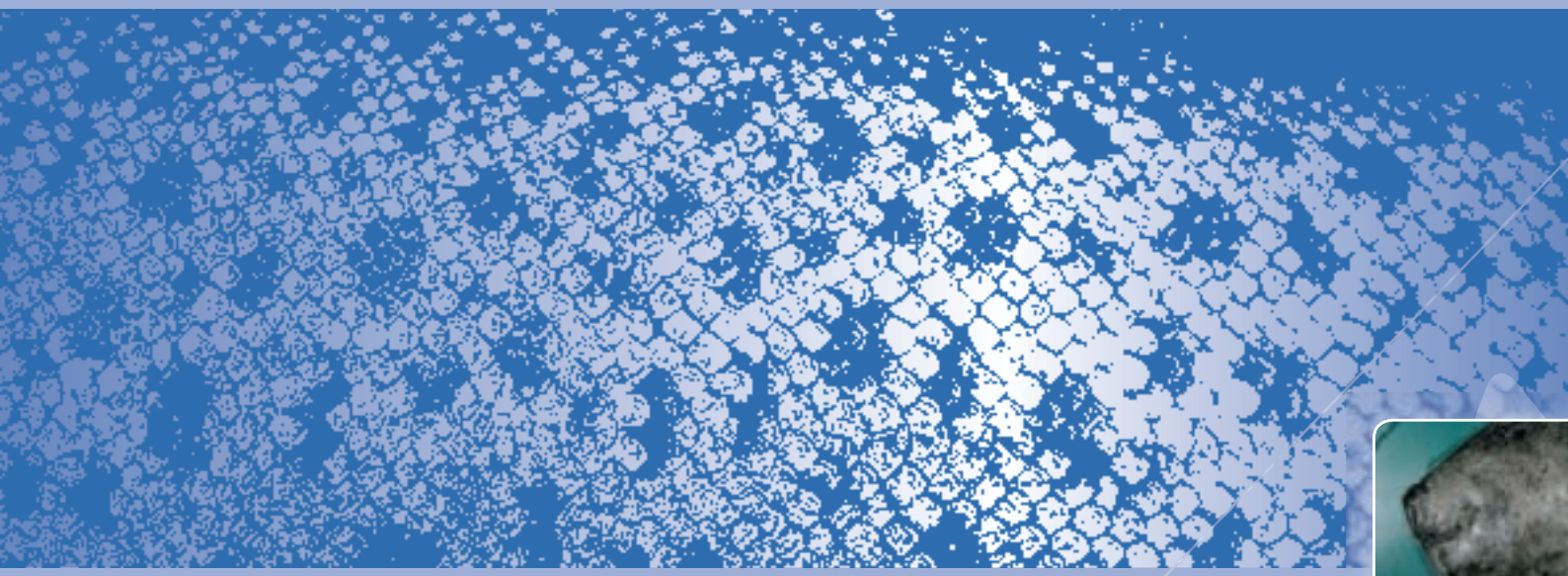
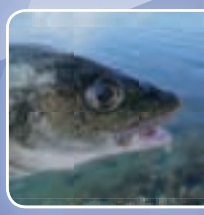
The health situation in farmed fish in Norway 2007





Veterinærinstituttet
National Veterinary Institute

Directors introduction

In the course of 2007, Norwegian aquaculture produced 750 000 tonnes of salmon, 80 000 tonnes of rainbow trout, 12 000 tonnes (estimate) of cod and 200 tonnes (estimate) of other species, representing a considerable increase from last year. For many years Norway has experienced a relatively favourable disease situation in farmed fish. Over the last few years this situation has, however, become slightly less straightforward.

In salmonid fish, pancreas disease (PD) gives grounds for concern. From only a handful of affected localities 10 years ago, the disease has now spread along the whole west coast. "New" diseases like heart and skeletal muscle inflammation (HSMI) in salmon and francisellosis in cod increase in frequency and extend their range.

Norway is not alone in experiencing a continually more serious disease situation. The world's second largest producer of salmon, Chile, is also experiencing difficulties, and the industry there is suffering large losses. The causes are complex, but there is good reason to believe that a focus on general hygienic principles will be important in turning the situation around.

For this work to be effective, extensive cooperation within the fish farming industry is required. The most significant risk factors for spread of disease will always be related to transport of fish. Measures aimed at reduction of transport and transport-related risk factors are therefore important. Such measures must however, not lead to a reduced prioritisation of other important control strategies e.g. vaccine development.

"New" diseases will always present challenges. We are dependent on a well-functioning fish health service which can identify and investigate emerging disease problems at an early stage. We are further dependent on a laboratory system which can collate and report information relating to new trends and problems.

Disease related losses remain unacceptably high. There is much to be won in the battle towards increased overall production through intensification of work directed at disease impact reduction, rather than a unilateral increase in numbers of fish cultured.

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The health situation in salmonid fish 2007

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Good fish health is a precondition for sustainable aquaculture. On suspicion of disease a broad diagnostic investigation should be initiated as quickly as possible. Increased mortality rates on a farm may have a multifactorial background and several diseases may occur either simultaneously or sequentially.

The diseases pancreas disease (PD), infectious pancreas necrosis (IPN) and winter ulcer are the most significant current cause of losses in salmon aquaculture. The large increase in diagnosis of heart and skeletal muscle inflammation (HSMI) also gives grounds for concern.

Summary

The total number of pancreas disease (PD) and heart and skeletal muscle inflammation (HSMI) outbreaks has increased dramatically over the last year. IPN remains the largest disease problem in salmon farming, and is diagnosed from start feeding through the first year of sea culture. The number of farms diagnosed with IPN during 2007 was, however, significantly lower than during 2006, and while some farms experienced high losses, IPN was generally considered to be less of a problem in 2007.

Cardiomyopathy syndrome (CMS) is, as before, a significant cause of loss in larger salmon. Proliferative gill inflammation (PGI) continues to contribute to large scale mortalities on a number of farms, particularly in the first autumn following spring transfer of smolts.

The frequency of infectious salmon anaemia (ISA) outbreaks remains at a fairly stable, low level. All outbreaks during 2007 were located within a relatively small area in Troms and Nordland. During 2007, for the first time since 1974, viral hemorrhagic septicaemia (VHS), a group A notifiable disease, was diagnosed in rainbow trout in western Norway.

The various bacterial diseases pathogenic for salmon continue to be largely unproblematic, which is due in the main to good vaccines and vaccination strategies. Furunculosis is only diagnosed intermittently. A minimal increase in yersiniosis (infection with *Yersinia ruckeri*) was registered during 2007. Winter ulcer, related to infection with *Moritella viscosa* continues to be problematic in some areas, both in salmon and rainbow trout.

The situation in 2007 is considered undramatic regarding salmon louse infection in farmed fish and an infection pattern similar to that reported for 2006 was observed. However, as the total number of farmed fish in the sea increased during 2007, there are grounds to believe that the total infection pressure may have increased.

On a national basis the salmon lice situation in relation to wild salmon is considered worse than during 2006.

Viral diseases

Pancreas Disease (PD)

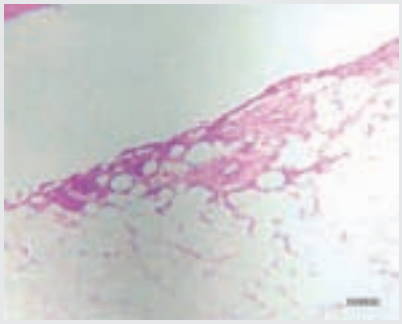
Pancreas disease (PD) was diagnosed on 98 farms during 2007, constituting a doubling in annual registered cases since 2005. The entire West Norwegian coast line was represented.

The main focus for the disease continues to be Hordaland, where there were particularly many diagnoses in June. Losses are reported between 3 – 52% at the cage level. PD related samples sent to the National Veterinary Institute from Møre og Romsdal increased dramatically during 2007, and PD was diagnosed on a large number of farms in this region. Mortalities were reported to be highest in May (20 – 30%). By the end of the year no PD diagnoses had been awarded to farms north of Hustadvika in Møre og Romsdal or in Trøndelag.

In Northern Norway PD remains a relatively small problem, limited to two outbreaks in a particular area of Finmark. There are however concerns that the disease may become established and eventually spread within the region.

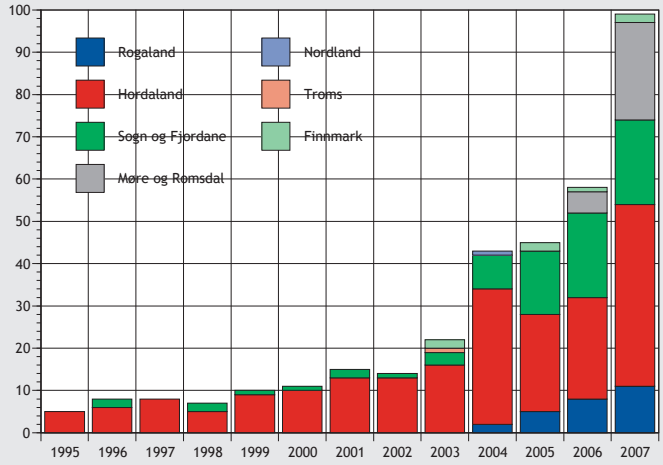
PD is caused by a virus called salmonid alphavirus (SAV) and clinical disease has so far only been diagnosed in sea farmed salmon and rainbow trout. Most cases are reported within the first year of sea culture, some as early

Post mortem PD: Fish with signs of serious circulatory failure with extensive, bloody ascites, oedema of the swimbladder wall and fibrinous encapsulation of the liver.



Histological photograph PD: atrophy of exocrine pancreas tissues.

as July in spring transferred smolts, although cases are also observed in larger fish. Following the period of peak mortality, it would appear that some fish recover quite well and given an extended period between disease and slaughter, few problems related to downgrading are experienced. However, should the outbreak affect large fish close to slaughter weight, it is not unusual for a large proportion of the fish to be downgraded at



The distribution of farms diagnosed with PD per year and county from 1995 to 2007

Anne Berit Olsen, National Veterinary Institute and Paul Nergård, National Food and Seafood Centre

harvest. Outbreaks may be of extended duration and last between three to eight months. Outbreaks of PD often occur prior to, at the same time, or following outbreaks of other disease e.g. IPN, PGI and HSMI. In farms holding both rainbow trout and salmon, PD has been reported in both species.

Diagnosis is resource intensive, and is based on observation of characteristic tissue changes e.g. inflammation and necrosis in heart and skeletal muscle, combined with loss of exocrine pancreatic tissues, together with detection of the viral nucleic acid (hereditary material) within tissues using real-time PCR, immunological methods (immunohistochemistry) and/or culture of the virus in cell culture. Specific antibodies against SAV may also be detected in blood samples. The highest mortality rates most commonly occur when the virus has been present on the farm for an extended period, and tissue changes have become chronic. Diagnosis during this period requires a broad spectrum of methods.

At the end of November 2007 PD became a notifiable group B disease, and new legislation relating to this disease was introduced. The new legislatory requirements are based on a management plan developed by the Norwegian Food Safety Authority in close collaboration with the aquaculture industry. The plan is aimed at control of PD in Western Norway, and prevention of spread to new areas. There are also several large industry led PD control projects underway.

Infection with SAV is a considerable problem in both Ireland and Scotland. In later years research projects and disease control measures against PD have been coordinated through a research cooperation between Norway, Ireland and Scotland.

While the mechanisms behind spread of PD remain under discussion, horizontal transmission is accepted by most workers as the most significant route of infection. Development work towards a more effective vaccine continues, and an improved vaccine is now in use. Provisional results should be available during 2008.

Infectious Pancreatic Necrosis (IPN)

Most fish health services report that IPN has been less of a problem in 2007 than in 2006, both in the freshwater- and sea-phases of culture. The total number of farms with registered IPN outbreaks was also significantly lower than in the two previous years. Some farms have, however, experienced significant problems and high mortality levels at start-feeding, par and ongrowing stages. Individual farms have reported mortality rates of 65-90% in start-feeding fry. Some outbreaks are acute and of short duration, while extended outbreaks with mortality levels approaching 30% are also reported. Reports from large egg-producing companies indicate that IPN was a problem for freshwater rainbow trout farming in both 2006 and 2007. A large project to investigate this problem has been initiated.

IPN is a group B disease and outbreaks must be confirmed by the National Veterinary Institute, and the Norwegian Food Safety Authority notified. The disease may be somewhat under-diagnosed and consequently under-reported. IPN occurs prior to, with and after outbreaks of other diseases e.g. PD and PGI.

An IPN diagnosis is arrived at through observation of typical tissue changes (histopathology) and detection of the IPN-virus in damaged tissues using specific antibodies (immunohistochemistry). Several different genotypes occur within serotype Sp, the normal type found in salmonid fish in Norway. It has been demonstrated that small variations in a surface protein (VP2) are important for virulence of the virus and for establishment of apparently healthy carrier status following infection.

Vertical transmission of IPN virus, by adherence of viral particles to sperm, has been documented in rainbow trout. While this is not documented for salmon it is accepted that vertical transmission most probably occurs in this species.

In Trøndelag, a large proportion of the spring smolt population was considered to consist of "runts" or emaciated fish, displaying high mortality rates. While it is speculated that IPN (sub-clinical) may be the underlying cause of the problem, other causes cannot be excluded. A similar problem has been observed in autumn smolts having undergone moderate IPN outbreaks. Vaccination against IPN is performed, but the degree of protection awarded by the vaccine is as yet unclear. Feed-back from the field indicates that vaccination appears to limit losses. During 2007 several farms used a new oral IPN vaccine during the juvenile stage of culture.

Heart and skeletal muscle inflammation (HSMI)

The number of farms in which HSMI was diagnosed increased dramatically from 2006 – 2007. Between 2004 and 2007 there has been a tripling in the annual number of diagnosed farms. HSMI was diagnosed for the first time in Trøndelag in 1999 and has only been recorded in salmon. Mid-Norway remains the epidemiological focal point for the disease, but new registrations occur along the whole coast.

In 2007 the disease was also diagnosed in single hatcheries in both Trøndelag and Nordland regions. The disease is diagnosed throughout the year and usually appears during the sea-phase of culture. In most cases clinical indications are observed some months following sea-transfer, although fish of all sizes may be affected. The outbreaks may be extended, and in many cases mortality levels remain moderate (1 – 4%). In other cases losses are high and several localities have reported losses of up to 15%, either in individual cages or on the farm as a whole. Reports from fish health services in the field suggest that HSMI now appears earlier in the year and that associated mortality levels are increasing. The disease often occurs prior to, with, or following outbreaks of other disease e.g. IPN, PD, CMS, PGI or parvicapsulosis.

HSMI-affected fish display inflammation of the cardiac membrane and heart musculature. In addition, the fish may display inflammation of the red skeletal muscle and liver necrosis. Occasionally, a high proportion of the affected population may have typical pathological changes in the inner organs, but due to the absence of external clinical findings and low mortality, the disease may remain undiagnosed.

Extended studies of HSMI infected fish have shown that the disease may develop over a long period of time. Individual fish may have serious inflammation in the heart for several months before mortality levels increase and clinical disease is diagnosed. There is therefore a significant risk of disease transmission to new areas from non-diagnosed outbreaks. Such spread of disease may eventually lead to establishment of HSMI as an endemic disease along the entire coastline.

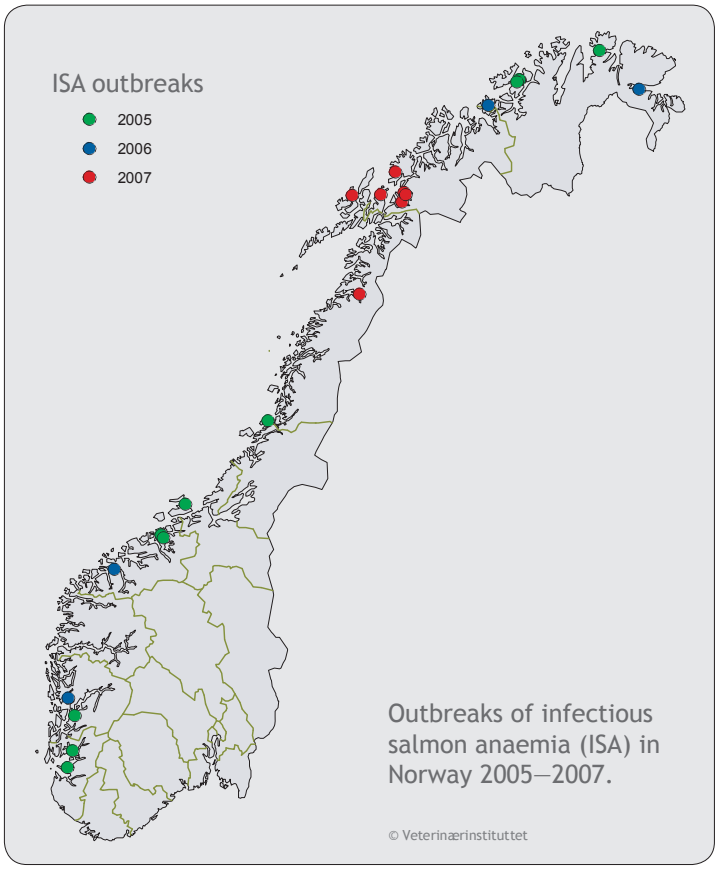
A virus has been isolated from fish displaying HSMI, which is capable, under laboratory infection trials, of reproducing HSMI. Characterisation of this virus is under way, but few details are currently publicly available. There is a requirement for development of specific and sensitive diagnostic methodology, such that disease specific pathological changes can be confirmed by virus detection. It is especially important that HSMI may be distinguished from other diseases which give heart inflammation e.g. PD. Tests for detection of the virus are also important for further research and development of vaccines. HSMI is not notifiable, but the National Veterinary Institute has recommended initiation of measures to limit disease spread and frequency of outbreaks.

Infectious salmon anaemia (ISA)

During the course of 2007, ISA was diagnosed on seven different farms. All outbreaks were in the north of the country, with five in Troms and two in Nordland. Affected fish varied in size, from first sea-year to large harvest ready fish. In all cases classical ISA was preceded by periods of generally increased mortality. The fish populations were slaughtered out following restrictions imposed by the Norwegian Food Safety Authority. All outbreaks occurred in a relatively small geographical area. The route of infection is under investigation such that measures may be set in place to avoid further development of the disease in this area. The frequency of diagnosed ISA outbreaks has been relatively stable over the last five years with between 4 and 16 cases annually.

ISA is a notifiable group B disease. Diagnosis is based on several criteria, relating typical pathological change with detection of ISA-virus. Viable virus may be detected following culture in cell culture, or by a combination of other detection methodologies e.g. immunological tests (using antibodies specific for ISA-virus) and PCR. Detection of ISA-virus nucleic acid (hereditary material) alone is not enough to initiate an official suspicion of ISA, with its regulatory consequences. Restrictions may be imposed when clinical findings justify an official suspicion of ISA.

Anti- ISA measures are activated following a contingency plan based on EU regulations and recommendations from the OIE (world animal health organisation). In early 2006, the controversial legislation relating to compulsory slaughter of all fish on affected localities within 80 working days was changed. This legislation was replaced



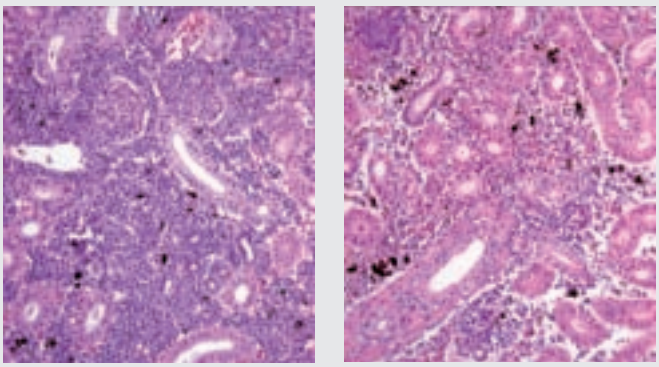
Outbreaks of infectious salmon anaemia (ISA) in Norway 2005—2007.

by a requirement for activation of an individual plan for slaughter based on local conditions. The main aim of the contingency plan i.e. the removal of all fish from infected farms as quickly as possible, still applies.

Previously, ISA is known from the east coast of Canada/ USA, the Faeroe Isles and Scotland. Both Scotland and the Faeroe Isles appear to have gained control of the disease. On the Faeroe Isles, where until 2005, the salmon population was considered almost 100% infected, extensive clearance and fallowing was practised. This was followed by re-stocking with vaccinated fish and massive testing for ISAV. The results so far have been good. There have been no further outbreaks of ISA, and the virus has not been detected. A non-pathogenic virus variant, HPR0, which has also been detected in Norway, has however, been identified during sea water culture. In addition to the favourable ISA situation, the Faeroe Isles have also experienced generally very low losses during the sea water phase of culture. During the summer of 2007, the first Chilean cases of ISA were diagnosed and the disease has now been confirmed on a number of sites. This, together with other diseases has contributed to the present generally difficult situation in Chilean aquaculture.

There is presently a discussion around the importance of vertical transmission of ISA-virus, its reservoir and virulence factors. A broad, international group of researchers has, under the auspices of the Norwegian Authority for Food Safety's scientific committee, reviewed internationally accepted knowledge relating to risk factors of consequence for ISA. The group has concluded that while vertical transmission cannot be excluded, the probability of such transmission is low. They conclude that tracking of infection by phylogenetic analysis of the virus alone cannot currently be recommended and that this information must be related to other epidemiological information in each individual case. The group concludes that the most likely reservoir for ISA-virus is farmed Atlantic salmon and wild salmonids, of which brown trout and salmon are the most important. The group also considers well-boat transport as an important factor for spread of ISA-virus.

Danish rainbow trout with VHS, with hemorrhage in the kidney region.



In a normal kidney hemopoetic tissues are normally seen as uniform blue cells (left), whereas the destroyed cells in a VHS infected fish can be seen (right).

Overview of the total number of localities diagnosed with infectious salmon anaemia (ILA), infectious pancreatic necrosis (IPN), pancreas disease (PD), heart and skeletal muscle inflammation (HSMI), piscirickettsiosis, furunculosis and bacterial kidney disease (BKD) in salmonid fish for the period 1998—2007. The figures are based on material submitted to the National Veterinary Institute, with the exception of the PD figures which are based on figures reported to the Norwegian Authority for Food Safety. The figures for 2007 are compared with figures from previous years.

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
ISA	13	14	23	21	12	8	16	11	4	7
IPN					174	178	172	208	207	165
PD*	7	10	11	15	14	22	43	45	58	98
HMSI							54	83	94	162
Piscericettsiosis	0	6	0	1	17	5	0	0	1	1
Furunculosis	1	2	6	3	0	2	3	1	3**	5***
BKD	0	3	3	3	1	1	1	2	0	0

* figures for 2002—2005 are adjusted according to the 2005 report

** one hatchery, two rivers

*** four seawater localities, one river

Viral Hemorrhagic Septicaemia (VHS — "Egtvedt disease")

In November 2007 the disease VHS was diagnosed in sea-farmed (fjord) rainbow trout in Møre og Romsdal. Increased mortalities were registered and fish observed with clinical, pathological changes. The virus was detected in diseased fish by immunohistochemistry, PCR and culture and identified as belonging to the marine type (genotype III). Farming of cod and coalfish is

also performed within the same fjord system, but the virus has not been found in species other than rainbow trout within the control zone. Infection challenge trials conducted at the EU reference laboratory confirmed that this virus variant produces disease in rainbow trout.

VHS is a serious infectious disease primarily affecting rainbow trout, but which may also affect other species of fish, both farmed and wild. Outbreaks may cause large losses and the disease is notifiable, belonging to group A. Acute outbreaks may give high mortality, hemorrhage of the skin, musculature and inner organs, anaemia, exophthalmia (protruding eyes) and distended abdomen. Abnormal swimming behaviour including spiral swimming and "flashing" is often observed. The disease may manifest either as a hemorrhagic (bleeding) or as a nervous form, as well as subclinically in surviving fish. The diagnosis VHS is arrived at through clinical findings, pathology and virus detection. VHS is caused by a novirhabdovirus and is found as different variants/ genotypes and from different types of fish. The virus has been shown to be present in a wide spectrum of fish species.

The disease VHS was last diagnosed in Norway in 1974 and has not since been recorded in Norwegian farmed fish, salmonid or marine, prior to 2007.

Bacterial diseases

Winter ulcer and septicaemia with *Moritella viscosa*

Winter ulcer continues to be problematical, and is in some areas considered to be a larger problem in rainbow trout than in salmon. Several rainbow trout farms have experienced large losses in recent years. In addition to direct losses (mortalities), winter ulcer also results in a significant degree of downgrading at harvest. Winter ulcer is also considered one of the most important diseases in relation to fish welfare. Most salmon are now vaccinated against *M. viscosa*. Currently studies are under way to investigate strain differences between *M. viscosa* from different geographical areas and from different types of fish.

Rainbow trout with *Flavobacterium psychrophilum* infection.

Furunculosis

Furunculosis was diagnosed in several groups of salmon transferred to sea from a hatchery subject to restrictions due to a previous furunculosis outbreak. Spring smolts were transferred to three different sea sites, and all three sites experienced furunculosis outbreaks. Mortality rates varied, but on two sites the total mortality was considered significant. Autumn smolts from the same hatchery were transferred to a single sea site, and while furunculosis was consequently diagnosed in some fish, the outbreak did not continue and the fish were not treated.

Proliferative Gill Inflammation (PGI)

Several fish health services have reported that proliferative gill inflammation (PGI) was a relatively significant problem in 2007, particularly so in individual farms in Hordaland, Sogn og Fjordane, Nordland, Troms and Rogaland.

One site in Hordaland experienced 50% losses due to PGI in 2007. One of the largest commercial companies considers PGI to be the disease responsible for most losses in terms of both numbers of fish and biomass. It would appear that PGI appears to be spreading within some areas.

PGI is a term used to describe a condition which has been observed in sea-farmed salmon in Norway since the 1980's. It is most frequently observed in the autumn (August – December) in salmon transferred to sea in the same year. As autumn progresses the fish may develop serious gill injury in which the most common reaction is moderate to extensive thickening of the gills. Hemorrhage, necrosis and inflammation are also common observations. Epitheliocysts (colonies of the bacterium *Pischichlamydia salmonis*) are often identified within affected tissues. Liver necrosis is not uncommon in PGI affected fish.

The cause/s of PGI is/are unclear. In addition to investigation of the importance of bacteria, the contribution of a virus, *Atlantic salmon paramyxovirus*, is also under study.

A condition similar to PGI, but apparently without the presence of epitheliocystis, was demonstrated in sea-run arctic char during 2007. No causal agent has been identified.

PGI is also reported from Scotland and Ireland, where considerable problems have been experienced. An initiative has been taken to coordinate international research on this condition.

Piscirickettsiosis

During late 2006/ early 2007 a single fish with piscirickettsiosis was identified on a salmon sea farm in Rogaland. The site had at that time considerable problems with HSMI and gill inflammation to which mortalities were attributed.

In 2002, seventeen cases were identified compared to five cases in 2003, no cases in 2004 or 2005, and one case in 2006. The disease is caused by the intracellular bacterium *Piscirickettsia salmonis*, and is classified as a group B disease. It most commonly manifests as a chronic infection with development of inflammatory nodules in various internal organs. In Norway the disease normally leads to low – moderate mortality.

Diagnosis has become easier than previously, due to the discovery that the bacterium can also be cultured extracellularly on special agar media.

The disease most commonly occurs during the autumn. In Chile, where it is a large problem, the disease is referred to as SRS – Salmonid Rickettsial Septicaemia. The Norwegian variant of the bacterium can be genotypically differentiated from the Chilean type.

Bacterial Kidney Disease (BKD)

BKD was not diagnosed during 2007. Bacterial kidney disease is caused by the bacterium *Renibacterium salmoninarum* and is characterised by a chronic progression with development of granuloma/ nodules in inner organs. BKD is a group B disease and was previously (particularly between 1987 – 1993) a significant problem in salmonid fish in Norway. Since 1999 between one to three cases have been detected annually. In 2006, the Norwegian Food Safety Authority initiated a screening of BKD prevalence in Norway. The National Veterinary Institute has responsibility for laboratory testing. The testing scheme replicates in the main, the surveillance programmes for VHS/IHN which are based on EU standards.

Yersiniosis

Yersiniosis, caused by the bacterium *Yersinia ruckeri*, was diagnosed in seven different salmon hatcheries during 2007, which is a small increase from 2006. In some cases, antibiotic treatment was performed. Some individual sites vaccinate using "auto" vaccines.

Other bacterial infections

In Western Norway a single case of infection with *Flavobacterium psychrophilum* was identified in 50 – 100 g rainbow trout. Systematic infection was demonstrated as was an increased mortality rate. Infection with this bacterium in smaller rainbow trout is known as rainbow trout fry syndrome (RTFS) and is a considerable problem in farming of rainbow trout in several countries.

An infection caused by a *Mycobacterium* sp., closely related to *Mycobacterium salmoniphilum* has been linked to increased mortalities in sea-transferred spring smolts.

In Northern Norway, atypical *Aeromonas salmonicida* infection in arctic char has been reported.

Parasitic infections

Salmon lice – *Lepeophtheirus salmonis*

According to reports prepared by producers, 2007 was undramatic in terms of salmon louse infection. The pattern of infection was similar to 2006, and the farms reported only occasional burdens of over 0.2 adult female lice per fish. The total number of farmed fish did however increase in 2007 over previous years such that the total infection pressure is assumed to have increased.

During 2006, several cases of deltamethrin treatment failure were reported. Resistance to this medication was later confirmed. In 2007, satisfactory effect was, however, achieved with this preparation through improvement of treatment routines. The preparation most commonly used against salmon lice today contains emamectin benzoate supplied as an in-feed supplement. In mid-Norway several instances of reduced effect of emamectin benzoate were registered. It is not clear whether this relates to development of resistance or whether it is related to some other factor. The Norwegian Research Council has recently awarded funding for research into emamectin resistance.

Tape worm – *Eubothrium* spp.

Tape worms are regularly found in the intestine of sea farmed salmon. In 2006 possible development of praziquantel resistance was reported. No problems have however been reported during 2007, as good effect was once again reported.

Parvicapsulosis – *Parvicapsula pseudobranchicola*

Some farms have reported problems with parvicapsulosis. As a rule, this occurs concurrently with other disease problems. Parvicapsulosis is most easily confirmed histologically by observation of the parasite in sections of the pseudobranch. With light infections, small pale spots may be observed in the pseudobranch. In heavier infections the parasite may be observed in several organs. Common findings include a pale or yellow liver, sometimes with liver hemorrhage, hemorrhage on the inside of the opercula and eye chamber together with a white "deposit" on the pseudobranchs.

Costia – *Icthyobodo* spp.

Several cases are reported from hatcheries (first-feeding fry upwards) and sea sites in which costia are reported to be problematical. Gill injuries in association with large numbers of costia have also been observed in broodstock salmon.

Salmon with large white lesions in the liver caused by infection with *Spironucleus salmonicida*.

Spironucleosis – *Spironucleus salmonicida*

The single celled flagellated parasite *Spironucleus salmonicida* (previously *Spironucleus barkhanus*) has previously been reported as the causal agent of systemic spironucleosis in farmed salmon. During 2007, the parasite was only identified in farmed salmon from Øksfjord and Altafjord (Finmark) and infected fish appear to be directly related to a single smolt supplier. The source of *S. salmonicida* remains unknown.

Gill amoebae

Amoebal gill infection was registered in spring smolts in the autumn of 2006. The problem was not registered in 2007, although some cases of gill amoebae were registered in Northern Norway.

Fungal disease

There were no reports of significant fungal problems during 2007, although fungal infections in eggs and broodstock are not unusual. Fungal infection of the kidney and swimbladder mycosis are intermittently reported.

Other health problems

Different problems at the juvenile stage

There were reports of fungal problems relating to egg production particularly in early batches. Different deformities and problems related to coagulation of the yolksac have been observed. Some farms report problems with start feeding, again particularly with earlier batches. IPN gave high mortalities in start -feeding juveniles in some farms, in both salmon and rainbow trout.

Other diagnoses from different stages of juvenile production include fungal infections, circulatory disturbances/ ascites, swimbladder mycosis, intestinal bacterial proliferation, bacterial yolksac inflammation and costia. A new phenomenon appeared in several farms during start feeding in 2007, characterised by mortalities exhibiting an extremely distended (full of food) abdomen.

Nephrocalcinosis

Every year a degree of nephrocalcinosis is registered in hatchery rainbow trout and salmon. Calcium deposits are observed in the tubuli of the kidney, with lesser or major changes in kidney tissues surrounding the tubuli. The condition is related to the level of dissolved CO_2 in the water.

Hemorrhagic smolt syndrome (HSS)

HSS is a condition characterised by anaemia and commonly extensive hemorrhage in several internal organs. HSS was registered in 2007 during the hatchery phase of salmon farming. The syndrome is observed mainly between January to April, and often in larger fish undergoing smoltification. HSS affects as a rule single fish and is not considered to be a serious problem on a population scale. Post mortem findings are similar to those normally found in relation to serious viral septicaemic diseases e.g. VHS, and histological and virological investigation of affected fish should be considered.

Poorly smoltified sea-transferred fish

In 2007, as in other years, some sea farms have experienced problems with smolts following sea transfer. The main reason is presumed to be incomplete smoltification. This has led to increased mortality rates and "runt"development.

Cardiomyopathy syndrome (CMS)

CMS occurs almost exclusively in large salmon, including broodstock, and is diagnosed throughout the year along the entire Norwegian coastline. There are no official statistics, but the number of cases investigated (approximately 85 sites in 2007) by the National Veterinary Institute is considered to have increased over the last year. Some fish health services report that the prevalence of CMS is similar to previous years while others report an increase over previous years. It has been suggested that some farm sites are more susceptible to this condition. While individual overall losses of up to 90 tonnes have been reported most cases appear to result in low to moderate mortality. Post mortem findings for CMS can be similar to those found for HSMI and PD. Diagnosis must be therefore based on histological findings. The cause of CMS is not known, but a virus may be involved.

Deformities

Local fish health services report that while there were generally few deformities to report in large fish during 2007, visible spinal deformities were present in some groups. Various different deformities were noted in newly hatched fry, but these fish generally die at an early age.

Vaccine side-effects

Local fish health services report levels of vaccine related side-effects of a level generally no worse than that of previous years. The tendency seems to be a towards a less severe degree of adhesion. Extreme adhesions are less common, but continue to occur sporadically. One of the larger slaughter facilities reports a significant reduction in pigment "spotting" (melanin) in fillets compared with 2 – 4 years ago. There are reports of granuloma formation in 1.5 year old fish transferred to sea in the autumn of 2006. This is considered a risk in this type of fish and the severity reduced with time.

Tumours

During 2005 and 2006, as reported in last years report, intestinal tumours were detected in fish held in particular commercial broodstock farms. During 2007, tumours were also observed, but to a lesser degree, in the intestine, liver and other organs of fish held in the same farms. The cause has not yet been identified, but appears to be associated with the broodstock feed. This feed is no longer used for production fish. Otherwise, tumours are observed sporadically in various organs of both farmed and wild fish.

Algae

In the late summer of every year since 1989, a bloom of the algae *Prymnesium parvum* has occurred in the Sandefjord system in Rogaland. This algae has been identified as highly toxic and fish have therefore not been farmed in this fjord until 2007. On arrival of the algae, the fish cages were lowered under the brackish water layer with good effect. One farm lying just outside the fjord system, which could not lower its fish cages suffered large losses.

In one sea farm in Vest-Agder a period of high mortality was associated with a local algal bloom.

The health situation in wild salmonids and in mitigation hatcheries

Salmon lice – *Lepeophtheirus salmonis*

On a national scale the salmon louse problem in regard to wild salmonids appears worse in 2007 than in 2006. The number of lice on fish from inner fjord areas was lower than that of outer fjord areas. In the West of Norway, lice numbers on wild fish were unexpectedly high considering the very low numbers of lice counted on farmed fish in the area. Highly infected sea trout were identified between Ryefylke and Møre in the open sea and in river estuaries. Most remarkable for 2007, was the early return of larger fish (post smolts) with high louse burdens to the rivers. The reasons for this may have been the warm winter of 2006 – 2007 in Southern Norway, combined with the large numbers of overwintered farmed fish present in the area. To reduce infection pressure towards wild fish in the Spring of 2008, large scale synchronised lice treatments were performed during the Autumn of 2007.

Wild fish examined in the salmon farming areas of Trøndelag were found to harbour fewer lice in 2007 than in 2006. In Northern Norway the infection level in wild fish was similar to previous years. In this part of the country it would appear that lice infestation on wild sea trout and arctic char in intensive farming areas has stabilised at a level 2 – 3 times that considered "normal".

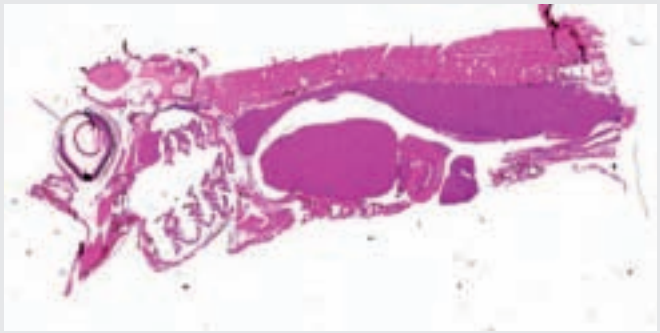
Gyrodactylus salaris

A total of 3500 salmon from 115 rivers and more than 2500 salmon/rainbow trout from altogether 82 farms were examined under a national surveillance programme (OK programme) for *Gyrodactylus salaris*. The rivers in the OK programme are investigated annually, generally from one site. In the fish farms involved, samples are taken every second year, and the sampling follows the same regime as the OK programmes for IHN and VHS in freshwater. The "freedom of infection" programme (FM-programme) for *G. salaris* monitors rivers and watersheds in which extermination actions directed at *G. salaris* have been carried out or in regions where such actions are planned. The rivers in the FM-programme are monitored three times per year from many sites on each river. In 2007 the FM-programme covered two regions (Rana and Laerdal) and seven rivers. In September 2007 *G. salaris* was identified in the river Laerdal (Sogn og Fjordane). The river Laerdal was treated with aluminium phosphate and rotenone in 2005 and 2006.

Proliferative kidney disease (PKD)

Proliferative kidney disease caused by the parasite *Tetracapsuloides bryosalmonae* (Myxozoa), was diagnosed in Norway for the first time in 1972. Over 100 detections have since followed, with most of them coming from mitigation hatcheries. The final host for the parasite are bryozoans and the fish are infected by spores which develop within the bryozoans. The disease is characterised in salmonid fish in freshwater by a visibly swollen kidney. Infection with *T. bryosalmonae*

Fish with swollen kidney, caused by infection with *Tetracapsuloides bryosalmonae*.



Cross section of 0+ salmon infected with *Tetracapsuloides bryosalmonae*. The section is stained with haematoxylin and eosin. The kidney is swollen, particularly at the posterior end.

is the most probable cause of increased mortality in juvenile salmonids in infected river systems.

Previous outbreaks of PKD have occurred in the Åbjørvassdraget (river) in Nordland and in the Håelva (river) in Rogaland. In a study performed in the Åbjørvassdraget, results suggest that the parasite may reduce smolt production by 50 – 75%. A pilot study has been performed in which the geographic range of *T. bryosalmonae* has been investigated. The parasite was found in 15 of 18 investigated rivers. A number of these rivers share the same watershed and in only one river system was the parasite not found.

That the parasite was found in the majority of river systems does not mean that outbreaks of disease occur in every case. However, fish displaying signs of disease were found in rivers other than those in which the disease was previously detected. Although the rivers selected for investigation were not randomly chosen, it is presumed that the parasite is common in many rivers from Nordland to Rogaland. As PKD normally manifests at a water temperature of over 15°C, there are indications that climate change and regulation of water flow with consequently higher water temperatures, may lead to outbreaks of this disease in an increasing number of rivers in the future.

Furunculosis

Over the last few years this disease has been detected in individual salmon in some rivers in Nord-Trøndelag, and a salmon with furunculosis was found in the river Namsen in early August 2007.

Other diseases, health problems

Gill irritation and inflammation of different cause are observed in mitigation hatcheries. Asphyxiation through iron deposition on the gills is occasionally experienced in hatcheries of this type. Parasites of various type are found as are occasional bacterial infections/ infected wounds in wild caught broodstock. Some farms report problems associated with underfeeding e.g. eye snapping, opercular and fin biting.

Surveillance programmes – monitoring infectious agents in healthy fish

The surveillance programmes for salmonid disease are based on a sampling regime by the Norwegian Authority for Food Safety such that all active fish farms are tested in the course of a two year period. In 2007, 1378 pooled samples from 446 farms were investigated for the presence of viral hemorrhagic septicaemia virus (VHS-virus) and infectious haematopoietic necrosis virus (IHN-virus). Under the bacterial kidney disease (BKD) programme, 4943 individual samples from 157 farms were investigated for the presence of Renibacterium salmoninarum. More than 2500 salmon/rainbow trout from 82 farms were examined for the parasite Gyrodactylus salaris. Through the "Freedom of Infection" monitoring programme, G. salaris was demonstrated in the river Laerdal (Sogn og Fjordane) in September 2007. For further information on these surveillance programmes please see the annual reports (NOK reports) at www.vetinst.no.

Welfare, ethically and environmentally justified production

Legislation relating to slaughter and processing facilities for aquacultured animals entered into force January 1. 2007. For the first time, on the grounds of animal welfare, specific requirements relating to anaesthesia and euthanasia of farmed fish now apply. The method most commonly in current use, CO_2 in water, is not considered suitable and will be forbidden after July 1. 2008. Several studies have therefore been initiated to investigate alternative methods, primarily electrical and non-penetrating bolt-pistol.

The European Scientific Committee, EFSA, is now considering animal welfare in relation to farmed fish. An international panel of experts has been established including participants from Norway. The study will consider species of importance for European fish farming.

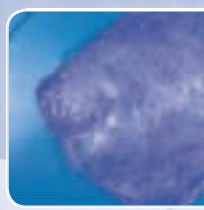
The World Animal Health Organisation (OIE) has over recent years expanded its scope to include animal welfare, including aquatic animals and crustaceans.

Sources of information for the health report

This report is based on the results of the diagnostic work performed at the National Veterinary Institutes laboratories in Oslo, Sandnes, Bergen, Trondheim and Harstad, interviews and written reports from fish health services nationwide, together with information from the Norwegian Food Safety Authority, fish farmers and other individuals.

The health situation in farmed marine fish 2007

Hege Hellberg
Duncan Colquhoun
Haakon Hansen
Hanne Nilsen




Veterinærinstituttet
National Veterinary Institute

During 2007, approximately 300 cases involving disease in farmed marine fish were investigated by the National Veterinary Institute. Over 80% of these cases involved cod, with halibut, coalfish and other species accounting for the remainder. Bacterial infections comprised the most significant disease problems in cod farming during 2007, with francisellosis (aetiological agent: *Francisella philomiragia* subsp. *noatunensis*) and vibriosis (aetiological agent *Vibrio* (*Listonella*) *anguillarum*) most prominent. A reduced antibiotic sensitivity level (oxolinic acid) was registered in *Vibrio anguillarum*. The notifiable diseases infectious pancreatic necrosis (IPN) and viral nervous necrosis (VNN) were also registered during 2007. VNN was diagnosed in 6 cod farms during 2007 compared with 3 in 2006. IPN was diagnosed on one halibut farm.

An outbreak of viral haemorrhagic septicaemia (VHS) diagnosed in Norwegian sea-farmed rainbow trout during 2007 may have consequences for marine fish farming, as the outbreak was caused by a viral genotype found most commonly in marine fish species. The following summary of the health situation in farmed marine fish for 2007 is based on material submitted to the National Veterinary Institute by fish-health services nationwide and from cooperating research institutions.

Cod

During 2007 the National Veterinary Institute investigated approximately 250 cases from approximately 80 different cod farms spread along the Norwegian coast. According to figures supplied by "The Cod Network" (A national network of cod producers and research institutions) there were 213 active cod farming concessions in Norway in 2006. Thus, the results from investigations performed by the National Veterinary Institute provide a good indication of the national health status of farmed cod. There is however, a long way to go before the level of information relating to cod, reaches that available for salmon farming.

Samples sent to the National Veterinary Institute contribute both to diagnosis of immediate disease problems for individual farmers and fish health services and to reliable documentation of the health status of domestic animals on a national basis. In addition to surveillance of recognised diseases, the National Veterinary Institute also works towards identification of emerging diseases, such that resultant losses may be reduced or eliminated.

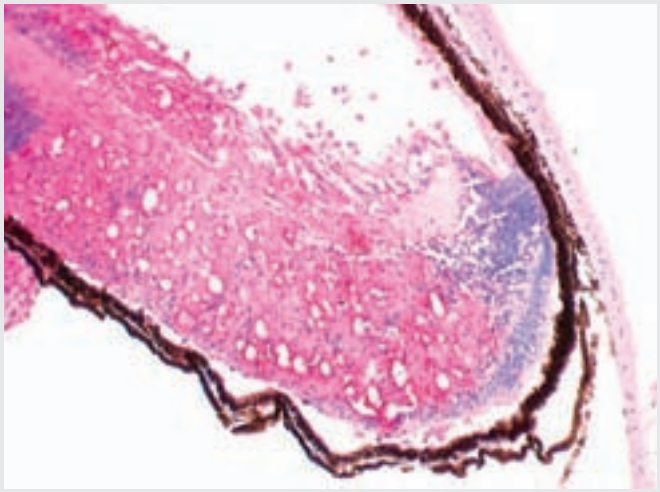
Bacterial- and viral- isolates collected in the course of diagnostic investigations and archived in National Veterinary Institute biobanks, constitute valuable scientific resources e.g. for vaccine development and production. This research and development work is performed in cooperation with national and international institutions and commercial actors and benefits the industry as a whole.

Number of cod farming localities with diagnosed viral or bacterial diseases

	2005	2006	2007
IPN	Not found	Not found	Not found
VNN (nodavirus)	Not found	3	6
Atypical furunculosis	3	13	9
Francicellosis	4	7	8
Vibriosis *(Vibrio anguillarum)*	18	19	19
Cold Water Vibriosis *(Vibrio salmonicida)*	2	Not found	1
Infection with *Vibrio ordalii*	1	Not found	3*
Infection with *Vibrio logei/Vibrio logei-like*	2	1	2
Infection with *Photobacterium sp.*	3	3	6

In two cases the bacterium was identified as a mixed infection with *Vibrio anguillarum* O2a biotype II, while in the remaining case it constituted the sole infectious agent.

Viral diseases



VNN. Histological (light microscopy) changes and immunohistochemical detection of nodavirus in the eye. The virus is stained red.

Viral Nervous Necrosis (VNN)

Viral nervous necrosis (VNN) or viral encephalopathy and retinopathy (VER), caused by a nodavirus, was officially diagnosed for the first time in cod in Norway in 2006.

In 2007, VNN was diagnosed in six farms compared with three in 2006. The disease was diagnosed at four new sites: two in Møre og Romsdal, one in Nordland and one in Troms. In addition, the disease was still present in two populations previously diagnosed during 2006. These outbreaks were chronic in nature, with moderately increased mortality. The fish displayed depressed appetite and abnormal swimming behaviour (spiral swimming with apparently unprovoked panic reactions). Fish were commonly observed with buoyancy control problems i.e. floating. Dark colouration was also observed. VNN is diagnosed by observation of characteristic histopathological changes in the brain, eye or spinal column, together with detection of the virus using molecular biological methods, immunohistochemistry or culture in relevant cell-lines.

VNN is a notifiable disease in Norway, which results in imposition of management restrictions. On a world-wide basis VNN constitutes an important cause of loss in farming of marine fish, and the disease has previously been a limiting factor in farming of halibut juveniles in Norway. While VNN has been traditionally considered a disease of juvenile fish, the recent cod outbreaks are unusual in that disease and mortalities have been registered in fish of differing age and size, from 5 g up to 1.5 kg. The source of the disease has not been identified. During the reported period, extensive movement of fish stocks between different producers and regions has occurred, such that fish on a particular farm may have been in contact with many other fish groups between hatching and slaughter.

VNN may be transmitted vertically i.e. transmission of virus from broodstock to offspring, and horizontally i.e. fish to fish. Many fish species appear to develop an age-related resistance i.e. juveniles are most at risk. Larger fish, whilst not fully protected against VNN, may require a higher infection pressure or must be compromised in some way for manifestation of clinical disease. In the Norwegian cases to date, the time of infection has not been established. The cod may have been previously infected with clinical disease later triggered by unfavourable environmental conditions or other stress factors, or they may have been infected on-site. During a large scale screening project, nodavirus was been detected in wild cod along the Norwegian coastline. There are, however, good grounds to advise against today's common practice of extensive movement of farmed cod along the coast. Transport of infected fish poses absolutely the greatest risk for spread of this and other diseases.

Several other diseases or disease causing agents have been detected in fish suffering VNN, including the bacterial diseases vibriosis and francisellosis. It is not known whether the fish develop VNN due to reduced disease

resistance caused by an already present disease, or whether fish already subclinically infected with VNN are more susceptible to other infections.

Halibut surviving a clinical VNN outbreak may maintain sub-clinical infection status and constitute therefore, apparently healthy, virus carriers. Investigation of halibut populations which have survived an outbreak reveal that sub-clinical infections are more common in fish displaying poor growth and increased mortality rates, so called "runts", than in groups displaying good growth and low mortality levels.

IPN I

IPN was not detected in cod during 2007.

VHS

Viral haemorrhagic septicaemia (VHS), also known as Egtved disease, is an infectious disease caused by a Novirhabdovirus, of the family Rhabdoviridae. VHS is mainly observed in farmed rainbow trout, but disease outbreaks have also occurred in farmed turbot and Japanese flounder as well as wild marine fish. Susceptible species in Norway in addition to salmonid fish, include turbot and cod.

During 2007 VHS was diagnosed in Norwegian farmed rainbow trout, with subsequent isolation of VHS virus (VHSV) genotype III. VHSV may be differentiated into four genotypes, of which genotype III has hitherto been regarded as a "marine" variant. VHSV genotype III has been detected in several species of marine fish including cod captured in Norwegian waters. Use of wild fish as broodstock therefore presents a risk of introduction of VHSV to cultured stocks. Further, feeding of broodstock with fresh or frozen fish comprises a possible source of infection. Transmission of virus from wild fish to farmed fish in sea cages may also occur. Infectious challenge studies have shown that several marine VSHV isolates can result in disease in juvenile turbot.

Current national and international legislation does not differentiate between the different genotypes of VHSV, resulting in compulsory slaughter and imposition of control zones following diagnosis of VHS in both marine and salmonid fish. Several marine-fish farms have been investigated for the presence of VHSV, e.g. in relation to the recent outbreak in rainbow trout in Sunnmøre. VHSV has not so far been detected.

Bacterial diseases

Francisellosis

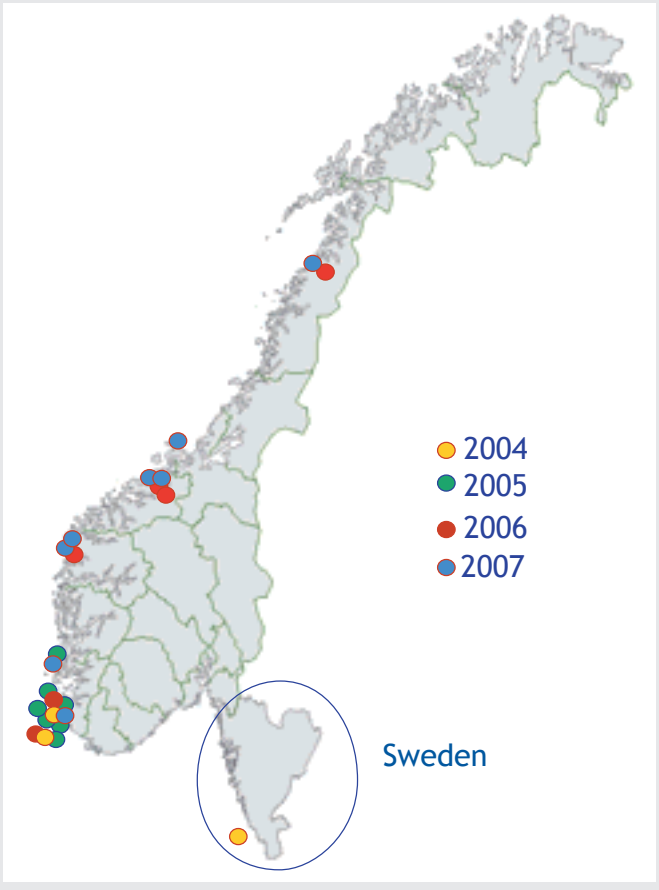
Francisellosis is caused by the bacterium *Francisella philomiragia* subsp. *noatunensis*. The National Veterinary Institute diagnosed francisellosis on eight cod farms during 2007. In addition, findings consistent with francisellosis were identified on several other farms, but without secure identification of the bacterium. The disease is widespread and has been detected in farmed cod from Rogaland in the south to Nordland in the North. Francisellosis has also been found in wild caught cod in Norway and Sweden.

In typical outbreaks, francisellosis develops as a chronic infection and when the fish eventually die, they have been infected for a considerable period. Mortality may be high over a short period or may typically be more moderate over an extended period. Reduced growth, increased mortality, and downgrading of slaughtered fish can result in significant financial losses. While mortalities may be low during the winter, the infection does not disappear from the population.

On post-mortem of infected fish, a moderate to massive presence of whitish nodules on inner organs, particularly the spleen, liver and heart is most commonly observed. Some fish display eye injuries and bloody nodulation of the skin. On histopathological (light microscopy) investigation, a chronic granulomatous inflammatory reaction with at times massive occurrence of inflammatory granuloma is observed. These changes are most often identified in the gills, heart, liver, spleen, kidney, intestinal mucosa, eye and skeletal musculature. Few to many bacteria may be observed in intracellular vacuoles within the granuloma.

Light microscopical detection of intracellular bacteria may indicate francisellosis, but a secure diagnosis is

Outbreaks of Francicellosis 2004—2007



dependent on identification of the bacterium. *Francisella philomiragia* subsp. *noatunensis* is identified by culture and/or use of molecular biological methodology. The bacterium requires a special culture medium and can therefore be difficult to culture in the field. As francisellosis is not notifiable, the disease is under reported. To enable a best possible overview of the geographical extent of this disease it is important that samples are sent to the National Veterinary Institute from all suspected cases.

Many farmers choose to slaughter stocks following diagnosis in an effort to reduce transmission of disease and further losses. Infectious challenge studies have shown that the disease is readily transmitted from fish to fish. Transport of subclinically infected fish represents a significant risk of disease transmission.

Number of cod farming localities with diagnosed *Vibrio (Listonella) anguillarum* during 2003-2007

TYPE	2003	2004	2005	2006	2007
Total*	19 (26)	27 (37)	18 (18)	19 (30)	19 (54)
O1	Not found	Not found	Not found	Not found	Not found
O2 α	6	9	1	5	5
O2 α biotype II	-	-	-	3	6
O2 β	11	18	17	15	15

* Some isolates has not been serotyped/biotyped. In some localities more than one serotype/biotype has been found.

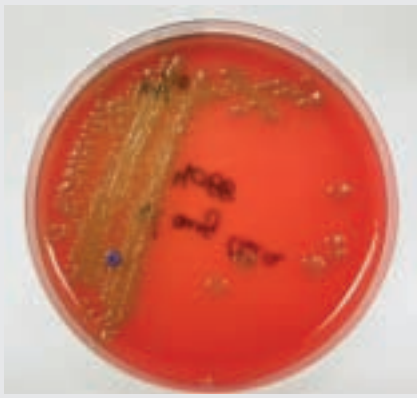
Vibriosis

Vibriosis in cod remains a significant problem in all age classes of fish, and outbreaks are often related to high water temperature. Various serotypes of *Vibrio* (*Listonella*) *anguillarum* were identified in over 50 cases submitted from a total of 19 different cod farms (Table 2). No significant changes in the distribution of serotypes O2α and O2β between 2006 and 2007 were noted. Observations of biotype O2a II (also known as "serotype O2x") continue to increase. Several farms report repeated outbreaks in fish vaccinated against vibriosis.

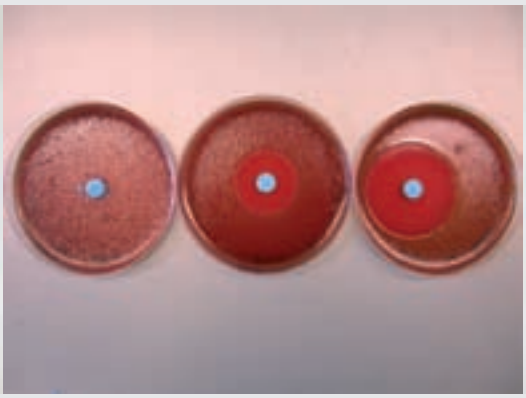
V. anguillarum isolates are routinely tested for antibiotic sensitivity. This is both an important part of the diagnostic work carried out by the National Veterinary Institute as well as a priority area of research. *V. anguillarum* serotype O2β isolates with reduced levels of sensitivity to quinolone antibiotics (oxolinic acid) have been detected from a total of nine farms nationwide. These isolates have been identified from both Northern and Southern Norway. For more detailed information relating to *V. anguillarum* and quinolone resistance, the reader is referred to "*gyrA* and *parC* mutations and associated quinolone resistance in *Vibrio anguillarum* serotype O2β strains isolated from farmed Atlantic cod (*Gadus morhua*) in Norway", by Colquhoun and co-workers in the journal Antimicrobial Agents and Chemotherapy, 2007. An alternative antibiotic (florfenicol) was used on one of these farms following poor response to oxolinic acid treatment. In the remaining farms no reduced effect of oxolinic acid was reported.

Other bacterial infections

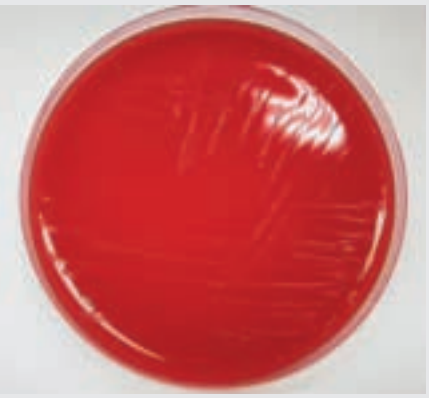
Infections with *Vibrio ordalii* were diagnosed on three different cod farms during 2007. In two of these cases this bacterium was identified as a mixed infection with *Vibrio anguillarum* O2a biotype II, while in the remaining case it constituted the sole infectious agent. *V. ordalii* is known as a fish pathogenic bacterium, and has only been



Vibrio (*Listonella*) *anguillarum* cultured on blood agar. The bacterium grows rapidly with relatively large colonies which discolour the surrounding agar green.



Isolates of *Vibrio* (*Listonella*) *anguillarum* O2β with different degrees of sensitivity to oxolinic acid (blue tablet). Resistant isolate on left, sensitive on right.



Vibrio ordalii cultured on blood agar. The bacterium grows slowly with small colonies.

isolated in relation to fish disease. It is previously known in the main from the USA, Japan, Australia and Chile and was identified for the first time in Norway in 2005. It is closely related to *Vibrio anguillarum* and was for some time known as a biovariant of that species. The obvious clinical findings are similar to those found in mild cases of vibriosis and include skin petechiation, particularly in the head region.

Vibrio logei has been isolated in pure culture from one case with increased mortality rate, but the role played by the bacterium in this case is uncertain. The isolate has been archived and the situation remains under observation.

Photobacterium spp. were isolated in the course of several diagnostic investigations in 2007. These isolates are closely related to, but do not belong to the species *Photobacterium phosphoreum*. As a group they are closely related but not completely alike. The importance of these bacteria as fish pathogens is currently unknown. These isolates have been archived and the situation remains under observation.

The situation regarding atypical *Aeromonas salmonicida* (causing atypical furunculosis) is considered stable in relation to the number of diagnosed outbreaks. The bacterium is isolated regularly from cod, but associated mortality is usually low. Strain typing of *A. salmonicida* isolated from cod in relation to vaccine development is a prioritised research area.

Parasites

Ectoparasites of the skin and gills are a recognised problem, with *Trichodina*, *Icthyobodo* ("Costia"), *Crytocotyle* ("black spot") and monogeneans such as *Gyrodactylus marinus* commonly registered.

As wild cod are hosts to over 120 parasites it is natural to suppose that some of these will infest farmed cod. The parasitic fauna of farmed and wild cod in Finnmark (Øksefjord), Nordland (Helgeland) and Møre og Romsdal (Ålesund) has been described by the research project CODPAR.

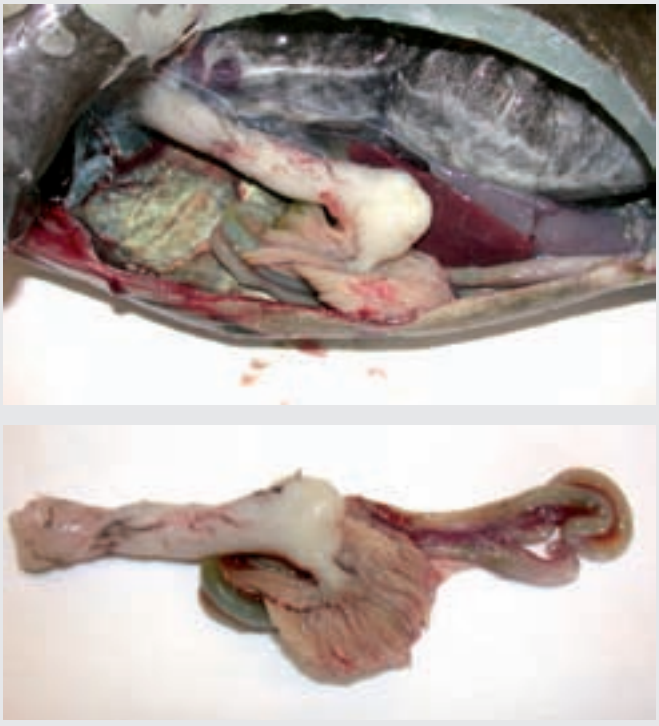
The background levels of parasites in wild stocks will decide the infection pressure on farmed stocks within respective geographic areas. Approximately 50 different species of parasites were identified during the project, of which several are new to science and others have been identified as parasites of cod for the first time. *Icthyobodo necator*, a single celled parasite which causes disease in many types of fish both marine and freshwater, was for the first time found in cod. The investigated cod were also found to host several species of monogeans of the genus *Gyrodactylus*, and the work of identification and description of these species using morphological and molecular biological methodology is underway. At least three species of *Gyrodactylus* have been found and preliminary results indicate that the different species are to be found in different niches (habitats) on the cod, including the gills, skin and throat (pharynx). The species identified on gill filaments appear to be particularly common in farmed cod.

Not surprisingly, wild cod were found to harbour a more varied parasitic fauna than farmed fish. While food-borne parasites are seldom found in farmed fish, the fact that they are found at all shows that despite being fed exclusively on commercial pellets, the farmed cod ingest enough plankton (intermediate hosts) to result in infection. Lice (Copepoda: *Caligidae*) found on wild fish, have not yet been identified in farmed fish.

Miscellaneous

Lateral line necrosis was registered in several farms. This condition can be characterised as a destruction of lateral line tissues, and has an unknown cause. Several research groups consider the condition to be of viral aetiology, and some farmers report an infectious "scenario" in afflicted populations.

Deformities such as "broken neck" and spinal deformities continue to be registered, but the scale of the problem is considered smaller than in previous years. Fish health services report that "colic" and other intestinal complaints are observed in cod, but in most cases do not lead to large scale mortalities. Colic is observed in fish from 200g and above. A welfare issue and cause of loss in larger cod is a condition where spawning does not occur in sexually mature females. These "egg-bound" females apparently die from secondary bacterial infections.



Normal anatomy of the peritoneal cavity and intestine of cod. The liver has been removed. The stomach/ intestinal tract is empty.

Halibut

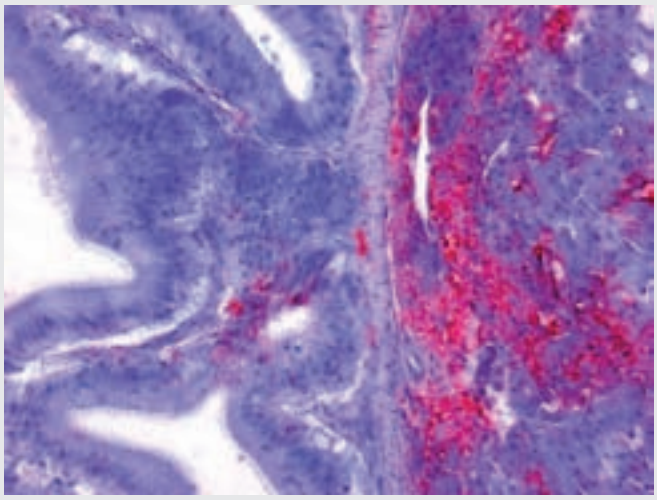
The National Veterinary Institute investigated samples sent from over 40 cases representing more than 10 halibut farms during 2007. Submissions from halibut farming comprise an increasingly smaller proportion of the total material sent in from marine fish. There were no large changes in the disease situation during 2007 in comparison with previous years.

Infectious pancreatic necrosis (IPN) was diagnosed on one halibut farm during 2007. Bacteria and parasite- related gill problems were also identified in the same fish.

Number of halibut farming localities with diagnosed IPN, VNN or Atypical furunculosis.

	2005	2006	2007
IPN	1	1	1
VNN (nodavirus)	Not found	2	1
Atypical furunculosis *(Aeromonas salmonicida)*	3	2	3

Viral nervous necrosis (VNN) was diagnosed on one halibut farm during 2007. The disease was repetitively diagnosed from the same population in a series of investigations between January – November. The fish were of the 2006 generation and displayed abnormal swimming behaviour. During the larval stage, significantly reduced appetite and increased mortality rate was observed.



IPN in halibut. Histological changes and immunohistochemical detection of IPN-virus in the pancreas and intestine. The virus is stained red.

The bacterial disease atypical furunculosis (infection with *Aeromonas salmonicida*) occurs regularly in halibut, and is often associated with disease and increased mortality. Various Vibrio-species also cause disease and increased mortality.

Miscellaneous

Various types of gill problems are common in farmed halibut and are often related to poor or varying water quality. Several different types of disease-causing agents may be involved and the single celled ectoparasites *Icthyobodo* ("Costia") and *Trichodina* are often detected. Bacterial gill inflammation and fin erosion are also commonly found. On culture from skin or kidney, different *Vibrio* spp. (i.e. *Vibrio* bacteria not belonging to a described species), and other water bacteria, are often found. Such bacteria are, as a rule, opportunists capable of infecting compromised individuals.

Focal epicarditis/myocarditis is often identified in halibut. These changes are often observed in apparently clinically healthy fish, and are of unertain significance. Some individuals display extensive chronic myocarditis, the cause of which is unknown. There may be a large degree of variation in degree between individuals in the same population. Systematic investigations are necessary to identify the significance of these changes for growth and general health of the fish.

Coalfish

The National Veterinary Institute received samples from four on-growing farms for wild caught coalfish. The majority of the samples sent are related to outbreaks of vibriosis. As for cod the causal agents are *V. anguillarum* serotypes O2α and O2β.

Other species

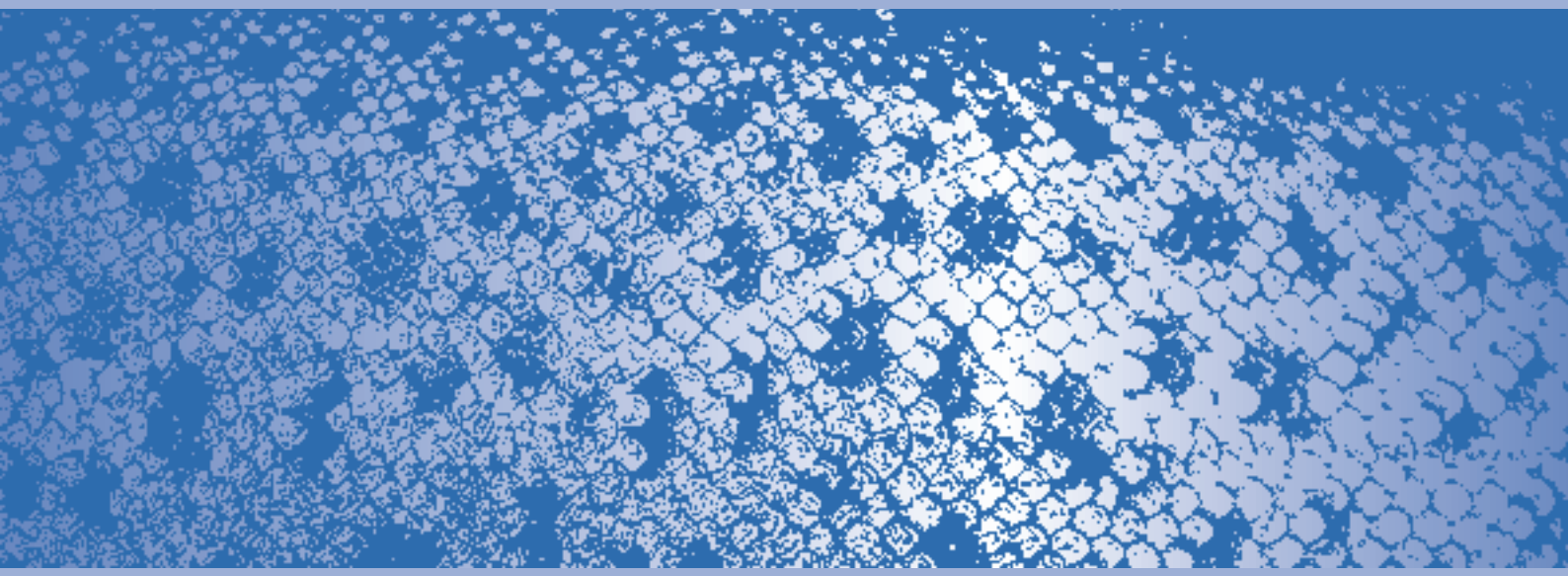
Farming of wolffish is now so limited that very few diagnostic samples are sent for investigation. Atypical furunculosis (infection with *A. salmonicida*) continues to be problematical in farming of this species. Gas supersaturation and mortality due to mechanical failure etc. are registered causes of death for this species.

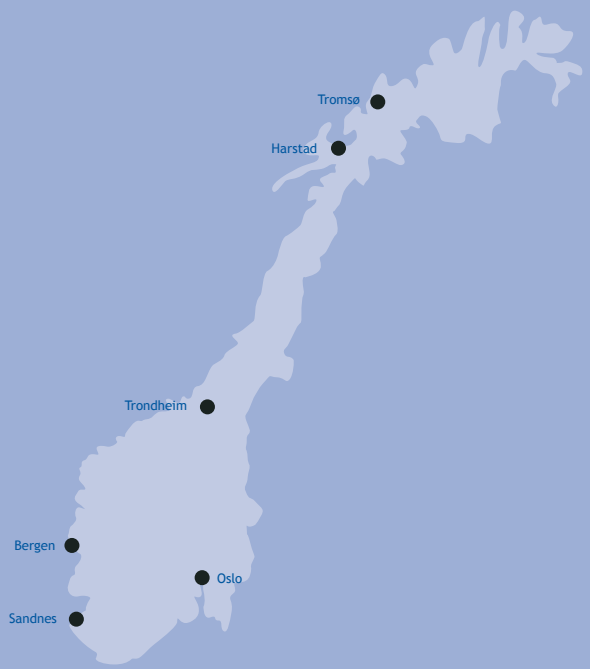
Although farming of turbot is also of limited scale, cases of gill inflammation are reported.

Photo: Espen A. Skjølsvik — National Veterinary Institute s 2, Ole B. Dale s 7,19, Duncan Colquhoun — National Veterinary Institute s 17, Hege Hellberg — National Veterinary Institute s 4, 15, 16, 18, Jan Arne Holm — Fjordlab s 8, Peder A. Jansen — National Veterinary Institute s 6, Trygve Poppe — Norwegian School of Veterinary Science s 10, 11, 12

The National Veterinary Institute (NVI) is a nation-wide research institute in the fields of animal health, fish health, and food safety. The primary mission of the NVI is to give research-based independent advisory support to ministries and governing authorities. Preparedness, diagnostics, surveillance, reference functions, risk assessments, and advisory and educational functions are the most important areas of operation.

The National Veterinary Institute has its main laboratory in Oslo, with regional laboratories in Sandnes, Bergen, Trondheim, Harstad og Tromsø, with about 330 employees in total.





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