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Risk of disease transfer with wellboats in Norway – Technical report

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Sammendrag

Brønnbåter kan i teorien bidra til spredning av sykdommer i norsk havbruk og akvakulturnæring, men i hvilken grad dette faktisk spiller en rolle er uklart. Feltet er komplekst, og mistanker kan sjeldent bekreftes, men heller ikke avkreftes.

Risikovurdering er en tilnærming til å analysere risiko på en systematisk og vitenskapelig måte. I denne rapporten samler vi data av betydning for å utføre en slik risikovurdering. Denne informasjonen vil i neste omgang brukes til å vurdere i hvilken grad smittespredning med brønnbåt i norsk akvakultur kan oppstå, hvilke punkter fører til størst risiko, og hvordan risikoen kan reduseres på den mest effektive måten.

Første delen av rapporten er viet brønnbåtenes aktivitet. Her samles informasjon om den norske brønnbåtflåten, gjeldende regelverk, ulike transporttyper, antall fisk som transporteres, hvor omfattende brønnbåttransporten er, hvilke ruter som benyttes, hva som skjer ved lasting og lossing, utskifting av vann, overflater i brønnbåt og biosikkerhet.

Andre delen av rapporten er viet smittestoff av betydning i Norge. Her samles informasjon om smittestoffenes utbredelse, utskillelse og konsentrasjon i vann, overlevelse i miljø og i biofilm, følsomhet for desinfeksjonsmidler, og infeksjonsdose.

Summary

Wellboats may theoretically contribute to the spread of diseases in Norwegian aquaculture, but to what extent this actually happens is unclear. The field is complex, and suspicions can rarely be confirmed nor disproved with certainty.

Risk assessment analyzes risk in a systematic and scientific way. In this report we collect data of significance to perform such a risk assessment. This information will later be used to assess to what extent the spread of infection with wellboat in Norwegian aquaculture may occur, which parts and pathways lead to the greatest risk, and how risk can be reduced in the most efficient way .

The first part of the report is devoted to wellboat activity. We present information about the Norwegian wellboat fleet, applicable regulations, different transport types, the number of fish being transported, how extensive the wellboat transport is, which routes are used, the loading and unloading of fish, replacement of water, surfaces in the wellboat, and biosecurity measures.

The second part of the report is devoted to significant infectious agents in Norway. We present information about the agents' distribution, excretion and concentration in water, survival in the environment and in biofilm, susceptibility to disinfectants, and infectious dose.

Background

The present report was written during a research project financed by the Norwegian Research Council (project no. 210667) and associated partners. These included: Cflow Fish Handling AS, SINTEF Fiskeri og Havbruk AS, Flatsesund Enigneering AS, Sølvtrans Rederi AS, Rolls-Royce Marine AS, Marine Harvest AS, in addition to the Norwegian Veterinary Institute. All partners have contributed to the report through discussions, data and other information, as well as hearing of the final report.

We thank our colleagues at the Norwegian Veterinary Institute for contributions regarding information on facts about disease agents, particularly Irene Ørpetveit, Duncan Colquhoun, Torstein Tengs, Randi Grøntvedt, Peder Jansen, Tor Atle Mo, Semir Loncarevic, Monika J. Hjortaas and Mona D. Jansen.

Debes Christiansen, Birgit Oidtmann, Sandy Murray and Stuart Wallace are acknowledged for providing information on fish diseases in the Faeroe Islands, England and Scotland.

Stian Johnsen at the Norwegian Food Safety Authority is acknowledged for comments and inputs on this manuscript, in particular facts regarding the legislation.

Abbreviations

Terms	Explanation
AGD	Amoebic gill disease
AIS	Automatic Identification System for tracking of ships
BKD	Bacterial kidney disease
BREF	Brønnbåteiernes forening (Wellboat-owner's association)
CMS	Cardiomyopathy syndrome
IHN	Infectious haematopoietic necrosis
IHNV	Infectious haematopoietic necrosis virus
IPN	Infectious pancreatic necrosis
IPNV	Infectious pancreatic necrosis virus
ISA	Infectious salmon anaemia
ISAV	Infectious salmon anaemia virus
NFSA	Norwegian Food Safety Authority
PD	Pancreas disease
PMCV	Piscine myocarditis virus
PRV	Piscine reovirus
SAV2	Salmonid alphavirus 2
SAV3	Salmonid alphavirus 3
VHS	Viral haemorrhagic septicaemia
VHSV	Viral haemorrhagic septicaemia virus

Introduction

Reared anadromous salmonids, including Atlantic salmon, are transported extensively in Norway. The wellboat fleet in Norway consists of 63 vessels, which transport every year approximately 350 million smolts and more than 1.4 million ton harvested fish (North East Atlantic 2012, Source: Brønnbåteiernes forening). Smolts are produced at freshwater sites and transferred to marine sea-sites. As they grow, they are often moved to new cages within the same site, and sometimes to new sea-sites. At the end of the production period they are finally transported live to slaughter houses, with the exception of one specialized "slaughter boat" that kill the fish on site and transport them in closed tanks to land for evisceration, fileting and sorting.

Anthropogenic transfer of stock has been recognized as one key disease emergence risk factor in salmonid production (Murray and Peeler, 2005). The transport of live aquaculture animals by well-boats is considered to play a significant role in spreading diseases in Norway, particularly between regions (Guttvik, 2006; Brun, 2010). It is commonly believed that the bacterial disease Furunculosis and the viral disease Infectious salmon anaemia (ISA) were spread by wellboat in Norway in late 80s (Guttvik, 2006). Also, it has been suggested that the suspected introduction of SAV2 from Scotland, and its further spread in Norway, is due to transport of fish between sea sites, in addition to passive spread in seawater between neighboring sites (Hjortaas et al., 2013; Hjeltnes, 2014). Live fish is allowed traded between the two countries according to current legislation, and salmon was occasionally imported from Scotland to Norway some years ago (pers. comm. Stian Johnsen, NFSA).

Scientific evidence of pathogen spread by wellboat transport is limited. A study from Scotland examined the role of shipping in the invasive spread of ISA among Scottish salmon farms (Murray et al., 2002). These authors carried out a quantitative analysis of the spread of ISAV in Scotland and its relationship to the movements of boats that serviced the farmed-salmon harvesting centre in the year preceding the epidemic. The results supported a strong link between the number of wellboats visits and the probability of ISAV detection in an area. The identical genetic nature of ISAV at different sites further supported a direct link between these incidents. In contrast, they found no relation between vessels delivering food or involved in other work, and disease spread (Murray et al., 2002). A recent study from the ISA epidemic in Chile (2007-2009) also demonstrated that increased number of shipments entering a farm was a risk factor for the spread of ISA (Mardones et al., 2014). Long distance transmission explained 3 % of the ISA cases, and seven outbreaks were caused by movement of latently infected fish (Mardones et al., 2014).

Indirect disease spread with wellboats, in the absence of introduction of infected fish, is even less studied. Large numbers of pathogens have been detected in ballast water of ships entering U.S. waters (Ruiz et al., 2000) and may potentially cause damage with regard to both environment and health when released to a native region (DNV, 2012). It is a concern that a number of fish pathogens may be spread either through ballast water of through wellboats.

Risk analysis provides a scientific frame for risk assessment and management, and includes a systematic analysis of available scientific knowledge. In this report, we gather available data required to undertake a risk assessment for the spread of disease through wellboats in the Norwegian aquaculture industry. The first part deals with the wellboats, including their activity and biosecurity measures. The second part deals with the hazards, i.e. relevant infectious agents, including their distribution, their survival in the environment and their resistance to disinfectants. Finally, relevant documents are appended, including reports produced following the visit of two wellboats responsible for a significant amount of transports in Norway.

Risk assessment – relevant data

We present here a number of data gathered from the literature, relevant websites, and contacts with people involved with the wellboat industry. Whenever possible, we report official data and data covering the whole industry. In the absence of such overviews, examples from the field are sometimes reported.

1. Data on wellboats

1.1. Wellboats in the maritime sector

In Norway, the wellboat owners are organized into the wellboat owners association, Brønnbåteiernes Forening (BREF). By 1 March 2013, a total of 67 Norwegian owned wellboats, having a total capacity of 68.688 m^3 transport volume was reported by BREF (Personal communication Jan Harald Haukvik). The main activity of wellboats consists of transport/shipping of smolt to sea sites, and on-grown fish for slaughter. Other activities include bath treatments against sea-lice and AGD, grading of fish on site.

Wellboats work for several fish producers. They have typically long-term contracts with a number of producers, but can take additional jobs for other ones when needed. The big companies do share well-boats. For example does Ronja Atlantic work primarily for Marine Harvest and Salmar, and occasionally for Lerøy (Personal communication, Jan Leikanger).

According to BREF, the sailing area (or contract) of the 67 Norwegian-owned wellboats by 1 March 2013 was reported to be Norway for 52 boats, UK for five boats, UK and Shetland for two boats, UK and Norway for one boat, Ireland for one boat, Chile for three boats and East Canada for one boat. The sailing area for two boats were missing. The average transport volume was 1025 m^3 and the mean age was 14.4 years.

The 52 boats sailing in Norway can be divided in four groups based on size where:

- 16 boats below 600 m^3
- 15 boats between 600 m^3 and 900 m^3
- 14 boats between 900 m^3 and 1500 m^3
- 7 boats above 1500 m^3

The majority of the wellboats are owned by five companies (Rostein AS, Frøy Sjøtransport AS, Bømlo Brønnbåtservice AS, Norsk Fisketransport (Dønna Brønnbåtservice AS) and Sølvtrans AS). These few large companies are investing in new boats, while smaller companies are not. The trend is towards well-equipped specialised larger boats (2 500 m^3). They represent a significant investment, the cost of a boat 1 200 m^3 being estimated to 150-170 million NOK.

The 17 more recent vessels have the possibility of transporting fish in a closed system, chilling the water. They have a sliding bulkhead to empty the tank, and are equipped for bath-treatment against sea-lice with H_2O_2. Some also have a lice filter (12 boats) and UV-disinfection (11 boats). Closed transports require advanced technologies to monitor and control the water quality during transport. More information can be found in DNV's report from 2012 (DNV, 2012).

1.2. Relevant legislation

Transport of aquatic animals is covered by both national and international legislation.

The legislation covers disease prevention, food safety and animal welfare, as well as shipping legislation and regulation of personnel security (see Appendix, in Norwegian).

Regarding disease transmission the legislation is based on three principles:

- Transport vehicles must be approved by the competent authorities, with necessary equipment and personnel trained to perform adequate wash and disinfection.
- Transported aquaculture animals must be clinically healthy and fit for transport. The risk of disease transmission along the route must be evaluated. The health status of the transported animals, the animals along the route, and the site of unloading, must be documented.
- If there is any possibility of disease transmission between the transported animals and aquaculture animals in the surrounding environment, appropriate measures must be prepared and implemented to reduce the contact between the transported animals / water and the surroundings.

1.3. Types of transport

Wellboats are used in the Norwegian aquaculture industry for the transport of live fish and in the application of pharmacological treatment against sea- lice and fresh water treatment against AGD:

- Shipping of fish (smolt) from hatchery/smolt producer to sea site
- Shipping of on-grown salmon for slaughter
- Shipping of salmon with infectious (notifiable) diseases (*E.g.* PD, ISA, IPN) for slaughter/destruction
- Shipping of salmon between sea sites (requires permission from the authorities)
- Grading or moving fish between pens on sea-sites.

Species: Atlantic salmon (*Salmo salar*) and rainbow trout (*Oncorhynchus mykiss*). Wellboats also transport other species, as atlantic cod (*Gadus morhua*), halibut (*Hippoglossus hippoglossus*) and different species of cleaner fish used in salmon farms.

1.4. Number/Weight of fish transported

According to a brochure available on the website of the Norwegian wellboat association (http://www.fraktefartoyene.no/), the Norwegian wellboats transported in 2011 around

- 1.2 million tonnes slaughtered fish and
- 320 million smolts

In addition, they contributed in

- grading 400 million fish in Norway, UK and Canada
- delousing 300 million fish in Norway, UK and Canada
- other tasks (undefined)

The most efficient transport, in terms of fish transported per tank volume, is undertaken by the specialised slaughter boat (MS Tauranga), which transports dead fish only. An 80% filling up is possible, although some clients require a maximum filling of 70%. Given a tank volume of 420m^3, this represents 336 or 294 tons of bled fish, respectively. With a slaughter speed of 150-200 fish per minute, it takes about five to six hours to fill the boat, which is considered long compared to live transports. On the other hand, fuel expenses are smaller than when transporting live fish, and the risk of spreading diseases is minimalized.

Transporting live fish demands a lower density during transport. Fish loading is not limited by a slaughtering process, but should be closely monitored and regulated to limit stress.

The exact number of fish dying during transport, or in slaughter nets, is unknown.

The details regarding biomass and number of fish transported are not available on official websites. We have therefore reported statistics kindly provided by one slaughterhouse. Delivered biomass, number of fish and average weight data are summarized below in Figure 1-Figure 4.

As shown in Figure 1, the average Biomass transported for slaughter per delivery has increased from 112 000 to 152 000 kg and the number of fish from 21 000 to 24 000 from 2009 to 2013 (2013 data only from January to June).

The distributions of biomass (Figure 2), number of fish (Figure 3), and mean weight (Figure 4) for both slaughter (left figures) and grading/ sea lice treatment (right figures) shows a wide variability. In 90 percent of deliveries, the average weight for slaugher is between 4.5 to 6.7 kg while similar figures for grading/ sea lice treatment is 0.7 to 4.5 kg.

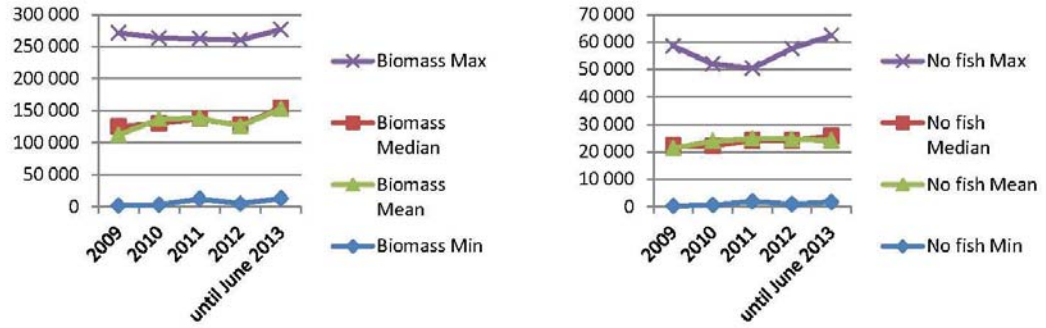

Figure 1. Biomass (kg, left figure) and number (right figure) of live fish transported for slaughter per delivery, shown as maximal, median, mean and minimal value per year. Data from one slaughterhouse.

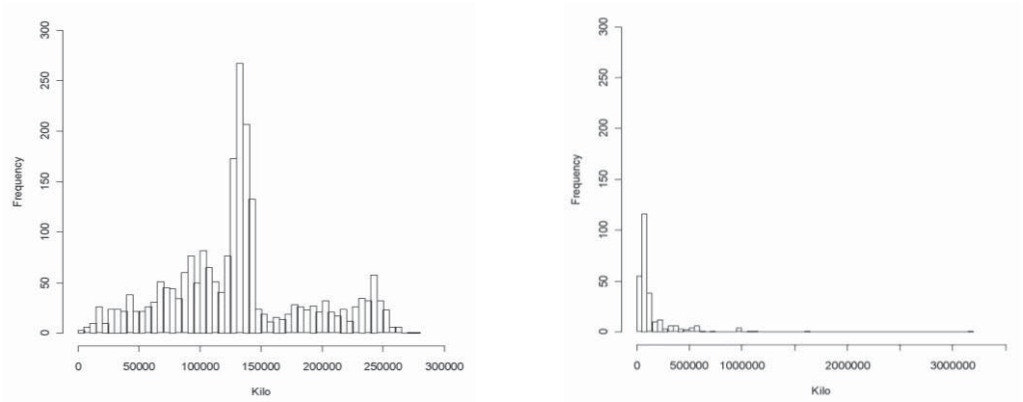

Figure 2. Distribution of biomass (kg) transported to slaughter (left figure, 2009-June 2013) per delivery, and graded/ treated for sea lice by two boats delivering fish to this slaughterhouse (right figure, 2009-2010) per event.

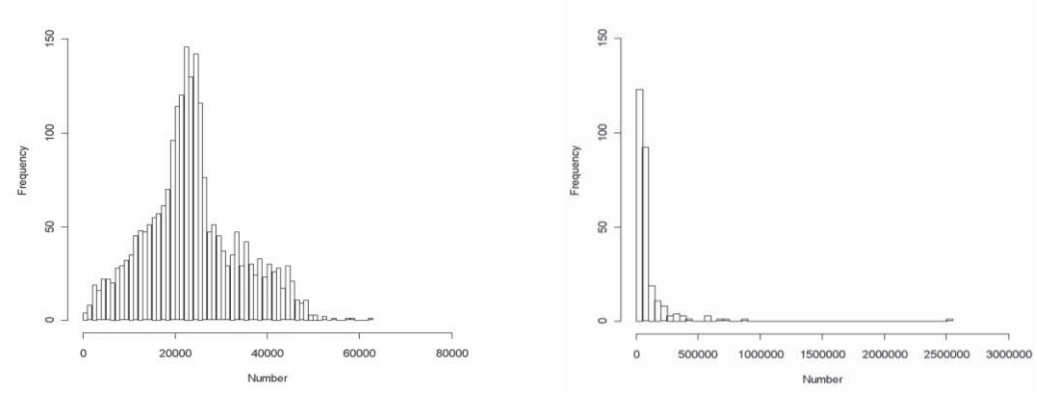

Figure 3. Distribution of number of fish transported to slaughter (left figure, 2009-June 2013) per delivery, and graded/ treated for sea lice by two boats delivering fish to this slaughterhouse (right figure, 2009-2010) per event.

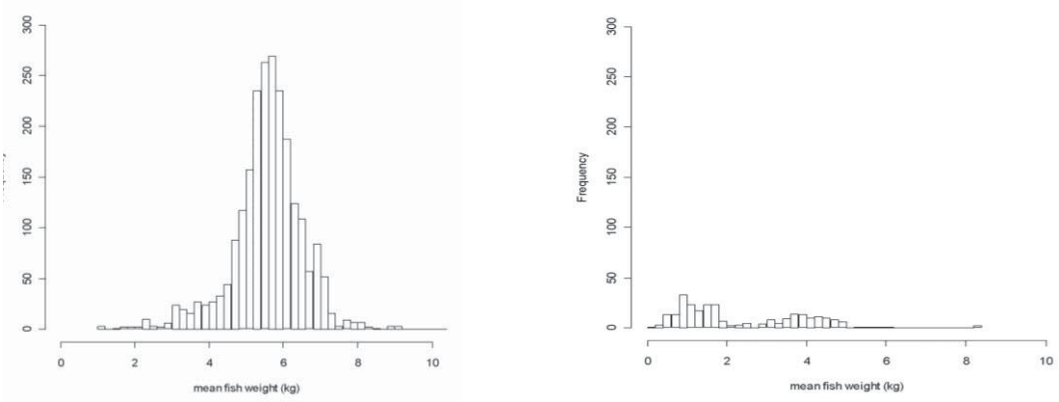

Figure 4. Distribution of mean weight (kg) transported to slaughter (left figure, 2009-June 2013) per delivery, and graded/ treated for sea lice by two boats delivering fish to this slaughterhouse (right figure, 2009-2010) per event.

1.5. Frequency of transport activities with wellboats

1.5.1. Positioning data

The Norwegian Veterinary Institute is in relation with Anteo AS for provision of national AIS data for further analysis. An agreement has been in place since 2013, and we expect data to be available in the near future. These data will be of maximal value once mandatory real-time tracking will be implemented through the new regulation (1 January 2016). After that date all wellboats have to report their geographical position electronically every half hour.

1.5.2. Data from one slaughterhouse

Data kindly provided by the industry give us an overview of the wellboat activity connected to one slaughterhouse in 2009-June 2013. This activity is summarized below.
Table 1 shows that the number of sites delivering fish for slaughter has decreased from 21 to 9 in a five-year period. During this time, the number of boats involved have decreased from 10 to 4.
Table 2 describes the activity related to grading and sea-lice treatment carried out by three major boats also involved in fish harvesting.

Table 1. Number of sites delivering fish and wellboat harvesting fish per year at one slaughterhouse.

Year	Number of sites	Number of boats
2009	21	10
2010	30	10
2011	21	8
2012	16	8
2013	9	4

Table 2. Number of different sites and single operations for three wellboats, related to grading/ treatment for sea lice of fish (2009-2010).

Year	Wellboat	Sites	Single operations
2009	A	15	156
2009	B	9	58
2010	C	14	50
2010	B	4	7

For each site, the yearly number of wellboat visits, as well as the number of wellboats involved, show large variation. Some sites were visited more than 80 times, while others less than 10 times. The number of wellboats involved per site varied from one to six.

For wellboats, the yearly number of sites visited related to fish harvest to this slaughterhouse varied from 1 to 26, and the total number of visits from 1 to 334 (2009-2013). Two of the wellboats performed 90 % of the single visits, harvested 91 % of the fish, and visited 71 % of the sites in 2010-2012.

The number of monthly visits related to fish harvest varied from 22 (July 2009) to 79 (Sep 2009), with a tendency for lower activity in July (**Figure 5**).

Figure 5. Number of sites (in red) and visits (in blue) per month and year related to fish harvest. Data from one slaughterhouse.

1.6. Routes of transport

1.6.1. Sources of information

According to current regulation (NFD, 2008b), each boat has to keep a journal with information on the route, including the fish-farms and slaughter-houses visited.

Norwegian fishery boats are obliged to have electronic positioning equipment allowing for hourly information to the Directorate of Fisheries (NFD, 2009, 2010). However, in 2014, this does not include wellboats. A private company (Marine Traffic) has so far kept real time tracking of shipping sending signals on a voluntary basis, allowing the position of registered boats to be visible on the internet for the last 24 hours. Historical data can be obtained on demand. However, only some of the wellboats are registered in the system, and they are free to interrupt the sending of signals. According to the new legislation on fish transport (NFD, 2008b), stricter requirements will be implemented from 1. January 2016. The boats will have to send signals every half hour to the Directorate of Fisheries.

From our experience at the Norwegian Veterinary Institute, the historical tracing of wellboat routes has been a challenging task. We have so far not been able to get an appropriate overview of the traffic in an area. Such studies have been based on the tracking of wellboats' visits to specific outbreak farms only, and not the overall traffic in the area. This may explain why the risk posed by wellboats has so far been difficult to estimate or validate scientifically. We hope that the future availability of relevant data will make such an approach possible.

1.6.2. Farms visited

The data presented here are based on data kindly provided by one slaughterhouse.

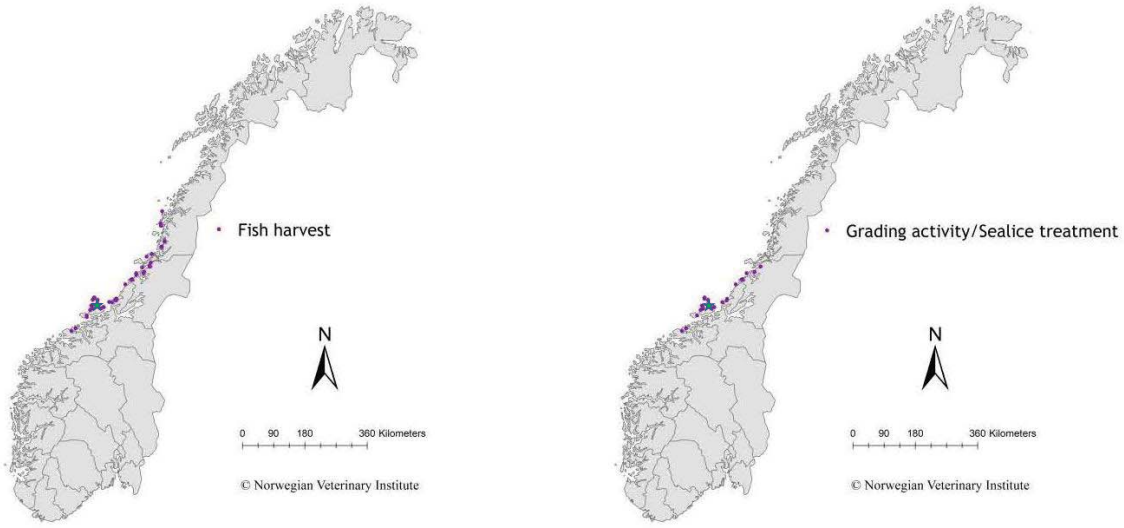

Figure 6. Map showing farm sites related to fish harvest (2009-2013) and grading activities/ Sealice treatment (2009-2010) connected to one slaughterhouse (green star on the maps).

1.6.3. Closeness to other farms

It has previously not been possible to quantify the proximity of the boat traffic to fish farms. It may be assumed that wellboats will tend to use the shortest distance between two points, and such a hypothesis may allow estimating an approximate distance. This assumption is supported by the current regulation, stating that the transport should be as quick as possible (NFD, 2008b, § 19). The future availability of positioning-data will allow a better understanding of this close traffic.

When transporting aquatic animals from a compartment of lower health status for diseases listed on list 2 of the legislation, the transport water must not be exchanged when passing a compartment of higher health status closer than four nautical miles. When transporting aquatic animals to a compartment of higher health status for diseases listed on list 2 of the legislation, the transport water must not be exchanged when passing a compartment of lower health status closer than four nautical miles. In addition the NFSA can impose stricter measures for wellboats passing farms that are known to be infected and under official restrictions. The movement of fish into and out of such a zone has to be approved by the NFSA.

In cases of no known infections and restrictions, wellboats are allowed to use open valves when passing active farmed sites in Norway, unless they transport fish of lower health status. This in contrast to Scotland, where a general five km distance to active sea-sites for transporting fish with open valves is applied. The Norwegian strategy is based on closing valves when the health status of the fish transported and the passed sites differ.

1.6.4. Highways and interregional routes

In the absence of overview of boat recordings, we have not succeeded in defining which paths can be considered as marine “highways” for boat transport. In addition to the main transport routes for wellboats, knowledge about common discharge areas for ballast water of other types of boats is relevant to estimate the risk of disease spread through wellboats.

Analysis of future available positioning-data will improve our understanding.

1.6.5. International exchanges

According to BREF, 15 boats, owned by four companies work between/outside Norway and UK, Shetland, Irland, Chile and Canada, but only one boat reports Norway-UK as sailing region. Precise data on the activity of wellboats between Norway, Scotland, and Faeroes are so far not available. This may be improved if AIS data are available also for boats crossing national borders.

1.7. Start and end points

1.7.1. Smolt producers

According to the Aquaculture register of the Directorate of fisheries, there were 225 registered smolt sites with Atlantic salmon in January 2014 (Figure 7). A total of 292 434 000 Atlantic salmon smolts, were reported transferred to sea sites in 2013 (www.fiskeridir.no).

As explained in the Fish Health Report 2013 (copied from Hjeltnes, 2014):
“ Although smolts may be considered to be free of significant disease causing agents when leaving the hatchery, any population may be covertly infected. Infection may be introduced during the smoltification process e.g. seawater supplementation may expose the fish to PD virus in the freshwater phase. The actual infection status at any particular time may be unknown in both the dispatching farm, the transport route and in the destination farm. Transport of fish over larger

distances occurs following production of smolts in one region to be grown in another region, and following transport of harvest fish to central harvesting facilities. Well-boats are almost the only form of transport used in such cases.

Comparison of regional smolt production with numbers of fish transferred to sea, can give an indirect estimate of inter-regional smolt transport (Table 3). In northern-Norway the total number of fish transferred to sea was 15 million smolts more than produced in that region. In mid-Norway (Trøndelag, Møre og Romsdal) the opposite situation was identified, with a total smolt production of 13 million greater than the number of smolts into sea. Of the remaining three regions in Western-Norway, Hordaland produced a surplus of 17 million more fish, while Sogn og Fjordane and Rogaland each showed a negative balance of five million smolts.

Table 3. Number of smolts (millions) produced and transferred to the sea in different counties in Norway. The index is calculated as the ratio between the two (Copied from Hjeltnes, 2014).

Fylke	2009			2010			2011			2012		
	Smolt Prod	Smolt Trans	Index	Smolt Prod	Smolt Trans	Index	Smolt Prod	Smolt Trans	Index	Smolt Prod	Smolt Trans	Index
Finnmark and Troms	15.7	40.4	0.39	18.5	42.7	0.43	21.3	52.8	0.40	24.6	57.3	0.43
Nordland	50.4	40.7	1.24	60.2	48.8	1.23	64.2	48.8	1.32	65.6	47.8	1.37
Nord-Trøndelag	26.0	15.5	1.68	30.5	24.5	1.24	34.8	19.1	1.82	31.9	27.6	1.16
Sør-Trøndelag	25.8	32.7	0.79	25.6	28.7	0.89	26.7	44.0	0.61	24.5	23.4	1.05
Møre og Romsdal	34.7	28.6	1.22	36.2	28.1	1.29	41.0	25.4	1.61	46.0	37.8	1.22
Sogn og Fjordane	19.1	19.0	1.01	18.8	21.8	0.86	23.0	21.6	1.06	17.3	22.5	0.77
Hordaland	44.3	39.8	1.11	50.3	36.2	1.39	57.7	47.2	1.21	57.6	40.5	1.42
Rogaland	14.1	18.8	0.75	14.8	23.2	0.64	15.6	18.0	0.87	13.6	19.0	0.72
SUM	230.1	235.5		254.9	254.0		284.3	276.9		281.1	275.9	

Factors other than distance to hatchery are decisive in influencing the origin of smolts transferred to individual on-growing sites; large companies favour their own smolts even if distances are large. For smaller operators, buying smolts from other companies, other factors, including price, will naturally be important when deciding on supplier of smolts."

1.7.2. Sea-sites

The number of on-growing sea sites with Atlantic salmon in Norway, comprised 944 registered sites by June 2014 (Aquaculture register), whereof 562 sites were reported as active during July-December 2013 (having stocked fish for at least three months during this period). This information is based on monthly production statistics reported to the Norwegian Authorities, using biomass data as described in Kristoffersen et al (2009). The geographical distribution of on-growing sea sites is shown in Figure 7.

On sea-sites, the fish are usually kept in open sea cages, which are open water systems with possibilities of contacts with wild fish and contamination from anthropogenic activity, including wellboats (Kristoffersen et al., 2009; Brun, 2010). According to national regulations, each site must have a management plan approved by the Competent Authorities. This includes an obligation on having fish of only one generation at a site during one production period. The sites have also to be fallowed for a minimum period of two months between production periods. There may be fish of different generations in a larger production region including several farmed sites. Disease management by the NFSA may include requirements for longer fallowing periods, or the synchronization of fallowing in given areas.

Wellboat activity is absolutely necessary on farms sites during the seawater production period, for transporting smolts to the sea site, grading, sea lice- or other treatment, and harvesting fish for slaughter. The overall wellboat activity in a region may therefore be high.

Special regulations have been implemented to control certain diseases. A SAV2 endemic and observation zone has been implemented in mid-Norway country. In this zone movement of fish, other than for slaughter, is prohibited. Transport of fish for slaughter out of the endemic zone is also prohibited, and finally, all smolt transport must be conducted using closed valves (FKD, 2012). In addition grading should not be done with pumping in fish groups that have tested positive (FKD, 2007 § 6).

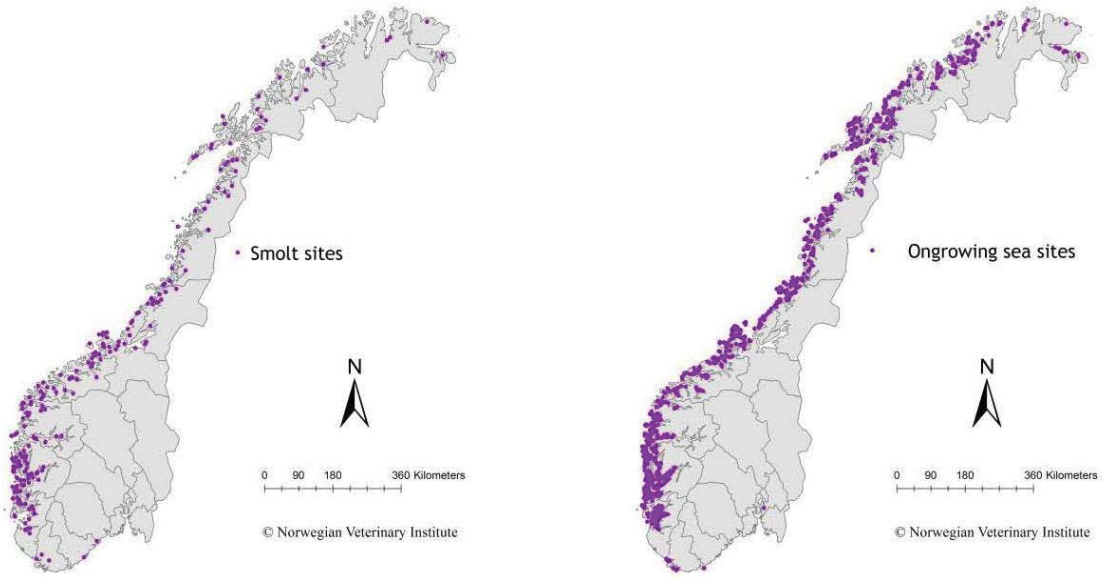

Figure 7. Map of Norway showing smolt sites registered in Jan 2014 (left) and active on-growing sea sites with Atlantic salmon in 2013 (right). An active on-growing sea sites was defined as a site stocked with fish for at least 3 of the last 6 month. Source: Aquaculture register of the Directorate of fisheries, Farm production data (biomass data) obtained as described in Kristoffersen et al (2009).

1.7.3. Slaughterhouses

A total of 1 244 180 tonnes of fish slaughtered in Norway were reported sold in 2013 (round weight, www.fiskeridir.no, preliminary results by 26 Aug 2014).

In 2013, there were 58 approved slaughterhouses along the coast, and one approved slaughtering boat (Tauranga) in Norway. Among those, 41 had slaughtering cages, in which live fish can be stored temporarily before being slaughtered (Source: NFSA 2013 and the Aquaculture register of the Directorate of Fisheries).

The geographical distribution of slaughterhouses and slaughterhouses with slaughtering cages is shown in Figure 8. The geographical references were obtained from the NFSA for the slaughterhouses with slaughtering cages, and from Google maps for 22 of the slaughterhouses not having a slaughtering cage.

Slaughtering cages are convenient for logistics purposes. They allow wellboats to deliver fish to the slaughterhouse independently of the activity at the slaughterhouse, which means at any time and at a faster pace. In this way, they reduce to a minimum the time needed to deliver fish. Also, they allow slaughterhouses to have fish available for slaughter whenever they have the capacity and the need to slaughter. In this way, they handle human work force and commercial demands easier.

According to the legislation, the maximum holding time for fish in the slaughter cages is six days, and fish from up to three sites may be present at the same time in the cages (NFD, 2008c). Shorter time may be preferred in order to reduce stress and increase product quality.

Slaughtering cages pose a risk related to disease spread, as infected fish may release pathogens. The pathogens may contaminate the areas around the slaughterhouse, the fish that are present, and the boats traveling through the area or delivering fish at the slaughterhouse. An important means may be the uploading of ballast water after delivering fish.

Also, slaughtering cages cannot be used if fish are transported in closed wellboats in which water temperature is progressively cooled to reduce stress and prepare the fish for slaughter, such as with RSW technology. The abrupt temperature change, which would be experienced if the fish were released into slaughtering cages, would be stressful, and direct delivery to the slaughtering line is therefore necessary.

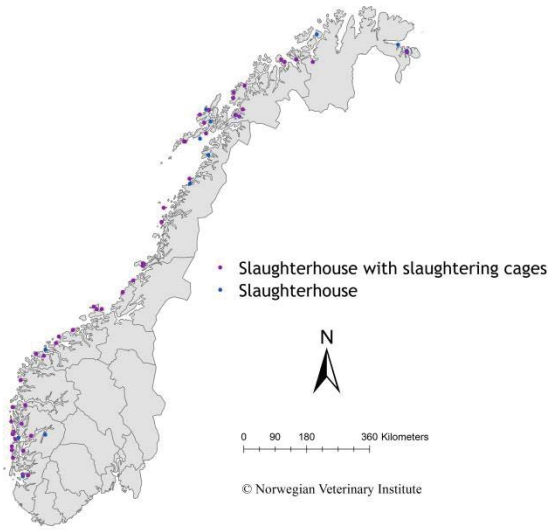

Figure 8. Map of Norway showing slaughterhouses and slaughterhouses with slaughtering cages. Source: Aquaculture register of the Directorate of fisheries and list of approved salmon slaughterhouses by the NFSA provided by June 2013.

1.8. Water movements

1.8.1. Fish transport water (open/closed systems)

Wells are entirely filled with water when transporting fish. It is pumped into the boat by creating vacuum.

The release of transport water is regulated “to avoid spreading infection”. This includes closing valves when transporting fish with a lower disease status than nearby sites. From 2021, released transport water will have to be disinfected after transporting fish for slaughter (NFD, 2008b).

The origin of transport water for harvested fish is regulated only in relation to listed diseases. For example, the origin of transport water for smolts is regulated in specific zones connected to outbreaks of ISA or PD. More generally, water should not be taken in “in the vicinity” of slaughterhouses or active sea sites (NFD, 2008b, §28). From 2021, all intake water must be disinfected when transporting smolts or brood fish.

During transport, the water is circulated and treated to ensure an adequate environment for live fish. In “open transport”, transport water is constantly exchanged with surrounding water. In “closed transport”, it is recirculated within the boat, and oxygen is added to maintain adequate levels through loading, transport and unloading. Most transports combine open and closed transport depending on the vicinity to sites and slaughterhouses. During closed transports, a rapid accumulation of the excretion products CO_2 and Ammonia (TAN) occurs. CO_2 is the most critical factor, but is possible to adjust by aeration of the circulating water. However, the ability to reduce CO_2 in transport water is considered a limiting factor for how long a closed transport can last, and how much fish may be transported. Ammonia will accumulate more slowly and during ordinary transports not to levels of immediate threat to fish welfare. Lowered pH caused by CO_2 accumulation assists lowering the toxicity of ammonia, but if fresh seawater is flushed into a wellboat after a period of closed transport immediate increase in pH could lead to toxic levels of un-ionized ammonia (NH_3)(NFD, 2008b; VKM, 2008).

The wellboats have systems to constantly monitor oxygen pressure, pH (and indirectly CO_2), and temperature.

During closed slaughter transport, the water may be progressively chilled. This has a calming effect on the fish, reducing the metabolism and preparing the fish for slaughter. A slight increase in CO_2 may also have a calming effect. Elements considered to ease closed transport are lower temperature, lower density, starving of fish before transport, and good technical equipment for water quality management.

Transport water is released either at the slaughterhouse, on the way away from the slaughterhouse, at the new locality before new water is taken in, or at places in agreement with the NFSA.

1.8.2. Process water

Seawater, mixed with specific substances, is used for wash and disinfection. To increase the effectivity of a wellboat, it is an advantage to start the washing/disinfection procedure right after fish are delivered, either to a net or to a slaughterhouse. Seawater for washing can therefore be expected to be filled in the immediate vicinity of slaughterhouses, or farms. The same water can be expected to be released after the washing is finished, which may occur at a significant distance from where water was taken in.

Then water for disinfection would be taken in, and released further out after disinfection has ended.

The risk associated with the release of process water is therefore dependent on several factors:

- the presence of pathogens in the water at intake
- the presence of pathogens in the boat
- the effect of washing substances / disinfectants on the pathogens
- the place where this process water is released.

Whereas disinfectants can be expected to inactivate most pathogens present in the water, washing substances can be expected to have limited effects on those.

The slaughter-boat Tauranga delivers all its process water to a land-based treatment plant, which gives maximal safety.

We lack information about the release procedures of other boats, but it is reasonable to assume that much of the process water is released in the vicinity of other fish farms.

1.8.3. Ballast water

Ballast water is often kept in specific tanks, although some boats use the fish wells to fill ballast water when they do not transport fish. The ballast tank is filled and emptied according to the needs for stabilizing the boat. The proportion of ballast water is 10-30% of the total water volume in a wellboat (DNV, 2012). According to Guttvik (2006), the practice around filling and emptying the ballast tank differs between boats. Small boats may have a greater need than large boats for using ballast water to compensate for the weight change associated with loading and unloading fish.

If boats need to fill water when they deliver fish, it would be expected that water around slaughterhouses would be commonly used as ballast water. This water may be contaminated by fish originating from different sites in a vast region, commonly stocked in slaughtering pens.

If boats need to release ballast water when they fill the boat with fish and transport water, it could be expected that ballast water would commonly be released around fish farms. This may have small consequences if the site is sending all fish to slaughter, but may have major impact on disease spread if the boat is used for treatment, or splitting of growing fish.

Weather conditions must also be expected to affect the practice. Hard weather conditions can be expected to impose practices that are otherwise avoided, like filling or emptying ballast water at risky spots.

We have seen no data allowing us to assess to which degree the practices around ballast water affect the risk of spreading diseases. There are at present no general regulations around this activity as long as wellboats transport fish within Norway.

1.8.4. “Dead volume”

A number of places cannot be emptied, such as the water pumps, and volumes below the exit level. We lack information about this dead volume, which can be expected to differ between boats. Water from these places will be mixed to the next water which is taken in.

The nature of the water present in this dead volume differs. Whenever washing, and sometimes an additional disinfection is undertaken, it is filled with processing water. In the absence of washing, it

is filled with transport water from the previous transport. The risk associated with disease spread varies accordingly.

1.9. Surface areas

The total area in contact with transport water is relevant because of the possibilities for pathogens to contaminate the surface. In particular, the existence of biofilm provides shelters for microorganisms, which protects them against being eliminated by water flow or inactivated by disinfectants.

The relative area of pipelines, compared to the fish tanks, is relevant to the ability for washing, disinfection, and inspection. Tanks are more available for inspection and physical washing, such as scrubbing, than pipelines.

It can be hypothesized that pipeline areas are particularly critical for the risk of transmitting disease agents from one transport to the next ones.

The total area depends on the boat's transport volume, but also construction. Some boats have an advanced system, the "Aas- model", which distributes water inlet and outlet points along the tank. This ensures a shorter circulation of water through the tank, allowing for a quicker renewal of water, with fresh oxygen and lower metabolite content. The price is a more complex system of pipelines, with increased contact surface with transport water.
The current regulation for authorization of wellboats (NFD, 2008b, §5 and 8) requests that boats document their construction, including pipelines, through adequate drawings. Also, the volume of the tanks should be known, and all areas of the boat should be possible to inspect. However, pipelines cannot be inspected, and the area and volume this represents is not subject to any constraints.

1.10. Biosecurity measures

Wellboats are inspected, cleaned and disinfected between assignment according to specific requirements (NFD, 2008b). The wells, much of the equipment and the outside of the boat are easy to inspect, but the inside of most pipelines and pumps is not accessible for any hygienic control. Cleaning of the pipelines is based on flushing with water, detergents and disinfectants, and the effect is difficult to monitor. Although easy access to all parts of the boat is demanded in the Norwegian transport regulation § 8, the construction of well boats, even the new ones, does not permit good access to the inside of the water circulating systems. Protein skimmers, and other elements which are either hidden or have an irregular surface are more difficult to reach. Earlier the removal of all fish and residues from pumps and pipework in wellboats has been reported as problematic (Guttvik, 2006), but the extent of this problem remains unknown. The possible accumulation of biofilm inside parts of this large pipeline system could in some cases lead to increased risk of pathogen survival and disease transmission. Therefore, washing and disinfection can only be considered as a risk-reducing measure, never reducing the risk to zero.

The controls performed the last years by the NFSA have not uncovered any major violations of the existing wellboat regulations. However, they have uncovered several shortcomings in these regulations, and some are now being revised and improved. There are at present no limits to the geographical distribution of the sites visited by wellboats, and what types of transport/activities a boat may perform. In particular, the transport of smolts following transport of harvested fish may occur, after additional washing and disinfection procedures. The boats are allowed to switch between different operations, and in absence of a known contagious disease, this could be done with only standard level of wash and disinfection. External inspection is not required, except in

specific cases of transport of diseased fish. Although it is demanded that all part of the wellboats circulation system should be easily accessible for inspection, this has in practice not been implemented, because of the complex nature of these modern vessels.

In Norway, wellboats are in general not owned by fish farmers but by separate companies. This could easily lead to tough competition with more focus on efficiency and prices rather than on biosecurity. To avoid the worst consequences of this the large farming companies or groups of smaller companies have to an increasing extent established long term contracts with boats, especially to establish and implement regulating better biosecurity and animal welfare measures during transport and other operating procedures where boats are involved. The most important measures in these contracts would typically be restrictions of geographical area the well boat is allowed to cover, and more thorough wash and disinfection procedures than in the official regulations.

1.10.1. Biosecurity measures prior to transport

All wellboats need technical and hygienic certification of the boat and all equipment, attestation of crew competence and an established and active internal control system. A risk assessment is undertaken when transporting fish, when they start working at a new location. Both the client (fish farmer) and the NFSA decide upon the route, based on known disease status in the area, and the disease status of the transported fish. If and when valves on the wellboat should be closed or opened is a part of this preparation process. Before undertaking new assignments the wellboat and equipment should comply with current regulations with regard to cleaning and disinfection (NFD, 2008b).

1.10.2. Biosecurity measures at start

Water is usually pumped in immediately before arrival at the sea site or at the site where the fish comes from. It is usually not disinfected, and may therefore carry pathogens present in the environment.

The health status of fish must be documented before loading. This is important to evaluate the fish welfare, to decide loading capacity (density) and to decide the transport route and if and where to open the vents (see 1.10.1).

The fish are usually starved before all handling and transport procedures. Starvation reduces the amount of feces released in the transport water, and is also believed to increase the stress tolerance of the fish.

The slaughter boat Tauranga takes in water used to transport the bled fish from 4.5 m depth. It is filtrated (300μm) and UV-treated. Water is regularly tested for foodborne pathogens (Listeria, coliforms). As fish are pumped into the slaughter system of the boat, the accompanying water is released through a filter meant for keeping sea-lice. The sea lice are subsequently killed by 10% HCl. Other wellboats do not at present filtrate sea lice in this way when harvesting fish.

1.10.3. Biosecurity measures during transport

To keep an adequate environment for the transported live fish, transport water is either exchanged with surrounding water (“open transport”), or recirculated within the boat (“closed transport”) or a combination of the two.

Open transports pose the greatest biosecurity challenge, as contaminated water from transporting infected fish may spread into the environment, and contaminated water masses may infect the fish

transported. There is at present no disinfection of water in most boats. Some have installed a combination of filters and UV treatment, which may disinfect water before being released. This is at present being accepted as equivalent to a “closed transport” in the implementation of existing regulation, but will not be mentioned as such in this review.

A special attention has been directed towards sea-lice. Emergence and rapid spread of sea-lice resistant to therapeutic chemicals has been seen as a problem when transporting full grown fish to slaughter. These fish could be heavily burdened with sea-lice, and also be requested slaughtered by NFSA because of resistant sea-lice. If transports are done with open valves this could lead to dissemination of possibly resistant eggs and larvae along the transport route. If and how much of the sea-lice that survives and remains infective after chemical treatments has also been discussed. Officially this risk is estimated as very low, but among the boat crews and the farmers the practice of releasing untreated water and sea lice after treatments has been questioned.

Closed transports pose a lower challenge during transport, as minimal water is exchanged with the environment. This is the favoured transport means when passing close to known infected farms, or transporting known infected fish. Oxygen is added as compressed Oxygen from generators on board, which poses no biosecurity challenges.

Some boats have a protein skimmer on deck to remove organic particles / foam and allowing CO_2 to diffuse from water into air. Other boats have aerators where water is mixed with air to remove surplus of CO_2 and stabilize pH in transport water during closed transports. The risk associated with entry of fish pathogens from the air through such systems must be considered negligible. However, they are challenging to wash and disinfect and may therefore contribute to the release of pathogens from previous transports.

The main biosecurity risk during closed transport is associated with the necessity to open the valves and change the water in case of disturbances in water quality, associated with distress reactions in the fish. Rather than risking massive mortality, boats may open valves during closed transport to normalize water quality. Since this happens unexpectedly, this may as well occur in the vicinity of fish farms. In addition, human error may occur. The moment valves are open or closed has so far only been registered manually, in a written log. From 1 Jan 2016 the geographical position of wellboats and the position of the boat must be logged automatically.

If the fish show signs of disease or increased mortality during transport this must be investigated and immediately reported to NFSA, and new and stricter biosecurity measures must be evaluated before the fish is unloaded.

A new addition to the transport regulation will be implemented in 2016 and 2021:
From 01.01.2015: geographic tracing of all wellboat movements, information on opening and closing of valves should be logged automatically.

From 01.01.2021: Transport water must be disinfected at intake when transporting smolt or brood stock, and at release when transporting fish for slaughter. Methods and equipment must be documented efficient for all types of transport. This regulation should, if adequately implemented, increase the biosecurity of open transports to the same level as the closed transports.

A specific transport route is used, to avoid passing close to infected farms or farms with fish a higher or lower health status, as decided in the risk assessment. However, due to weather conditions, the boats sometimes deviate from the preferred route. The frequency of this happening is not known, but can be expected to be more frequent in certain areas or certain seasons.

The route used is registered automatically for boats connected to an AIS system. This is so far the case for only the newest and biggest boats.

1.10.4. Biosecurity measures at arrival

Harvested fish. The fish itself is either delivered directly to the slaughterhouse, or released in slaughter pens. When delivering fish into slaughtering cages the transport water is released together with the fish. When transport is closed both fish and transport water is delivered into the slaughter house, and the water is returned to the boat to maintain sufficient water level and a stable water quality in the wells. Slaughterhouses may also process organic waste from the boat, including dead fish and more rarely processing water. In slaughtering pens it is allowed to stock fish from up to three different farms simultaneously, representing a risk of cross-contamination between fish in the pens and the well boat when delivering new fish. New transport water is not loaded close to the slaughter pens, but the outside of the boat would be in close contact with water on the slaughter site. If and how pathogens could adhere to the outside of well boats (and other vessels) and be transferred to other locations with susceptible hosts has been discussed over the years. So far it has not been possible to estimate the possible risk of disease transmission by this route. However, there are no limitations on the intake of ballast water outside the slaughter house.

Smolt. The smolt is delivered to farm sea sites. It is not allowed to split the load between different sea-sites. Full wash and disinfection is not needed if they immediately return to the same hatchery to transport more smolts to the same sea-site. Boats are usually designated to transport smolts for a longer period, to reduce the risk of introducing pathogens to the new smolt groups.

1.10.5. Biosecurity measures after transport

After delivery of fish, transport water needs to be released. Some boats and slaughterhouses have a system in place to deliver the fish and return the transport water into the boat. The water can then be released into the environment at some distance from the slaughterhouse.

This water is usually not disinfected, but released at places defined by the NFSA. A manual log of the place it is released is to be kept. This is a totally trust-based system.

Boats are required to undertake washing and disinfection between transport assignment according to specific regulations (NFD, 2008b).

Wash and disinfection is often supervised by both the boats personnel and by customers or their veterinary services. After transport of fish with notifiable diseases or transport in specific disease-zones, it is required inspection by authorized aquatic animal health professionals. Control is based on visual control, document control and tests for bacterial contamination on surfaces (ATP).

Washing and disinfection is undertaken in different ways.
Common ways are

- Washing is done with ozone or with standard detergents (Ex: Aquaclean). Soap can be administered on surfaces as foam, inside pipelines it has to be circulated in a water solution (sea-water) On surfaces pressure washing or higher temperature can be used to remove organic material. In tubes some boats have tried rotating high-pressure tubes (moles) to increase washing effect, but the effect has been reported as variable, and this has not been established as a general standard.
- Disinfection could also be performed with locally produced ozone (Redox®) or with chemical disinfectants, from a list of disinfectants approved for use in aquaculture.

- Chemical wash and disinfection in large volumes is an expensive and time-consuming procedure. Using ozone reduces the cost of chemicals, but still the crew has to be involved. The time spent to this procedure, during which no fish may be transported (e.g. 1.5 h for washing, and 3 h for ozone treatment) is therefore usually undertaken as the boat is on its way to a new sites. This reduces the personnel cost, but may sometimes not be finished before arrival at the site.
- The quality and effect of combined wash and disinfection relies mostly on an efficient washing process, including initial flushing and removing of organic particles and debris. When applying different chemicals to wash and disinfect it is always necessary to flush out the washing water before applying disinfection at prescribed levels. Boats using ozone have sometimes been reported to perform a combined wash and disinfection procedure in one step. This should be considered as an unwanted shortcut with increased risk of pathogen survival inside the wells and pipelines.

Washing and disinfection is logged manually on the wellboat, in a written book.

The minimal frequency of washing and disinfection is determined by the client and the regulation in place.

When slaughtering fish from a specific site, or transporting smolt from one hatchery to one sea site the boats do not have to wash and disinfect between every transport (NFD, 2008b).
Also, when leaving the endemic SAV2 zone boats must be washed and disinfected, be inspected by authorized personnel and be docked or go through a 48 hours quarantine before taking new assignments outside the zone (NFD, 2008b).

The slaughter boat Tauranga checks for bacterial contamination on surfaces weekly. Listeria is checked for 4 times during each transport, which means 600 samples/y (3 transport/week).

Boats are sometimes taken into dock for more thorough wash and disinfection. This is systematically undertaken when moving from a restricted zone to a non-restricted zone (PD-zones). In addition, some clients demand this to be done for risky transitions, such as changing from transporting slaughter fish or fish with known infections to transporting smolts, or before/after splitting/delousing salmon at sea.

Some large, modern boats report following this procedure 1-2 times a month, on average.
Alternatively, or in addition, an extra “dry day” after disinfection may be required, or the transport of healthy slaughter fish in order to flush the system.

1.10.6. Known precautions when transporting sick fish – legislation and follow up

Boats are required to undertake washing and disinfection after transport of fish with known infectious diseases / restrictions (NFD, 2008b). Such procedures may be followed by inspection by the NFSA.

1.10.7. Known precautions when transporting smolts – legislation and follow up

Wellboats and farming companies give extra attention to wellboat hygiene and procedures before smolt transports. They usually establish a detailed transport plan designating specific boats for transporting smolts during spring/early summer and late summer/autumn, when smolts are usually transferred to sea sites. The industry considers that the risk for transferring pathogens between smolt transports is significantly lower than the risk of transferring disease to smolts, after

harvesting or other procedures involving large fish. Company standards are therefore often more detailed and strict than the official transport regulations.

The transport may otherwise be done either open or closed, depending on the official disease situation along the route. In mid-Norway (2013-14), they always transport smolts with closed valves (FKD, 2012).

1.10.8. Biosecurity measures for ballast water

Ballast water is known to pose a hygienic threat. A quantitative estimate of this has been calculated by Ruiz et al. (2000) for Chesapeake Bay, USA . Water samples collected from boats arriving to the bay from foreign ports contained an average on 8.3×10^8 bacteria and 7.4×10^9 virus like particles per litre. Given the estimated 1.2×10^{10} litres of foreign ballast water in 1991 alone, measures indicate that ballast water probably delivers large numbers of microbial species and potential pathogens to this estuary. *Vibrio cholera* (O1 and O139) was found in plankton samples from all ships (both serotypes were detected in 93 % of the ships). There were 100 times more *V. cholera* in water samples than in plankton samples from the same ships (Ruiz et al., 2000).

So far, no disinfection of ballast water is undertaken, neither when charged nor when released. Place and date for ballast water charge and release are only logged manually in a book.

1.10.9. Biosecurity measures when using wellboats for delousing and splitting

Delousing and splitting are activities undertaken on fish that will remain in sea for a while, and thus potentially develop disease if infected. The use of wellboats represent therefore a potential risk for the farmer. Delousing produces a lot of organic material both inside and outside the boat and washing and disinfection procedures could often be more time-consuming than after regular transport missions.

Legislation and industrial protocols on the farms demand that the boat undergoes wash and disinfection before they work at the farm, as for other transport missions. Sometimes the farms themselves require stronger precautions, as docking or “dry days”, especially if the boat has been operating in other areas with unknown or lower health status.

1.10.10. Other relevant biosecurity aspects

High work pressure is a dominant feature of wellboats. As the investments in newer boats increase, the need for intensifying their use for covering expenses increases. Night work is common, and resting hours limited. This is a major biosecurity challenge as many operations are manual, thus dependent on human awareness. A number of human errors must be expected. Unfortunately, the boats lack automatic recordings which can help us quantify the frequency of such errors, leaving it as a major uncertainty factor.

Any problems under way may be recorded manually in a written book.

2. Data on hazards

2.1. Hazard identification

A number of diseases have been identified in farmed Atlantic salmon (*Salmo salar*) and Rainbow trout (*Oncorhynchus mykiss*), whereof many are infectious, having a potential for spread to other farmed populations both nationally and internationally, or to the wild salmonid populations.

Status and information on important diseases in Norwegian aquaculture is available in the Fish health report (Hjeltnes, 2014). This report is based on information from the fish health services along the Norwegian coast, journal data from the diagnostic laboratories of the Norwegian Veterinary Institute, information from other research institutes and the NFSA, and gives a unique overview of the disease situation in Norwegian aquaculture.

Infectious agents (diseases) identified as relevant hazards for farmed salmonids are listed in able 4, where aspects relevant for transmission through well-boats in the Norwegian salmon farming industry are summarized.

Table 4. Characteristics of infectious agents (diseases) registered in farmed Atlantic salmon and rainbow trout in Norway, UK or the Faeroe Islands. Agents in bold are associated with mandatory reportable diseases in Norway (http://www.lovdata.no/dokument/SF/forskrift/2008-06-17-819).

Agent (disease)	Present in Norway[1] (Reg. cases in 2013)	Reported in Scotland [2,3] (year, last outbreak)	Reported in England and Wales[2,4] (year, last outbreak)	Reported in the Faeroe Islands[2,5] (year, last outbreak)	Survival time in SW (hours, days, weeks)	Resistance to disinfectants (type)	Smolts may be infected in FW	Marine reservoir	Subclinic forms or long latent period	Ref
Viruses										
ISAV (ISA)	+ (10)	+(2009)	-	- (2005)	Weeks	-	+	+	+	Rimstad et al. (2011)
SAV (PD)	+ (100)	February 2014 (to date never type III)	-	-	Hours-days	-	+ (if SW is used)	+	+	Graham and McLoughlin (2011)
PRV (HSMB)	+ (134)	April 2014	-	- (No confirmed outbreaks but widespread PRV detection by PCR)	Unknown	-	+	+	+	Løvoll et al. (2012)
IHNV (IHN)	- (0)	To date never found	-	-	Days	-	+	(+)Proposed but not confirmed in in Europe	-	Office International des Epizooties (2014a)
VHSV (VHS)	- (0)	1995 (turbot), 2013 (wrasse spp & various wild marine fish), all genotype III	+ (2006)	-	Days	-	+	+	(+) Some marine species	Office International des Epizooties (2013) Skall et al. (2005)
IPNV (IPN)	+ (56)	April 2014 / vaccination undertaken	+ (2007)	+ (Several outbreaks in FW and few outbreaks in SW	Weeks	+	+	+	+	Munro and Midtlyng (2011)

				each year)						
PMCV(CMS)	+ (100)	April 2014	-	- (no confirmed outbreaks since the 90'ies and first PCR detection of PMCV in 2013)	Unknown	-	Unknown	Unknown	+	Pers. com. Torstein Tengs
Bacteria										
***Renibacterium salmoninarum* (BKD)**	+ (1)	April 2014	+ (2011, from wild fish)	-(Last outbreak in 2005 and last detection in 2008)	Unknown	-	+	Unknown	+ (long)	Austin and Austin (2007) Dale (1999)
Aeromonas salmonicida* subsp. *Salmonicida	(0)	July 2009 / vaccination undertaken	+ (endemic)	-(No outbreaks and only detection of Aeromonas salmonicida xx)	Unknown ?	-	+	Unknown	+	Austin and Austin (2007)
Vibrio salmonicida	+ (13)	No data (Vibrio species May 2014)	-	- (No outbreaks and Detected in one farm in 2013)	Weeks	-	-	+	-	Austin and Austin (2007)
Moritella viscosa	+ (51)	November 2013	-	+(Associated with winter ulsers in 2011-2013)	Weeks	-	+ (if SW is used)	+	-	Austin and Austin (2007)
Flavobacterium psychrophilum	+ (5)	April 2014	+ (endemic)	+(Detected in smolt farms in 2012 and 2013)	Hours/days	-	+	-	Unknown	Austin and Austin (2007)
Yersinia ruckeri	+ (20)	July 2013 / vaccination undertaken	+ (endemic)	+(Detected in one smolt farm in 2013)	Unknown	-	+	-	+	Austin and Austin (2007)
Vibrio anguillarum	+ (4)	No data (Vibrio species May	-	+(No outbreaks and first	Weeks	-	+ (if SW is	+	Unknown	Austin and Austin (2007)

		2014)		detection in 2013)			used)			
Piscirickettsia salmonis	? (0)	May 2009	-	-(No outbreaks and no detection)	Weeks	-	+ (Chile!)	+	Unknown	Austin and Austin (2007)
Pasteurella sp.	+ (0)	June 2008 (P. skyensis)	+ (2011, from wild fish)	-(No outbreaks or detections. But never screened for the bacteria)	Unknown	-	?	+	Possible	Austin and Austin (2007)
Parasites										
Parvicapsula pseudo-branchicola (Parvicapsulosis)	+ (32)	-To knowledge not yet found	-	-(No outbreaks or detections. But never screened for the myxozoan)	Weeks+	Unknown	-	+	+	Nylund (2005) Sterud (2003)
Salmon louse *Lepeophtheirus salmonis*	+	+On-going / widespread	-	+(high detection and high number of treatments each year)	Weeks+	-[6]	-	+	-	Costello (2006) Stien (2005)
Paramoeba perurans (Amoebic gill disease, AGD)	+ (5)	+On-going / widespread	-	+(No outbreaks and first detection of *P. perurans* by PCR in 2013)	Weeks+	Unknown	-	+	(+)	Steinum et al (2008) Mitchell et al (2011)

[1] Fish Health Report 2013 (Hjeltnes, 2014)

[2] European Union Reference Laboratory for Fish diseases, survey & diagnosis (http://www.eurl-fish.eu/Activities/survey_and_diagnosis)

[3] Marine Scotland Science, Marine Laboratory, UK, Stuart Wallace

[4] Centre for Environment, Fisheries & Aquaculture Science (CEFAS), UK, Birgit Oidtman

[5] Food and Veterinary Agency, National Reference Laboratory for Fish Diseases, Faroe Islands, Debes Christiansen

[6] The salmon louse is resistant against many medical treatments

We will here focus on two hazards considered of special interest to the Norwegian salmon industry. These are infectious agents which may spread horizontally, survive many weeks in the environment, have subclinical forms and cause significant losses. They are therefore highly relevant as examples of hazards regarding the risk of disease transmission through wellboats.

ISAV. The first hazard is ISAV, causing ISA, which is a severe and economically important disease in farmed Atlantic salmon. ISA is a notifiable disease in Norway, and is also listed within the European Union and the OIE. ISAV is a single stranded, segmented, enveloped RNA virus within the Orthomyxoviridae family. Two of the segments (Segment 5 and 6) encode surface glycoproteins, believed to be important for the pathogenicity of the virus; the fusion protein and the hemagglutinin-esterase (HE) genes. The virus occurs in virulent and low virulent variants (HPR0). The virulent variant is associated with ISA, and the HPR0 variant is not associated with clinical disease (Rimstad et al., 2011).

SAV. The second agent is SAV, which is the aetiological agent causing PD. SAV is recognized as a serious pathogen with significant impact on farmed Atlantic salmon and rainbow trout in the seawater phase. The disease is notifiable within Norwegian legislation, and is recently also listed by the OIE. SAV is an enveloped, single stranded, spherical, positive-sense RNA virus of the genus *Alphavirus* within the *Togaviridae* family (Nelson et al., 1995; Weston et al., 1999; Weston et al., 2002). There are currently six subtypes of SAV (SAV1-6) identified, based on genetic differences (Fringuelli et al., 2008). While subclinical SAV infections have been reported (Graham et al., 2007b), no avirulent SAV subtypes have yet been identified.

2.2. Known geographical distribution and prevalence

The geographical distribution and the prevalence (proportion of infected individuals or farms) of disease agents, are major determinants of the risk of disease spread with wellboats.
This knowledge requires that diagnostic tools are available, applied to a sufficient sample, and that the results are communicated. Official statistics are available for a few notifiable disease agents (see 2.3.1), including ISA and PD.

ISA. The disease was first reported in 1984 in Norway, and has since then been described in salmon farming countries as Faeroes, Scotland, Canada, USA and Chile. Figure 9 shows the number of annual outbreaks from 1984 to 2013. Figure 10 shows the geographical distribution of ISA from 2009 to 2014.

The disease was a severe problem in Norway in the late 80s and early 90s, and was the main reason for implementing several biosecurity measures to control horizontal spread. The measures were followed by a remarkable reduction in the annual number of outbreaks, however ISA was not eradicated despite the actions taken. Since 1993, the annual number of ISA has been fairly stable.

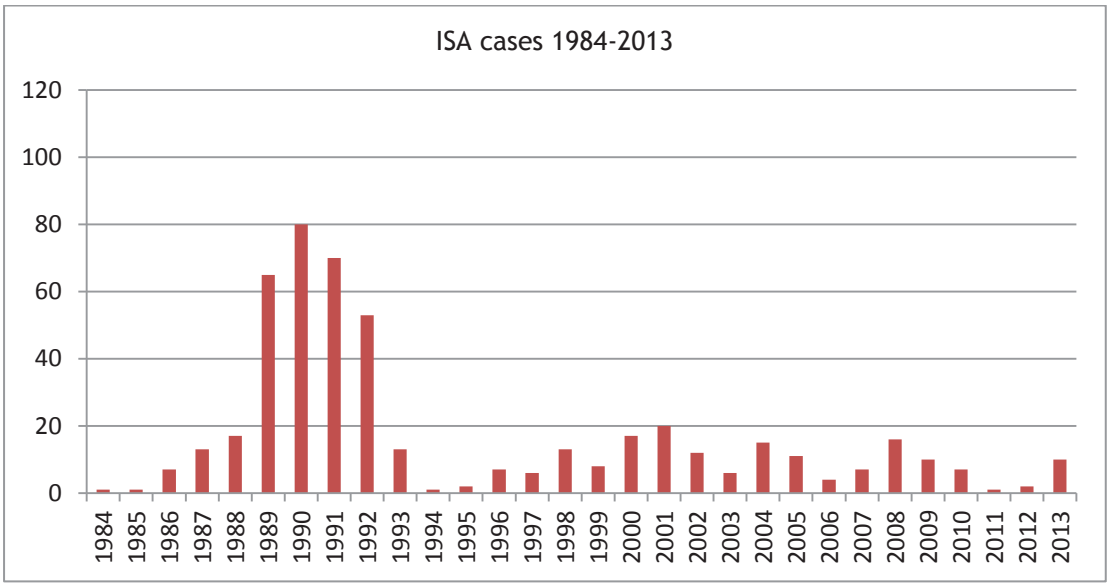

Figure 9. Confirmed infectious salmon anaemia (ISA) outbreaks in Norway between 1984 to 2013. Data sources: the Norwegian Veterinary Institute.

The ISA outbreak pattern is characterized by isolated outbreaks or local epidemics due to horizontal transmission between neighbouring farmed sites (Lyngstad et al., 2011). Outbreaks are found along the Norwegian coast through the years. In 2013, 10 outbreaks of ISA were confirmed, whereof 8 in the county of Nordland, one in Sogn and Fjordane and one in Troms. Only 3 of the 10 outbreaks could be explained by horizontal transmission from an infected neighbour (Hjeltnes, 2014). So far in 2014 (by November), there have been 7 outbreaks, where 5 are associated by close genetic and geographic relationship, supporting horizontal transmission between neighbouring farms.

The origin of infection for the “isolated” outbreaks is not known. ISAV may be introduced by a wild marine reservoir, or anthropogenic activity including fish movement and wellboat activity (Rimstad et al., 2011; Mardones et al., 2014). Also, the hypothesis that ISA may evolve from a low virulent variant (ISAV-HPR0) mutating to virulent ISAV may explain some of the outbreaks.

The importance of well boat activity related to ISAV spread has recently been addressed in a Chilean study. Here the authors suggest that movement of live fish and well boat activity may have played a more important role than environmental or passive transmission in the 2007-2009 ISA epidemics in Chile (Mardones et al., 2014).

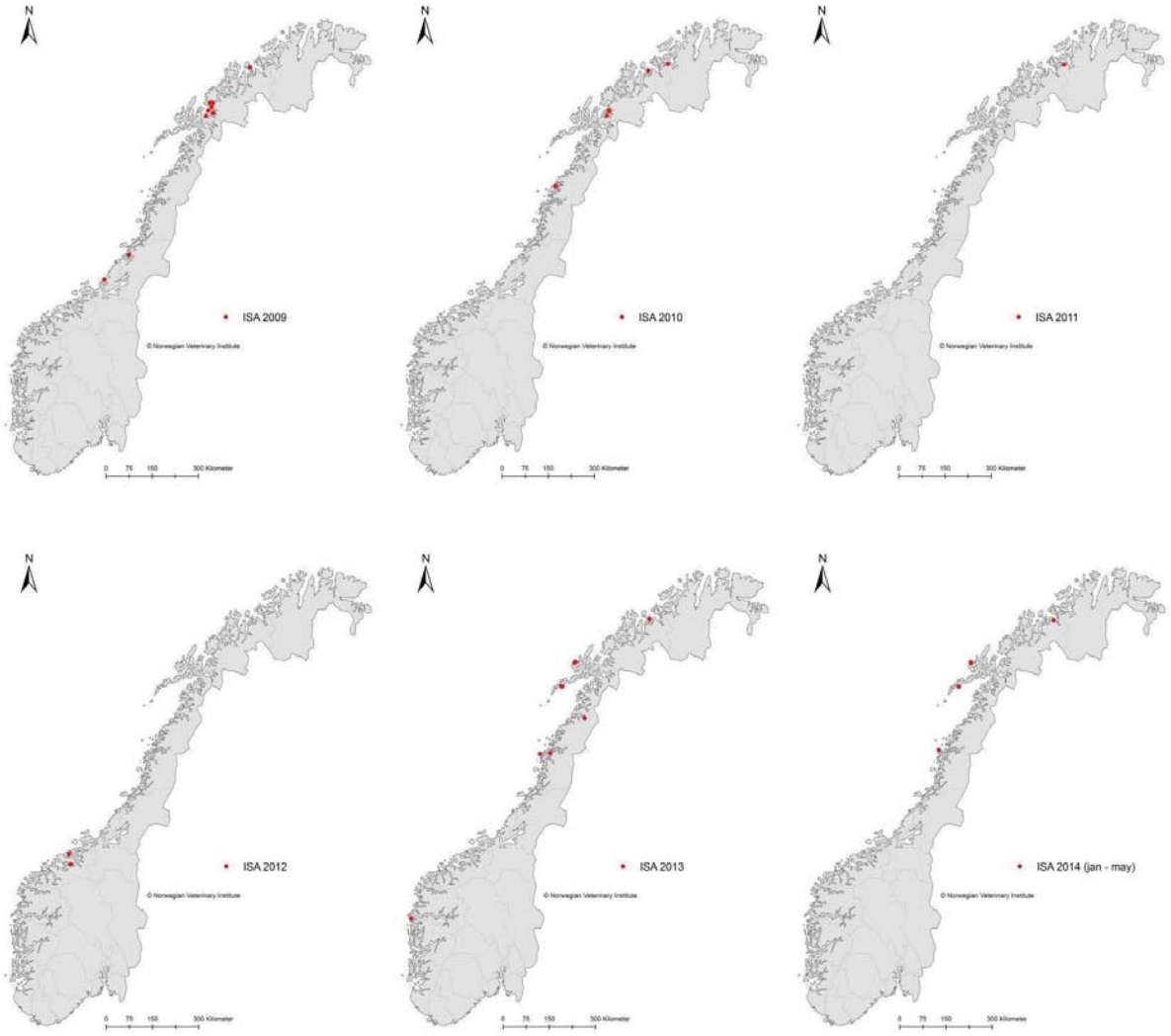

Figure 10. Geographical distribution of ISA 2009-2014

PD. The disease was first detected in farmed Atlantic salmon in Scotland in 1976, and thereafter described in Norway in 1980, and in Ireland early in the 1990s. For several years PD was considered endemic to western Norway (Hordaland and Sogn og Fjordane), however a southward spread (Rogaland, 2004) followed by a northward spread (Møre og Romsdal, 2006) resulted in the establishment of an endemic zone encompassing the entire west coast from Rogaland to Hustadvika (63°latitude) in 2007. In addition, a low number of outbreaks were recorded north of the endemic zone. Except for a number of sites located within a single fjord system in the northernmost county (Finnmark) where direct horizontal transfer of SAV between neighbouring farms may be assumed, the exact mode of introduction of SAV to infected sites outside the endemic zone has not been identified. Although movement of infected fish from the endemic zone has been suspected as the source of the point introductions, no investigations have been carried out to specifically address this issue. The role of wellboats as possible vector for spread of SAV has not been determined. While multiple SAV subtypes have been identified in both Irish and Scottish salmonid aquaculture, all SAV characterised from Norwegian PD outbreaks were until recently exclusively identified as SAV3 (Hodneland et al., 2005; Karlsen et al., 2006; Fringuelli et al., 2008; Jansen et al., 2010a) In the spring of 2011, marine SAV2 was for the first time identified as the cause of Norwegian PD outbreaks and characterization showed identity to marine SAV2 sequences obtained from Scottish sea-reared Atlantic salmon in 2006 (Hjortaas et al., 2013). Last year (2013) this newly introduced marine SAV2

was the dominating SAV subtype in Norway (Hjeltnes, 2014). Given the close genetic relationship between the Norwegian and Scottish marine SAV2 sequences, it is likely that the source of the Norwegian marine SAV2 is introduction from Scottish aquaculture. The exact transmission route is unknown, but could involve ballast water or wellboats.

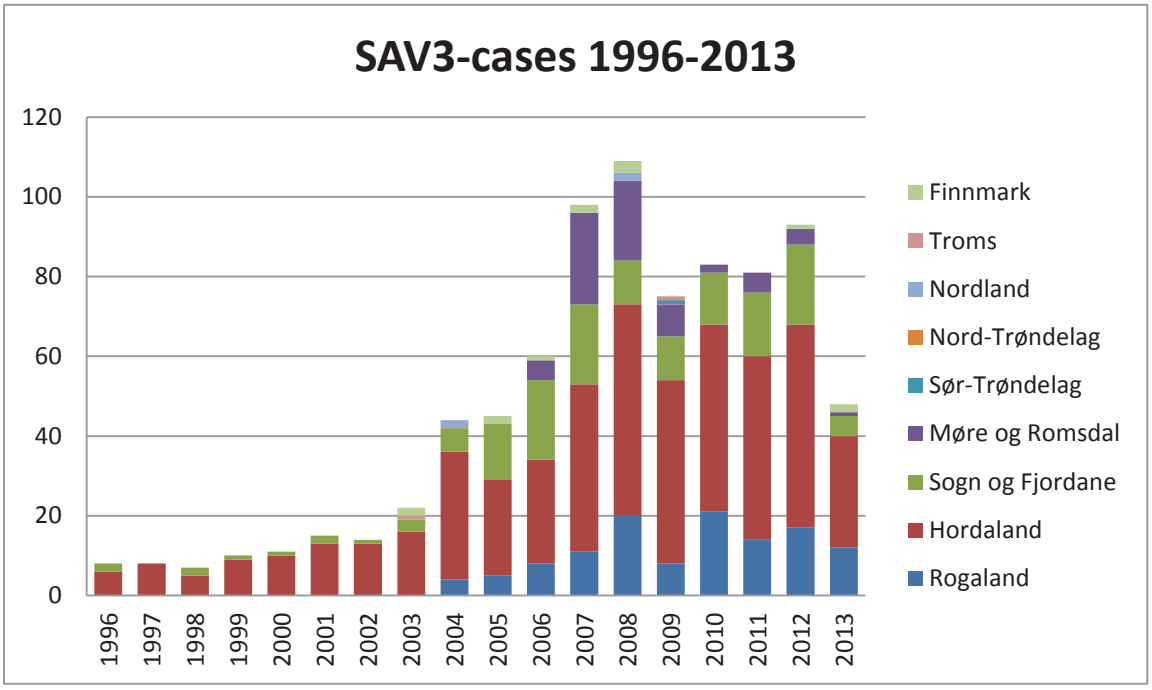

Figure 11. Number of PD cases in Norway from 1996 to 2013 caused by SAV3. (Source: The Norwegian Veterinary Institute)

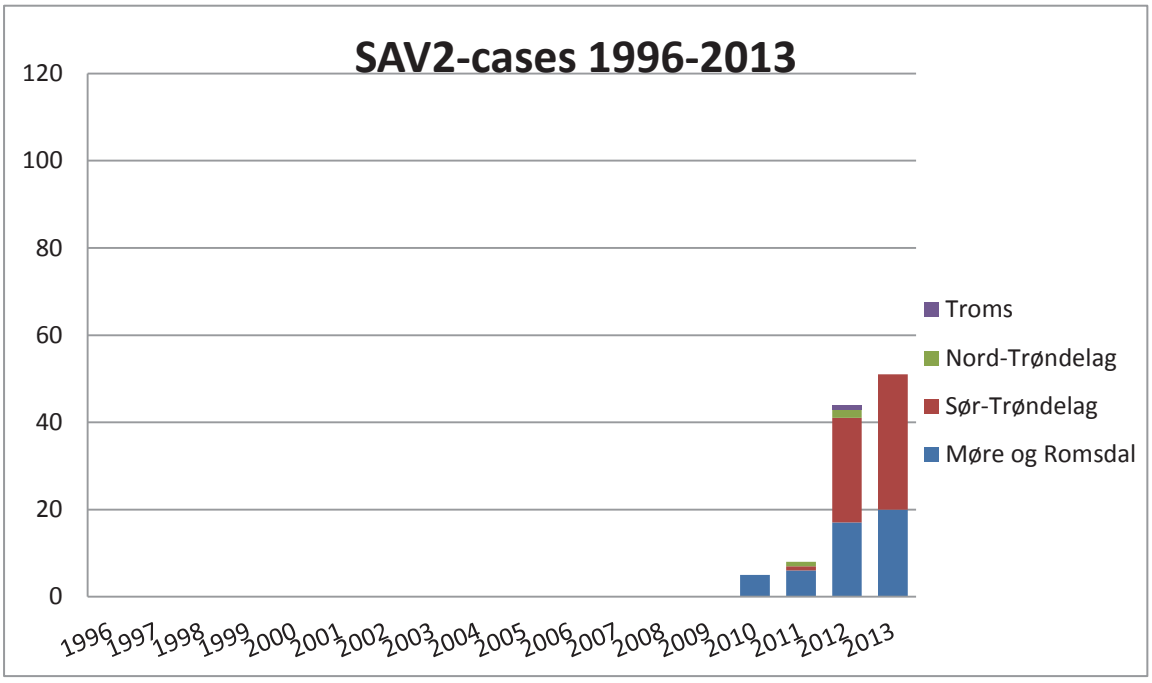

Figure 12. Number of PD cases in Norway from 1996 to 2013 caused by SAV2. (Source: The Norwegian Veterinary Institute)

The peak number of yearly diagnosed/suspected cases was reached in 2012, with a total of 137 cases (both SAV subtypes). SAV infections and PD outbreaks have been described only in seawater in Norway, however SAV 2 has been detected in rainbow trout in fresh water in England, Scotland (Branson, 2002; Graham et al., 2003b), Germany (Bergmann et al., 2005), and Italy and Spain (Graham et al., 2007c). The outbreak pattern is dominated by transmission to neighbouring farming site through short seaway distances (Graham and McLoughlin, 2011).

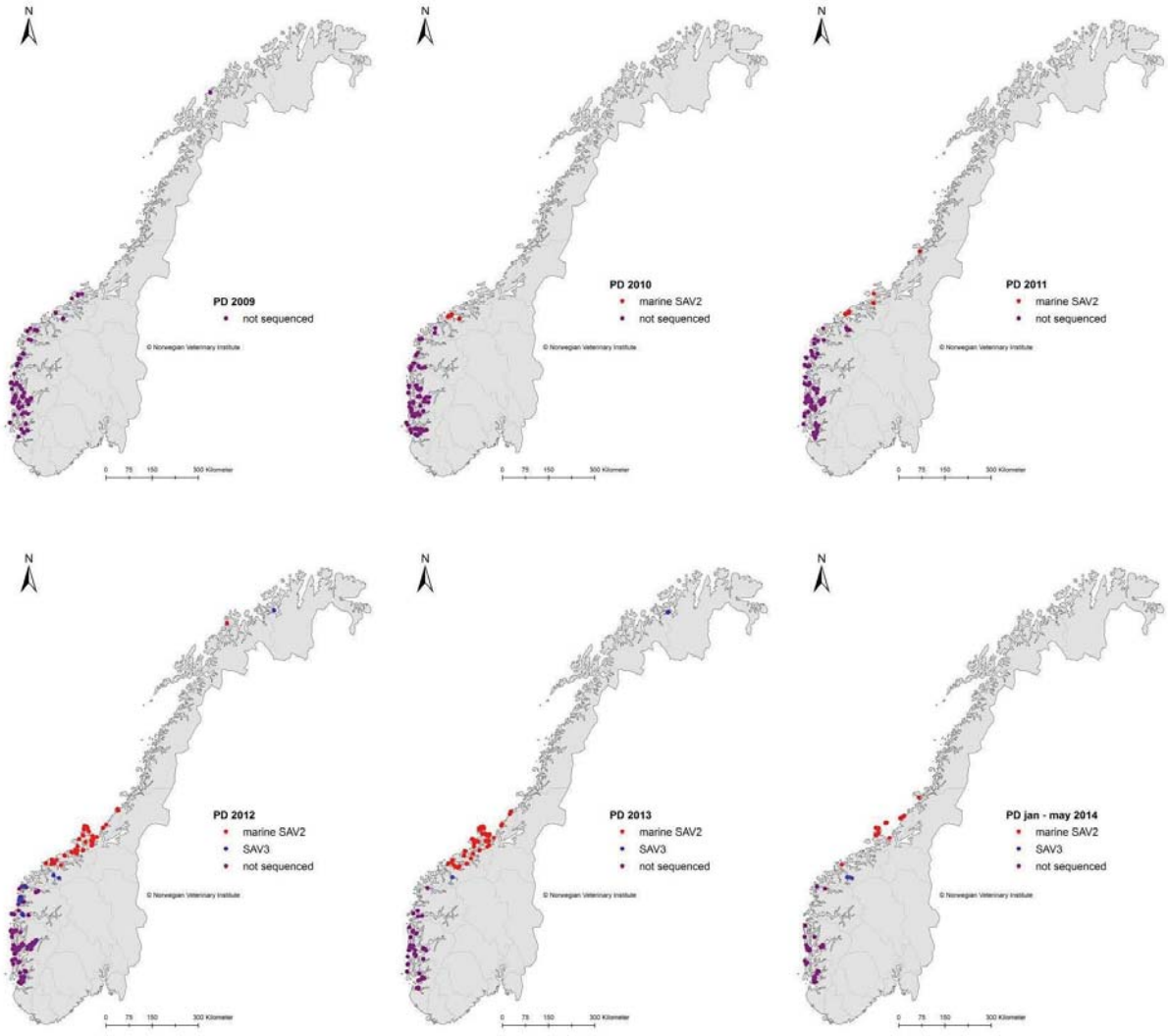

Figure 13. Geographical distribution of PD 2009-2014

More statistics on ISA and PD are available at http://www.vetinst.no/. Ongoing suspicions and outbreaks of ISA and PD are available on an interactive map, where information is updated on a daily basis http://odin.vetinst.no/ta/pd/. This real time information has recently also been made available in the maps provided by the Directorate of Fisheries (http://kart.fiskeridir.no).

2.3. Real geographical distribution, prevalence: uncertainty aspects

The real distribution of disease agents is always larger than the known distribution. The known occurrence of a disease agent is limited by the ability (knowledge and diagnostic tools) and the willingness to look for the agent. In addition, only reportable diseases, as for example ISA and PD, are mandatory to be communicated to the authorities. These may in turn communicate the situation to interested parts, such as wellboats, within a reasonable time-frame. For non-reportable diseases, knowledge about their distribution is limited.

2.3.1. Mandatory reportable salmonid diseases in Norway

The list of mandatory reportable salmonid diseases in Norway is based on the OIE, EU and national considerations (NFD, 2008a). The listed diseases are grouped in three categories, according to their severity and presence in Norway:

List 1 - Exotic diseases
Epizootic hematopoietic necrosis (EHN)

List 2 - Non-exotic diseases
Viral haemorrhagic septicaemia (VHS)
Infectious hematopoietic necrosis (IHN)
Infectious salmon anaemia (ISA)

List 3 - National diseases
Bacterial kidney disease (BKD, *Renibacterium salmoninarum*)
Infection with *Gyrodactylus salaris*
Furunculosis (*Aeromonas salmonicida* subsp. *salmonicida*)
Pancreas disease (PD, salmonid alpha-virus)
Infection with *Flavobacterium psychrophilum* in Rainbow trout (*Oncorhynchus mykiss*)
Francisellosis (*Francisella* sp.)
Salmon louse (*Lepeophtheirus salmonis*)

Suspicion and confirmation of these mandatory reportable diseases will be notified to the competent authorities (NFSA) in accordance to the Food Law (HOD, 2003), thus ensuring an overview of the distribution and occurrence of these listed diseases.
Other diseases will have a lower reporting rate, and figures reported in the yearly fish health report (Hjeltnes, 2014) must be seen as minimum prevalences. Also, when it comes to emerging diseases and diseases of unknown etiology, knowledge on contagiousness, pathogen identification and diagnostic tools, etc. need to be generated before they may be considered added to the list.

2.3.2. Detection in fish

The detection of infectious agents in a fish farm is challenging for different reasons:

- Symptoms are often unspecific, so laboratory diagnosis is necessary. This requires the collaboration between fish farmers and laboratories. This is costly and may be time consuming.
- Symptoms are sometimes absent, as infections may be subclinical. In that case, active surveillance, which consists of searching for the agents in apparently healthy fish, is useful.
- Only some fish may be infected, in which case we may not find the agent even if it is present in the farm. The smaller the proportion of infected fish, the more difficult it is to sample infected fish. Picking the newly dead and moribund fish increases the chance of finding the agent.

- The tests used to detect the agent are rarely perfect. Therefore, they are described by their
    - Sensitivity, which is their ability to give a signal ("positive test") if the tested fish is infected, and their
    - Specificity, which is their ability to *not* give a signal ("negative test") if the tested fish is not infected.

Some tests identify the agent, its genes or surface structure (direct methods, e.g. reverse transcriptase - polymerase chain reaction (RT-PCR), immunohistopathology, isolation) whereas others identify the fish's reaction to this agent (indirect methods, e.g. serology).

Due to biological and technical variation, an overlap between tested variables (diagnostic cues) in infected and uninfected fish is often seen (Figure 14), which makes it difficult to classify a fish as infected or not. A cut-off is applied to decide if a given test-value classifies the sample as positive or negative. The selection of a cut-off depends on the purpose of testing: Sometimes a high sensitivity is necessary, in order to be sure to detect agents; this may be associated with a low specificity, which means that some uninfected fish may yield a positive test result (false positives). In other situations, the consequences of having a positive test may be so high, that a high specificity is required to avoid misclassifying a fish as infected; this may be associated with a lower sensitivity, which means that some infected fish may yield a negative test result (false negatives).

The combination of several tests allows to increase both the sensitivity and the specificity.

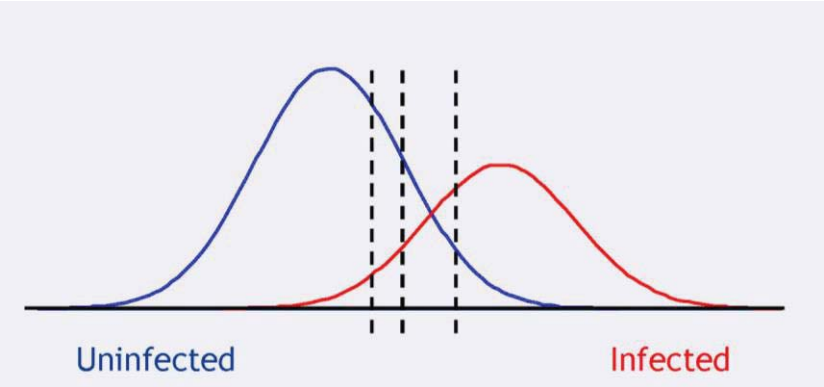

Figure 14. Illustration of diagnostic test cut-off. Example of overlap between diagnostic cues in infected fish (red line) and uninfected fish (blue line). Different cut-offs are suggested by the black dashed line. The cut-off most to the left leads to classifying almost all infected as test-positive (high sensitivity), but also a significant amount of uninfected (false positives, low specificity). The cut-off most to the right leads to classifying almost all uninfected as test-negative (high specificity), but also a significant amount of infected as negative (false negatives, low sensitivity).

A sample size of 30 or 60 individual fish from a fish group (cage or site) is common to sample and test in order to document the health status of the fish. With a perfect test (100% sensitivity and specificity), such sample sizes allow us to detect the disease with 95% confidence if it is present in at least 10% or 5%, respectively, of the fish. This means that it is relatively easy to get a negative result even if the agent is present in a significant number of animals. In contrast, when tens of thousands of fish are transported in wellboats, it's very likely that the infectious agent will be transported, even if it infects a very small proportion of the fish.

For diseases listed by the OIE, standards for detection in aquatic animals is set (World Organisation for Animal Health, www.oie.int). Due to the major consequences related to the diagnosis of listed diseases, a high specificity is required.

ISA. The diagnosis of ISA was initially based on clinical and pathological findings only. Following the isolation of the causal agent, a number of direct methods for detection of virus and confirmation of the diagnosis have been established. Available diagnostic methods for ISA and ISA-virus is listed in the OIE manual (OIE, 2014a), and comprise field diagnostic methods (clinical or behavioral signs), clinical methods (post mortem examination, gross pathology, clinical chemistry, microscopic pathology), and agent detection and identification methods. Fluorescent antibody test (IFAT), immunohistochemistry (IHC), cell culture, RT-PCR and enzyme linked immunosorbent assays (ELISAs) are tests that are commonly used with regard to ISA.

A specific semi-quantitative Taqman real-time RT-PCR (qRT-PCR) method for detection of ISAV have been developed and reported to be both highly sensitive and specific (Snow et al., 2006; OIE, 2014a), and is the RT-PCR test recommended by the OIE.The test does not discriminate between virulent and low-virulent (ISAV-HPR0) variants. As ISAV-HPR0 frequently occurs in farmed salmon population in Norway, additional testing or sequencing to differ between the variants is therefore necessary (Lyngstad et al., 2012). Several other variants of RT-PCR test for ISAV have also been reported, but with a few exceptions (Nerette et al., 2005), most of them have not been formally validated.

In a cage containing ISA infected fish, the prevalence of ISAV may vary widely, and may be difficult to detect in some cages and not the adjacent ones (OIE, 2014a). It may take weeks or months before clinical disease develops in neighboring cages in an outbreak site (Rimstad et al., 2011).

PD. The diagnosis of PD is based on evidence for the presence of SAV from two independent laboratory tests, such as microscopic pathology, cell culture, RT-PCR test or serology. The most reliable results are obtained from kidney and pyloric caeca, compared to heart and brain. Different genotypes of SAV exists in and sequencing is necessary to differ between the genogroups (Graham and McLoughlin, 2011). Details of each diagnostic test and the recommended sampling procedure is available in the OIE manual (OIE, 2014b).

Information on diagnostic sensitivity and specificity of the recommended tests for SAV is scarce. However, the OIE recommended RT-PCR tests (Hodneland and Endresen, 2006; Fringuelli et al., 2008) is assumed to be methods with good diagnostic sensitivity and specificity.

The detected SAV-prevalence within an infected salmonid seawater site will depend on the timespan between infection and sampling, and on the diagnostic tests used. However, during clinical PD outbreaks the prevalence is usually high, with figures as high as 70–100% having been reported (Graham et al., 2010). In a mathematical model the average time between SAV infection and PD diagnosis has been estimated to 2 months (Viljugrein et al., 2009). While the majority of sites will have PD diagnosed shortly after SAV infection, screening in conjunction with an epidemiological study found a time lapse of 18 – 71 weeks between SAV detection and PD diagnosis for four of the studied sites (Jansen et al., 2010b).

2.3.3. Detection in water and on the boat (including protein foam and biofilm)

Available RT-PCR methods may be used for detection of agents such as ISAV and SAV in seawater and organic material such as protein-foam and biofilm. However, when it comes to detection in seawater, pre-treatment of sample before RNA extraction is a major challenge, as large volumes need to be filtered in order to concentrate the virus. A range of factors, such as water temperature,

presence of bacteria and organic material, may furthermore affect virus detection and cause standardization challenges.

2.4. Known excretion rate / Infection pressure

It is well established that the spread of both ISAV and SAV occurs through horizontal transmission, which means that the agents will be transferred between individuals through water. This transmission route is supported by different sources, including phylogenetic studies, laboratory cohabitant models and epidemiological studies of between-site spread, including studies of ocean currents (Hodneland et al., 2005; McLoughlin and Graham, 2007; Fringuelli et al., 2008; Kristoffersen et al., 2009; Viljugrein et al., 2009; Jansen et al., 2010a; Jansen et al., 2010b; Aldrin et al., 2011; Graham and McLoughlin, 2011; Stene, 2013).

The amount of virus present in the water increases with the number of infected fish and the virus excretion rate. Sub-clinical forms are likely to be associated with a lower excretion than clinical forms.

Vertical transmission, i.e. transmission of pathogen from parent to offspring, could play a role when assessing whether transports of infected smolt may generate an infection pressure along the route. However, evidence of vertical transmission of SAV is lacking (Kongtorp et al., 2010). The question of vertical transmission of ISAV has been and still is debated, and it is unclear whether and to what extent ISAV can be transmitted through sexual products (Vike et al., 2009; Rimstad et al., 2011; Marshall et al., 2014). Nevertheless, smolts may also be infected horizontally, in their production site or during transport. In Norway, seawater cases by far dominate the freshwater ones (Rimstad et al., 2011).

2.5. Survival, growth and inactivation

2.5.1. In seawater

Seawater is not a constant entity but varies depending on factors such as temperature, presence of bacteria, enzymatic activities, organic material and UV radiation.

ISA. According to Rimstad et al. (2011), ISAV survives 7 days in seawater at 4-15°C, and up to 105 days in sterile seawater at 4°C. Survival of ISAV in organic material is in general longer than in seawater only. According to Vike et al. (2014), the level decreases more rapidly in seawater exposed to UV radiation.

PD. The half-life (t1/2) of SAV1 was estimated to 4.3 days and 1.0 day at temperatures of 4°C and 10 °C respectively in a laboratory experiment using natural seawater, while no t1/2 could be determined at 15°C or 20°C due to an absence of viable SAV in the samples (Graham et al., 2007a).

2.5.2. In biofilm and other organic material

Water is an excellent environment for biofilm production ("fouling"), and a biofilm will form on all solid surfaces, such as fish farming installations. These biofilms will largely consist of non-pathogenic seawater organisms, but pathogenic bacteria, fungi and viruses, can also establish themselves and survive in these biofilms and contribute to several disease outbreaks. Today we have very little knowledge about the possible significance of this. Information on biofilm research is available at
http://biofilmforskning.wordpress.com/.

Organic material such as protein-foam and fat fractions leaking from the salmon, and may function as a transport route for fish pathogens. ISAV is an enveloped virus with glycosylated surface proteins and accordingly is attached easily to different particulate material, which could affect virus survival as well as spread. ISAV may remain infective for extended periods of time outside its host (Rimstad et al., 2011).

Information on the presence of pathogens in such materials was recently presented at Programkonferansen Havbruk in Tromsø, April 2014. Preliminary results from the research project "Exploring the role of biofilm and protein-foam to reduce the spread of fish pathogens in the aquaculture industry", reported the detection by PCR of ISAV in protein-foam in samples from a wellboat carrying ISA sick fish. ISAV was also isolated in cell-culture from these samples, proving the virus was viable. Detection of SAV in protein-foam was also reported (pers.com Audny Hellebø). The detection of SAV in liquid fat fractions leaking from dead PD infected salmon was reported in another study (Stene, 2013).

It is common practice to have wellboats on land for at least 24 h in order to reduce infectivity. The effect of such practice has not been evaluated.

2.5.3. Reservoir

ISA. Atlantic salmon is the only species in which ISA occurs naturally. The virus can however replicate in several other species including wild fish, which may be carriers of the virus (Rimstad et al., 2011).

ISAV-HPR0 is known to occur widely in the salmon populations, both in juveniles, on-grown salmon and brood stock, in freshwater and in seawater environments (Lyngstad et al., 2012). Reservoirs of ISAV-HPR0 outside the farmed production chain, are not known so far.

PD. The prevalence of SAV in wild fish species is largely unknown. SAV RNA has been detected in surveys of wild marine fish species. In both Scotland and Ireland the flatfish species common dab (*Limanda limanda*) and plaice (*Pleuronectes platessa*) have tested positive for SAV RNA, while also the long rough dab (*Hippoglossoides platessoides*) has tested positive for SAV in Scotland (Snow et al., 2010; McCleary et al., 2014). In both surveys SAV RNA were detected in flatfish distant to salmonid aquaculture sites. The recent report of successful culture of SAV from common dab in a salmonid cell line (Bruno et al., 2014) suggests that common dab, and possibly other flatfish species, could constitute a non-salmonid reservoir of SAV. In a Norwegian surveillance program monitoring the health of wild anadromous salmonids, only one salmon (a released smolt) tested positive for SAV3 out of the 543 salmon and 100 sea trout tested (Biering, 2013). No antibodies against SAV were detected in a serological survey of wild salmonids in fresh water river systems in Northern Ireland, despite the fact that farmed salmonids at local sea sites were SAV infected (Graham et al., 2003a). Based on these results, it appears that wild anadromous salmonids are only rarely infected by SAV. It is, however, possible that a higher number of individuals become infected and die prior to returning to the rivers thereby being unavailable for sampling. The lack of SAV detection in wild salmonids in Norway and Ireland, countries with high number of SAV affected sites, suggest that wild anadromous salmonids are of little importance in the spread of PD. However, the role of wild fish species as an underlying reservoir or as the original source of SAV introduction into marine aquaculture remains to be determined. Although SAV RNA has been detected in the sea louse, *Lepeophtheirus salmonis* (Petterson, 2009), it has yet to be identifed as an important vector of SAV.

2.6. Effect of disinfection

ISA. ISAV is stable in the pH range 5-9, completely inactivated after 30 min at pH 4 (Rimstad et al., 2011). Under experimental conditions, UV increases the speed of inactivation of ISAV in natural seawater (Vike et al., 2014). Under natural conditions, organic material reduces the effectivity of such radiation.

PD. Under laboratory conditions, SAV shows rapid inactivation in the presence of organic matter at both pH 4.0 and pH 12.0, with a notably slower inactivation at pH 5.0 and no inactivation reported at pH 6.0 (Graham et al., 2007d). Similarly, rapid inactivation was seen after exposure to 60 °C (Graham et al., 2007d). When testing a range of commercially available disinfectants according to the protocol defined in the draft European Standard prEN 14675, all disinfectants were found to be effective against SAV (Graham et al., 2007a).

2.7. Infection dose

Information on infection dose is in general limited, but relevant data can be found in experimental infection models, where the most relevant data is assumed to be from immersion and cohabitation trials as they mimic natural route of infection.

ISA. An approximation of the minimum infective dose leading to mortality under different infection regimens were provided in a study using a Scottish isolate (Raynard et al., 2001). Modes of infection were intra-peritoneal injection (i.p.), cohabitation and immersion exposure. The average time to first morality ranged from 26 d with the lowest dose (2,5 x 10^2 $TCID_{50}$ /ml^{-1}) to 16.5 days with the highest dose (2,5 x 10^4 and 2,5 x 10^5 $TCID_{50}$ /ml^{-1}) after immersion infection of freshwater Atlantic salmon parr with ISAV. High cumulative percentage mortalities were recorded for all viral dosages administered by i.p. injection, and maximum level of mortality (100%) was achieved in individual tank replicates with doses of 2,5 x 10^5 and 2,5 x 10^7 $TCID_{50}$ /ml^{-1}. After experimental infection of seawater Atlantic salmon with ISAV, a mean cumulative mortality reached 86.4% with doses of 5 x 10^5 and 5 x 10^7 x $TCID_{50}$ /ml^{-1} following i.p. infection. Mortality in cohabitating fish increased with the dose administered to the i.p. fish within a dose range of 5 x 10^1 and 5 x 10^4 x $TCID_{50}$ /ml^{-1}.

A dose of 10^4 $TCID_{50}$ /ml^{-1} were used in a recent study on Norwegian ISAV isolates. In this study, a low and highly virulent ISAV were compared in immersion challenge (McBeath et al., 2014). Mortality first occurred at day 13 with the highly virulent variant, and day 17 with the low virulent variant.

SAV. No infection trail addressing the issue of minimum infective dose has been reported in literature, however details of dosages used in successful experimental studies are available for both marine SAV2 and SAV3. In a recent Norwegian study comparing Norwegian marine SAV2 and SAV3 isolates, an infection dose of 100µl 10^4 $TCID_{50}$ SAV/fish by i.p. injection induced no significant mortality in injected fish groups or in marine SAV2 cohabitant fish groups while all SAV3 cohabitant fish groups had significantly increased cumulative mortality (up to 17.2 %, Taksdal et al., 2014). At three weeks post infection 98% of all cohabitant fish tested positive by real-time RT-PCR for marine SAV2 or SAV3 respectively (Taksdal et al., 2014). Other studies have reported the successful use of a lower dose (1 x $10^3$$TCID_{50}$/fish) for SAV3 (Graham et al., 2011; Thim et al., 2014) as well as for a Scottish marine SAV2 isolate (Graham et al., 2011).

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1.1. Forskriftskrav smittehygiene

1.1.1. Konstruksjon

Regelverket har flere generelle bestemmelser som krever at konstruksjonen skal være hensiktsmessig med tanke på smittehygiene.

Transportforskriften (7)
(Transportforskriften § 8 Krav til konstruksjon, gjengitt under kapittel 4.4.1, gjentas derfor ikke)

§ 19. Generelle smittehygieniske krav til transport
Akvakulturdyr skal transporteres så raskt som mulig til bestemmelsesstedet. Transporten skal gjennomføres på en måte som sikrer helsen til:
a) akvakulturdyrene som transporteres,
b) akvakulturdyrene på bestemmelsesstedet, og
c) akvatiske dyr som passeres under transporten. (..)

§ 22. Sjøtransport
Ved brønnbåttransport av settefisk og stamfisk til et akvakulturanlegg skal transportvannet behandles før det tas inn i brønnen. Dette gjelder ikke vann som tas inn fra akvakulturanlegget som settefisken eller stamfisken kommer fra. Ved brønnbåttransport av matfisk til et slakteri eller akvakulturanlegg skal transportvannet behandles før det slippes ut fra brønnbåten.
Behandling av transportvann etter første ledd skal skje ved bruk av godkjent metode for desinfeksjon som tilfredsstiller krav til effekt i henhold til forskrift 20. februar 1997 nr. 192 om desinfeksjon av inntaksvann til og avløpsvann fra akvakulturrelatert virksomhet § 10 nr. 1. Organisk slam som produseres ved behandling av transportvann som slippes ut fra brønnbåten, skal samles opp og behandles som animalsk biprodukt.
Ved transport av akvakulturdyr fra segment med lavere helsekategori med hensyn til sykdom på liste 2 skal transportvann ikke skiftes ut når transporten passerer gjennom segment med høyere helsekategori og går nærmere enn 4 nautiske mil fra grunnlinjen, med mindre Mattilsynet har gitt tillatelse til det.
Ved transport av akvakulturdyr til segment med høyere helsekategori med hensyn til sykdom på liste 2 skal transportvann ikke skiftes ut når transporten passerer gjennom segment med lavere helsekategori og går nærmere enn 4 nautiske mil fra grunnlinjen, med mindre Mattilsynet har gitt tillatelse til det.

0 Endret ved forskrifter 29 mars 2010 nr. 490, 11 april 2014 nr. 528.
Første og annet ledd trer i kraft 1 jan 2021. For dagens ordlyd, se § 28.

§ 23. Transport til karantene
Transport av akvatiske dyr til karantene skal foregå lukket og alt transportvann skal desinfiseres før det slippes ut. Ved sjøtransport kan vannskifte skje når transporten går mer enn 4 nautiske mil fra grunnlinjen.

Soneforskriften- PD (3)
§8 Vilkår overfor transportører
Mattilsynet kan stille vilkår overfor transportører, herunder:
a) område for inntak av transportvann,
b) godkjenning av transportrute,
c) krav om helt eller delvis lukket brønn,
d) krav om behandling av transportvann,
e) vask og desinfeksjon av transportmiddel

§14. Krav til slakting av fisk fra akvakulturanlegg med klinisk utbrudd av PD
Slakting av fisk fra akvakulturanlegg med klinisk utbrudd av PD skal skje direkte fra brønnbåt.

Så langt har det vært ansett velferdsmessig tryggest for fisken å transporteres i et åpent system med god vanngjennomstrømming. Dersom den tekniske utviklingen fortsetter og man får gode erfaringen med lukkede transporter, har disse en klar smittehygienisk fordel. Dersom man utviklet systemer med tilfredsstillende filtrering og desinfeksjon av inntaksvann/benyttet transportvann kan man se for seg et mer åpent system som kan kombinere fordelene av både god gjennomstrømming og god smittehygiene. Teknologien er per dags dato ikke kommet langt nok i forhold til kapasitet på slike systemer.

Smittehygieniske krav til konstruksjon

- Overflater i transportenheten skal være glatte, lette å rengjøre og desinfisere (dvs. transportutstyr uten lommer, sprekker, skarpe vinker med mer).
- Alle områder må være inspiserbare for å kontrollere tilstrekkelig renhold (krever ristplater, deksler, hengsler og liknende som er lette å demontere).
- Volum på tank, kar, brønn (resirkuleringssystem) skal være kjent (essensielt for vurdering mengde desinfeksjonsmiddel og kontakttid).
- I enkelte tilfeller vil det være krav om at transporten skjer i lukket system. Det må dermed finnes transportenheter som kan imøtegå kravet. Dette kravet vil kunne gjelde oftere dersom sykdomssituasjon forverrer seg, men også ved at teknologien forbedrer seg og risikoen ved slike transporter minimeres.
- Transporten skal sikre helsen til transportert fisk, slik at disse ikke smittes underveis (NB! Smolttransport). Både ved valg av transportrute og utforming av transportenhet (lukket system).
- Det er krav om at yngeltransport til settefiskanlegg skal foregå uten vannutskifting.
- Transporten skal gjennomføres slik at den sikrer helsen til akvakulturdyrene på bestemmelsesstedet.
- Transportenheten må være slik utformet/foregå på slik måte at akvatiske dyr som passeres ikke smittes. (For eksempel unngå spredning av lakselus).
- Mulighet for behandling/desinfisering av transportvann: Ved krav om lukket transport kan også krav om desinfisering av transportvann gjøres gjeldene.
- Må kunne slakte fisk direkte fra brønnbåt (uten merdsetting) ved for eksempel PD.

1.1.2. Generelle smittehygieniske krav

Transportforskriften (7)
§ 19. Generelle smittehygieniske krav til transport
Fisk, unntatt akvariefisk, fra ulike akvakulturanlegg skal ikke transporteres samtidig i samme transportenhet.

Matloven (17)
§ 7. Etablering, utforming og drift "Virksomheten skal sørge for at plassering, utforming og drift av aktiviteter er hygienisk forsvarlig."

Generell hygiene relatert til mattrygghet er ikke berørt spesielt i denne rapporten. Matloven setter imidlertid krav til at utforming/drift skal være hygienisk forsvarlig. Ved bruk av "dead haul" vil hygienekrav for næringsmidler bli sentrale. En brønnbåt må være slik uformet og driftet at fisken i næringsmiddelsammenheng ikke påføres/tilsettes smitteførende agens/stoffer med folkehelsemessig betydning. Et praktisk eksempel på uheldig hygieneutforming kan være automatisk tømming av brønnbåtens septiktank. Dette gir ingen kontroll med hvor septiken tømmes, og man kan se for seg tømming ved slaktermerd.

Generelle smittehygieniske krav

- Det er forbud mot samtransport (dvs. blande fisk fra ulike anlegg i samme transportenhet).
- Fremtidens brønnbåt må være hygienisk utformet/driftet i forhold til mattrygghet.

1.1.3. Rengjøring og desinfeksjon

Det er spesifikke krav til når transportenheten skal rengjøres og desinfiseres og med hvilke desinfeksjonsmidler.

Transportforskriften (7)
§ 20. Rengjøring og desinfeksjon av transportenhet som gjenbrukes

Dersom det ikke benyttes engangsemballasje skal transportenhet rengjøres og desinfiseres i følgende tilfeller:

a) Før hver enkelt transport av akvakulturdyr til akvakulturanlegg, havbeite eller annet utsett. Desinfeksjon kan unnlates når:
1. gjentatte transporter av smolt eller settefisk fra ett settefiskanlegg til samme mottaksanlegg anses som en operasjon (kippkjøring),

2. *avstanden mellom settefiskanlegget og matfiskanlegget er kort, og*
3. *det iverksettes nødvendige tiltak for å hindre spredning av smitte under lasting fra båt, utstyr, mv. til settefiskanlegget.*

b) Etter at transporter er gjennomført fra ett akvakulturanlegg eller akvakulturområde for bløtdyr til slakteri eller tilvirkningsanlegg, og før man begynner på tilsvarende transporter fra et annet akvakulturanlegg eller akvakulturområde for bløtdyr.

c) Etter at slaktefisk er losset ved slakteri hvor det oppbevares fisk i ventemerd fra andre akvakulturanlegg.

d) Etter at slaktefisk er losset ved slakteri hvor det samtidig losses fisk fra andre akvakulturanlegg.

e) Etter gjennomført transport av akvakulturdyr fra akvakulturanlegg eller akvakulturområde for bløtdyr, som er pålagt restriksjoner som følge av listeført smittsom sykdom. Transportutstyret skal være tømt for akvakulturdyr før rengjøring og desinfeksjon gjennomføres. Rengjøringen skal sikre at belegg og organisk materiale fjernes før desinfeksjon gjennomføres.

Desinfeksjonsforskriften (18)

§ 7. Bruk av godkjent desinfeksjonsmiddel

Ved desinfeksjon av akvakulturanlegg, transportenheter og utstyr (pålagt i Matloven eller dens forskrifter) skal det kun benyttes listeført preparat som er godkjent i henhold til § 4. Listen kunngjøres på www.mattilsynet.no.

Rengjøring og desinfeksjon mellom transportoppdrag er med på å redusere smitterisikoen forbundet med slaktetransporter. Krav til når vask og desinfeksjon skal gjennomføres er detaljregulert i forskrift. I praksis har man sett at god nok rengjøring og desinfisering kan være en utfordring. Dersom rengjøringen ikke er tilstrekkelig, vil det være så mye organisk materiale (blant annet fiskeblod, slim, fett, eventuelt hele dødfisk) at desinfeksjonen ikke virker. Man har også sett eksempler på at det på grunn av kostnadsbesparelser er benyttet utilstrekkelige mengder desinfeksjonsmidler, noe som medfører manglende desinfeksjonseffekt. Mattilsynets utførte i 2007 en tilsynskampanje som omfattet brønnbåter, hvor 80 % av godkjente transportenheten ble inspisert (totalt 41 brønnbåter og 7 biler) (24). Det ble i 30 % funnet utilstrekkelig rutiner vedrørende vask og desinfeksjon. Det var hovedsakelig mangel på hvordan vask og desinfeksjon skulle gjennomføres, og rutiner rundt tilstrekkelige mengder desinfeksjonsmidler benyttet i forhold til vannmengde i brønnen.

Rengjørings- og desinfeksjonskrav

- Rengjøring og desinfeksjon:
  1. Før hver enkelt transport av dyr til akvakulturanlegg (kippkjøring smolt over korte avstander med smitteforebyggende tiltak kan unntas krav).
  2. Etter at transporter er gjennomført fra ett anlegg til slakteri, og før man starter transporter fra annet anlegg.
  3. Etter lossing ved slakteri der det oppbevares fisk i ventemerd fra annet anlegg.
  4. Etter lossing ved slakteri der samtidig losses fisk fra andre anlegg.
  5. Etter gjennomført transport av dyr fra anlegg som er restriksjonspålagt (listeført smittsom sykdom)
- Rengjøring skal fjerne belegg og organisk materiale før desinfeksjon gjennomføres. Fremtidens brønnbåt må være slik utformet at god rengjøring kan gjennomføres. Brønnbåten må kunne tømmes for all fisk før rengjøring og desinfeksjon gjennomføres.
- Det må benyttes godkjent desinfeksjonsmiddel jfr. liste på www.mattilsynet.no
- NB! Fremtidens brønnbåt må ha gode rengjørings/desinfeksjons systemer/muligheter som enkelt kan betjenes/utføres av personellet om bord.

1.1.4. Dødfiskhåndtering

Transportforskriften (7)
§ 24. Håndtering av døde akvakulturdyr
Døde akvakulturdyr skal ikke lagres på transportenheten mellom ulike transportoppdrag. Akvakulturdyr som har dødd under transport til akvakulturanlegget, unntatt ved massedød under transport, skal leveres til mottakeranlegget. Ved massedød skal døde akvakulturdyr leveres direkte til godkjent anlegg for mottak og behandling av animalske biprodukter.

Akvakulturdriftsforskriften (19)
§ 16. Slakting og håndtering av døde akvakulturdyr
Akvakulturdyr skal slaktes på godkjent slakteri. "Det skal sikres at døde akvakulturdyr er fjernet fra produksjonsenheten før lasting til transportenhet. Akvakulturdyr som har dødd under transport til akvakulturanlegget, unntatt ved massedød under transport, skal tas imot av akvakulturanlegget."

Døde akvakulturdyr må behandles slik at risikoen for smittespredning reduseres. Ved massedød hvor dødfisken må transporteres til godkjent mottak, må det påsees at det ikke foregår avrenning som kan generere smitte.

Dødfisk hos leverandøranlegget skal fjernes før levering til brønnbåt. Slik fisk representerer en smitterisiko og kan også føre til tetting av avløpsrister og til forurensing av transportvannet.

Krav til dødfiskhåndtering
- Dødfisk skal ikke lagres på transportenheten mellom ulike transportoppdrag.
- Dødfisk generert under transporten skal leveres til mottakeranlegget (unntatt ved massedød).
- Ved massedød under transport: leveres til godkjent mottak.
- Dødfisk hos leverandøranlegget skal fjernes før innlasting.

1.2. Krav til beredskap og dokumentasjon av etterlevelse av regelverket-velferd og hygiene

1.2.1. Beredskap
Det presiseres i regelverket at driften skal være smittehygienisk og fiskevelferdsmessig forsvarlig. Det skal foreligge beredskapsplan for å ivareta smittehygienen og fiskevelferden i krisesituasjoner.

Transportforskriften (7)
§ 11. Forsvarlig drift, beredskapsplan og vurdering av risikofaktorer
Driften skal være smittehygienisk og fiskevelferdsmessig forsvarlig. Det skal foreligge en beredskapsplan for å ivareta smittehygiene og fiskevelferd i krisesituasjoner. Den skal gi oversikt over smittehygieniske og fiskevelferdsmessige tiltak som er aktuelle å iverksette for å forhindre og eventuelt håndtere akutte hendelser og massedød, herunder håndtering av døde akvakulturdyr, avliving av akvakulturdyr og varsling av hendelser til mottaker og Mattilsynet.

§ 10. Varslingsplikt
Ved forøket dødelighet, unntatt når dødeligheten åpenbart ikke er forårsaket av sykdom, skal helsekontroll gjennomføres uten unødig opphold for å avklare årsaksforhold. Helsekontrollen skal gjennomføres av veterinær eller fiskehelsebiolog.
Mattilsynet skal varsles umiddelbart ved:
a) uavklart forøket dødelighet,
b) grunn til mistanke om sykdom på liste 1, 2 eller 3, eller
c) andre forhold som har medført vesentlige velferdsmessige konsekvenser for fisken, herunder sykdom, skade eller svikt.

Det ansees som svært viktig at Mattilsynet varsles ved enhver hendelse som har betydning for dyrevelferden. Slik kan det bedømmes om bestemte rutiner, metoder el. generelt sett gir økt sannsynlighet for at fisken utsettes for ubehag, unødig stress eller smerte[1]. Slik informasjon vil kunne benyttes til å revidere gjeldene bestemmelser og treffe avbøtende tiltak.

[1] Utdyping av emnet er hentet fra "Kommentarer til forslag til forskriftsbestemmelser transportforskriften" (www.mattilsynet.no)

Det er viktig å få informasjon om forøket dødelighet eller mistanke om listeført sykdom umiddelbart, slik at eventuelle smitteforebyggende tiltak kan iverksettes.

Det skal utarbeides beredskapsplan hvor det med utgangspunkt i uønskede hendelser beskrives en akseptabel håndtering av disse. Godt beredskapsarbeid bygger på prinsipper som farekartlegging og risikovurdering.

Krav til beredskap

- Fremtidens brønnbåt må være konstruert på en slik måte at dyrevelferd og smittehygiene kan ivaretas ved akutte hendelser og massedød, og transportenheten må ha gjennomtenkte systemer/rutiner for avliving av fisk ved krisesituasjoner.
- Varslingsplikt til Mattilsynet; umiddelbart ved forøket dødelighet når denne er uavklart, mistanke om listeførte sykdommer, andre forhold med vesentlig velferdsmessige konsekvenser for fisken.
- Utarbeidelse av beredskapsplaner.

1.2.2. Godkjenning

Godkjenningen i den norske transportforskriften for akvakulturdyr går utover kravene i transportforordingen i tillegg til å gjelde for fiskehelse. Kravet om godkjenning er uavhengig om transporten foregår på land eller sjø, og uavhengig av korte og lange transporter. Dette fordi de fleste transporter faktisk er langtransporter. Det finnes da kun en felles godkjenning for alle transportmidler for fisk.

Transportforskriften (7)

§ 4. Krav om godkjenning av transportenhet

Transportenhet som benyttes til transport av levende akvakulturdyr, unntatt akvariedyr, krepsdyr, bløtdyr og rogn og melke av akvakulturdyr, skal være godkjent av Mattilsynet. Plastposer som benyttes til transport av mindre mengder fisk er ikke omfattet av krav om godkjenning. Godkjenning er gyldig i høyst fem år fra utstedelsesdatoen og blir ugyldig så snart transportmiddelet endres eller får montert nytt utstyr som påvirker akvakulturdyrenes velferd.

§ 5 Krav til søknad om godkjenning av transportenheter

Søknaden om godkjenning skal inneholde de opplysninger som er nødvendige for å vurdere om godkjenning kan gis og hvilke vilkår som eventuelt skal stilles. Søknad skal sendes inn i god tid til det distriktskontor hvor transportenheten er hjemmehørende. Søknad om godkjenning av transportenhet skal minst inneholde følgende:

a) Personalia som navn på transportenheten, ansvarlig for transportenheten, eierform, adresse, telefonnummer og mobilnummer.
b) Opplysninger om type transportoppdrag transportenheten søkes godkjent for og hvorvidt transportenheten tidligere har vært godkjent.
c) Tegninger som viser transportenhetens konstruksjon, vann-, brønn- og/eller rørsystemer.
d) Internkontrollsystem som sannsynliggjør at krav til smittehygienisk og velferdsmessig forsvarlig drift, herunder om kompetanse, rutiner for rengjøring og desinfeksjon, dødfiskhåndtering, vannutskifting, overvåking av vannkvalitet, uttak av vannkvalitetsprøver og journalføring, kan etterleves.
e) Dokumentasjon på innretninger og utstyrets egnethet i forhold til fiskevelferd.

Søknad om godkjenning av brønnbåt skal i tillegg inneholde følgende:

a) Dokumentasjon på at posisjonsrapporteringsutstyr tilfredsstiller kravene i forskrift 24. mars 2010 nr. 454 om krav til utstyr og installasjon av posisjonsrapporteringsutstyr.
b) Opplysninger om utstyr for automatisk registrering av tidspunkt for åpning og lukking av bunnventiler.
c) Søknad om godkjenning av brønnbåt med utstyr for behandling av transportvann må også inneholde dokumentasjon utarbeidet av en uhildet faginstans på at det tekniske utstyret for behandling av transportvannet oppfyller krav til desinfeksjonseffekt fastsatt i denne forskrift. Utstyrets kapasitet for behandling av transportvann, uttrykt som mengde vann behandlet per tidsenhet, skal oppgis.

0 Endret ved forskrift 11 april 2014 nr. 528.
Annet ledd bokstav a og b trer i kraft 1 jan 2016. Annet ledd bokstav c trer i kraft 1 jan 2021.

§ 6. Forhold som vurderes ved godkjenning

For at godkjenning skal kunne gis må transportenheten tilfredsstille krav som er fastsatt i denne forskriften, samt krav i forskrift 8. februar 2012 nr. 139 om næringsmessig transport av dyr, jf. forordning (EF) nr. 1/2005 vedlegg I, kapittel II med hensyn til utforming, konstruksjon og vedlikehold. Det skal foreligge et internkontrollsystem som sannsynliggjør at krav til smittehygienisk og velferdsmessig forsvarlig drift, herunder om kompetanse, rutiner for rengjøring og desinfeksjon, dødfiskhåndtering, overvåking av vannkvalitet, uttak av vannkvalitetsprøver og journalføring, kan etterleves.

Brønnbåter som ikke har utstyr for behandling av transportvann i henhold til § 22 annet ledd, kan bare godkjennes for lukket transport av settefisk og stamfisk. Med lukket transport menes her at transportvannet tas inn fra akvakulturanlegget som fisken kommer fra, og at det ikke tas inn eller slippes ut vann under transporten.

0 Endret ved forskrift 11 april 2014 nr. 528.

Annet ledd trer i kraft 1 jan 2021.

§ 7. Tilbaketrekking av godkjenning

Mattilsynet kan trekke tilbake godkjenning som nevnt i § 4 dersom:

a) Det foreligger vesentlige brudd på vilkår i godkjenningen eller bestemmelser gitt i, eller i medhold av, matloven eller dyrevernloven.

b) Det viser seg at kunnskap om sykdomsmessige eller fiskevelferdmessige forhold er vesentlig endret i forhold til da godkjenningen ble gitt.

Transportforskriften §§ 4-7 inneholder krav vedrørende søknad om godkjenning, vurdering og eventuell tilbaketrekking av godkjenning. Det presiseres at det må søkes om fornyet godkjenning dersom transportmiddelet/utstyret endres i løpet av gyldighetsperioden.

Krav til godkjenning

- Transportenheten skal godkjennes av Mattilsynet. Godkjenningen kan ha maksimum 5 års varighet.
- Søknaden skal inneholde nødvendig informasjon, blant annet:
  - Personalia, ansvar etc.
  - Type transportoppdrag, eventuelt tidligere godkjenning.
  - Tegninger- konstruksjon, vann-, brønn- og/eller rørsystemer
  - Internkontrollsystem (utdypet nærmere kap.4.6.3)
  - Dokumentasjon på utstyr/innretninger i forhold til fiskevelferd

1.2.3. Internkontroll med journalføring

Internkontroll fungerer som et styringsverktøy for virksomhetene, hvor etterlevelse av regelverket kan dokumenteres og gjennomføres.

Internkontrollforskriften (21)

§ 5. Internkontrollens innhold

Internkontrollen skal tilpasses virksomhetens art, aktiviteter, risikoforhold og størrelse i det omfang som er nødvendig for å etterleve krav i eller i medhold av akvakulturlovgivningen.

Internkontroll innebærer at virksomheten skal:

1. *sørge for at de lover og forskrifter i akvakulturlovgivningen som gjelder for virksomheten er tilgjengelig,*
2. *sørge for at arbeidstakerne har tilstrekkelige og oppdaterte kunnskaper og ferdigheter i virksomhetens internkontroll,*
3. *fastsette mål for internkontrollarbeidet,*
4. *ha oversikt over virksomhetens organisasjon, herunder hvordan ansvar, oppgaver og myndighet knyttet til etterlevelse av akvakulturlovgivningen er fordelt i virksomheten,*
5. *kartlegge farer og problemer og på denne bakgrunn vurdere risiko, og utarbeide tilhørende planer og tiltak for å redusere risikoforholdene,*
6. *iverksette rutiner for å avdekke, rette opp og forebygge overtredelser av krav fastsatt i eller i medhold av akvakulturlovgivningen, og*
7. *foreta systematisk overvåking og gjennomgang av internkontrollen for å sikre at den fungerer som forutsatt. Internkontrollen skal dokumenteres i den form og i det omfang som er nødvendig på bakgrunn av virksomhetens art, aktiviteter, risikoforhold og størrelse. Dokumentasjon som følger av krav i eller i medhold av akvakulturlovgivningen, for eksempel instrukser, tillatelser, kompetansebevis, sertifikater o.l. skal inngå.*

   Skriftlig dokumentasjon etter denne forskrift skal minst omfatte forhold som nevnt i § 5 annet ledd nummer 3 til 7.

Transportforskriften (7)
§ 9. Journalføring

For hvert transportoppdrag skal følgende opplysninger journalføres:

a) Mengde akvakulturdyr transportert (antall, art og størrelse eller vekt),
b) sykdom, skader på akvakulturdyr og dødelighet. Ved kjent eller sannsynlig årsak skal denne angis,
c) Reiserute, inkludert akvakulturanlegg og slakterier som besøkes,
d) tid og sted for eventuelt vannskifte og lukking og åpning av ventiler,
e) eventuelt forbruk av oksygen,
f) vanntemperatur og andre vannkvalitetsparametere som overvåkes jf. § 16 og § 17, og
g) tidspunkt, mengde rengjørings- og desinfeksjonsmiddel og metode for gjennomført rengjøring og desinfeksjon av transportenheten.

Journalen skal være tilgjengelig for lastens leverandør og mottaker samt for tilsynsmyndighet. Journal for tidligere turer skal oppbevares tilgjengelig for tilsynsmyndighetene i fem år etter at den er utskrevet.

På brønnbåt kan dekksdagbok benyttes som journal så fremt den inneholder de samme registreringer som kreves journalført.

Internkontroll fungerer som et styringsverktøy for virksomhetene, hvor etterlevelse av regelverket kan dokumenteres og gjennomføres. Ved en godkjenningssøknad av transportenhet skal derfor internkontrollen fremlegges. Transportforskriften inneholder spesifikke krav om journalføring som vil være en naturlig del av internkontrollrutiner.

Veterinærinstituttet er et nasjonalt forskningsinstitutt innen dyrehelse, fiskehelse, mattrygghet og dyrevelferd med uavhengig forvaltningsstøtte til departementer og myndigheter som primæroppgave. Beredskap, diagnostikk, overvåking, referansefunksjoner, rådgivning og risikovurderinger er de viktigste virksomhetsområdene.

Veterinærinstituttet har hovedlaboratorium i Oslo og regionale laboratorier i Sandnes, Bergen, Trondheim, Harstad og Tromsø, med til sammen ca. 330 ansatte.

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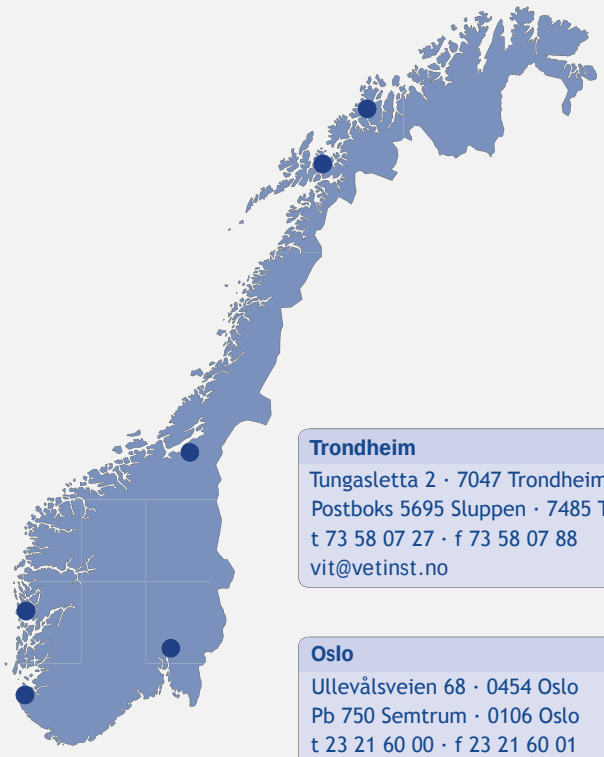

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