

Summary of epidemiological reports regarding outbreaks of ISA in Norway 2004

To Norwegian Food Safety Authority
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Veterinærinstituttet
National Veterinary Institute

Summary

The Norwegian Veterinary Institute has summarized epidemiological reports on infectious salmon anaemia (ISA) outbreaks in growers of Atlantic salmon (*Salmo Salar* L.). The information is gathered by the Local District Offices of the Norwegian Food Safety Authority in accordance with the Directive 93/53/EEC Art. 8.1. The Local District Offices have not recorded their information according to a mutual standard format therefore; each outbreak is reported with various degrees of details. This report covers eight primary outbreaks from Jan 2004 till Oct 2004.

The report shows a complex picture with various disease problems prior to suspicion and verification of ISA. On average, the fish have been kept on the site for 10-15 months before any ISA-suspicion occurred. Seven of the primary outbreaks received fish from more than one smolt supplier. Except for one of the cases, smolts were transported in well boats over long distances from hatchery to sea site. For all cases, only one generation of salmon was kept on the site.

The epidemiologic investigation performed so far gives no clear indication of possible origin of the outbreaks. Further investigations are necessary to clarify this point. The possibility of carriers of the disease can not be excluded, and needs further investigation.

Introduction

Infectious salmon anaemia (ISA) is a viral disease of Atlantic salmon which was first diagnosed in Norway in 1984 (Thorud and Djupvik, 1988). Since then, the disease has been registered in Canada (1996), Scotland (1998), Chile (1999), Faroe Islands (2000), USA (2001), and Ireland (2002).

The outbreak in Scotland was the first reported ISA case in the European Union. Within the European Union, ISA is classified as a List I disease. ISA was made notifiable as a List B disease in Norway in 1988.

A total of 437 ISA outbreaks have been reported in Norway during the time period from 1984 to Oct 2004. Figure 1 shows the number of outbreaks and the national annual salmonid production during this period. The yearly number of outbreaks peaked in 1990 with a total of 80 cases. The authorities decided in 1989 to ban the use of sea water in hatcheries, movement of fish from one sea water site to another, and introduced compulsory health certificates for aquaculture farms.

In 1991, regulations were implemented on disinfection of waste water from slaughter houses and processing plants and on smolt transport.

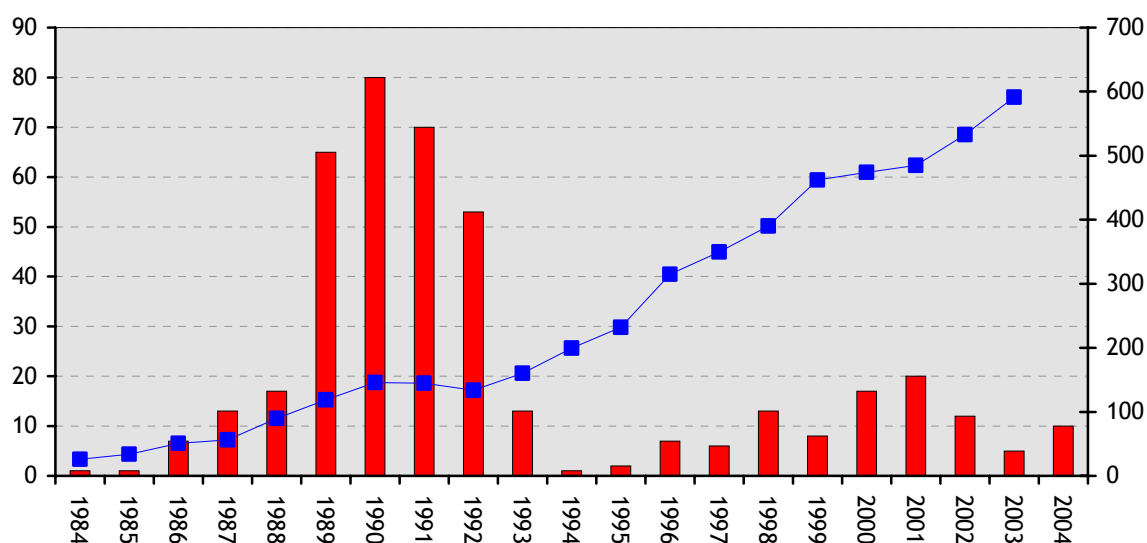


Figure 1. The number of verified ISA outbreaks (red bars) and the salmonid production in 1,000 tons (blue line) in Norway from 1984 to Oct 2004

Since 1993, the annual incidence of ISA has varied between one and twenty. The salmonid production has increased almost every year since 1984 and was in 2003, approximately 591,000 tons.

This report summarizes the epidemiological investigations performed in 2004 by the Local Offices of the Norwegian Food Safety Authority in accordance with Article 8.1 of Directive 93/53/EEC for primary outbreaks. By Oct 2004, eight primary and two secondary outbreaks were verified in Norway. Figure 2 shows the geographical location of the aquaculture farms (sites) with ISA outbreaks by Oct 2004.

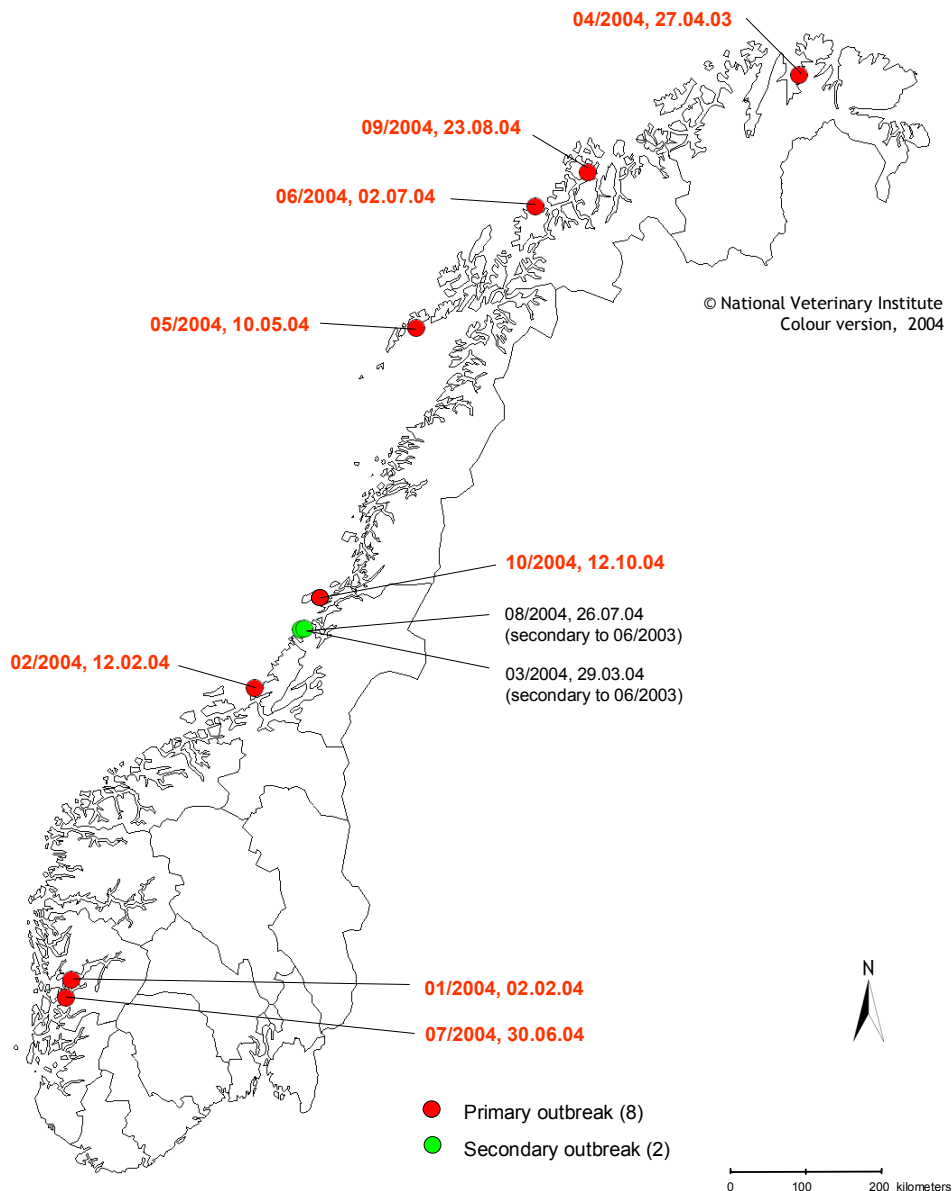


Figure 2. The geographical location and dates of ISA outbreaks in Norway from Jan-Oct 2004

The likely length of time during which the disease may have existed on the farm before being notified or suspected

The epidemiological reports demonstrate a complex clinical picture in ISA-positive sites. ISA-outbreaks may appear with acute symptoms, alone or in combination with other diseases or more often, ISA is suspected after a prolonged period of increased mortality due to various defined or non-defined disease problems.

Table 1 gives an overview of the epidemiological reports regarding primary ISA outbreaks in Norway in 2004. Details about each outbreak are given below.

Outbreak 01/2004

Smolts were transferred to the sea water location “13057, Teigland I”, 15 Oct 2002. Disease problems were not reported until non-specific disease symptoms were registered in Dec 2003. A health inspection concluded with winter ulcer and fin rot. By this time, slaughtering of fish from this site had been initiated. Disease symptoms continued through to Jan 2004. Mortality rate was however, reported to be negligible. The clinical symptoms were not considered typical for ISA, but a sample for investigation of ISA was anyway taken from fish at the slaughterhouse 16 Jan 2004. Histological examination of the sample performed at the National Veterinary Institute, indicated ISA. New samples were collected at the slaughterhouse 22 Jan 2004. Although clinical findings were still regarded not typical for ISA, ISA was verified from these samples. All fish from the sea water cage in which ISA-positive fish were detected, had been slaughtered by the time of verification.

The salmon had been kept in sea water cages for 15 months when ISA was first suspected.

Outbreak 02/2004

Smolts were transferred to the sea water location “12795, Tiltervågen” 9 and 26 May 2002. The fish were graded and redistributed on the sea site three times. First time 19-21 Nov 2002, second time 6-13 Jun 2003, and third time 2, 15 and 16 Oct 2003. Some of the fish were transferred to a new location (“13083, Steinvikodden”) during the third grading.

Infectious pancreatic necrosis (IPN) was diagnosed during summer 2002, but the mortality was low and only a few fishes showed clinical symptoms of IPN. Particular disease problems were not reported after this, except winter ulcer in one of the sea cage at “13083, Steinvikodden”-location, the same cage where ISA was detected later.

The harvesting of “12795, Tiltervågen” and “13083, Steinvikodden” started 3 Sep 2003 and proceeded until 11 Mar 2004. Because of a slaughtering agreement where finished fish had to be transported to the neighbouring county of Rogaland for slaughtering, samples were taken and analyzed with regard to ISA-virus using an RT-PCR test.

The mortality rate in one of the sea cages at “13083, Steinvikodden”-location was 0.3‰ per day for a period of 26 days prior to the ISA suspicion (10 Feb 2004). The suspicion was based on increased mortality, positive test results of RT-PCR testing and macroscopic pathological lesions.

The salmon had been kept in sea water cages for 21 months when ISA was first suspected.

Outbreak 04/2004

Smolts were transferred to the sea water location “19335, Eidemolla” 12 May 2003 and 12 Jun 2003. In February 2004, slightly increased mortality <0.5‰ per day was observed in one of the cages combined with non-specified findings after post-mortem examination. The mortality rate increased to 0.5-2‰ per day in Mar 2004, and 2-7‰ per day in Apr 2004. Samples from the cage were collected 22 Mar 2004 and tested for ISA-virus. The results supported an ISA suspicion. Further post-mortem examinations showed both non-specific findings and findings consistent with ISA. More laboratory examinations finally verified the ISA-diagnosis.

The salmon had been kept in sea water cages for 10 months when ISA was first suspected.

Outbreak 05/2004

Smolts were transferred to the sea water location "11193, Gamskjæran" in four different turns; 5 May 2003, 5 Jun 2003, 22 Jul 2003, and 3 Oct 2003. Increased mortality or any other indications of irregular health status of the fish was not reported until Feb 2004 when acute mortality occurred. Samples investigated during Feb and Mar 2004 were negative with regard to ISA. Low sea water temperature was assumed the cause of the mortality. The situation normalized during Mar and Apr 2004, although increased mortality was still observed together with winter ulcer and fin rot. Further investigations were performed by the local fish health service and the Norwegian Food Safety Authority 23 Apr 2004 and 4 May 2004. Both clinical signs and findings from post-mortem examination of diseased fish were consistent with ISA. New samples were taken and investigated by the National Veterinary Institute. ISA was verified.

In the period 1-12 May 2004, the mortality rate in the infected cage was 1.1% per day. In the same period the mortality rate was 0.03% per day in the other sea cages at the location.

The salmon had been kept in seawater cages for 12 months when ISA was first suspected.

Outbreak 06/2004

Smolts were transferred to the sea water location "13794, Kråksølvneset" in three different turns; 11 Jun 2003, 11 Jul 2003 and 24 Jul 2003. The fish were on the whole of poor quality and health. Cardiomyopathy syndrome (CMS) was diagnosed 9 Oct 2003. In Jun 2004, increasing mortality was reported especially in two cages where the rate increased from 0.025%-0.2%.

An inspection was performed by the fish health service and the Norwegian Food Safety Authority 25 Jun 2004. Clinical signs consistent with ISA were seen. Samples were collected and investigated by the National Veterinary Institute. ISA was verified.

The salmon had been kept in seawater cages for 12 months when ISA was first suspected.

Outbreak 07/2004

Smolts were transferred to the sea water location "12077, Tveitnesvik" in three turns; 1 Sep 2003, 7 Oct 2003 and 6 Nov 2003. Disease problems were reported three weeks after sea transfer in Oct 2003, accumulated mortality being 0.6‰ per day during the first three months. IPN was suspected.

A health inspection 13 Jan 2004 reported fish showing winter ulcer and non-specific clinical symptoms.

Fish from "12077, Tveitnesvik" were transferred to a new location, "13232, Eidsvikøy NV" on 16 Jan 2004. During the time period from 16 Feb until 6 Jun 2004 a mean mortality rate of 0.6‰ per day was reported and extensive problems with winter ulcer described. 17 Mar 2004 samples were collected for ISA-testing. This sampling was a part of an ISA-virus-screening project on sea sites located in ISA observation zones.

A new inspection of the "13232, Eidsvikøy"-location was performed 11 Jun 2004. Some of the fish were clinically ill showing diffuse disease symptoms. Samples for ISA-investigation were collected, both from apparent healthy fish and from fish with disease symptoms. The investigations indicated ISA, but more samples were needed to verify the diagnosis. At the succeeding inspection 5 Jul 2004, a general improved health situation was found, except for one cage where the mortality rate was 0.7‰ per day. Post-mortem examination of fish from this cage showed symptoms consistent with ISA. New samples confirmed the ISA-diagnosis.

The salmon had been kept in seawater cages for 7 - 9 months when ISA was suspected.

Outbreak 09/2004

Smolts were transferred to the sea water location "10753, Strandmo" in more than four turns; 3, 18, 20 and 25-27 May 2003. High mortality and disease problems were reported already from the time of transfer and IPN, Parvicapsula, and pancreas disease were subsequently diagnosed.

The fish was graded and redistributed 10-11 Jun 2004. From 16 Jul-18 Aug 2004 the mean mortality rate was 0.5‰ per day in one of the cages and 0.25‰ per day in another sea cage. Post-mortem examinations

performed by the fish health service and the Norwegian Food Safety Authority 11 and 17 Aug 2004, showed symptoms consistent with ISA. ISA was thereafter verified by laboratory investigation.

The salmon had been kept in seawater cages for 15 months when ISA was first suspected.

Outbreak 10/2004

Smolts were transferred to the sea water location “12715, Steinsøya” in four turns; 6, 14, 29 May and 6 Jun 2003. Increased mortality was soon reported and IPN was diagnosed 23 Jun 2003. The fish was graded in Oct/Nov 2003.

In Apr 2004, investigation due to increased mortality, concluded with an infection of *Vibrio salmonicida*. The fish was again graded 12-15 Jul 2004. Increased mortality registered 14 Aug 2004 was explained by high sea water temperatures and low oxygen levels in the cages. By Aug 2004 harvesting had started. In Oct 2004, ISA was suspected due to clinical symptoms in one of the cages.

The salmon had been kept in seawater cages for 16 months when ISA was first suspected.

Table 1. Summary of the epidemiological reports regarding primary outbreaks of ISA in 2004

| Primary outbreak | 01/2004 | 02/2004 | 04/2004 | 05/2004 | 06/2004 | 07/2004 | 09/2004 | 10/2004 |
|----------------------------------|--|---|---|--|--|--|--|---|
| County | Hordaland | Trøndelag | Finnmark | Nordland | Troms | Hordaland | Troms | Trøndelag |
| Sea site ID | 13057, Teigland | 13083, Steinvikodden | 19335, Eidemolla | 11193, Gamskjæran | 13794, Kråksølvneset | 13232, Eidsvikøy | 10753, Strandmo | 12715, Steinsøya |
| Species | Atlantic salmon ¹ | Atlantic salmon ¹ | Atlantic salmon ¹ | Atlantic salmon ¹ | Atlantic salmon ¹ | Atlantic salmon ¹ | Atlantic salmon ¹ | Atlantic salmon ¹ |
| Date of transfer to the sea site | 15 Oct 2002 | 9 May 2002, 26 May 2002 | 12 May 2003, 12 Jun 2003 | 5 May 2003, 5 Jun 2003, 22 Jul 2003, 3 Oct 2003 | 11 Jun 2003, 11 Jul 2003, 24 Jul 2003 | 1 Sep 2003, 7 Oct 2003, 6 Nov 2003 | 3 May 2003, 18 May 2003, 20 May 2003, 25 May 2003, 26 May 2003, 27 May 2003 | 6 May 2003, 14 May 2003, 29 May 2003, 6 Jun 2003 |
| No. of fish at sea site | 228,900 ² | 704,379 ² | 371,405 (29 Mar 2004) | 480,000 ² | 670,001 ² | 580,000 (16 Feb 2004) | 670,001 ² | 413,000 ² |
| Grading | Not reported | Nov 2002, Jun 2003, Oct 2003 | Not reported | Feb 2004 | Jun 2004 | Jan 2004 | Jun 2004 | Oct/Nov 2003, Jul 2004 |
| ISA suspected | 26 Jan 2004 | 10 Feb 2004 | 1 Apr 2004 | 10 May 2004 | 29 Jun 2004 | 18 Jun 2004 | 18 Aug 2004 | 7 Oct 2004 |
| Time period ³ | 15 months | 21 months | 10 months | 12 months | 12 months | 7-9 months | 15 months | 16 months |
| Mortality rate | Mortality rate was reported to be negligible | 0.3‰ per day the last 26 days before ISA suspicion in the infected sea cage | 0.5‰ per day in Feb 2004, 0.5-2‰ per day in Mar 2004, 2-7‰ per day in Apr 2004 in the infected sea cage | Acute mortality in Feb 2004: 1.1% per day 1-12 May 2004 in the infected sea cage | 0.025-0.2% per day in two sea cages from 22 Jun 2004 | 0.6‰ per day from 16 Feb 2004 - 6 Jun 2004 (mean mortality) | 0.5‰ per day in one cage and 0.25‰ per day in another from 16 Jul 2004-18 Aug 2004 | Jun 2003: Increased mortality, Apr/May 2004: Increased mortality, Aug 2004: Increased mortality |
| Clinical symptoms | Jan 2004: Diffuse non-specific symptoms | Feb 2004: Symptoms consistent with ISA | Mar/Apr 2004: Both non-specific symptoms, and symptoms consistent with ISA | Apr 2004 and May 2004: Symptoms consistent with ISA ⁴ | Jun 2004: Symptoms consistent with ISA | Jun 2004: Both non-specific symptoms, and symptoms consistent with ISA | Symptoms consistent with ISA | Oct 2004: Symptoms consistent with ISA |
| Other diseases than ISA | Dec 2003: Diffuse, non-specific symptoms, fin rot and winter ulcer | Summer 2002: IPN Jan 2004: Winter ulcer | Mar 2004: Parvicapsula | Feb 2004: Winter ulcer and fin rot | 9 Oct 2003: Cardiomyopathy syndrome (CMS) | Oct 2003: IPN Jan 2004: Winter ulcer | 29 Jul 2003: IPN 11 Aug 2003: Parvicapsula 9 Dec 2003: PD | 23 Jun 2003: IPN, 12 Feb 2004: Epteliocystis, 21 Apr 2004: <i>Vibrio Salmonicida</i> , 14 Aug 2004: Slimy gills |

¹ Seawater reared growers of Atlantic salmon (*Salmo salar* L.)

² Number of fish by date of transfer to sea site

³ Time period from transfer to sea site until suspicion of ISA

⁴ Samples investigated by the National Veterinary Institute in Feb 2004 and Mar 2004 gave no indications of infection with ISA

The possible origin of the disease on the aquaculture farm and the identification of other aquaculture farms on which there are eggs and gametes and fish of susceptible species which may have become infected

Knowledge about reservoirs and spreading of ISA virus is insufficient. However epidemiological studies indicate that ISA is mainly spread by infected live Atlantic salmon, well boats or infected material as waste, discharge from normal operations and slaughter houses (Djupvik *et al.* 1992, Vågsholm *et al.* 1994, Jarp 1999, Murray *et al.* 2002). It is believed that vertical transmission of ISA-virus does not occur, but studies show that this should be investigated further (Nylund *et al.* 1999).

The ISA-virus may be introduced to a sea site in different ways:

- Trading of live smolts using well boat transportation over long distances
- Moving fish between sea sites using well boats for transportation
- Other well boat assisted activities on the site (e.g. grading)
Well boats operate along the entire coast and because of difficulties in performing a proper hygienic cleaning, they constitute a risk in spreading the ISA-virus. This is pointed out by Murray *et al.* 2002 who demonstrated a link between number of vessel visits and the probability of ISA outbreaks in the area visited
- Contaminated equipment and materials
- ISA-virus may be endemic present in a region and carrier fish and/or various other marine organisms may act as infectious reservoirs for the virus
- Smolt transferred to sea may be sub-clinically infected in the hatchery through contaminated sea water used in the production

The Figures 3 to 8 show salmon sites containing growers at the time of ISA suspicion, located within the control- and surveillance zones established around each primary outbreak.

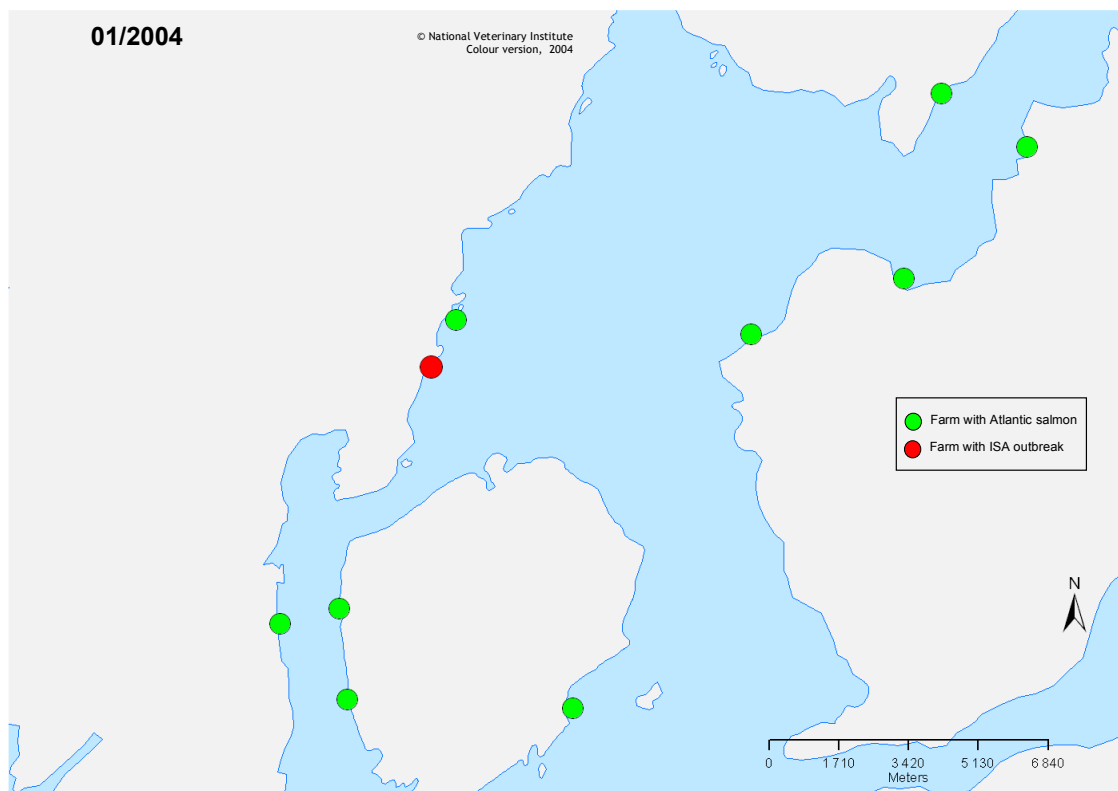


Figure 3. The geographical location of aquaculture activity within the control- and surveillance zone established for outbreak 01/2004

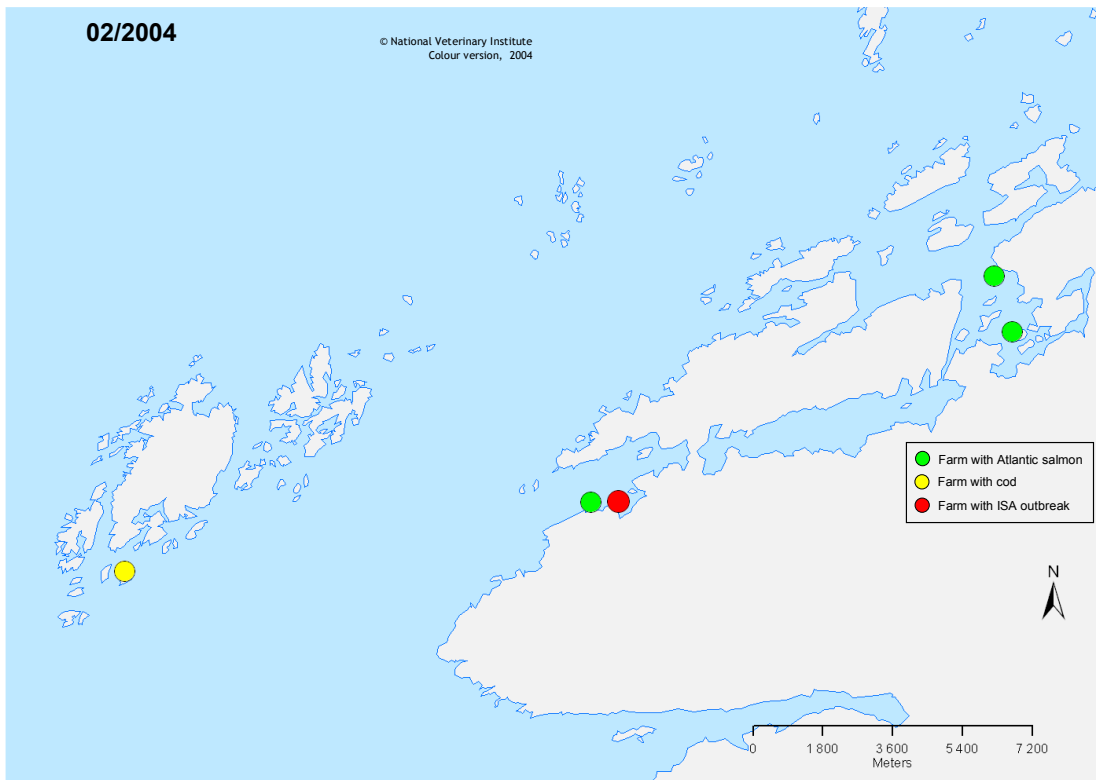


Figure 4. The geographical location of aquaculture activity within the control- and surveillance zone established for outbreak 02/2004

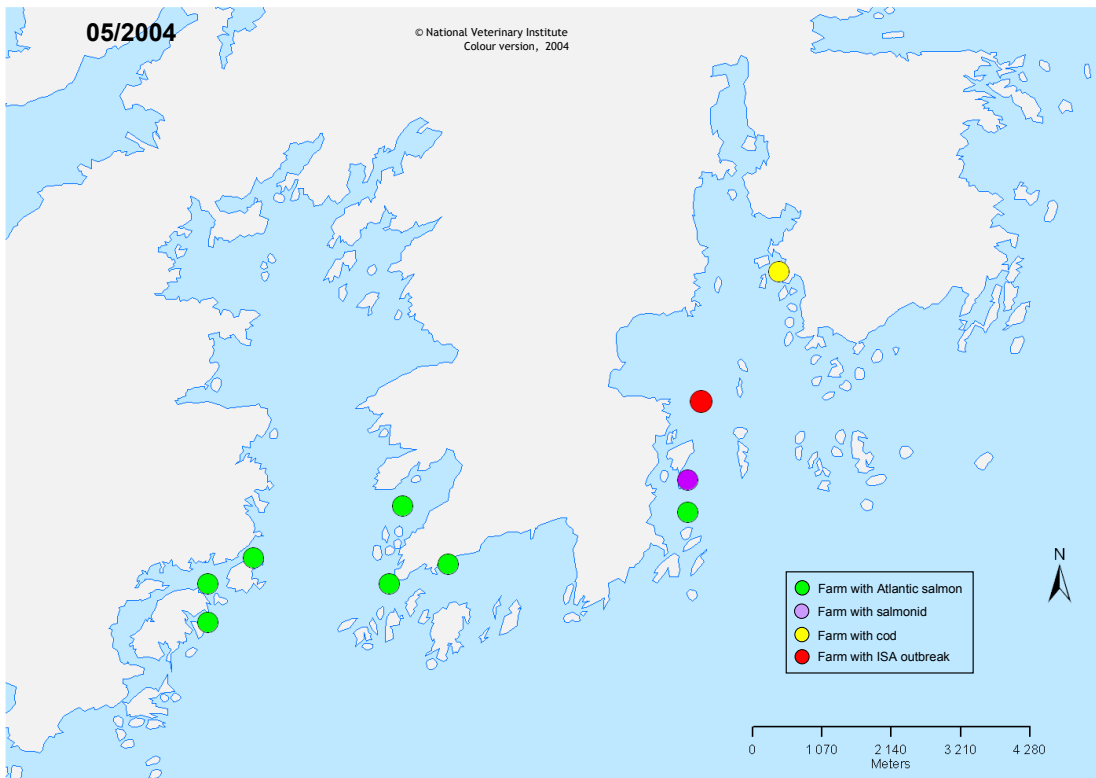


Figure 5. The geographical location of aquaculture activity within the control- and surveillance zone established for outbreak 05/2004

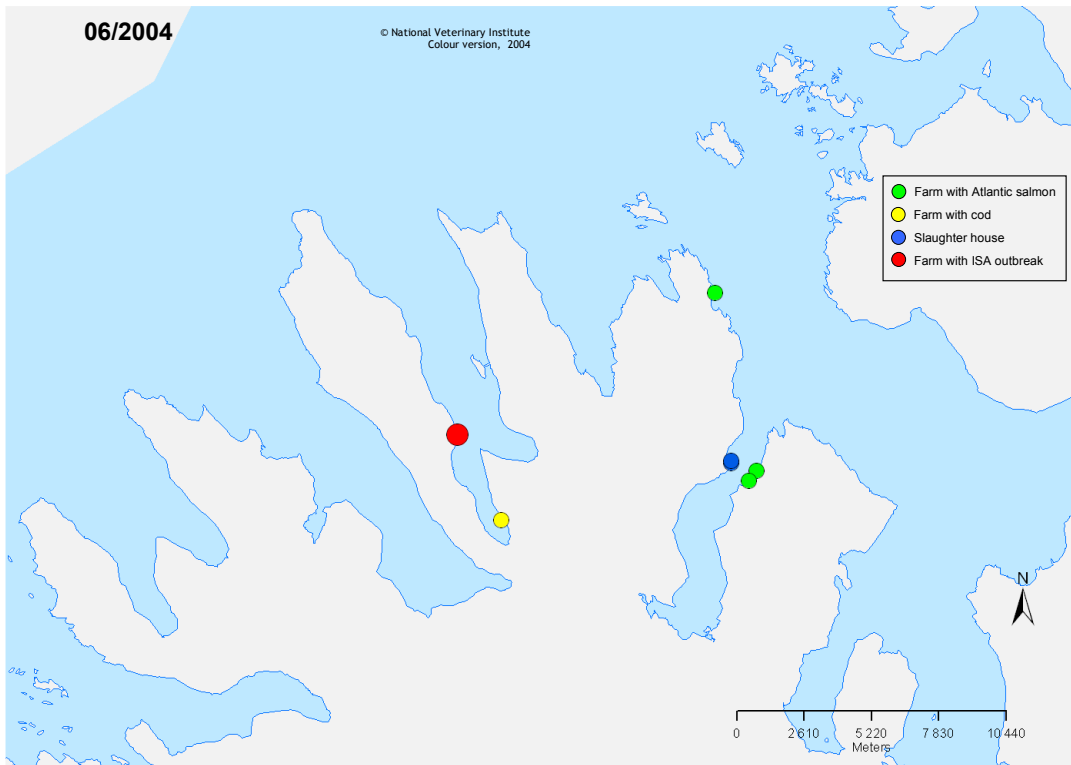


Figure 6. The geographical location of aquaculture activity within the control- and surveillance zone established for outbreak 06/2004

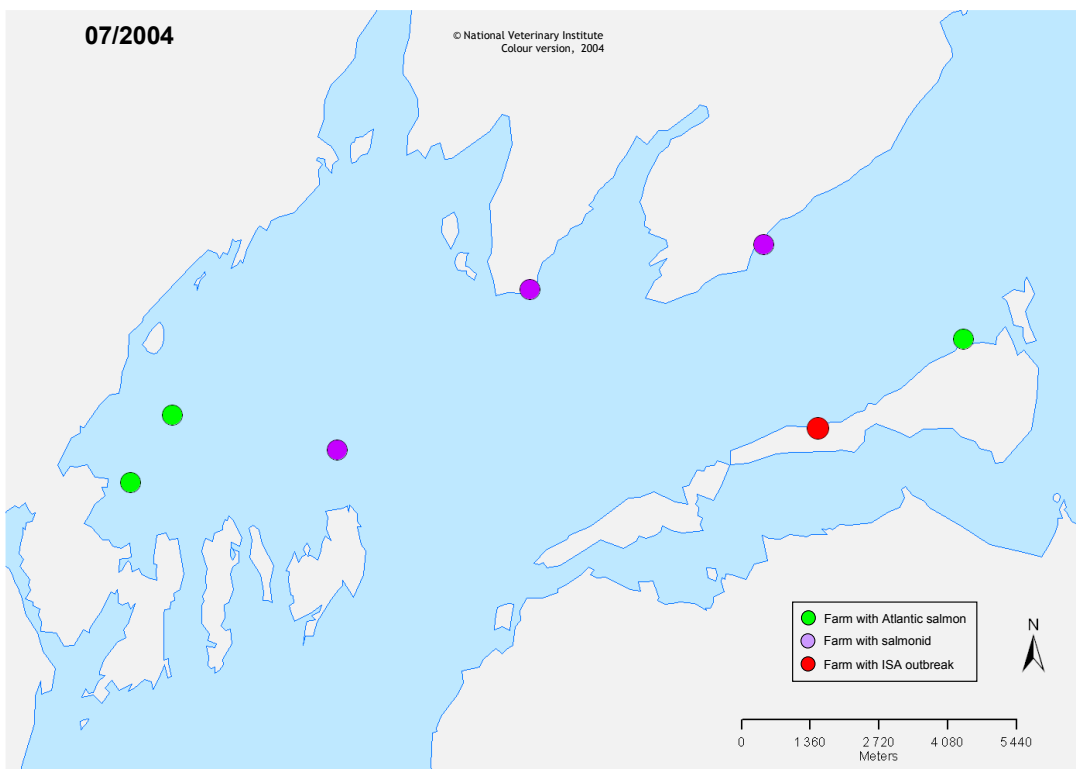


Figure 7. The geographical location of aquaculture activity within the control- and surveillance zone established for outbreak 07/2004

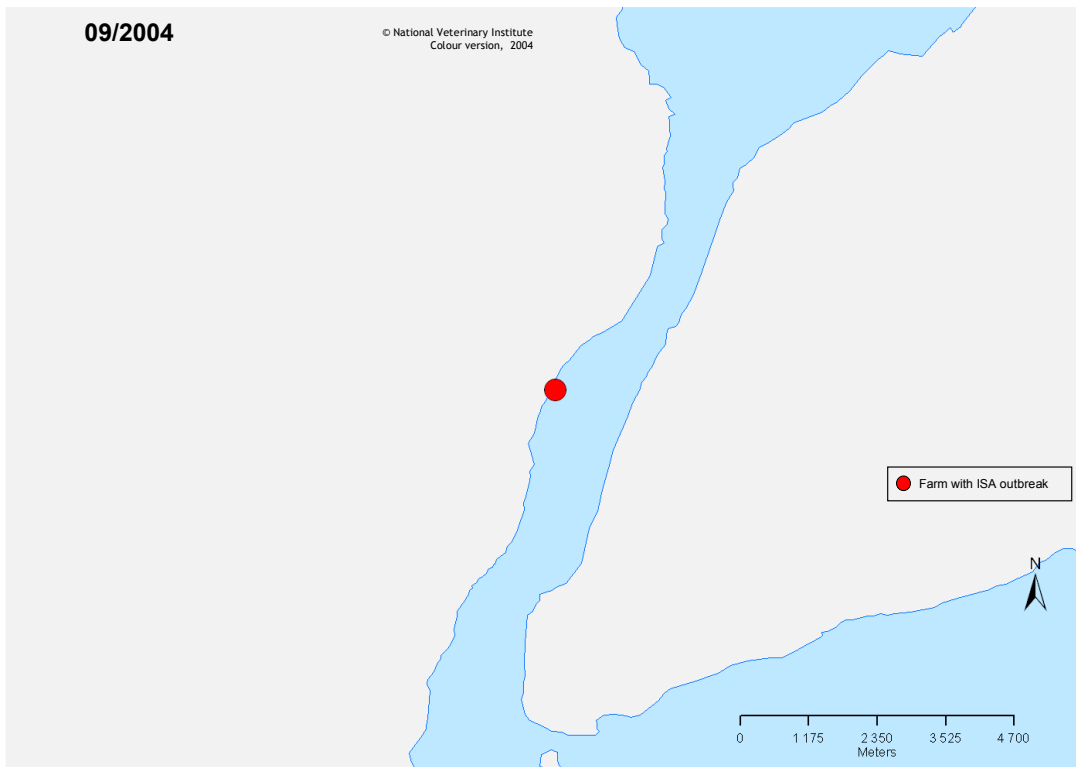


Figure 8. The geographical location of aquaculture activity within the control- and surveillance zone established for outbreak 09/2004

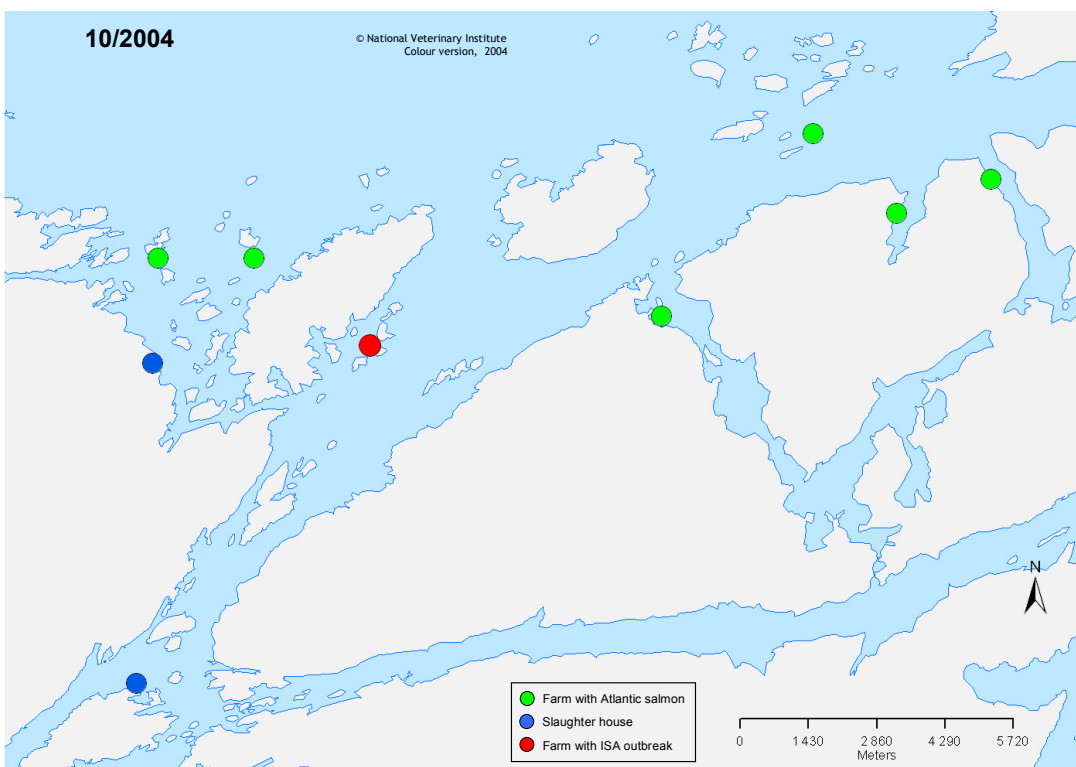


Figure 9. The geographical location of aquaculture activity within the control- and surveillance zone established for outbreak 10/2004

The movement of fish, eggs or gametes, vehicles or substances and persons likely to have carried the agent of the disease to or from the farms in question

Available information about movement in and out of the case farms is presented below and Table 2 shows a summary of this information.

Outbreak 01/2004

Information about movement by vehicles, substances and persons is not reported. The case farm was located in the Hardanger area where ISA was diagnosed in 2001 and 2002. Figure 10 shows the geographical location of the smolt suppliers to the farm.

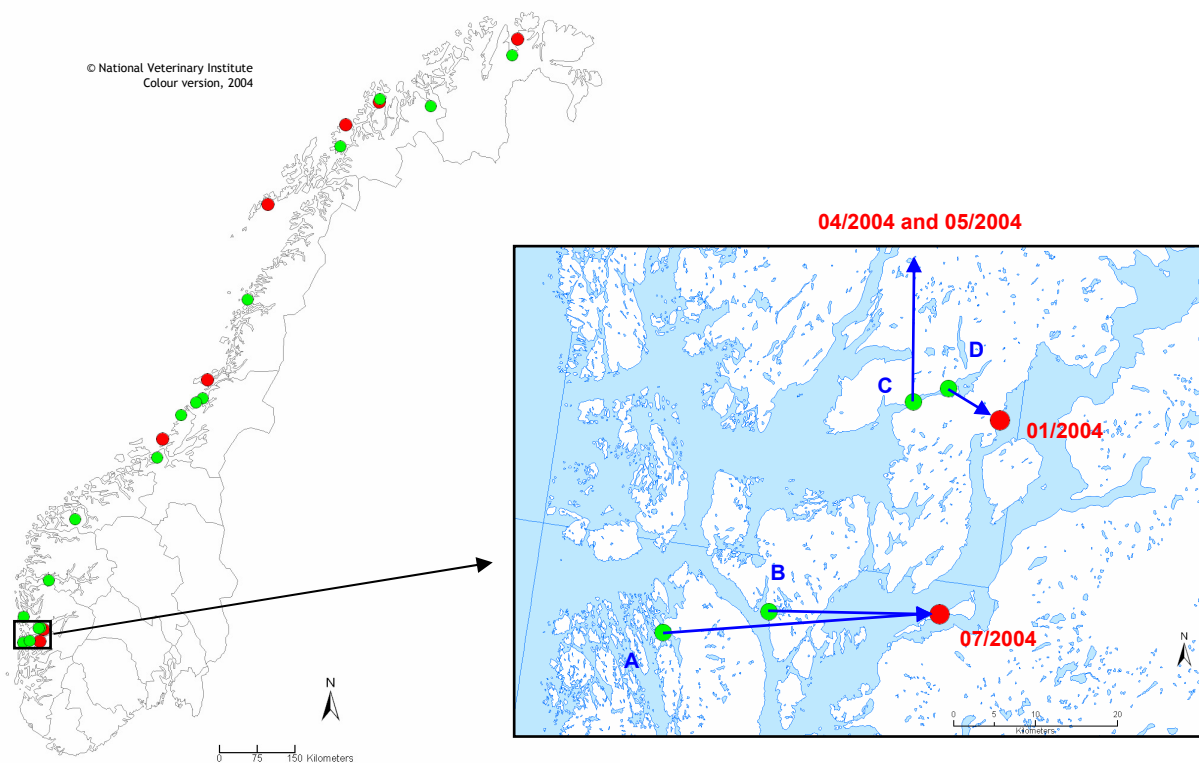


Figure 10. Smolt suppliers to the outbreaks 01/2004 and 07/2004

Outbreak 02/2004

The sea site is served by an on shore facility. There is no contact between this on shore facility and other sea sites with farmed Atlantic salmon, but it is located close to a plant receiving shellfish for further processing. External service boats have not been used on the farm except for well boats hired for grading the fish. Two of the well boats used for grading in Oct 2003 are primarily used by the company, but do occasionally take external engagements. Feed are transported to the location by sea and stored on a separate fleet at the site. Figure 11 shows the geographical location of the smolt suppliers to the farm.

Outbreak 04/2004

The aquaculture farm has routines to secure that all traffic to and from the locations is performed in a hygienic manner. The previous ISA outbreak in this region was in 1994. There has only been indirect contact to other aquaculture farms by well boats and boats transporting feed. The same well boat which delivered smolts to this location was also used for delivering fish to another location in the same region. Figure 11 shows the geographical location of the smolt suppliers to the farm.

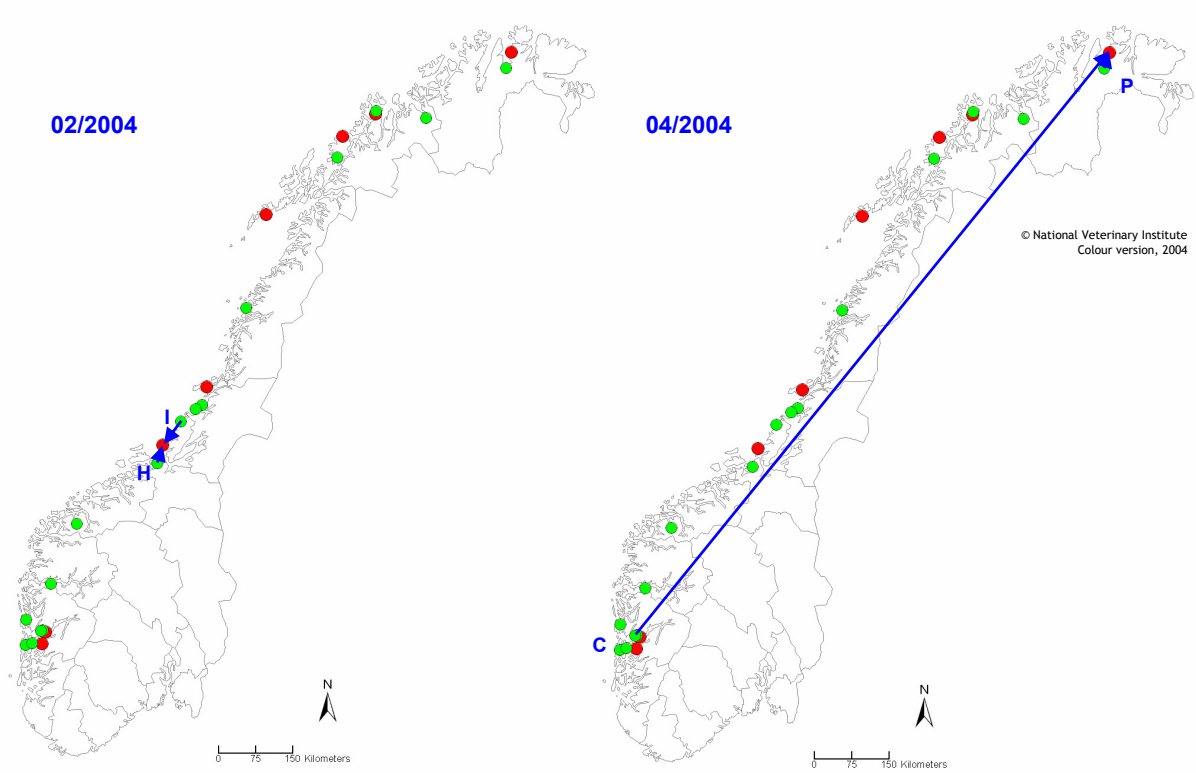


Figure 11. Smolt suppliers to the outbreaks 02/2004 and 04/2004

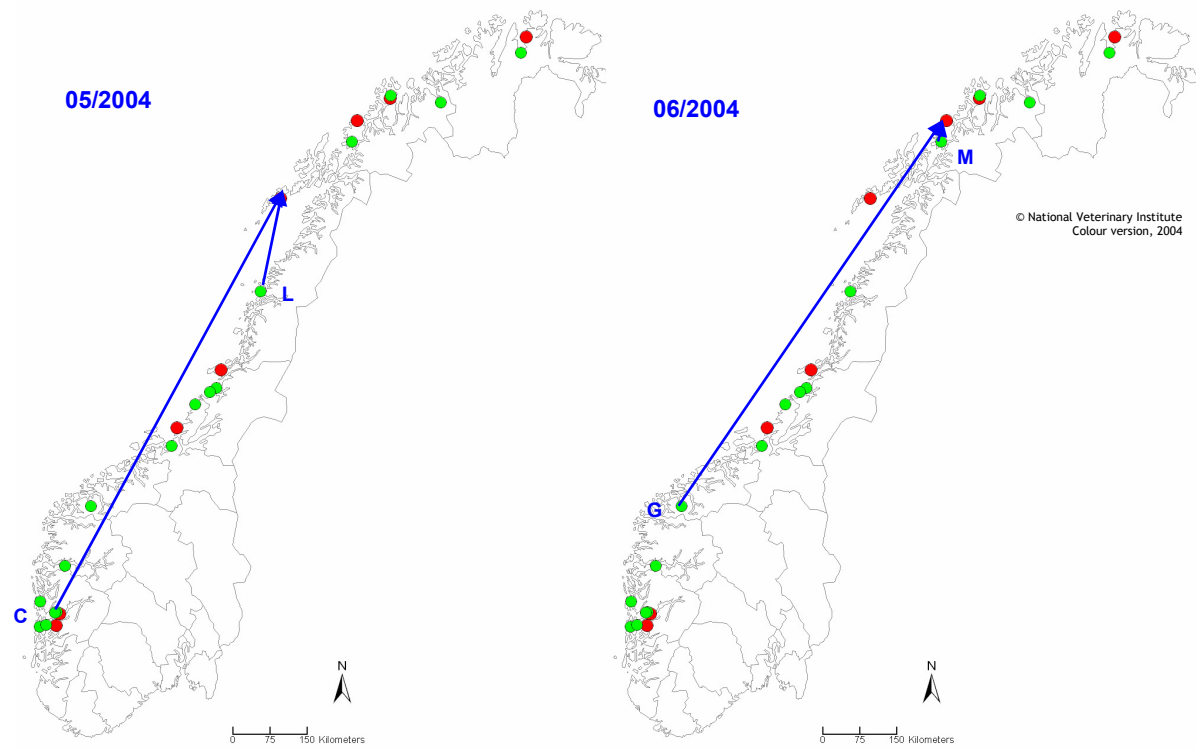


Figure 12. Smolt suppliers to the outbreaks 05/2004 and 06/2004

Outbreak 05/2004

The on shore facility is located 1.5 km from the sea site. Dead fish are collected and transported to shore for treatment with formic acid. This ensilage is collected for further processing by an external company. Feed is delivered by road. Figure 12 shows the geographical location of the smolt suppliers to the farm.

Outbreak 06/2004

A hired well boat was used for grading a few weeks before the outbreak. All equipment used at the sea location has been cleaned and disinfected before use by the personnel at the sea site. Feed is delivered both by road and sea. Dead fish are treated on shore with formic acid, and the ensilage is collected for further processing by an external company. Figure 12 shows the geographical location of the smolt suppliers to the farm.

Outbreak 07/2004

The case farm was located in the Hardanger area where ISA was diagnosed in 2001 and 2002. Information about movement by vehicles, substances and persons is not reported. Figure 10 shows the geographical location of the smolt suppliers to the farm.

Outbreak 09/2004

No fish has been slaughtered since smolts were transferred to the sea site in 2003. No accidents or escaping of fish from the sea site has been reported. The on shore facility is located 300m from the sea site. Dead fish are treated on shore with formic acid, and the ensilage is collected for further processing by an external company.

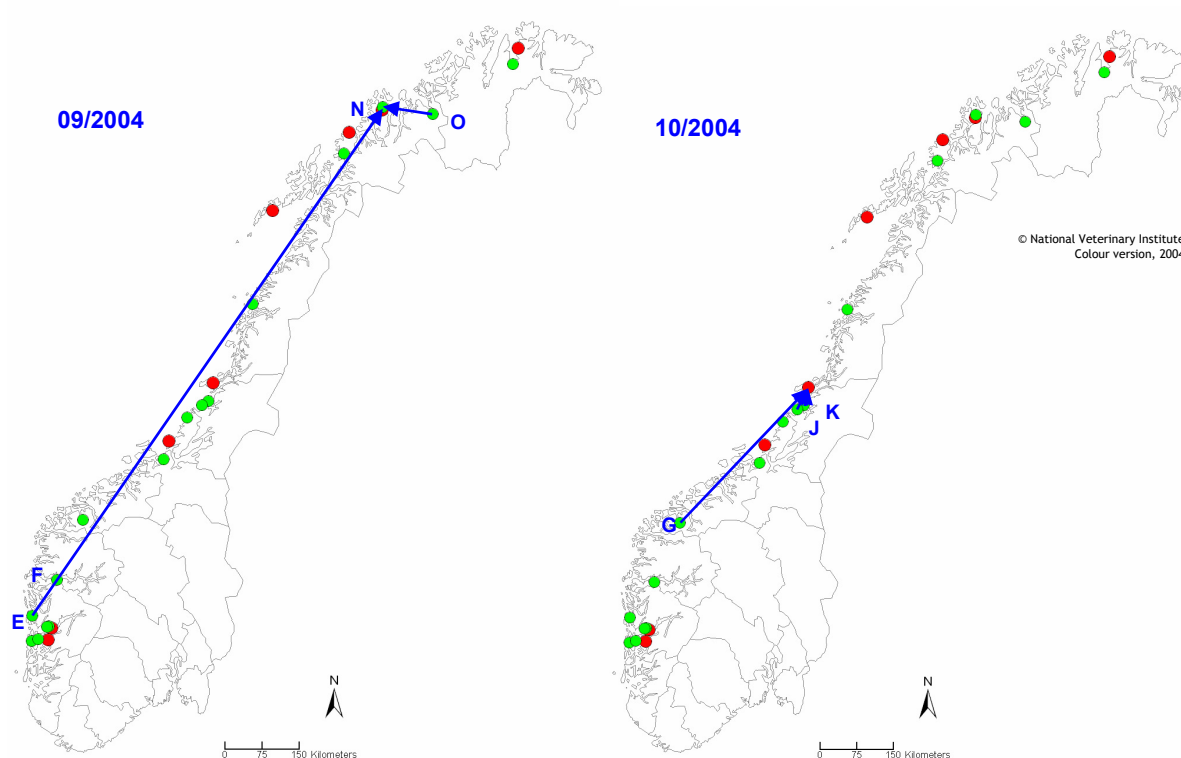


Figure 13. Smolt supplies to the outbreaks 09/2004 and 10/2004

A service boat is used between the on shore facility and the sea site. There is no indication that this boat is used for other purposes. The aquaculture farm receives feed from a nearby production plant and feed is transported to the location both by sea and road. A well boat from the county of Trøndelag was used for grading of fish. The well boat was cleaned and disinfected before this task, and the graded fish were redistributed in newly cleaned and disinfected cages. Figure 13 shows the geographical location of the smolt suppliers to the farm.

Outbreak 10/2004

A well boat was used for grading the fish. Two other well boats were used for transport of fish for slaughtering. Figure 13 shows the geographical location of the smolt suppliers to the farm.

Table 2. Smolt suppliers, maximum transport distance for the smolt and well boat visits per primary outbreak in 2004

| Primary outbreak | County | Sea site ID | Letter on maps | Maximum transport distance* | Well boat visits** |
|------------------|-----------|----------------------|------------------|-----------------------------|--------------------|
| 01/2004 | Hordaland | 13057, Teigland | D | ~ 10 km | 1 |
| 02/2004 | Trøndelag | 13083, Steinvikodden | H I | ~ 50 km | 5 |
| 04/2004 | Finmark | 19335, Eidemolla | C P | > 1,800 km | 2 |
| 05/2004 | Nordland | 11193, Gamskjæran | C L | > 1,100 km | 5 |
| 06/2004 | Nordland | 13794, Kråksølvneset | G M | > 1,000 km | 4 |
| 07/2004 | Hordaland | 13232, Eidsvikøy | A B | ~ 40 km | 4 |
| 09/2004 | Trøndelag | 10753, Strandmo | E F N O | > 1,300 km | 7 |
| 10/2004 | Trøndelag | 12715, Steinsøya | G J K | ~ 450 km | 6 |

*) Approximately distance is given

**) Number of visits includes only transfer of smolt to sea site and grading

The possible existence of carriers of the disease, and their distribution

Atlantic salmon is the only susceptible fish species known to develop clinical disease. The ISA virus (ISAV) may survive and replicate in sea trout (*Salmo truttae*), rainbow trout (*Oncorhynchus mykiss*) and Atlantic herring (*Clupea harengus*), which thus may act as carriers of the virus. Reference is made to report no 13/01 from FRS Marine Laboratory about epizootiological investigations into an outbreak of infectious salmon anaemia (ISA) in Scotland (Stagg *et al.* 2001) point 2.4 Hosts and Carriers, which is in accordance with the experiences from Norway.

Conclusion

The epidemiological reports demonstrate a complex clinical picture in ISA-positive sites. ISA-outbreaks may appear with acute symptoms, alone or in combination with other diseases or more often, ISA is suspected after a prolonged period of increased mortality due to various defined or non-defined disease problems.

In six of the primary outbreaks this year, the fish have been kept at sea sites for 10-15 months before ISA was suspected and verified. In one of the primary outbreaks the salmon was kept in seawater cages for 21 months, while in another only seven to nine months.

Two of the smolt suppliers did deliver fish to two of the ISA outbreaks each. Seven of the primary outbreaks received fish from more than one smolt supplier. Except for one of the cases, smolts had been transported over long distances. A minimum number of two to seven well boat visits took place on all locations during the production time.

This report gives no indication of possible existence of carriers of the disease and their distribution. The possibility of carriers can not be ruled out and needs further investigation.

The epidemiologic investigation performed so far gives no clear indication of possible origin of the ISA outbreaks. Further investigations are necessary. An investigation of the genetic relationship between virus isolates from the outbreaks 2004, has started and may give interesting information to help tracing the source of infection.

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