular area to focus attention on is the capacity of NorthLink ferries, which unlike the Western Isles have peak periods from June to December (inclusive) for the reasons provided earlier in this report. The peak season for mortalities also falls into this period, which means that in the event of a significant mortality event, specific plans should be identified and agreed with the ferry operator, to facilitate the movement of fish morts to the mainland, if needed.

Orkney

There is no licensed bulk storage storage or processing facility on Orkney, at the time of writing. As such a significant mortality event will require support from seagoing vessels (e.g. Scandinavia) and/or the booking of space on NorthLink ferries. Issues in terms of the capacity of these vessels, as described earlier in this report need to be considered. In terms of processing, the additional capacity available in the north east of Scotland is very limited, and capacity elsewhere in the central belt, Dumfries and Galloway, or outwith Scotland may need to be considered.

The issues mentioned above, in terms of peak periods for NorthLink Ferries also apply, though to a lesser extent, for Orkney, since a number of scheduled trips from Orkney to Aberdeen originate from Shetland. However, there are also direct sailings from Orkney to the mainland, and Pentland Ferries, (not approached) could be engaged with as part of the development of specific plans for Orkney that reduce the potential for bottlenecks.

North West & South West

There is no licensed bulk storage storage or processing facility in the North West or South West, hence the reason for the large shortfalls shown in the previous tables., Mortalities are typically being processed in the central belt at the time of writing. As such a significant mortality event will require a continuation of this. In Scotland there is circa 35,000 tonnes of additional processing capacity that can be provided through AD, IVC and rendering facilities. This additional capacity could potentially provide an outlet for a Level 3 event in the North West, or Level 4 event in the South West. In terms of haulage. However, in a circumstance where a number of regions are experiencing significant events concurrently, then additional capacity would be required from the rUK and wider afield (Scandinavia).

12. Conclusions

12.1 Data on Fish Morts

(a) The total level of fish mortalities in Scotland, in 2017, was 25,737 tonnes, with levels increasing steadily as production levels have also been increasing.

(b) This project, which considered in detail approximately one-third (75) of the fish farm sites registered, has analysed the quantities and percentages of mortalities for each of these sites, classifying them into different mortality levels. In the period 2008 to 2017, the percentage of all mortalities, as a percentage of average biomass, has changed from 4.9% in 2008, to more than 14% in 2017. Significant mortality events, defined by Levels 1 to 5, increased from 1% of average boimass in 2008 to just under 7% in 2017. Level 1 to 5 mortalities over the same period also grew from 21% of all mortalities in 2008, to 48% in 2017. i.e. the occurrence and scale of significant mortality events has been increasing significantly in this time period.

(c) From a regional perspective, Level 1 to 5 mortality tonnages, as a percentage of average monthly biomass in 2017, were 18% South West, 14.7% North West and 19% for the Western Isles. This compares to 7.17% for the Shetlands and 0.28% for Orkney.

(d) Level 1 to 5 mortality tonnages, as a percentage of total mortalities in 2017, were 63% South West, 45% North West, 56% Western Isles. This compares to 33% for the Shetlands. For Orkney this was 3% in 2017. The Shetlands like other regions has seen an increase in total mortalities (% and tonnage) accompanying increases in average monthly biomass. However, this is lower than the other regions. The more striking difference with Shetland is when it is compared to the other regions in terms of Level 1 to 5 mortalities.

(e) For Orkney total mortalities were 3% of average monthly biomass in 2017. This was a reduction from 14% in 2016, 37% in 2015 and 32% in 2014. Orkney, like other regions, has seen an increase in **all** mortalities (% and tonnage) accompanying increases in average annual biomass. However, this is lower than the other regions. Like Shetland, the more striking difference is when Level 1 to 5 mortalities are compared to the Western Isles, the North West and South West.

(f) In terms of the causes of mortalities, FHI data for 2015 (partial), 2016 and 2017 has been analysed. 4,756 tonnes of gill related mortalties in 2017 make up 64% of the FHI event mortalities (7,506 tonnnes). The available data indicates that the South West and Western Isles regions, during 2016 and 2017, had significantly higher levels of gill related causes of mortality.

(g) Seasonality was considered in the data analysis, important because of the potential for significant mortality eventds to take place over a short period. An analysis of historical data, from 2010 to 2017, indicated that there is a significant peak in all mortalities (including gill-related) during the period August to November inclusive. This has the potential to be a particular concern for Shetland, co-inciding with the peak period in terms freight ferry capacity.

12.2 Stakeholder Engagement

12.2.1 Fish Farm Companies

(a) In terms of fish farm contingency plans information provided indicated that existing infrastructure and processes would be used to manage such events.

(b) There was little disagreement or concern about the data generated and analysed, however a number of companies indicated that they do not use percentages as part of their management methodologies. Those which did consider percentages as part of their methodologies indicated that events above 10% would be very significant for them.

(c) A number of companies indicated their support for the establishment of processing infrastructure on each of the five regions. There is currently no significant licensed processing infrastructure (beyond maceration/ensiling) in any of the regions, except for the Western Isles, where the level of additional capacity for fish morts is small (2,500 tonnes per annum). A facility is being built on Shetland which will have the capacity to process routine mortalities, but would not be able to manage events more significant, from a tonnage perspective than Level 1.

12.2.2 Processing Companies

(a) Taking Scotland, the rUK and wider afield (Scandinavia) there is sufficient capacity, using currently ***licensed*** facilities, to deal with Level 1 to 4 Event Mortalities on the basis of 2017 levels of production. This is also the case for the scenario where there is growth in production of 30%. With 50% growth the capacity is sufficient for Level 1 to 3 events. Adding ***potential*** future processing infrastructure to the licensed facilities will give options in terms of capacity to manage and process a 100% Event Mortality (Level 5), - on the basis of 2017 production/mortality tonnages.

(b) For Scotland alone, considering licensed plus ***potential*** processing capacity there is sufficient capacity to manage 2017 mortality tonnages up to Event Mortality level 2. The position then worsens significantly when production growth rates of 30% and 50% are considered.

(c) All of the licensed processing companies operating in Scotland were contacted, and the extent of additional capacity understood. This amounts to circa 38,000 tonnes. The majority of this additional capacity lies with one rendering company while just under 13,000 tonnes is available at AD and IVC companies.

(d) The total additional processing capacity in Scotland is circa 72,000 tonnes per annum. Further, additional capacity could be secured for processing morts in rUK and Scandinavia, with discussions identifying 67,500 tonnes of additional capacity in the former. An estimate has been made for the quantity that could be hauled using vessels from Scandinavia, for processing outwith Scotland and the rUK, amounting to 38,000 tonnes. This means that a total licensed processing infrastructure amounting to 126,000 tonnes was identified, with a further 34,173 tonnes of potential capacity (not built and licensed) available. All together this results in circa 200,000 tonnes of potential capacity being available. A further increase in this would require significant infrastructure developments in Scotland and/or the identification of further capacity outwith the country.

(e) The addition of new regional capacity, on Shetland and the Western Isles (the latter uncertain) may add a further 9,000 tonnes per annum. Currently (2018) there is only one small-scale processing option for fish morts in all of the Scottish aquaculture sector regions (Western Isles, Lewis), with the Shetland facility mentioned being built and due for completion late 2018.

(f) Significant Event Mortalities will lead to a need for processing on the mainland, outwith the aquaculture regions analysed in detail, mainly in the central belt of Scotland and further south.

(g) Additional capacity was considered, in terms of the forthcoming, new municipal, Energy from Waste (EfW) facilities at four locations, three of which are in extremely close proximity to harbour infrastructure (Aberdeen, Dundee and Dunbar). On the basis of assumptions concerning the percentage of feedstock that fish morts would be limited to, such facilities were estimated to be able to provide circa 25,000 tonnes per annum of additional processing capacity. Discussions would be required to understand the issues that the operators may have for these facilities, in taking fish morts, which are not licensed to do so. However, discussions with one company were positive, and the view of the APHA was that as long as due process is followed, and the facilities subsequently licensed, there would be no issues from their perspective with their receipt of fish morts.

12.2.3 Logistics Capacity

(a) Discussions with a number of key players indicate that Scotland has a significant level of additional capacity in terms of land haulage, which can be mobilised in response to Event Mortalities. Engagement with this sector identified additional, licensed haulage capacity not currently being used to haul fish morts, and which could be deployed if required e.g. a large scale haulier, for one of the regions, indicated that it is not currently licensed for this service, but commented that it would be happy to go through the required steps to become licensed and provide a service.

There may be value in further understanding the benefits that could be realised by such companies being able to provide additional capacity, in particular in those regions where bottlenecks in terms of road haulage have been identified.

(b) More bottlenecks potentially exist for future Event Mortalities when seagoing capacity is considered. Only one independent company was engaged with that provides this service in Scotland, while another, larger-scale, haulage and processing company from Scandinavia was also engaged. However, an additional service company located in Scotland, was identified, with significant capacity, which would be interested in providing a fish morts service if requested by clients. The analysis indicates that a significant Event Mortality occurring over one region could be managed by the current seagoing capacity. However, if there were signirificant events occurring across the country as a whole (across multiple regions) at the same time, the capacity would be insufficient to manage beyond a Level 3 Event Mortality (this assumes that the vessels considered would be available at that time).

(c) In terms of ferry capacity, the fish farming companies have indicated that there are challenges at times, particularly in summer for the Western Isles. Discussions with the operator of the service have identified the potential to charter evening ferries, in addition to timetabled services, which would provide significant additional freight opportunities. The peak periods for freight movements on ferries from Shetland are June to December, which overlaps with the peak period for mortalities (from the historical analysis carried out in this project). Analysis of the data provided by the ferry operator, in terms of the quantity of salmon being shipped for human consumption, indicates that this makes up a significant percentage of the overall freight movement. As such, if there is a significant Event Mortality, the quantity of product for human consumption would be reduced and there may be the potential for the space usually allocated for this to be substituted by fish morts.

(d) In terms of regional bulk storage facilities, fish farm companies were more focussed on the need for regional processing infrastructure than storage infrastructure. However, the latter was of interest to three of the logistics/processing companies engaged with, who felt that this represented a significant opportunity to add value to the industry.

13. Recommendations

(a) Feedback from fish farm companies is that there would be great value to the industry, in having regional processing infrastructure and there may be value in Zero Waste Scotland, Marine Scotland, the SSPO and companies getting together to discuss this in more detail, and to identify if there are ways in which support and facilitation can be provided to make this happen. Interest from logistics/processing companies engaged with, to establish regional bulk storage facilties should be explored at the same time as considering processing infrastructure. Further work could consider the scale and locations of such infrastructure, as well as the financial implications and the potential for support. This could consider infrastructure such as AD or similar being established on the quayside.

(b) There may be value in understanding how Zero Waste Scotland and the Scottish Government, the SSPO etc could work to understand how the capacity at existing processing facilities, in particular AD, could be increased. An important element of this involves the recipes of feedstocks, with concerns that adding fish morts beyond a specified percentage will lead to digester failure. Work which develops a more detailed understanding of the minimum and maximum levels of feedstocks such as fish morts that achieve effective digestion could provide AD facility operators with the confidence to accept larger tonnages/percentages of morts.

(c) Data collation and analysis should move forward in addition to current reporting and Code of Good Practice thresholds through Scotland's 10 Year Farmed Fish Health Framework, to assist the industry in the significant efforts it is making to improve understanding of the causes of mortalities, and to identify trends, where there are present.

(d) Further work is required to map out the detailed options for Shetland and Orkney, to understand ferry capacity,and the contingency measures that are required to manage significant mortality events that could occur at peak periods.

(e) The opportunities to effectively add further road haulage capacity on the Western Isles should be explored, to overcome the increasing constraints being experienced, associated with growing tourist numbers. This could be considered along with how seagoing vessel capacity could be maximised, to

take fish morts off the roads. There would be value in understanding how other operators with land and seagoing vehicles, not active or licensed to collect/move fish morts could potentially play a part, to provide additional capacity for significant mortality events.

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APPENDIX A

Total Mortality Levels for the Regions

TOTAL MORTALITY LEVELS FOR REGIONS

1. Results for the Western Isles

The table below provides a summary of how Level 1 to 5 mortalities have changed for the Western Isles over the period 2008 to 2017.

Table A. Western Isles – Description of Mortalities

Year	Ave Annual Biomass, Tonnes	Mortalities – Listed disease	Total - All Mortalities, Tonnes	% All Mortalities of Ave Biomass	% L1-5 Mortalities of Ave Biomass	%L1-5 Mortalities of All Mortalities
2008	2,763	N/A	396	14.34%	2.49%	17%
2009	2,711	N/A	184	6.80%	0.00%	0%
2010	5,997	N/A	161	2.68%	0.05%	2%
2011	3,078	N/A	288	9.35%	2.59%	28%
2012	7,171	N/A	738	10.30%	2.67%	26%
2013	4,250	N/A	420	9.88%	1.66%	17%
2014	7,038	N/A	1,893	26.89%	19.27%	72%
2015	9,113	0	1,517	16.65%	14.70%	88%
2016	8,615	0	2,043	23.71%	13.30%	56%
2017	6,652	0	2,277	34.22%	19.07%	56%

Table B. Western Isles – Description of Mortalities by DMA

Year	Ave Annual Biomass, Tonnes			Total Mortalities, Tonnes			% Mortalities of Ave Biomass		
	A	B	C	A	B	C	A	B	C
2008	341	2,348	74	6	375	15	2%	16%	20%
2009	387	1,364	960	6	54	125	2%	4%	13%
2010	235	5,178	584	5	128	28	2%	2%	5%
2011	501	1,592	985	7	246	35	1%	15%	4%
2012	566	5,424	1,181	25	624	89	4%	12%	8%
2013	719	1,808	1,724	84	226	111	12%	12%	6%
2014	321	5,235	1,483	18	1,189	686	6%	23%	46%
2015	4,452	4,465	196	1,319	191	8	30%	4%	4%
2016	1,289	4,854	2,471	502	1,226	315	39%	25%	13%
2017	3,025	2,098	1,529	1,309	812	156	43%	39%	10%

Table C. Western Isles – Description of Mortality Levels

Year	Tonnes, L1 – L5 Event Mortalities Reported							% of Mortalities		% of Ave Biomass		No. of Month-Incidents, Event Mortalities					
	5-10%	10-20%	*20%*	*40%*	*100%*	Total	3 Yr Ave	Annual	3 Yr Ave	Annual	3 Yr Ave	5-10%	10-20%	*20%*	*40%*	*100%*	**Total**
2008	61	7	0	0	0	69	n/a	17%	n/a	2.49%	n/a	1	1	0	0	0	**2**
2009	0	0	0	0	0	0	n/a	0%	n/a	0.00%	n/a	0	0	0	0	0	**0**
2010	3	0	0	0	0	3	24	2%	6%	0.05%	0.85%	1	0	0	0	0	**1**
2011	0	0	80	0	0	80	28	28%	10%	2.59%	0.88%	0	0	1	0	0	**1**
2012	118	73	0	0	0	191	91	26%	19%	2.67%	1.77%	3	1	0	0	0	**4**
2013	49	0	18	3	0	71	114	17%	23%	1.66%	2.31%	1	0	1	1	0	**3**
2014	342	264	537	213	0	1,356	539	72%	38%	19.27%	7.87%	5	2	2	2	0	**11**
2015	286	118	687	249	0	1,340	922	88%	59%	14.70%	11.88%	6	1	4	1	0	**12**
2016	317	543	286	0	0	1,146	1,281	56%	72%	13.30%	15.76%	8	6	3	0	0	**17**
2017	244	630	395	0	0	1,269	1,251	56%	67%	19.07%	15.69%	4	4	2	0	0	**10**

2. Results for Shetland

The table below provides a summary of how Level 1 to 5 mortalities have changed for Shetland over the period 2008 to 2017.

Table D. Shetland – Description of Mortalities

Location / Scale	Ave Annual Biomass, Tonnes	Mortalities – Listed disease	Total - All Mortalities, Tonnes	% All Mortalities of Ave Biomass	% L1-5 Mortalities of Ave Biomass	% L1-5 Mortalities of All Mortalities
2008	8,556	N/A	695	8.12%	2.45%	30%
2009	9,964	N/A	1,073	10.76%	4.28%	40%
2010	7,936	N/A	641	8.08%	1.28%	16%
2011	9,633	N/A	852	8.84%	2.72%	31%
2012	7,639	N/A	960	12.56%	1.85%	15%
2013	8,749	N/A	968	11.06%	0.25%	2%
2014	8,762	N/A	1,160	13.24%	2.15%	16%
2015	10,183	0	1,483	14.56%	2.12%	15%
2016	9,603	0	2,186	22.76%	4.38%	19%
2017	11,690	0	2,575	22.02%	7.17%	33%

Table 1 Shetland – Description of Mortalities by DMA

Year	Ave Annual Biomass, Tonnes				Total Mortalities, Tonnes				% Mortalities of Ave Biomass			
	A	B	C	D	1b	2a	3b	4c	A	B	C	D
2008	4,029	2,100	2,007	420	369	51	113	161	9%	2%	6%	38%
2009	4,667	2,676	1,489	1,132	318	226	205	323	7%	8%	14%	29%
2010	3,856	1,481	1,928	670	270	162	153	56	7%	11%	8%	8%
2011	5,494	1,826	1,843	470	340	211	229	71	6%	12%	12%	15%
2012	4,313	1,422	538	1,366	494	164	75	226	11%	12%	14%	17%
2013	5,578	1,851	896	423	640	233	69	25	11%	13%	8%	6%
2014	5,985	814	896	1,066	828	84	140	108	14%	10%	16%	10%
2015	7,229	1,297	851	806	1,017	238	81	147	14%	18%	10%	18%
2016	6,733	1,045	1,503	322	1,572	235	262	118	23%	22%	17%	37%
2017	8,531	1,281	1,102	777	1,899	427	68	181	22%	33%	6%	23%

Table F. Shetland – Description of Mortalities by Category

Year	Tonnes, **Event Mortalities** Reported							% of Mortalities		% of Ave Biomass		No. of Month-Incidents, **Event Mortalities**					
	5-10%	10-20%	*20%*	*40%*	*100%*	Total	3 Yr Ave	Annual	3 Yr Ave	Annual	3 Yr Ave	5-10%	10-20%	*20%*	*40%*	*100%*	**Total**
2008	112	72	25	0	0	209	n/a	30%	n/a	2.45%	n/a	6	1	1	0	0	**8**
2009	353	25	48	0	0	427	n/a	40%	n/a	4.28%	n/a	8	2	2	0	0	**12**
2010	102	0	0	0	0	102	246	16%	29%	1.28%	2.67%	6	0	0	0	0	**6**
2011	173	73	16	0	0	262	264	31%	29%	2.72%	2.76%	5	2	1	0	0	**8**
2012	68	73	0	0	0	141	168	15%	20%	1.85%	1.95%	2	2	0	0	0	**4**
2013	22	0	0	0	0	22	142	2%	16%	0.25%	1.61%	2	0	0	0	0	**2**
2014	107	81	0	0	0	188	117	16%	11%	2.15%	1.41%	7	2	0	0	0	**9**
2015	126	50	0	40	0	216	142	15%	11%	2.12%	1.51%	5	1	0	1	0	**7**
2016	290	4	126	0	0	420	275	19%	17%	4.38%	2.88%	7	1	1	0	0	**9**
2017	733	105	0	0	0	838	491	33%	22%	7.17%	4.55%	16	2	0	0	0	**18**

3. Results for Orkney

Table G. Orkney – Description of Mortalities by DMA

Year	Ave Annual Biomass, Tonnes	Total - All Mortalities, Tonnes	% All Mortalities of Ave Biomass	% Event Mortalities of Ave Biomass	%Event Mortalities of All Mortalities
2008	1,052	18	1.7%	0.1%	4%
2009	1,925	42	2.2%	0.0%	0%
2010	1,367	884	64.7%	58.4%	90%
2011	2,539	148	5.8%	0.0%	0%
2012	2,328	146	6.3%	0.0%	0%
2013	3,327	218	6.6%	0.1%	1%
2014	2,428	216	8.9%	2.9%	32%
2015	2,992	404	13.5%	4.9%	37%
2016	2,789	219	7.9%	1.1%	14%
2017	4,891	497	10.2%	0.3%	3%

Table H. Orkney – Description of Mortalities by DMA

Year	Ave Annual Biomass, Tonnes		Total Mortalities, Tonnes		% Mortalities of Ave Biomass	
	A	B	A	B	A	B
2008	164	888	1	17	1%	2%
2009	208	1,717	0	42	0%	2%
2010	294	1,073	39	845	13%	79%
2011	569	1,971	45	103	8%	5%
2012	1,477	851	66	81	4%	9%
2013	1,256	2,071	71	147	6%	7%
2014	1,262	1,166	78	138	6%	12%
2015	1,428	1,564	238	166	17%	11%
2016	1,502	1,288	102	117	7%	9%
2017	1,487	3,404	112	385	8%	11%

Table I. Orkney – Description of Mortalities by Category

Year	Tonnes, **Event Mortalities** Reported							% of Mortalities		% of Ave Biomass		No. of Month-Incidents, Event Mortalities					
	5-10%	10-20%	*20%*	*40%*	*100%*	Total	3 Yr Ave	Annual	3 Yr Ave	Annual	3 Yr Ave	5-10%	10-20%	*20%*	*40%*	*100%*	**Total**
2008	1	0	0	0	0	1	n/a	4%	n/a	0.06%	n/a	1	0	0	0	0	**1**
2009	0	0	0	0	0	0	n/a	0%	n/a	0.00%	n/a	0	0	0	0	0	**0**
2010	0	0	0	0	799	799	267	90%	31%	58.44%	19.50%	0	0	0	0	2	**2**
2011	0	0	0	0	0	0	266	0%	30%	0.00%	19.48%	0	0	0	0	0	**0**
2012	0	0	0	0	0	0	266	0%	30%	0.00%	19.48%	0	0	0	0	0	**0**
2013	0	2	0	0	0	2	1	1%	0%	0.07%	0.02%	0	1	0	0	0	**1**
2014	0	70	0	0	0	70	24	32%	11%	2.88%	0.98%	1	4	0	0	0	**5**
2015	5	143	0	0	0	148	73	37%	23%	4.94%	2.63%	1	1	0	0	0	**2**
2016	30	1	0	0	0	31	83	14%	28%	1.11%	2.98%	3	1	0	0	0	**4**
2017	13	0	0	0	0	13	64	3%	18%	0.28%	2.11%	3	0	0	0	0	**3**

4. Results for the North West

The table below provides a summary of how Level 1 to 5 mortalities have changed for the North West over the period 2008 to 2017.

Table J2. North West – Description of Mortalities

Year	Ave Annual Biomass, Tonnes	Total - All Mortalities, Tonnes	% All Mortalities of Ave Biomass	% Event Mortalities of Ave Biomass	%Event Mortalities of All Mortalities
2008	5,816	259	4.46%	1.02%	23%
2009	4,904	301	6.13%	1.59%	26%
2010	5,671	387	6.82%	0.18%	3%
2011	5,593	282	5.04%	0.44%	9%
2012	7,217	830	11.51%	2.50%	22%
2013	5,581	626	11.22%	4.90%	44%
2014	7,883	1,214	15.40%	5.98%	39%
2015	7,083	1,218	17.20%	3.75%	22%
2016	8,031	2,126	26.48%	14.26%	54%
2017	8,266	2,697	32.63%	14.69%	45%

Table K3. North West – Description of Mortalities by DMA

Year	Disease Management Areas														
	Ave Annual Biomass, Tonnes					Total Mortalities, Tonnes					% Mortalities of Ave Biomass				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
2008	194	1,296	610	307	3,409	21	32	24	85	97	11%	2%	4%	28%	3%
2009	934	1,008	1,505	360	1,098	150	27	48	46	29	16%	3%	3%	13%	3%
2010	334	1,452	435	453	2,997	104	28	19	45	192	31%	2%	4%	10%	6%
2011	181	1,253	1,106	1,617	1,436	29	71	57	46	79	16%	6%	5%	3%	6%
2012	471	1,427	449	1,017	3,853	145	60	80	155	390	31%	4%	18%	15%	10%
2013	294	1,096	1,847	851	1,494	123	83	339	20	61	42%	8%	18%	2%	4%
2014	324	1,211	952	1,622	3,775	143	149	104	497	321	44%	12%	11%	31%	9%
2015	284	1,028	1,503	1,072	3,196	93	57	565	74	429	33%	6%	38%	7%	13%
2016	529	1,520	861	1,506	3,615	56	64	331	928	747	11%	4%	38%	62%	21%
2017	450	1,055	2,011	1,080	3,671	285	20	650	157	1,585	63%	2%	32%	15%	43%

TableL. North West – Description of Mortalities by Category

Year	Tonnes, **Event Mortalities** Reported							% of Mortalities		% of Ave Biomass		No. of Month-Incidents, Event Mortalities					
	5-10%	10-20%	*20%*	*40%*	*100%*	Total	3 Yr Ave	Annual	3 Yr Ave	Annual	3 Yr Ave	5-10%	10-20%	*20%*	*40%*	*100%*	**Total**
2008	0	59	0	0	0	59	n/a	23%	n/a	1.02%	n/a	0	1	0	0	0	**1**
2009	43	35	0	0	0	78	n/a	26%	n/a	1.59%	n/a	2	1	0	0	0	**3**
2010	10	0	0	0	0	10	49	3%	17%	0.18%	0.93%	1	0	0	0	0	**1**
2011	15	9	0	0	0	24	37	9%	12%	0.44%	0.73%	1	1	0	0	0	**2**
2012	48	0	52	81	0	181	72	22%	11%	2.50%	1.04%	6	0	2	1	0	**9**
2013	134	116	0	23	0	273	159	44%	25%	4.90%	2.61%	11	1	0	2	0	**14**
2014	121	135	216	0	0	472	309	39%	35%	5.98%	4.46%	8	1	2	0	0	**11**
2015	232	33	0	0	0	266	337	22%	35%	3.75%	4.88%	7	2	0	0	0	**9**
2016	487	92	162	405	0	1,145	628	54%	38%	14.26%	8.00%	10	1	3	4	0	**18**
2017	707	140	368	0	0	1,214	875	45%	40%	14.69%	10.90%	15	2	5	0	0	**22**

5. Results for the South West

The table below provides a summary of how Level 1 to 5 mortalities have changed for the South West over the period 2008 to 2017.

Table M. South West – Description of Mortalities

Location / Scale	Ave Annual Biomass, Tonnes	Total - All Mortalities, Tonnes	% All Mortalities of Ave Biomass	% Event Mortalities of Ave Biomass	%Event Mortalities of All Mortalities
2008	5,622	277	4.93%	0.23%	5%
2009	7,238	605	8.37%	0.62%	7%
2010	5,918	314	5.31%	1.84%	35%
2011	7,797	1,018	13.06%	6.25%	48%
2012	4,481	306	6.84%	0.27%	4%
2013	7,727	1,260	16.31%	7.83%	48%
2014	7,192	739	10.28%	3.27%	32%
2015	11,081	1,141	10.30%	6.61%	64%
2016	5,423	1,406	25.93%	10.14%	39%
2017	11,622	3,352	28.84%	18.20%	63%

Table N4. South West – Description of Mortalities by DMA

Year	Ave Annual Biomass, Tonnes				Total Mortalities, Tonnes				% Mortalities of Ave Biomass			
	A	B	C	D	A	B	C	D	A	B	C	D
2008	1,288	2,829	738	768	70	141	22	45	5%	5%	3%	6%
2009	1,606	3,527	1,535	571	96	225	268	15	6%	6%	17%	3%
2010	831	3,166	804	1,118	138	120	24	32	17%	4%	3%	3%
2011	1,590	4,310	1,294	603	131	750	112	25	8%	17%	9%	4%
2012	84	2,514	666	1,217	9	148	65	85	11%	6%	10%	7%
2013	2,161	3,757	1,104	706	319	246	643	52	15%	7%	58%	7%
2014	1,688	2,790	145	2,568	139	238	67	296	8%	9%	46%	12%
2015	3,694	3,109	1,744	2,534	563	260	65	253	15%	8%	4%	10%
2016	504	2,455	305	2,159	120	481	7	798	24%	20%	2%	37%
2017	3,446	4,734	1,899	1,543	801	1,087	909	555	23%	23%	48%	36%

Table O5. South West – Description of Mortalities by Category

Year	Tonnes, Event Mortalities Reported							% of Mortalities		% of Ave Biomass		No. of Month-Incidents, Event Mortalities					
	5-10%	10-20%	*20%*	*40%*	*100%*	Total	3 Yr Ave	Annual	3 Yr Ave	Annual	3 Yr Ave	5-10%	10-20%	*20%*	*40%*	*100%*	Total
2008	13	0	0	0	0	13	n/a	5%	n/a	0.23%	n/a	2	0	0	0	0	2
2009	45	0	0	0	0	45	n/a	7%	n/a	0.62%	n/a	3	0	0	0	0	3
2010	109	0	0	0	0	109	56	35%	16%	1.84%	0.90%	2	0	0	0	0	2
2011	31	457	0	0	0	488	214	48%	30%	6.25%	2.90%	3	4	0	0	0	7
2012	12	0	0	0	0	12	203	4%	29%	0.27%	2.79%	1	0	0	0	0	1
2013	117	152	336	0	0	605	368	48%	33%	7.83%	4.78%	2	4	3	0	0	9
2014	68	139	28	0	0	235	284	32%	28%	3.27%	3.79%	5	7	1	0	0	13
2015	191	541	0	0	0	732	524	64%	48%	6.61%	5.90%	4	4	0	0	0	8
2016	237	227	85	0	0	550	506	39%	45%	10.14%	6.67%	7	3	1	0	0	11
2017	449	610	154	903	0	2,115	1,132	63%	55%	18.20%	11.65%	5	5	2	3	0	15

APPENDIX B

Fish Farm Company Questionnaire

Questions Used for Engagement with Fish Farm Companies

1. Do you have any views on the historical data showing the trend in Event Mortalities over the period 2008 to 2017?
2. How does the company deal with Event Mortalities? (If not already answered);
    a. At farm level?
    b. At disease management level?
    c. At regional level?
3. If Q2 doesn't cover methods - What types of methods do you currently use for disposal of ABP material from Event Mortalities (e.g. do you know if it is hauled to mainland Scotland, the English midlands etc, for incineration, rendering, etc)? (If not already answered);

    a. There are regional variations in terms of Event Mortalities (extent still to be confirmed). Do the methods for management/disposal of morts differ between locations?

    b. How do they differ between scale of event (e.g. small, medium, large)? (Would you mind defining 'small', 'medium', 'large'?)

    c. How do they differ between causes (e.g. diseases, jellyfish, harmful algae etc.)

    d. (If not already stated) Would you mind giving some examples of the differences?

    e. Have you explored alternative methods in the past? Could you indicate why these methods are not currently used?

4. In terms of the number of incidents of Event Mortalities, there is a trend to show this increasing in the period from 2008 to 2017. How does this impact on how you manage Event Mortalities, and how should we look to manage this in the future (*from the waste management perspective*)?

5. The aquaculture industry has been described as having significant growth potential up to 2030. Has this influenced your waste contingency plans for the future? (If not already answered);

    a. How do these differ from current scenarios?

    b. How do these differ between locations?

    c. (If open to talking) Would you be willing to provide any more detailed information on these plans?

6. How would you feel about infrastructure being developed at a regional level which would have capacity for managing Event Mortalities? e.g. the development of a land-based bulking, macerating and ensiling facility?

    a. What type of infrastructure (haulage, processing) development would most add value to you, for current and future Event Mortalities?

    b. Do you have a formal contingency plan in place that you would be happy to share aspects of, in particular where you think that this could be enhanced by having improved/alternative opportunities from elsewhere, in terms of bulking, haulage and processing capacity (as covered above)?

7. Are there any specific barriers/ opportunities that you would like to see overcome or further explored? Are there any specific steps/ actions that could be taken that would support the industry?

APPENDIX C
Regional Process & Logistics Capacity

Table A . Shetland, with Potential Processing Infrastructure

		Morts		AVAILABLE CAPACITY (-VE = SHORTFALL) FOLLOWING MORTS EVENTS INDICATED									
				Seagoing		Storage		Land Haulage		Ferry		Processing	
		Annual	*Monthly*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*
Based on 2017 data													
8%	Level 1	3,587	299	39,253	3,271	12,013	1,001	46,813	3,901	47,113	3,926	2,413	201
15%	Level 2	7,175	598	35,665	2,972	8,425	702	43,225	3,602	43,525	3,627	-1,175	-98
30%	Level 3	14,350	1,196	28,490	2,374	1,250	104	36,050	3,004	36,350	3,029	-8,350	-696
70%	Level 4	33,482	2,790	9,358	780	-17,882	-1,490	16,918	1,410	17,218	1,435	-27,482	-2,290
100%	Level 5	47,832	3,986	-4,992	-416	-32,232	-2,686	2,568	214	2,868	239	-41,832	-3,486
2030, 30% growth													
8%	Level 1	4,664	389	51,028	4,252	15,616	1,301	60,856	5,071	61,246	5,104	1,336	111
15%	Level 2	9,327	777	46,365	3,864	10,953	913	56,193	4,683	56,583	4,715	-3,327	-277
30%	Level 3	18,654	1,555	37,038	3,086	1,626	135	46,866	3,905	47,256	3,938	-12,654	-1,055
70%	Level 4	43,527	3,627	12,165	1,014	-23,247	-1,937	21,993	1,833	22,383	1,865	-37,527	-3,127
100%	Level 5	62,182	5,182	-6,490	-541	-41,902	-3,492	3,338	278	3,728	311	-56,182	-4,682
2030, 50% growth													
8%	Level 1	5,381	448	58,879	4,907	18,019	1,502	70,219	5,852	70,669	5,889	619	52
15%	Level 2	10,762	897	53,498	4,458	12,638	1,053	64,838	5,403	65,288	5,441	-4,762	-397
30%	Level 3	21,524	1,794	42,736	3,561	1,876	156	54,076	4,506	54,526	4,544	-15,524	-1,294
70%	Level 4	50,224	4,185	14,036	1,170	-26,824	-2,235	25,376	2,115	25,826	2,152	-44,224	-3,685
100%	Level 5	71,748	5,979	-7,488	-624	-48,348	-4,029	3,852	321	4,302	359	-65,748	-5,479

Table B. Orkney with Licensed Processing Infrastructure

		Morts		AVAILABLE CAPACITY (-VE = SHORTFALL) FOLLOWING MORTS EVENTS INDICATED									
				Seagoing		Storage		Land Haulage		Ferry		Processing	
		Annual	*Monthly*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*
Based on 2017 data													
8%	Level 1	1,314	110	40,326	3,360	13,086	1,090	16,686	1,390	16,431	1,369	-1,314	-110
15%	Level 2	2,629	219	39,011	3,251	11,771	981	15,371	1,281	15,116	1,260	-2,629	-219
30%	Level 3	5,258	438	36,382	3,032	9,142	762	12,742	1,062	12,487	1,041	-5,258	-438
70%	Level 4	12,268	1,022	29,372	2,448	2,132	178	5,732	478	5,477	456	-12,268	-1,022
100%	Level 5	17,526	1,461	24,114	2,009	-3,126	-261	474	39	219	18	-17,526	-1,461
2030, 30% growth													
8%	Level 1	1,709	142	52,423	4,369	17,011	1,418	21,691	1,808	21,360	1,780	-1,709	-142
15%	Level 2	3,418	285	50,714	4,226	15,302	1,275	19,982	1,665	19,651	1,638	-3,418	-285
30%	Level 3	6,835	570	47,297	3,941	11,885	990	16,565	1,380	16,233	1,353	-6,835	-570
70%	Level 4	15,949	1,329	38,183	3,182	2,771	231	7,451	621	7,120	593	-15,949	-1,329
100%	Level 5	22,784	1,899	31,348	2,612	-4,064	-339	616	51	284	24	-22,784	-1,899
2030, 50% growth													
8%	Level 1	1,972	164	76,418	6,368	19,628	1,636	25,028	2,086	24,646	2,054	-1,972	-164
15%	Level 2	3,943	329	74,447	6,204	17,657	1,471	23,057	1,921	22,674	1,890	-3,943	-329
30%	Level 3	7,887	657	70,503	5,875	13,713	1,143	19,113	1,593	18,731	1,561	-7,887	-657
70%	Level 4	18,403	1,534	59,987	4,999	3,197	266	8,597	716	8,215	685	-18,403	-1,534
100%	Level 5	26,290	2,191	52,100	4,342	-4,690	-391	710	59	328	27	-26,290	-2,191

Table C. Western Isles + Potential Processing Infrastructure

		Morts		AVAILABLE CAPACITY (-VE = SHORTFALL) FOLLOWING MORTS EVENTS INDICATED									
				Seagoing		Storage		Land Haulage		Ferry		Processing	
		Annual	*Monthly*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*
Based on 2017 data													
8%	Level 1	3,015	251	39,825	3,319	12,585	1,049	40,185	3,349	37,545	3,129	2,485	207
15%	Level 2	6,030	502	36,810	3,068	9,570	798	37,170	3,098	34,530	2,878	-530	-44
30%	Level 3	12,059	1,005	30,781	2,565	3,541	295	31,141	2,595	28,501	2,375	-6,559	-547
70%	Level 4	28,138	2,345	14,702	1,225	-12,538	-1,045	15,062	1,255	12,422	1,035	-22,638	-1,886
100%	Level 5	40,197	3,350	2,643	220	-24,597	-2,050	3,003	250	363	30	-34,697	-2,891
2030, 30% growth													
8%	Level 1	3,919	327	51,773	4,314	16,361	1,363	62,801	5,233	49,121	4,093	1,581	132
15%	Level 2	7,838	653	47,854	3,988	12,442	1,037	58,882	4,907	45,202	3,767	-2,338	-195
30%	Level 3	15,677	1,306	40,015	3,335	4,603	384	51,043	4,254	37,363	3,114	-10,177	-848
70%	Level 4	36,579	3,048	19,113	1,593	-16,299	-1,358	30,141	2,512	16,461	1,372	-31,079	-2,590
100%	Level 5	52,256	4,355	3,436	286	-31,976	-2,665	14,464	1,205	784	65	-46,756	-3,896
2030, 50% growth													
8%	Level 1	4,522	377	79,016	6,585	18,878	1,573	65,078	5,423	57,878	4,823	978	81
15%	Level 2	9,044	754	74,494	6,208	14,356	1,196	60,556	5,046	53,356	4,446	-3,544	-295
30%	Level 3	18,089	1,507	65,449	5,454	5,311	443	51,511	4,293	44,311	3,693	-12,589	-1,049
70%	Level 4	42,207	3,517	41,331	3,444	-18,807	-1,567	27,393	2,283	20,193	1,683	-36,707	-3,059
100%	Level 5	60,295	5,025	23,243	1,937	-36,895	-3,075	9,305	775	2,105	175	-54,795	-4,566

Table D. North West with Licensed Processing Infrastructure

		Morts		AVAILABLE CAPACITY (-VE = SHORTFALL) FOLLOWING MORTS EVENTS INDICATED									
				Seagoing		Storage		Land Haulage		Ferry		Processing	
		Annual	*Monthly*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*
Based on 2017 data													
8%	Level 1	4,415	368	38,425	3,202	35,185	2,932	56,785	4,732	0	0	-4,415	-368
15%	Level 2	8,829	736	34,011	2,834	30,771	2,564	52,371	4,364	0	0	-8,829	-736
30%	Level 3	17,658	1,472	25,182	2,098	21,942	1,828	43,542	3,628	0	0	-17,658	-1,472
70%	Level 4	41,202	3,434	1,638	136	-1,602	-134	19,998	1,666	0	0	-41,202	-3,434
100%	Level 5	58,860	4,905	-16,020	-1,335	-19,260	-1,605	2,340	195	0	0	-58,860	-4,905
2030, 30% growth													
8%	Level 1	5,739	478	49,953	4,163	44,541	3,712	73,821	6,152	0	0	-5,739	-478
15%	Level 2	11,478	956	44,214	3,685	38,802	3,234	68,082	5,674	0	0	-11,478	-956
30%	Level 3	22,955	1,913	32,737	2,728	27,325	2,277	56,605	4,717	0	0	-22,955	-1,913
70%	Level 4	53,563	4,464	2,129	177	-3,283	-274	25,997	2,166	0	0	-53,563	-4,464
100%	Level 5	76,518	6,377	-20,826	-1,736	-26,238	-2,187	3,042	253	0	0	-76,518	-6,377
2030, 50% growth													
8%	Level 1	6,622	552	64,658	5,388	52,778	4,398	85,178	7,098	0	0	-6,622	-552
15%	Level 2	13,244	1,104	58,036	4,836	46,156	3,846	78,556	6,546	0	0	-13,244	-1,104
30%	Level 3	26,487	2,207	44,793	3,733	32,913	2,743	65,313	5,443	0	0	-26,487	-2,207
70%	Level 4	61,803	5,150	9,477	790	-2,403	-200	29,997	2,500	0	0	-61,803	-5,150
100%	Level 5	88,290	7,358	-17,010	-1,418	-28,890	-2,408	3,510	292	0	0	-88,290	-7,358

Table E. South West with Licensed Processing Infrastructure

		Morts		AVAILABLE CAPACITY (-VE = SHORTFALL) FOLLOWING MORTS EVENTS INDICATED									
				Seagoing		Storage		Land Haulage		Ferry		Processing	
		Annual	*Monthly*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*	*pa*	*pm*
Based on 2017 data													
8%	Level 1	2,889	241	36,111	3,009	12,711	1,059	40,311	3,359	0	0	-2,889	-241
15%	Level 2	5,779	482	33,221	2,768	9,821	818	37,421	3,118	0	0	-5,779	-482
30%	Level 3	11,557	963	27,443	2,287	4,043	337	31,643	2,637	0	0	-11,557	-963
70%	Level 4	26,967	2,247	12,033	1,003	-11,367	-947	16,233	1,353	0	0	-26,967	-2,247
100%	Level 5	38,524	3,210	476	40	-22,924	-1,910	4,676	390	0	0	-38,524	-3,210
2030, 30% growth													
8%	Level 1	3,756	313	46,944	3,912	16,524	1,377	52,404	4,367	0	0	-3,756	-313
15%	Level 2	7,512	626	43,188	3,599	12,768	1,064	48,648	4,054	0	0	-7,512	-626
30%	Level 3	15,024	1,252	35,676	2,973	5,256	438	41,136	3,428	0	0	-15,024	-1,252
70%	Level 4	35,057	2,921	15,643	1,304	-14,777	-1,231	21,103	1,759	0	0	-35,057	-2,921
100%	Level 5	50,081	4,173	619	52	-29,801	-2,483	6,079	507	0	0	-50,081	-4,173
2030, 50% growth													
8%	Level 1	4,334	361	54,166	4,514	19,066	1,589	60,466	5,039	0	0	-4,334	-361
15%	Level 2	8,668	722	49,832	4,153	14,732	1,228	56,132	4,678	0	0	-8,668	-722
30%	Level 3	17,336	1,445	41,164	3,430	6,064	505	47,464	3,955	0	0	-17,336	-1,445
70%	Level 4	40,450	3,371	18,050	1,504	-17,050	-1,421	24,350	2,029	0	0	-40,450	-3,371
100%	Level 5	57,786	4,815	714	60	-34,386	-2,865	7,014	585	0	0	-57,786	-4,815

APPENDIX D

Risk of Transfer of Disease

ROUTES AND STEPS FOR MORTALITY MANAGEMENT

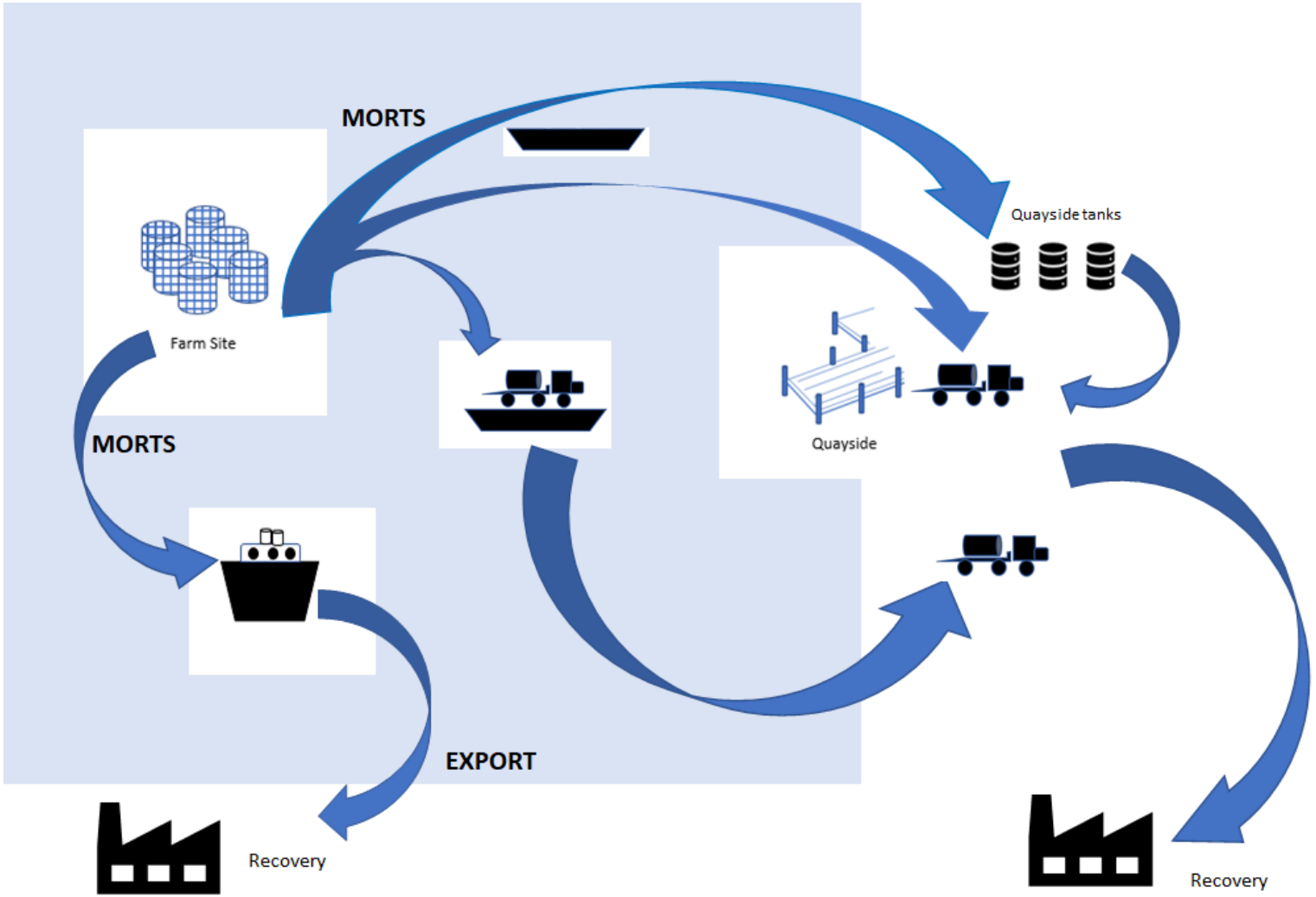

TABLE 1

STEPS	RISKS			PAPERWORK/APPROVALS/SIGN-OFF REQUIRED
	Before arriving	*During Operation*	*After Operation*	
Transfer directly at pens to sea-going vessel e.g. to Scandinavia	• Delay in arrival increases risk of transmission of infective material throughout the site • If significant mortality, may be a risk to structure of pens and possible failure of system to contain weight of mortalities. • Risk that mortality is not removed • If not removed there is an increased risk of predators. Increased risk of predator damage to nets and a possible containment issue	• Vessel may introduce infective disease to site • Handling of mortalities may release infective particles on site increasing risk of pen to pen transfer • Operation is weather dependent • Risk of Spillage. • Staff involved in removal procedures means risk of interruption to normal husbandry procedures leading to potential increase in mortality • Prolonged time to complete mortality removal, increases risk of disease • Insufficient resources available to remove mortality (divers, staff) • Vessel not of sufficient capacity to remove mortality	• Vessel carrying mortality is a disease risk • Site not fully cleared of mortality • Mortality is on-going • Insufficient capacity at delivery site to accept mortality load	Transporter must have APHA approval[2&3], e.g. Hordafor acts as both a transporter and a storage facility. A Commercial Document is required that includes: - detailed description of the contents including the ABP category -quantity of the load -the address of the site of origin -the address of the destination of the load - contact details for origin and destination -the approval and registration numbers of the vehicle/vessel and the sites of origin and destination (wastes must be delivered to an approved site) -the date of transport -signature of person responsible for the load in transit. Commercial Document must be produced in triplicate by an approved site (destination) or registered transporter. • A copy for the origin site • A copy with the transporter • A copy at the storage/disposal site An export health certificate (EHC), signed by an 'Official Veterinarian' is required if the mortality load is to be exported outside of the EU for disposal. Guidance is available on the requirements for exports within and out with the EU[4].
Transfer directly at pens to road tanker, on sea-going vessel (e.g. new system)	Risks as above	Risks as above plus • Tanker may introduce infective disease to site • Road tankers not designed to handle mortality • Risk of overfilling road tanker	Risks as above plus • Vessel and road tanker carrying mortality is a disease risk	Transporter (as contractor to fish farm) must have APHA approval[2]. A Commercial Document must accompany load as above

Transfer at quayside to road tankers	• Equipment not designed for mass mortality transfer	• Additional handling step for mortalities introduces additional risks • Risk of Spillage • Risk transfer operations affected by tide • Road tankers not designed to handle mortality • Transfer operations may be delayed or affected by tide • Risk of overfilling road tanker • Pier authority will not permit transfer of mortality • Tanker exceeds weight limit for pier	• • Spilled material left on pier	Transporter (as contractor to fish farm) must have APHA approval[2]. A Commercial Document must accompany load as above
Transfer at quayside to storage tanks	• Equipment not designed for mass mortality transfer and storage	• Additional handling step for mortalities introduces additional risks • Risk of Spillage • Risk transfer operations affected by tide • Risk of overfilling quayside tanks • Pier authority will not permit Storage of mortality on pier • Tank or container capacity exceeds weight limit for pier	• Risk of leakage of stored material • Tank capacity insufficient • Vandalism • Lack of security • Risk of pests and vermin	Storage tanks must have APHA approval [3] before they can receive or store ABPs. Sites need to demonstrate that they have Operating Procedures in place, supported by documentation, records, biosecurity procedures, H&S system, HACCP plan (if storing more than 1 category of ABP) and disposal procedures. Storage sites will be inspected by APHA as part of the approval process. Standard regulatory approval (Planning Permission, SEPA consent) may also be required. Movement of waste into and out of storage must be covered by a Commercial Document, as above.
Transfer from storage tanks to tanker		• Spillage risk		A Commercial Document must accompany load as above
Transfer from tanker/trailer to Processor		• Spillage risk • Insufficient capacity at processor		A Commercial Document must accompany load as above

Table References:

[1] http://www.gov.scot/Topics/marine/Fish-Shellfish/FHI/healthpractice/DisGuideIV

[2] https://www.gov.uk/guidance/transporting-animal-by-products

[3] https://www.gov.uk/guidance/animal-by-product-categories-site-approval-hygiene-and-disposal

[4] https://www.gov.uk/guidance/export-animal-bones-protein-and-other-by-products-special-rules

[5] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/711926/form-ab117.pdf

[6] https://www.gov.uk/guidance/export-animal-bones-protein-and-other-by-products-special-rules#create-your-own-commercial-document

TABLE 2

STEPS	MITIGATION ACTIVITIES – NOTIFIABLE DISEASES (BLUE FONT)			PAPERWORK/APPROVALS/SIGN-OFF REQUIRED
	Before arriving	During Operation	After Operation	
General Mitigation applicable to all routes of removal	• Emergency plan for mass mortality in place at farm site which covers: ○ Identification of equipment required ○ Identification of all possible routes of removal of mortality ○ Contact details for all relevant contractors e.g. Hordafor; Divers etc ○ Identify transporters, disposal and storage sites and their capacity • Communication of risks, disease details and estimated quantity to approved mortality transporter • Communication of risks to farms in DMA & neighbouring sites - Stitch on top net to improve containment if cage sinks and prevent predator access - Ensure all predator management systems are in place and operational • Equipment must be suitably designed to handle both the size of fish and the volume of the mortality.	• Plan for bad weather • Any vessel or container used to store or transport ABP Category 2 waste must be covered and leak proof. • Remove mortality as soon as possible to minimise decomposition and reduce spread of any infective material • Ensure mortality and mortality breakdown products are contained during removal where possible. • Make sufficient staff resource available		• **Fish cannot be moved without permission. Applications for permission to move fish (live or dead), equipment and staff subject to movement restrictions should be sent to the Fish Health Inspectorate at least 14 days in advance of the planned movement.** • **Approval must be obtained from FHI for the movement of all items of equipment liable to transmit infection to or from sites suspected or confirmed infected with a List I or List II notifiable disease of fish.** • **A Prohibition Notice may be applied to control the movement of persons entering any farm within a designated area.**
Transfer directly at pens to sea-going vessel e.g. to Scandinavia	• Vessel must register with APHA[2&3]. • Remove mortality while waiting for vessel arrival to	• Equipment moved to the site must be cleaned and disinfected prior to arrival to reduce the risk of spread of disease.	• Disinfection of vessel and equipment prior to leaving site. Areas covered must include surfaces to water line,	

	reduce weight on cage infra structure. • Ensure disinfection procedures[1] have been completed and signed off by the master of the vessel prior to arrival on site • Permissions in place to move fish-see 'Paperwork Required'. • Check capacity is available at storage and disposal sites. Identify alternatives	• Estimate scale of mortality (numbers and weight) as early as possible to ensure sufficient vessel capacity • Have spill clean-up procedures and spill kit equipment in place	loading equipment and crew PPE. • **Disinfection[1] of pens, nets, equipment** • **Fallow period synchronised with any other farms in DMA** • **The Fish Health Inspectorate is responsible for overseeing the withdrawal of fish from sites confirmed with a listed disease and the cleaning and disinfection of equipment on site[1].** • **Minimum fallow period is normally 3-6 months** • Alternative method of removal if vessel has insufficient capacity • Ensure the cause of any subsequent or on-going mass mortality is identified
Transfer directly at pens to road tanker, on sea-going vessel (e.g. new system)	As above • Mortality containers must be designed to be fit for purpose. • They must be covered, leakproof and designed for easy cleaning and disinfection	• Equipment moved to the site must be cleaned and disinfected prior to arrival to reduce the risk of spread of disease. • Estimate scale of mortality (numbers and weight) as early as possible to ensure sufficient vessel capacity • Do not over fill tanker • Have spill clean-up procedures and spill kit equipment in place • Tanker design should include clear visibility of	As above and • Tanker must be appropriately cleaned and disinfected to reduce risk of disease transfer[1] • Second tanker must be available to continue operations if required

		load level to reduce risk of overfilling	
Transfer at quayside to road tankers	• Mortality containers must be designed to be fit for purpose. • They must be covered, leakproof and designed for easy cleaning and disinfection	• Do not over fill tanker • Have spill clean-up procedures and spill kit equipment in place • Tanker design should include clear visibility of load level to reduce risk of overfilling • Plan delivery at quayside to ensure operation not affected by tidal conditions • Check with harbour authority that transfer of mortality will be permitted and that road tanker does not exceed any weight limit for quay or pier	• Ensure adequate facilities to clean and dispose of any spillage are available during operations • Clean area after operation completed

Transfer at quayside to storage tanks	• Ensure storage tank facility has APHA site approval[3].
	• Ensure storage tanks are located in a secure area and are:
	  ○ tamper proof
	  ○ pest proof
	  ○ weather proof
		• Do not overfill tank
		• Have spill clean-up procedures and spill kit equipment in place
		• Tank design should include clear visibility of load level to reduce risk of overfilling
		• Plan delivery at quayside to ensure operation not affected by tidal conditions
		• Check with harbour authority that transfer of mortality will be permitted and that tank capacity does not exceed any weight limit for quay or pier
			• Tanks must be suitably bunded to contain any leaks.
			• Secure area against unauthorised access
			• Label tanks appropriately

Transfer from storage tanks to tanker	• Appropriate equipment in place prior to start of operations:
	  ○ pumps
	  ○ pipework
	  ○ connectors for any transfer pipework
	  ○ Spill kit
		• Have spill clean-up procedures and spill kit equipment in place	• Ensure adequate facilities to clean and dispose of any spillage are available during operations
			• Clean area after operation completed

Transfer from tanker/trailer to Processor	• Communicate expected arrival time and load details to processor prior to departure
	• Appropriate equipment in place prior to start of operations:
	  ○ pumps
	  ○ pipework
	  ○ connectors for any transfer pipework
	  ○ Spill kit
		• Have spill clean-up procedures and spill kit equipment in place	• Ensure adequate facilities to clean and dispose of any spillage are available during operations
			• Clean area after operation completed

General Notes:

- Transporters must register with APHA before moving mortalities. The registration process is completed on line using form AB117[5]. There is no fee to register and the registration is not limited to a maximum time period. Registration could be completed in advance by any transporter wishing to add mortality removal to their operations. APHA inspections are carried out on a risk-based approach. Risk is assessed based on the category of the material being handled (ABP Category 2) and the frequency and volume of loads.
- Storage tank sites require approval from APHA, which will include an inspection. Registration of the site is through completion of form AB117[5].
- Disposal of mortality via export outside of the EU requires an 'Official Veterinarian' to inspect the load and issue a health certificate EHC for every export[4].
- Movement of mortality in the UK must be accompanied by a Commercial Document to ensure full traceability[6].

Notes - Notifiable Diseases

- Fish mortality is classified as Animal By-Product Category 2, regardless of whether the cause of death was as a result of a notifiable disease. The presence or suspicion of a Notifiable Disease on site does mean that there are additional requirements associated with the movement of mortalities, vessels, vehicles, equipment and personnel.
- On confirmation of a notifiable disease MSS would apply a controlled designation notice (CDN) or if there is reasonable suspicion before confirmation an initial designation notice (IDN) which severely restricts people and equipment (including those individuals and transport involved in mort disposal). If ISA is confirmed, compulsory slaughter would likely be enforced and any movement of wellboats involved would need to be made in consultation and with permission of MSS, and full disinfection performed (stage 3).