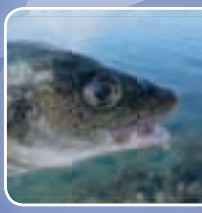
The health situation in farmed fish in Norway 2006



Veterinærinstituttet
National Veterinary Institute

Although the health situation in farmed fish is relatively good, losses related to disease and health related issues are significant. Some of these losses can be clearly related to defined diseases, while the causal relationships in others appears more diffuse. If the industry is to remain sustainable these losses must be reduced.

As part of this work the National Veterinary Institute has over several years produced annual reports of the health situation in -salmonid and -marine fish. These reports are based partly upon diagnostic investigations performed at our laboratories in Oslo, Sandnes, Bergen, Trondheim and Harstad.

We work continuously with quality assurance and improvement of our diagnostic service. Diagnoses are based upon a broad spectrum of diagnostic tests, including both traditional histological methods and newer molecular biological diagnostics.

Equally important is the information we receive from fish health services along the coast and from cooperating research institutions. The reports are not exhaustive, and we work continuously to quality assure and improve them. It is particularly difficult to establish precise statistics for those diseases which are non-notifiable. These include important, loss-causing diseases such as winter-ulcer and "new" diseases such as heart and skeletal muscle inflammation (HSMI) and cardiomyopathy syndrome (CMS).

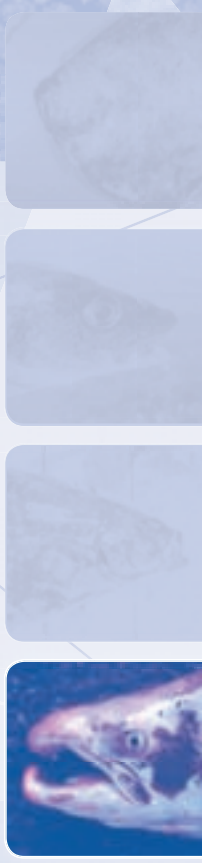
The Ministry of Fisheries and Coastal affairs has given the National Veterinary Institute the task of development of a public surveillance system for monitoring the health and disease situation in aquatic organisms, primarily fish (M-fisk). Establishment of this system will require the extensive cooperation of both the aquaculture industry and fish health services. The National Veterinary Institute expects this system to be an effective tool in improving fish health.

Brit Hjeltnes

Deputy Director,
Department for Fish and Shellfish Health,
Regional Laboratories

The health situation in salmonid fish 2006

Anne Berit Olsen
Geir Bornø
Duncan J. Colquhoun
Kjell Flesjå
Randi Haldorsen
Tor Atle Mo
Hanne Nilsen
Hanne R. Skjelstad
Brit Hjeltnes



Veterinærinstituttet
National Veterinary Institute

The health situation for farmed salmon and rainbow trout is generally good, and the consumption of antibiotics in salmonid farming is extremely low. There are, however, grounds for concern. While previously serious diseases are now under control, other newer problems such as PD and HMSI are spreading and attaining new importance. In addition, significant non-specific losses have been documented between sea-transfer and harvest. Although a large proportion of these losses comprise unregistered escapes, environmentally related problems (e.g. jellyfish injury, algal blooms) and smoltification problems, disease also accounts for a significant proportion. Reduction of these losses should be a primary goal for the aquaculture industry, fish health services, the public authorities and scientists working in this field.

Summary

It would appear that the viral disease ISA in salmon is under control. The number of cases registered in 2006 was the lowest since 1994 and 1995, when two outbreaks were registered per year. The annual number of officially diagnosed ISA outbreaks has been relatively stable since 1996, with between six and twenty outbreaks per year with an annual average of approximately 10 outbreaks. During this period the production of salmon has doubled.

The situation regarding other viral diseases is, however, of greater concern. Infectious pancreatic necrosis (IPN) continues to be widely diagnosed and can cause large losses, both during juvenile production and in sea-farmed smolts. This situation exists despite extensive vaccination and IPN's status as a group B notifiable disease.

The situation for pancreas disease (PD) and heart and skeletal muscle inflammation (HSMI) has undergone a serious escalation over the last five years. Registered cases of PD have increased sharply, and the disease has spread from the core area of Hordaland. In 2006, PD was registered for the first time in Møre og Romsdal. Calculations show that costs related to PD in the most affected areas are high. HSMI has now been registered along the entire coast, with an increase in the number of outbreaks in northern regions and in Trøndelag during 2006. HSMI does not necessarily result in high levels of mortality, but infected fish often have extensive inflammation in the heart and are therefore weak.

Cardiomyopathy syndrome (CMS) continues to account for large losses. As the disease affects adult, harvest-ready salmon, even limited mortalities give significant biomass losses. The aetiological agent/cause is not yet identified, but a virus may be involved.

During the autumn, as is normal, proliferative gill inflammation (PGI) was diagnosed in a number of localities. Some outbreaks were associated with high mortality levels. The gill-tissue reactions appear to be strongly related to the presence of epitheliocysts, i.e. cellular inclusions containing Chlamydia-like bacteria, although a virus is also detected.

The most important bacterial disease is winter-ulcer, which occurs particularly from Møre and northwards. The bacterium *Moritella viscosa* is considered an important factor in development of this disease, although environmental conditions are most likely also of significance. As well as direct losses, the condition also leads to marketing/quality problems and considerable fish-welfare issues. Most of the other important bacterial diseases including vibriosis, coldwater vibriosis and furunculosis are under control through use of effective vaccines.

Of the parasites, it is the salmon louse (*Lepeophtheirus salmonis*) that demands most attention. More lice were registered in 2006 than during the previous year, which may be related to the longer reproductive season for the lice due to high sea temperatures. Reports of reduced effect of pyrethroid bath treatments give grounds for concern.

Tapeworms (*Eubothrium* sp.) were less of a problem in 2006 than in previous years. Thresholds for treatment are high due to resistance to available chemotherapeutants.

Gill disease with associated amoebae (amoebic gill disease, AGD) in sea-farmed salmon was diagnosed in Norway for the first time late in 2006. There were at least four separate outbreaks in Western Norway, associated with varying, but in some cases high mortality in salmon transferred to sea in the spring of 2006.

Incidences of unacceptable side-effects related to use of oil-adjuvanted vaccines continue to be registered. It is highly desirable that vaccines without such side-effects be developed. Consumption of chemotherapeutants in salmon farming is extremely low. While there is only occasional antibiotic treatment of winter-ulcer, 2006 saw an increase in use of oral lice preparations.

Good health and welfare for the fish are fundamental parameters for the aquaculture industry. The disease situation, with continuous spread of certain infectious diseases, the presence of often more than one disease within a population, and the appearance of new diseases, demands a high degree of alertness in the industry, a well developed diagnostic apparatus, a well functioning registration system and high levels of research activity.

Global warming with concurrent higher sea temperatures means that we should be increasingly aware of new disease conditions and diseases known to occur at high water temperatures. The large increases in production of a marine species like cod, may also lead to changes in the disease situation in salmonid fish. Previously exotic infectious marine agents may become established in farmed cod and thereby constitute an increased risk of infection for salmon and rainbow trout.

Viral diseases

Infectious pancreatic necrosis — IPN

The number of IPN affected localities in 2006 was similar to 2005 i.e. slightly over 200. Around 45% of these diagnoses were related to juvenile production, most commonly in fry. In marine farms, smolts during the first three to four months post sea-transfer were most commonly diagnosed, although IPN was also diagnosed in fish up to 2kg.

While both salmon and rainbow trout were affected, almost all rainbow trout outbreaks were experienced during the juvenile stage. The disease was diagnosed in all counties from Telemark to Finnmark. IPN is a group B disease, and outbreaks must be confirmed by the National Veterinary Institute and the Norwegian Authority of Food Safety notified. The disease is almost certainly under-diagnosed and therefore under-reported. While IPN related mortalities vary and may be moderate, high mortality and outbreaks of extended duration were experienced both during juvenile production and in sea-farmed fish during 2006. Emaciation in some surviving fish is reported. IPN is seen before, with and after outbreaks of other diseases e.g. PD and proliferative gill inflammation.

IPN is diagnosed using microscopy (histopathology) and detection of the IPN-virus in damaged tissues using antibodies specific for IPN-virus (immunohistochemistry). Within the Sp serotype, which is the most common serotype in farmed salmonids in Norway, there occur several variant virus types. It has been shown that small variations in a viral surface protein (VP2) are most important in relation to the virus's ability to cause disease and in establishment of covertly infected carrier fish. There are indications that the virus can change (mutate) within the fish.

Vertical transmission of IPN-virus has been documented in rainbow trout, and although not irrefutably demonstrated in salmon, it is expected that this can also occur.

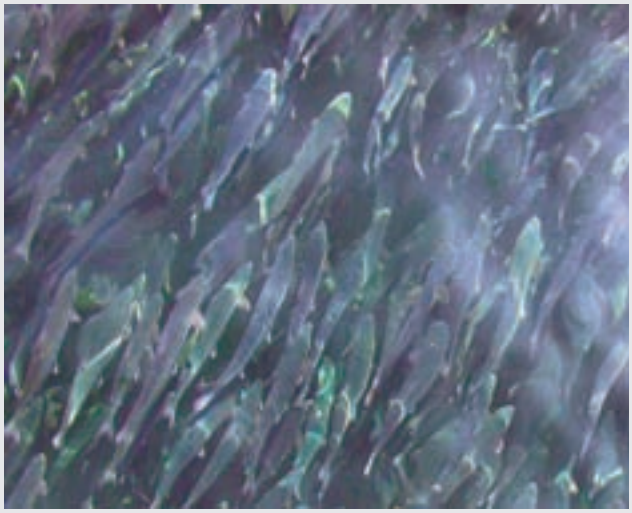
Farmed salmon in Norway are extensively vaccinated against IPN, but the degree of protection awarded by vaccination is not yet clear. Indications from the field suggest that vaccination may reduce losses.

Sea-farmed salmon smolt with IPN. The fish has a pale, yellow liver, petechial haemorrhage in the visceral fatty tissues and a congested spleen.

IPN in rainbow trout fry. The distended abdomen is caused by accumulation of fluid and mucus in the stomach. Distended abdomen may also be associated with other diseases.

Pancreas disease — PD

Fifty-eight farms were affected by pancreas disease (PD) in 2006 i.e. an increase compared with 2005, when PD was registered on 45 farms. As figure 1 shows, PD was for the first time diagnosed in Møre og Romsdal, where five farms were affected. It would appear that the disease is continuing its spread from the core area of Hordaland and southerly regions of Sogn og Fjordane to other areas of the coast. Both Rogaland and Sogn og Fjordane have experienced an increase in the number of affected localities in recent years. For Hordaland the number of cases has been stable for the last two years, and lower than in 2004, when many cases were registered. Although PD is most probably under-diagnosed in those areas where it is most common, there are indications that the situation in Hordaland is improving. Efforts to control the disease through identification of possible infection routes e.g. well-boat transport and reduction of infection pressure through coordinated fallowing within larger areas have been initiated.



Atlantic salmon with PD often school closely together, swimming near the surface, against the current.

PD remains exclusively identified in sea-farmed fish, despite reported detection of PD-virus in juvenile fish. Both salmon and rainbow trout are affected. The average time from sea-transfer to outbreak of disease is approximately eight months, although outbreaks may

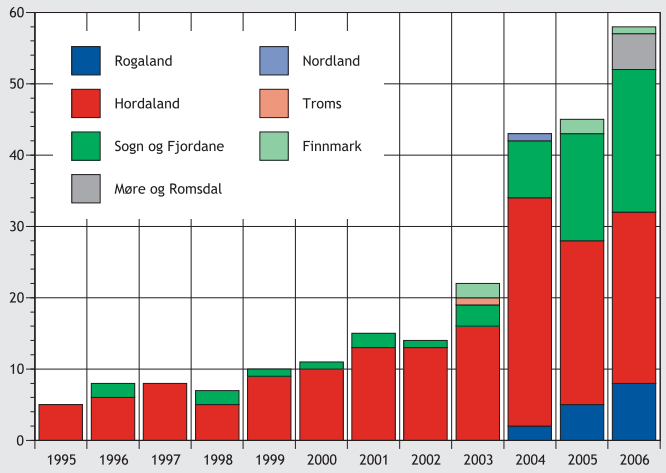


Figure 1. The distribution of farms diagnosed with PD per year and county from 1995 to 2006

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

be registered throughout the whole marine production period. PD is diagnosed throughout the year, but most often between May and October. In 2006, many samples were sent to the National Veterinary Institute for analysis as early as January. While PD outbreaks are often extended with high mortality, moderate outbreaks with low mortality also occur. Growth is generally reduced, and chronic muscle change can result in reduced product quality at harvest.

PD related losses were calculated, based on average statistics for 2005 from a selection of PD infected and non-infected farms. Given the assumption that these figures are representative, it is calculated that a model-farm stocked with 500,000 smolts, suffering a PD outbreak, will lose approximately 9 million kroner ($1.5 million). Considering the 100+ known outbreaks during the last two years, total losses to the aquaculture industry in Western Norway are estimated to be in the range of 1 billion kroner ($160 million).

PD may occur prior to, with or after outbreaks of other diseases. Diagnosis of PD requires exacting on-site clinical investigation and sampling of optimal and representative materials for laboratory investigation. Further sampling is often required during extended outbreaks.

Diagnosis of PD is based on identification of typical histopathological changes and detection of virus in the diseased fish using several independent detection methods e.g. immunological tests using specific antibodies, PCR and viral culture. Methods for detection of antibodies against PD-virus in the blood of affected fish are available and can reveal whether the fish has been exposed to PD-virus.

Pancreas disease is caused by *Salmonid alphavirus* (SAV) belonging to the genus *Alphavirus* within the family *Togaviridae*. The Norwegian virus is one of three genotypes (sub-types) of SAV and is termed SAV3. Neither SAV1, which gives PD in Scotland and Ireland, nor SAV2 which causes a similar disease in fresh-water farmed rainbow trout in France and the UK, have been detected in Norway. Research on PD has intensified in recent years, and a cooperative association, with several coordinated projects, has been formed including researchers from Ireland, Northern Ireland, Scotland and Norway.

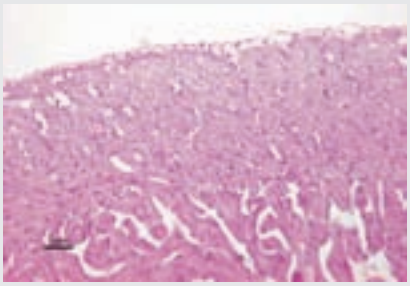
Heart and skeletal muscle inflammation — HSMI

HSMI has now been diagnosed in all coastal counties between Vest-Agder and Finnmark. Both the most northerly region and North- and South- Trøndelag experienced record HSMI registrations last year. Mid-Norway, where the first case was diagnosed in 1999, remains the most frequently affected area.

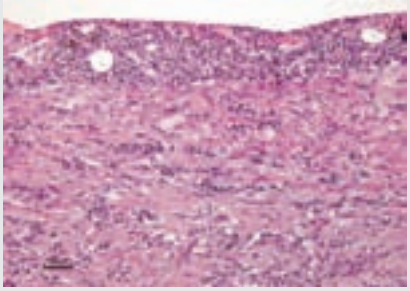
HSMI is only found in salmon and has been detected at all stages of marine culture. Most commonly the disease

Heart and skeletal muscle inflammation (HSMI) in Atlantic salmon. Note the varying liver colour and the fibrinous membrane covering the liver. In addition, the spleen is enlarged and the heart pale in colour. Blood is observed in the pericardium. Fish with HSMI need not have visible pathology.

Normal heart in Atlantic salmon



Heart from Atlantic salmon with HSMI. Inflammation of epicardium and myocardium. Fish with HSMI may also have inflammation in red muscle tissues.



is identified after some months of sea-culture, but it has also been registered a relatively short time after sea-transfer. In 2006, HSMI was diagnosed in fish of approximately 110g three weeks after sea-transfer but also in fish of 5-6kg. The disease occurs throughout the whole year, but most samples for investigation are received by the National Veterinary Institute in May—June and October—November. HSMI outbreaks may be of extended duration and associated with high mortality, but losses are most often moderate. On occasion, while many individuals may display typical internal pathological changes, the disease may be overlooked due to the lack of external clinical signs combined with low mortality levels.

Fish suffering HSMI display inflammation of the epicardium and heart muscle, and may also display inflammation in the red skeletal musculature. A virus has been isolated from fish with HSMI which in laboratory trials was capable of reproducing the disease. There is a need for development of specific and sensitive diagnostic techniques, such that histological detection of typical pathological changes may be confirmed by detection of the virus. Analytical detection of the virus is also important for further research on the disease and development of a vaccine. HSMI is not notifiable.

ISA in Atlantic salmon. The upper image shows pale gills due to anaemia, a dark liver and congested spleen. The ascites is bloody. The lower image shows congestion with blood in the gut wall. Fish with ISA may not always exhibit these characteristic findings.

Infectious salmon anaemia — ISA

ISA was officially confirmed in four localities during 2006 (East Finnmark, West Finnmark, Møre and Hordaland). At the Hordaland site, fish displaying typical signs of ISA were detected during the autumn of 2005, and restrictions were enforced. The outbreak was officially confirmed by the Norwegian Authority for Food Safety in 2006. Diagnosis of ISA is based on several criteria, where clinical findings and typical pathological changes are considered together with detection of the ISA-virus in the fish. Detection of virus can be sufficient for establishment of a suspicion of disease. Detection can be based either upon culture of living virus, or combination of other methods, such as immunological tests (with specific antibodies against the ISA-virus) and PCR. Detection of viral RNA alone, as with PCR, is not enough for initiation of an official "suspicion" of ISA, with its subsequent statutory consequences.

The number of outbreaks during 2006 was extremely low, the lowest since 1994 and 1995, when two new outbreaks were reported each year. The frequency of officially diagnosed ISA outbreaks has been relatively stable since 1996, with between six and twenty outbreaks each year, and an average of approximately 10 outbreaks per year. Over the same period, production of salmon has doubled. Control of ISA is based on a contingency plan conforming to EU regulations and recommendations from the OIE (World Animal Health Organisation). Early in 2006, the controversial regulation regarding compulsory slaughter of all fish on the locality within 80 working days was revoked. This requirement was replaced with statutory destruction/slaughter of the fish in accordance with a time frame specified in an individual plan authorised by the Norwegian Authority for Food Safety. The main goal of the contingency plan i.e. removal of fish from infected localities as fast as possible, still applies.

Internationally, ISA has been found on the East coast of Canada/USA, the Faeroe Islands and Scotland. Both Scotland and the Faeroe Islands appear to have gained

Table 1. Overview of number of fish farms with diagnosed Infectious salmon anaemia (ISA), Infectious pancreatic necrosis (IPN), Pancreas disease (PD), Heart and skeletal muscle inflammation (HSMI), pisciricettsiosis, furunkulosis and Bacterial kidney disease (BKD) from 1998 to 2006.

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

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

** one hatchery, two rivers

control over the disease. Both countries have practised "stamping out" procedures, and virus testing continues for early diagnosis. In the Faeroe Islands, all sea localities were until 2005, considered infected, and were fallowed. At the same time the aquaculture industry was restructured. In addition, all fish sea-transferred during and after 2005 were required to be vaccinated, following granting of special permission from the EU. In New Brunswick/Maine, ISA remains of significant economical importance, despite surveillance for early detection of virus, "stamping out" of infected cages and vaccination.

There is currently a great deal of discussion regarding the importance of vertical transmission of ISA-virus, its reservoir, and virulence factors. A broad international scientific group has, at the request of The Norwegian Scientific Committee for Food Safety (VKM), conducted a risk analysis in relation to some central queries regarding ISA-virus in relation to management of the disease. The group has concluded that vertical transmission cannot be discounted, but that the probability of such transmission of disease is low. They conclude further that spread of infection cannot currently be mapped using phylogenetic information alone, but that this information must be combined with epidemiological information in each individual case.

The group conclude that the most probable reservoirs for ISA-virus are farmed Atlantic salmon and wild salmonids, with brown trout and salmon as the most important species. The group consider well-boat transport to be an important factor in spread of ISA-virus.

Bacterial diseases

Winter-ulcer and septicaemia with *Moritella viscosa*

No national register for winter-ulcer exists. The number of samples (approximately 30) sent to the National Veterinary Institute for investigation during 2006 was similar to 2005. In many cases material is not sent for laboratory culture or verification, therefore the real prevalence is almost certainly higher. Experiences from the field indicate that the most severe problems associated with winter-ulcer during 2006 occurred from Møre and northwards. In some areas the problem was considered worse than 2005. Winter-ulcer appears, however, to have caused only limited problems in western Norway last year. Winter-ulcer is identified in sea-farmed salmon and rainbow trout between October and April. Ulcer development and infection with *M. viscosa* is also problematical in hatcheries which pump in a proportion of seawater.

Moritella viscosa is considered to constitute an important factor in development of winter-ulcer. That the bacterium has the capability to cause ulcer and mortality under experimental conditions is well documented. However, some farms do not develop a winter-ulcer problem despite the presence of the bacterium, and some farms have significantly larger problems than others. Development of winter-ulcer may have a complex aetiology, as *M. viscosa* is not always identified.

A vaccine against *M. viscosa* has been developed, although the effect appears to be variable. In serious cases the fish are treated with antibiotics. The ulcers also constitute a serious marketing/quality problem and lead to losses due to downgrading at harvest. Surviving fish exhibiting large open ulcers also comprise a significant animal welfare problem.

Proliferative gill inflammation — PGI

Following identification of proliferative gill inflammation (PGI) on many farms in 2003 and 2004, the prevalence dropped in 2005, then increased again during 2006. Most of the outbreaks in 2006 were registered later in the year than in previous years. As seen before some outbreaks were particularly severe in nature. PGI was in some cases reported together with, or prior to outbreaks of other disease e.g. PD or HSMI.

Proliferative gill inflammation is the term used for a condition found in sea-farmed Atlantic salmon since the 1980's. Most cases are identified between August and December, in salmon transferred to sea in the spring of the same year. As autumn progresses the fish may develop very severe gill damage in which the dominating reaction is moderate to extreme thickening of gill tissues, with haemorrhage, tissue necrosis and inflammation as common findings.

Commonly, epitheliocysts are identified in gill tissues i.e. inclusions of bacteria called *Pischichlamydia salmonis*. Not uncommonly, patchy liver necrosis is also identified in these fish. The cause/s of this condition is/are unclear. Research into the contribution of bacteria and a virus, *Atlantic salmon paramyxovirus*, also associated with the condition is in progress.

Furunculosis

Furunculosis i.e. infection with the bacterium *Aeromonas salmonicida* subsp. *salmonicida,* is a group B notifiable disease only sporadically found in Norway since vaccination began in the early 1990's. Furunculosis occurs in both wild and fresh- and sea-water farmed salmonids. In 2006, the disease was diagnosed in fingerlings and sea-ready smolts in a hatchery in Trøndelag. The infection was subsequently identified in all populations on the farm. The smolts were transferred to sea.

Piscirickettsiosis

During the autumn of 2006, an outbreak of piscirickettsiosis with very low mortalities was identified in 300g sea-farmed salmon. In 2002 piscirickettsiosis was identified in 18 localities and in 2003 five localities were affected. The disease was not diagnosed during 2004 and 2005. The disease is normally identified during the autumn. Piscirickettsiosis is classified as a group B notifiable disease manifesting as a chronic infection with development of inflammatory processes in various organs. While normally only associated with moderate mortality in Norway, significant mortalities

have been experienced. In Chile the disease is known as SRS- salmonid rickettsial septicaemia, and is a very serious disease. The Norwegian variant of the bacterium is different from the Chilean.

Bacterial kidney disease — BKD

BKD was not diagnosed in 2006. Bacterial kidney disease is characterised by a chronic progression with development of granuloma/processes in various organs. BKD is a group B notifiable disease and was a particular problem in salmonid fish in Norway between 1987 and 1993. Since 1999, between 1 and 3 cases have been identified annually. In 2006, the Norwegian Authority for Food Safety initiated a surveillance programme for BKD in Norway, under which the National Veterinary Institute is responsible for laboratory investigations. The programme follows in the main, the framework of the control programme for VHS/IHN and is thus based on EU regulations.

Other bacterial infections

Few outbreaks of vibriosis have been diagnosed in salmon, and the vaccine appears to give very good protection. Several outbreaks have, however, been identified in vaccinated rainbow trout, some with notable mortality levels. Vibriosis is diagnosed in the field and isolates are only occasionally sent in to the laboratory for serotyping and antibiotic resistance testing. Of the samples sent to the National Veterinary Institute, both serotype O1 and O2α are registered in salmon, while only serotype O1 was found in rainbow trout.

As in 2005, only few outbreaks of yersiniosis were identified in 2006. Outbreaks were registered in two farms in Møre og Romsdal and one in Trøndelag. Both hatchery fish and sea-farmed smolts were affected. In one case, 70g smolts were affected three weeks post sea-transfer. Some hatcheries vaccinate against the disease due to repeated annual outbreaks.

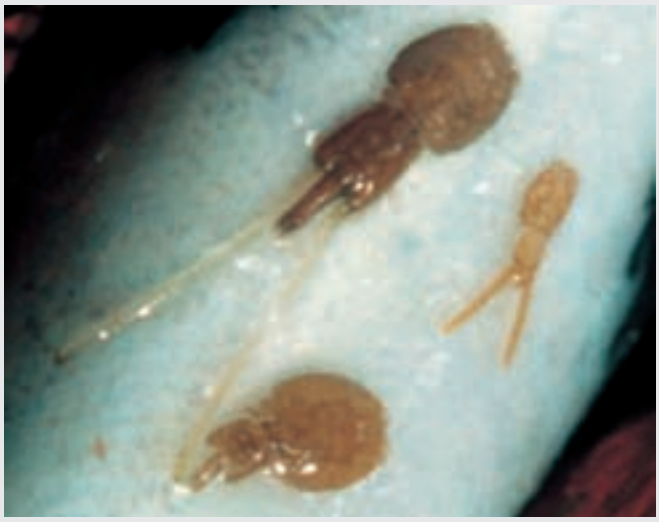
Every so often, mycobacterial infection is detected in salmon. In one case last year, "fish tuberculosis" was identified at low prevalence in a sea-farm. The fish displayed granuloma in the kidney containing acid-fast bacteria, and *Mycobacterium chelonae* was cultured.

One case of atypical furunculosis, infection with atypical *Aeromonas salmonicida*, was diagnosed in Atlantic salmon juveniles during the freshwater stage of culture.

Parasitic diseases

Salmon louse — *Lepeophtheirus salmonis*

During recent years the number of sexually mature female lice per farmed fish has steadily declined. The Norwegian Animal Health Authority's (now The Norwegian Authority for Food Safety) national action plan against salmon lice, initiated nearly 10 years ago, has had an effect. Production of salmon during this period has, however increased, such that the total number of salmon lice remains high.



Salmon louse *(Lepeophtheirus salmonis)*

The prevalence of salmon lice during the first half of 2006 was around the same as the first half of 2005. The second half of 2006, however, saw a significant increase in the number of lice compared to the same period in 2005. It may appear that higher sea temperatures during 2006 extended the reproductive season. The presence of *Caligus elongatus* was also registered over a longer than normal period during the autumn. Fewer farms than in 2005 used wrasse during the first half of the year, while wrasse were used at the same level as 2005 during the second half of the year. More anti-lice treatments were registered during the autumn of 2006, compared with 2005. In fish under 1.5kg, an oral preparation, emamectinbenzoate (EMB) is most commonly used, while bath treatment with pyrethroids is most commonly used in larger fish. During the last year, bath treatments have not always acheived optimal results, and resistance against the chemotherapeutant has been demonstrated. Achievement of the optimal dose is also a challenge in the large 160m cages which have recently been taken into use. In these cages, oral preparations are most practical, and there has been an increase in the number of treatments with EMB during 2006. This increase is relatively larger than the increase in biomass in these cages.

Salmon lice represent a large cost to the Norwegian aquaculture industry and are a problem for wild salmon populations. Development of a vaccine is in progress, but despite promising experimental results, it will be a considerable time before a commercial product becomes available.

Tapeworm — *Eubothrium* sp.

Tapeworms continue to be found in the intestine of sea-farmed salmon. It is reported that this is most commonly found in fish transferred to sea in the spring. As in 2005, it would appear to be a rather more restricted problem than in previous years. The threshold for treatment is high due to the limited effect of treatment with praziquantel.

Tapeworm of the genus *Eubothrium* are found both in fresh water and sea water. The species found in fresh water is *E. crassum*, but it is not clear if that found in sea water is the same species. Both are therefore called *Eubothrium* sp. Tapeworm have a head with attachment apparatus and a segmented body, of which each segment includes both male and female parts. Tapeworm lack a mouth and intestine and absorb nutrition directly across the body surface. Fish is the final-host. Eggs exit in the fish faeces and are eaten by an invertebrate which becomes the intermediate host. Fish become infected on eating the invertebrate intermediate host. Tapeworm infection leads to reduced growth and an increased feed factor. They also compromise a marketing problem as well as an animal welfare problem.

Parvicapsula pseudobranchicola

There continue to be many diagnoses of this parasite in mid and northern Norway. Although also identified in western Norway, only few cases are registered. Parvicapsulosis is most probably under-diagnosed. It can be difficult to diagnose in organs other than the pseudobranch, an organ which in many cases is not investigated. Infected pseudobranchs are initially congested, becoming later grey and slimy due to tissue necrosis. The fish may become blind as a result of the disease. The infection may on occasion result in significant problems, but generally the importance of the infection is most often unclear. The parasites life cycle and potential to cause disease are not yet resolved.

Costia — *Ichtyobodo* sp.

This parasite has been diagnosed as an occasional gill problem in both fresh water hatcheries and in sea-farms. Gill damage caused by large numbers of costia has also been recorded in broodstock salmon.

Amoebic gill disease

Gill disease as a result of amoebal infection was described during the late autumn of 2006 in spring transferred salmon, in four sea-farms in the west of Norway. The outbreaks were of extended duration, and mortalities were in some cases high. Fish in the affected sites also displayed signs typical of proliferative gill inflammation. As far as we are aware this is the first description of amoeba-related gill disease in sea-farmed salmon in Norway. The detected amoeba is similar to the amoeba responsible for development of amoebic gill disease (AGD) in Tasmania and other countries, which has periodically caused considerable losses.

Fungal diseases

Fungal diseases are only sporadically diagnosed in farmed fish. Both kidney infections with *Exophiala* spp., swimbladder infections (several fungal spp.) and gill problems with *Saprolegnia* spp. are registered.

Other health problems

Cardiomyopathy syndrome — CMS

CMS occurs primarily in large salmon, including broodstock, and is diagnosed throughout the year along the whole coast. No official statistics exist, and there is a considerable degree of uncertainty around the prevalence of the disease. For 2006, the National Veterinary Institute registered an increase in CMS related investigations in northern Norway. For the remainder of the country, CMS registrations appear to be around the same level or slightly lower than 2005. Individual cases of CMS related mortality of up to 100 tons are reported. Mortality is otherwise normally low or moderate, but biomass loss can be significant due to the size of affected fish. On post-mortem, CMS can appear similar to both PD and HSMI. Diagnosis must therefore be confirmed by histopathology. The cause of CMS is not yet identified, but a virus may be involved. Research continues.

Haemorrhagic smolt syndrome — HSS

HSS is a condition typified by anaemia and haemorrhage and is sporadically found in salmon during the hatchery phase, particularly between January and April. The disease is normally found during routine post mortem of dead fish and does not normally pose a serious threat to the population. HSS normally disappears when the fish are transferred to sea. There were fewer cases registered during 2006 than in previous years. The condition has been recognised since the 1980's, but the cause is not known. On post-mortem HSS may be confused with viral haemorrhagic septicaemia (VHS) and infectious haemopoetic necrosis (IHN), two serious viral diseases. These diseases may be discounted by histological and virological investigations.

Intestinal tumours

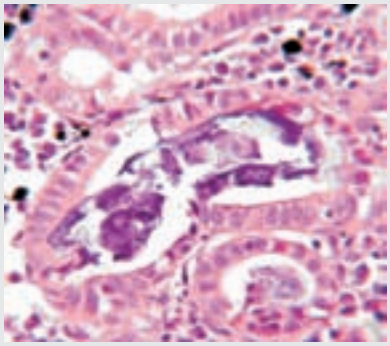
As mentioned in last years report, intestinal tumours have been observed in some broodstock farms. During 2006 these problems became more severe. Investigations indicate that early stage tumours of the same type are also found at very low frequency in harvested fish. The fish and feed have been investigated with respect to carcinogens, but no findings have been made which indicate the cause of the tumours. Experimental studies with the aim of reproduction of tumour development and evaluation of the importance of e.g. vegetable feed components are under planning.

Deformities

In 2006, as in previous years, skeletal deformities and heart anomalies were reported. The tendency towards an improvement in this situation, registered during 2005, would appear to be continuing.

Nephrocalcinosis

Nephrocalcinosis is observed in a number of hatcheries, and would appear to be connected with high levels of CO_2 in the water.



Nephrocalcinosis in Atlantic salmon in freshwater with high levels of CO_2. Mineral deposits cause occlusion of kidney tubules and damage to epithelial cells

Vaccine side-effects

Unacceptable levels of vaccine-related peritoneal inflammation and organ damage were also registered during 2006. Vaccination is an important prophylactic procedure, but development of vaccines with fewer side-effects is highly desirable, not least on animal welfare grounds.

The health situation in wild salmonids and in mitigation hatcheries

Salmon louse — *Lepeophtheirus salmonis*

Salmon lice are a particular problem for outwardly migrating salmon smolts and sea trout. Improved lice control in the aquaculture industry has led to a lower prevalence of lice on wild smolts in recent years. During 2006, the lice burden on wild smolts in some areas was, however, somewhat higher than in 2005. In some aquaculture areas, sea trout continue to carry large numbers of lice. In Hardangerfjord an increase in sea trout lice burden has been observed despite very low lice registrations in salmon farms. This suggests that high temperatures and salinity make lice control difficult in areas with intensive salmonid aquaculture.

Gyrodactylus salaris

No new rivers or farms infected with *Gyrodactylus salaris* were registered in 2006. Totally, salmon from 88 rivers and salmon/rainbow trout from 57 farms were investigated under the national surveillance programme for *G. salaris*. Rivers in the surveillance programme are investigated annually, in the main at a single location. Farms are sampled every second year, and the sampling is synchronised with the surveillance programmes for IHN/VHS in freshwater.

In 2006, a new surveillance programme for *G. salaris*, termed epidemiological mapping (EM) was established. This programme will monitor infected areas and rivers where there have been, or are planned, extermination actions against *G. salaris*. The rivers in the EM programme are sampled three times per year, with sampling performed at many locations at each time. During 2006, the EM-programme covered six regions and 19 rivers. In September 2006, *G. salaris* was again found in the river Batnfjordelva in Nordmøre.

Proliferative kidney disease — PKD

Proliferative kidney disease is caused by the parasite *Tetracapsuloides bryosalmonae* and results in a swollen kidney in salmonids in fresh water. In 2006 there was particular attention paid to a detection in juvenile fish in two rivers, the Åbjøravassdraget in Helgeland and the Jølstra in Sogn og Fjordane. There was considerable mortality in juvenile fish in these rivers, indicating that this parasite may have an important effect on the fish populations. The disease develops primarily at water temperatures in excess of 15°C and can cause high mortality. Infected fish may show no signs of disease. The main host for the parasite is a bryozoan which is found on submerged substrates e.g. plants. The fish are infected with spores, the parasites transmission stage, which develop in the bryozoans. The parasites do not spread directly from fish to fish. The first registered finding of PKD in Norway was in 1972. Since then there have been around 100 findings, mostly in mitigation and commercial hatcheries. PKD has been detected from southern Norway to Helgeland. The disease is observed in salmon, rainbow trout, sea trout and arctic char. A study to establish the presence/prevalence of the parasite in selected Norwegian rivers has been initiated.

Furunculosis

In August 2006 furunculosis was diagnosed in mature salmon of 0.9 and 2.9kg in a river in Nord-Trøndelag in which the disease has occurred annually over many years. The infection was also diagnosed in wild trout in Nordland.

Other diseases, health problems

The bacterium *Yersinia ruckeri* was detected in broodstock salmon, where it may be present without causing disease. In mitigation hatcheries tapeworm (*Eubothrium* and *Diphyllobothrium*), and gill parasites (*Trichodina,* Costia and *Chilodonella)* are occasionally found. Some trout hatcheries experience an annual infection with *Gyrodactylus derjavini*.

Otherwise, sporadic environmentally related conditions e.g. fin biting, gas supersaturation and nephrocalcinosis are found. It would seem that there were more fungal gill infections during 2006 than previous years, which may be related to high water temperatures.

Surveillance programmes

Each year, national surveillance programmes are carried out for two viral diseases i.e. infectious haemopoetic necrosis (IHN) and viral haemorrhagic septicaemia (VHS) and the parasite *Gyrodactylus salaris*. In 2006 a surveillance programme for bacterial kidney disease (BKD) was commenced. Testing for infectious agents was also

performed in various research projects, and on private basis, as part of the biosecurity program in some farms.

Chemotherapeutant consumption

Most diseases caused by bacteria or parasites may be treated with chemotherapeutants. Consumption of antibacterial compounds in the salmon farming industry is extremely low. There is occasional treatment of serious cases of winter-ulcer. During 2006 there was an increase in use of anti-lice compounds.

Welfare, ethics and environmentally sound production

During the last few years, there has been increasing focus on the welfare of farmed fish. Prevention and treatment of ulcer, vaccine side-effects, and deformities are examples of central challenges to the industry. Fish have a relatively primitive brain compared to mammals, and the degree to which fish are capable of pain perception is discussed, but not yet established. It is nevertheless important that the industry does as much as possible to enable farming of fish under the best possible conditions. There are currently a number of large research projects whose aim is the definition of environmental and welfare parameters for fish.

A significant proportion of smolts are produced as 0+ smolts, and it has been questioned whether this production is consistent with fish welfare. The Norwegian Scientific Committee for Food Safety (VKM) has concluded that there are larger challenges in production of 0+ smolts than in production of 1+ smolts. Should environmental conditions be unfavourable for smoltification, there may be an increased risk of reduced animal welfare on production of 0+ smolts due to the smaller smoltification window and narrower production-related time margins. Given optimal conditions the committee consider that such a production form is satisfactory in relation to sea water performance indicators such as growth, health and welfare.

Consumers demand steadily increasing standards of welfare and ethical and environmentally friendly production. It is therefore important that Norway can document an ethically defensible production of farmed fish, with a focus on good health and welfare.

Basis for the health report

This report is based on the results of the diagnostic work performed at the National Veterinary Institutes regional laboratories in Oslo, Sandnes, Bergen, Trondheim and Harstad, discussions with representatives of fish health services nationwide and information from the Norwegian Authority for Food Safety. Thanks to all who contributed. Thanks also to Arnfinn Aunsmo, Norwegian School of Veterinary Science, for help in estimating the costs related to PD.

anne-berit.olsen@vetinst.no

geir.borno@vetinst.no

duncan.colquhoun@vetinst.no

kjell.flesja@vetinst.no

randi.haldorsen@vetinst.no

tor-atle.mo@vetinst.no

hanne.nilsen@vetinst.no

hanne.r.skjelstad@vetinst.no

brit.hjeltnes@vetinst.no

The health situation in marine fish 2006

Hege Hellberg

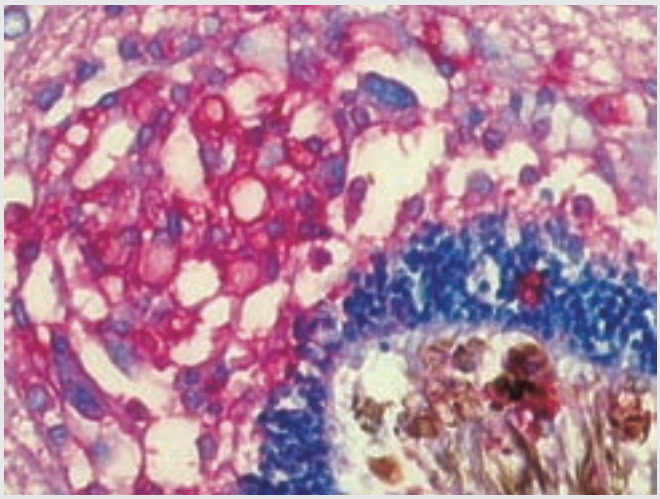
Veterinærinstituttet
National Veterinary Institute

The most significant finding of 2006 was diagnosis of viral nervous necrosis (VNN) in cod. This disease is caused by a nodavirus, and has not previously been diagnosed in cod in Norway. Other important diseases in cod have included bacterial infections caused by *Francisella philomiragia* subsp. *noatunensis* (Mikalsen *et al.* in press) and *Vibrio* (*Listonella*) *anguillarum*. Cod once again accounted for the majority of samples received by the National Veterinary Institute for investigation. Of notifiable diseases in halibut, two cases of VNN and one case of infectious pancreatic necrosis (IPN) were registered. The following report of the health situation in marine fish in 2006 is based on materials sent to the National Veterinary Institute and information from fish health services nationwide.

Cod

Viral diseases

Viral nervous necrosis (VNN; caused by nodavirus) was diagnosed for the first time in Norwegian farmed cod in 2006. The National Veterinary Institute received material from three cases of increased mortality in cod, during the late summer of 2006. Clinical signs included reduced appetite, spiral swimming and other aberrant behaviour. Post mortem findings included distended swimbladders in all three cases and cataract in one case. Histological (light microscopy) investigation of tissue samples revealed vacuolisation and necrosis of nerve cells in the eye and brain. Immunohistochemical investigations for nodavirus gave positive reaction in the eye, brain and spinal column. Molecular biological investigation for nodavirus using so-called RT-PCR gave positive results. Comparison of the gene sequences produced by RT-PCR revealed that the virus in cod is similar but not identical



VNN in cod. Immunohistochemical detection of nodavirus in the eye of cod with VNN. The virus is stained red.

VNN in cod.

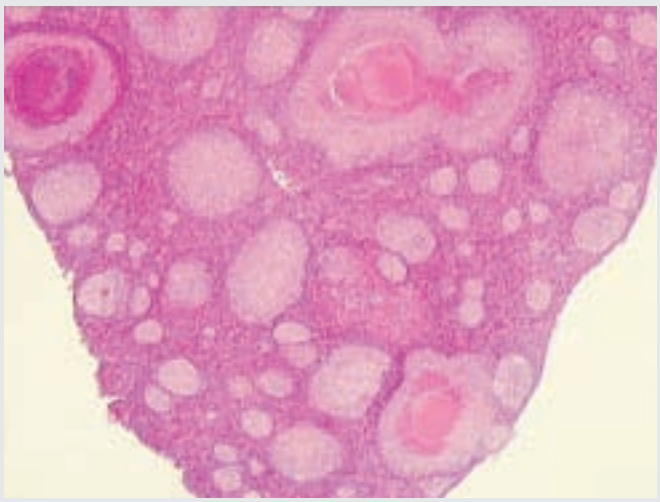
to nodavirus in halibut. In addition to viral investigations, bacterial culture was performed in every case. In one case *Francisella philomiragia* subsp. *noatunensis* was isolated.

The three VNN outbreaks in cod differ from previously described outbreaks in halibut. The fish were larger, from 5g to 1.5kg, and the disease ran a more extended course with reduced appetite, distended swimbladder and moderately increased mortality levels. That VNN is not previously registered in Norwegian farmed cod, may be due to inadequate investigation of previous VNN cases. It is also possible that the virus has been present in the farmed population, but that other necessary trigger factors have not been present. One possibility is that the high water temperatures during the summer of 2006 provoked the disease. Nodavirus challenge trials performed at the Norwegian Institute of Fisheries and Aquaculture Research in Tromsø show that cod more easily develop clinical signs of VNN and die when water temperature is increased. Routes of infection in the three field cases are not identified, but nodavirus is hardy and can survive lengthy periods in the environment.

Vertical transmission (i.e. from broodstock) is one possibility, horizontal transmission between fish groups on the farm or farmed and wild fish another. Investigations performed at the University of Bergen show that nodavirus is present in wild fish, including cod. Fish age and size at time of infection may affect the course of the disease. It is not known when the fish became infected in the studied cases, but infection trials with turbot and halibut have shown that the older the fish are, the more difficult it is to infect them with VNN. Experiences with striped jack (*Pseudocaranx dentex*) in Japan have shown that outbreaks of VNN in larvae younger than 10 days caused 100% mortality in two—four days. In outbreaks in fish older than eleven days, survival increased, as did the occurrence of distended swimbladders. This is a possible explanation for the disease course experienced in diseased cod in 2006. It is also possible that cod may have a higher degree of resistance than halibut to nodavirus, or that the nodavirus variant identified in Norwegian farmed cod is less virulent (aggressive). Infection trials should resolve some of these questions.

Bacterial diseases

FRANCISELLOSIS, the "new" bacterial disease caused by *Francisella philomiragia* subsp. *noatunensis*, has been found to be a problem from Rogaland to Nordland. It is a chronic disease, and produces typical granulomatous processes in the skin, muscle, and internal organs. In 2006, the National Veterinary Institute diagnosed francisellosis in cod on six sites: three in Møre og Romsdal, two in Rogaland and one in Nordland. There are however, strong indications that more than six cases occurred in the course of 2006. Francisellosis is currently not a notifiable disease, but is at present considered by many to be the biggest threat towards commercial farming of cod, and there is concern that the situation may worsen. Field fish health services report large problems with francisellosis, and in some cases affected stocks



Francisellosis in cod. Granulomas in spleen.

have been destroyed. Testing of auto-vaccines is now underway.

The disease is diagnosed in all age groups. The economical consequences of an outbreak are large, especially when the disease affects large fish approaching harvest size. Although caused by a bacterium, antibacterial treatment is not advised as the bacteria are located intracellularly (within the fish cells). Granuloma formation will in addition contribute to further encapsulation of the bacteria. Research into the disease and the bacterium has been led by the National Veterinary Institute with the Institute for Marine Research in Bergen as a collaborating partner. Some work is also performed at the University of Bergen. Bacterial challenge trials have been performed to elucidate route of infection and course of the disease. Preliminary results show that the disease transmits easily between fish, and that even low concentrations in bath challenge can lead to disease. Further characterisation of the bacterium and mapping its prevalence are also important themes for research. Preliminary analyses performed by the University of Bergen indicate that *F. philomiragia* subsp. *noatunensis*. is present in a range of wild fish species in the west of Norway, although no signs of disease have been noted in wild caught fish. Sequencing of genes from *F. philomiragia* subsp. *noatunensis* from wild fish indicate that the same species is found in Norwegian wild and farmed fish. *F. philomiragia* subsp. *noatunensis* has also been identified in diseased wild cod in Sweden. Related species have also been identified in fresh water farmed salmon in Chile, tilapia in Taiwan, Hawaii and in North- and South-America as well as marine fish in Japan and the USA.

VIBRIOSIS has proven to be a continual problem in cod farming, during juvenile, ongrowing and broodstock culture. The disease is diagnosed in cod farms from Rogaland to Troms. Vibriosis can occur as a chronic or acute infection, dependent on fish age and resistance to disease. The highest mortalities are usually experienced during juvenile production. Stress, caused by grading, vaccination and handling may also trigger outbreaks, and several outbreaks have been reported immediately after vaccination. While almost 100% of all farmed cod are vaccinated, wild caught fish of over 500g are not vaccinated. Water temperature is also an important factor, and acute outbreaks are often observed at high temperatures. Reports from fish health services indicate that vibriosis in cod is less of a problem in northern Norway than in the south. Outbreaks with associated high mortalities have been reported in Nord-Trøndelag where the same bacteria have been isolated from wild coalfish (*Pollachius virens*) near the cages. In Rogaland there are reports of repeated outbreaks of vibriosis during juvenile production, and that the least degree of stress can trigger an outbreak. Antibiotic treatment is given in some cases. In Møre og Romsdal, Hordaland and Sogn og Fjordane the situation is similar to previous years, with antibiotic treatment necessary in a number of vibriosis cases.

Vibriosis in cod.

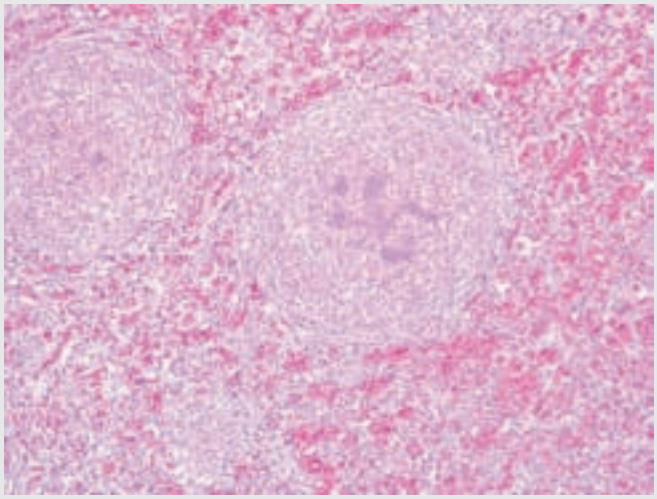
During 2006, the National Veterinary Institute diagnosed 30 cases of vibriosis. Vibriosis in cod is mainly caused by *Vibrio (Listonella) anguillarum* serotype O2a og O2b. Samples were received from 19 fish farming sites in total, and several sites experienced repeated outbreaks. Serotype O2b dominates and was identified in 15 sites.

Research carried out in 2005/2006 by the Norwegian Institute for Fisheries and Aquaculture Research, the Norwegian College of Fisheries and the National Veterinary Institute has identified a new variant of *V. anguillarum* serotype O2 which gives positive agglutination (precipitation) with anti-O2a rabbit sera, but differs from "normal" O2a in antigenic, phenotypical and genetic criteria. The bacterium has been retrospectively identified from outbreaks as far back as 2001, and may explain some outbreaks experienced in vaccinated fish.

The new variant of *V. anguillarum* O2 was identified in three sites, in one case together with O2b. *V. anguillarum* O2a was identified in five sites and O2b was also identified in three of these sites. Vibriosis is not a notifiable disease, and in many cases is diagnosed by the local fish health service or research institution. A proportion of these isolates are sent on to the National Veterinary Institute for antibiotic resistance testing and further characterisation. The statistics given here do not represent "the whole truth", but provide an indication of trends and developments in the vibriosis situation.

A complete, nationwide survey of all vibriosis cases in cod aquaculture, with standardised resistance testing and serotyping would provide surveillance of antibiotic resistance development and constitute a valuable foundation for further vaccine development.

ATYPICAL FURUNCULOSIS (infection with atypical *Aeromonas salmonicida*) was diagnosed in cod in several localities along the entire coast. This is not thought to constitute a significant problem in cod, and the bacterium is often isolated in association with other diseases. Typical findings during the acute stage include bacterial micro-colonies in several organs. Over time granuloma may develop, making atypical furunculosis a differential diagnosis in francisellosis investigations.



Atypical *Aeromonas salmonicida* infection in cod. Granuloma.

Granulomas are often identified in cod and in many cases the causes of these changes are not identified. The newly initiated NFR project "Characterisation of the inflammatory response in cod" aims to increase our understanding of the inflammation process and disease development in cod. Examples of work already initiated include provocation of an inflammatory response in cod followed by histological, immuno-/ enzymhistochemical and molecular biological studies. Such basal studies will contribute significantly to improved diagnostics and vaccination. The project is a cooperation between the National Veterinary Institute and the Norwegian School of Veterinary Science.

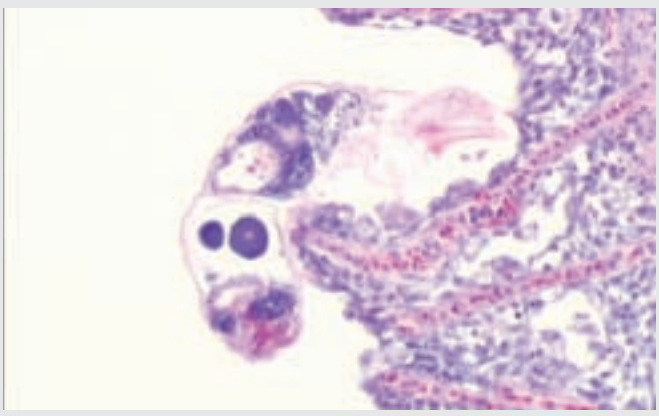
OTHER BACTERIAL DISEASES of cod can be caused by many different types of bacteria e.g. proliferation of bacteria in the intestine and swimbladder in cod juveniles. In these cases *Vibrio* species are often present. Bacterial gill inflammation is also observed, both in juvenile and larger fish, and Gram-negative rod-shaped bacteria are commonly found in these cases. Epitheliocystis is also found in association with gill inflammation in cod. Ulcers equivalent to winter-ulcer in salmon are also found in cod and *Moritella viscosa* (previously *Vibrio viscosus*) has been isolated from these fish. Otherwise, mixed floras dominated by different *Vibrio* species are often found.

Parasite diseases

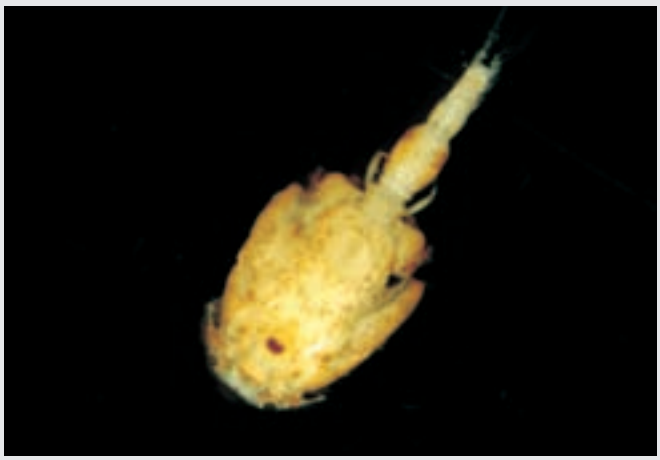
Parasitic gill inflammation is common in cod, and the commonest parasites involved are *Ichthyobodo* ("*Costia*") and *Trichodina*. *Gyrodactylus marinus* has also been found in cod with gill problems and increased mortality. Skin infections with *Trichodina* and *Cryptocotyle* (black spot disease) are commonly seen. Findings of unknown importance include myxosporidia-like parasites in kidney tubules and bile ducts. Significant tissue damage in relation to these infections is seldom identified.

Parasites can move freely from fish to fish in open cages and to and from wild fish in the surrounding area. Cod are natural hosts to over 120 parasitic species, and some of these inevitably find their way into the sea-cages. The background level of parasites in wild fish will define the infection pressure towards hatchery raised fish following transfer to the open sea. It is therefore important to know which parasites are found in the natural populations of wild cod around the farm sites and the prevalence of naturally infected fish, to evaluate the infection pressure. Wild-caught farmed fish will bring with them their own parasitic fauna to the coast, where they will also meet other, new parasites.

A research project lead by the National Veterinary Institute will monitor the parasitic fauna in wild and farmed cod in two areas where cod farming is currently performed, Øksfjord in Finnmark and Helgeland in Nordland. The project started in the autumn of 2006 and will continue until spring 2007. Local fjord cod, migratory cod, hatchery produced cod and live-caught cod for ongrowing will be investigated. Preliminary results indicate that parasites which may transmit directly e.g. *Gyrodactylus*-species and *Trichodina*-species are most common in caged fish, while food-borne parasites are most common in wild fish. It also appears that some parasites with an indirect life-cycle such as myxosporidia disappear from wild-caught fish following a period in captivity. This does not however, apply to all myxosporidia. So far, lice have not been found in significant numbers, but those found were on wild cod. The



Cod, gill with *Gyrodactylus marinus*.



Caligus elongatus.

intestinal trematode *Hemiurus communis* was identified only on the Helgeland coast, while its relation *H. levinseni* was found only in Øksfjord. Larvae of the tapeworm *Diphyllobothrium phocarum* were identified only in Øksfjord, probably because its final host, the bearded seal, is an arctic species. The project is financed by NFR and Innovation Norway, with local partners Ultra Seafood Loppa, Helgelandstorsk og Fjord Marin Cod.

Caligus elongatus is an ectoparasite which may become a significant problem for the cod farming industry. The National Veterinary Institute has performed several investigations into the prevalence and host preferences of *Caligus elongatus* in wild and farmed fish. It has been found that *C. elongatus* occurs as two genotypes, and that the prevalence of these varies with the time of year (Øines & Heuch, "*Caligus elongatus* Nordmann genotypes on wild and farmed fish", Journal of Fish Diseases 2007, 30, 81-91). Laboratory studies of these two genotypes show that they have somewhat different host specificities, but that cod is the preferred host for both (Øines *et al*. "Host preference of adult *Caligus elongatus* Nordmann in the laboratory and its implications for Atlantic cod aquaculture", Journal of Fish Diseases 2006, 29, 167–174). In addition, it was shown that adult lice easily move between different host species. This means that populations of fish along the coast can constitute a large potential infection pressure for farmed cod.

Lateral line necrosis in cod.

Miscellaneous

Mortality in sexually mature "egg bound" female cod continues to be a problem. Bacteria are isolated from such fish, but whether a bacterial infection of the cloaca is the cause of mortality or whether it is a secondary condition due to the weakened nature of the fish is not known. Reports of "twisted gut" or colic were received during 2006 in ongrowing cod. The extent of this problem is unknown. Another condition observed is lateral-line necrosis, where damaged skin is observed along the lateral line. The cause is not known, but a viral aetiology is suspected.

Medication of large cod is difficult, and there are reports of appetite loss and mortality following treatment. Mortality associated with operational procedures is a recurring problem. Procedures and equipment are in the main still designed for salmonid fish. In addition to being more sensitive to pressure changes, cod have completely different behaviour than salmonids, which can lead to unexpected consequences.

Deformities such as "broken neck" and spinal deformities continue to occur. Akvaforsk has mapped deformities in farmed cod and examined the effect of temperature on the development of deformities over time. The mapping shows that the incidence of "broken neck" is reduced, but there continues to be a large proportion of fish with more or less severe deformites. The study shows a relationship between a large proportion of deformities and high water temperatures at start feeding. Differences in the proportion of deformed fish have also been observed between farms as has increase of degree of deformity with time, indicating that environmental factors have an effect beyond the juvenile production stages.

Halibut

During 2006, VNN was diagnosed on two halibut farms, one in Hordaland and one in Møre og Romsdal. In one case acute mortality was observed in 0.1g fry, three weeks after start feeding. The fish were fed on rotifers and Artemia and had displayed good appetite and full intestines prior to the outbreak. Affected production units showed >50% mortality in the course of the two first days of the outbreak. Total mortality in affected groups approached 100%, which is typical for VNN in halibut fry.

IPN was also diagnosed in halibut during 2006. Mortality was high, but the situation was complicated and IPN was probably not the only cause of death.

Atypical furunculosis (infection with atypical *Aeromonas salmonicida*) continues to be a problem in halibut farming nationwide. Outbreaks of disease are often related to periods of high water temperature, poor water quality or handling of fish. Vaccination does not give complete protection, and this disease will likely continue to be a problem in the future. Atypical furunculosis has a different manifestation in marine fish than in salmonid

fish. While haemorrhagic ulcers of the musculature are less common in halibut, a more common finding is microscopic colonies of short, Gram-negative bacteria in most organs. The bacterial micro-colonies may be surrounded by haemorrhage, aggregations of inflammatory cells and some early cell organisation. With time, granulomas may develop.

Other bacteria, e.g. *Tenacibaculum* spp. (previously *Flexibacter* spp.) and different *Vibrio* spp. may also cause problems. *Vibrio alginolyticus* and another *Vibrio* species have been associated with intestinal bacterial proliferation. *Tenacibaculum* spp. have been detected in association with dermatitis (skin inflammation). Treatment with flumequin was reported to be effective in treating bacterial dermatitis.

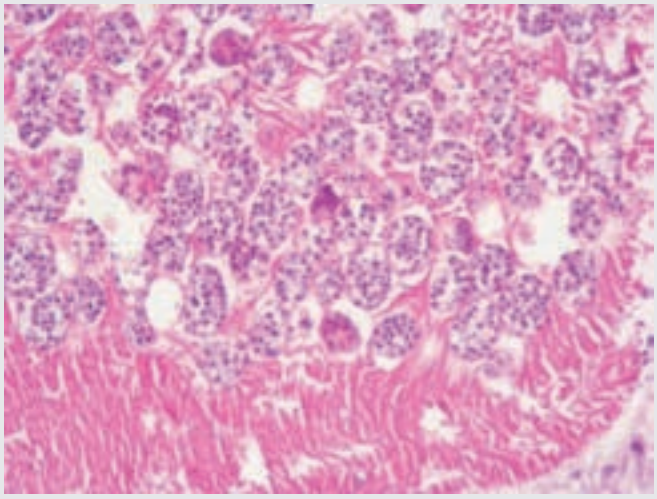
There are no reports of significant losses due to parasitic infection in halibut, but ectoparasites such as *Ichthyobodo* ("*Costia*") and *Trichodina* may be problematical.

Environmental problems/poor water quality may lead to gill damage. Moderate gill change in halibut is often revealed during light microscopy investigation. These changes most commonly become more severe with fish age. It is generally concluded that this condition is not enough in itself to kill the fish, but reduced gill function in association with further episodes of poor water quality, increased temperature or stress may result in death. An unfavourable environment constitutes an animal welfare problem. Many fish species can adjust to extreme water quality changes given time, but fish normally regulate their environment by moving to water of a different quality. Wild fish are free to choose — farmed fish, like all domestic animals, are dependent on the conditions we give them.

A common finding in halibut is a focal (limited) epi-/myocarditis (heart inflammation). Light microscopy reveals a granulomatous inflammatory reaction at the tip of the heart. It appears that the changes may begin in the epicardium (outer surface of the heart) then spread to the myocardium (heart muscle). The importance of this condition is not known.

Wolffish

The main problems reported in wolffish, as in previous years, are atypical furunculosis (atypical *Aeromonas salmonicida*) and infections with the ectoparasites *Trichodina* and *Ichthyobodo* ("*Costia*"). Environmental problems e.g. gas supersaturation also cause losses.



Pleistophora ehrenbaumi in wild-caught wolffish.

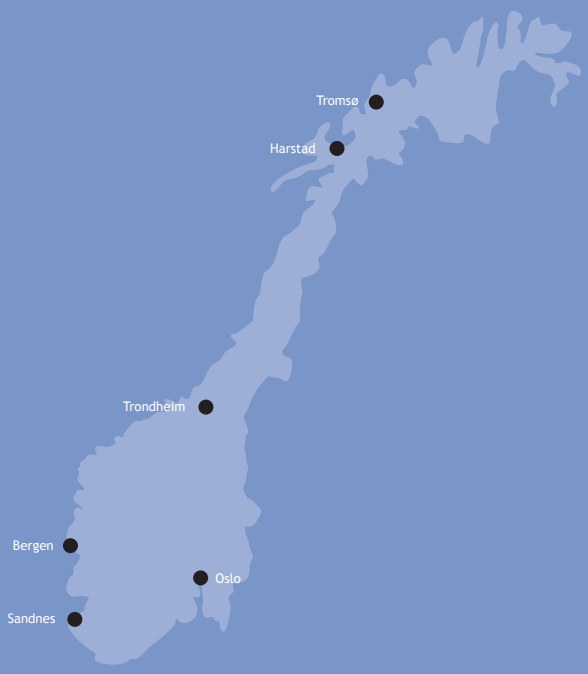
In wild wolffish from Trondheimsfjord caught in June 2006, extensive *Pleistophora ehrenbaumi*-infection of the musculature was found. This single celled parasite forms large cysts in the musculature and damages the fillet. *Pleistophora ehrenbaumi* is well known in wild wolffish and was also registered in farmed wolffish during 2006.

Hege.hellberg@vetinst.no

Photo: Bornø, Geir — National Veterinary Institute p 7, 15, 16, 17, Heuch, Peter Andreas — National Veterinary Institute p 9, Hellberg, Hege — National Veterinary Institute p 15, 17, Håstein, Tore — National Veterinary Institute p 1, Jensen, Freddy — Fiskehelse og Miljø AS p 5, Kongtorp, Ruth Torill — National Veterinary Institute p 6, Nilsen, Hanne K — National Veterinary Institute p 18, Olsen, Anne Berit — National Veterinary Institute p 5, 10, Poppe, Trygve — Norwegian School of Veterinary Science p 1, Sjelstad, Hanne Ringkjøb — National Veterinary Institute p 19, Sterud, Erik — National Veterinary Institute p 1, Tørud, Brit — Fiskehelse BA, Øines, Øyvind — National Veterinary Institute p 18

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.



Form: GRAF as · mai 2006

www.vetinst.no