Norwegian Veterinary Institute

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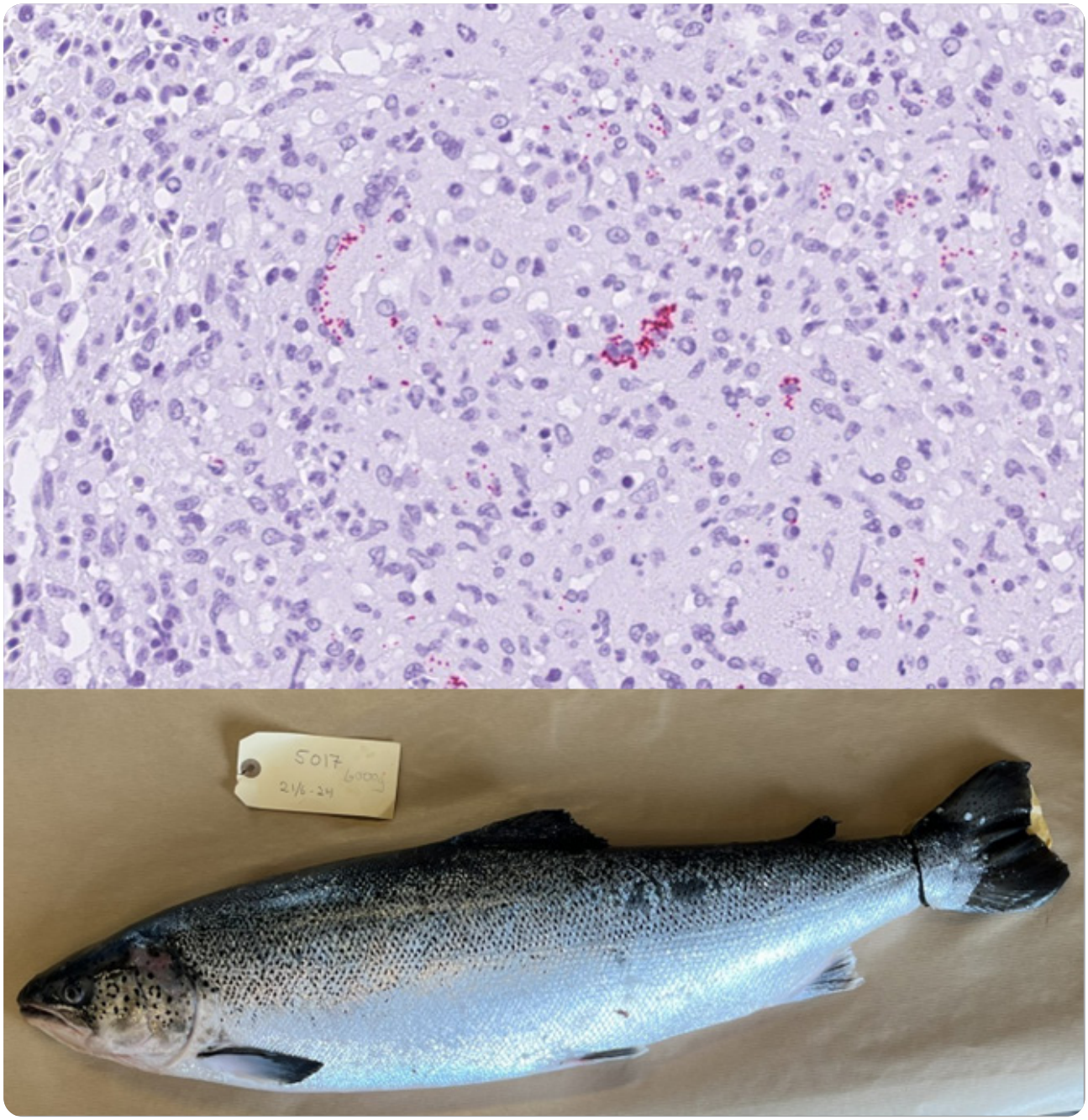

Health monitoring of wild anadromous salmonids in fresh water in Norway - Annual report 2025

REPORT 14/2026

Health monitoring of wild anadromous salmonids in fresh water in Norway - Annual report 2025

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Colophon

Cover photo: *Renibacterium salmoninarum* granuloma in spleen of farmed Atlantic salmon. Bacteria visualised by IHC. Photo Synne Grønbech.
Escaped farmed salmon. Photo: Åse Helen Garseth
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Content

Norsk sammendrag

Bakteriell nyresyke, forårsaket av *Renibactrum salmoninarum* (*R. salmoninarum*) har fått ny aktualitet i norsk akvakultur etter at flere sjølokaliteter i produksjonsområdene 4, 5 og 6 (PO4-PO6, NFD 2017) har fått påvist sykdommen i perioden 2022-2026. Helgenomsekvensering av *R. salmoninarum* fra smittede oppdrettslokaliteter tyder på at tilfellene i oppdrett fra denne perioden utgjør minst to ulike epizootier, det vil si at de har minst to ulike smittekilder. Vill laksefisk er regnet som en sannsynlig kilde til smitte i oppdrett, samtidig har flytting av fisk og felles bruk av brønnbåter og servicefartøy bidratt til spredningen internt i oppdrettsnæringen. I 2024 rømte 8400 oppdrettslaks fra en av de smittede sjølokalitetene (13887 Reitholmen). Undersøkelser viste at 2.04 % av den gjenfangede rømte laksen var bærere av *R. salmoninarum*.

Den generelle BKD situasjonen i oppdrettsnæringen og rømmingen av smittet laks medførte at Mattilsynets helseovervåkingsprogram for vill laksefisk i 2025 fikk som mål å undersøke smittestatus og påvirkning på ville laksefisk. Veterinærinstituttet ble tildelt ansvar for å overvåke forekomst av *R. salmoninarum* hos villfisk i ferskvann, herunder ungfisk og tilbakevandret voksen fisk, mens Havforskningsinstituttet fikk ansvar for overvåking i sjøfasen.

Veterinærinstituttet har undersøkt til sammen 528 laksefisk og påvist tre individer som er PCR-positive for *R. salmoninarum*. Alle tre individer er fanget i elva Orkla i Trøndelag, og består av to voksne villaks og en rømt oppdrettslaks. Den rømte laksen er sporet genetisk til rømmingen fra 13887 Reitholmen i 2024 (Sporbarhet AS). Det er forsøkt dyrking av bakterien fra alle tre individer uten resultat. Veterinærinstituttet vil følge opp påvisningen med nye undersøkelser i 2026.

I 2025 ble Veterinærinstituttet tildelt ansvar for å overvåke *Renibacterium salmoninarum* hos vill laksefisk i ferskvann, herunder ungfisk og tilbakevandret voksen fisk. Havforskningsinstituttet fikk ansvar for overvåking i sjøfasen.

Blant 528 undersøkte laksefisk er *R. salmoninarum* påvist hos to villaks og en rømt oppdrettslaks (fra 13887 Reitholmen), alle fanget i elva Orkla i Trøndelag. Veterinærinstituttet (NRL) vil følge opp påvisningen med nye undersøkelser i 2026.

Summary

Bacterial kidney disease (BKD), caused by *Renibacterium salmoninarum*, has re-emerged in Norwegian aquaculture during the period 2022–2026. Whole-genome sequencing indicates at least two separate epidemics with different infection sources. Wild salmonids are considered a likely reservoir, while fish movements and shared wellboats have contributed to spreading within the industry. In 2024, 8,400 salmon escaped from one of the infected sites (13887 Reitholmen), and 2.04% of the recaptured fish carried *R. salmoninarum*.

These developments led the Norwegian Food Safety Authority to prioritize BKD in its 2025 health monitoring program for wild salmonids. The Norwegian Veterinary Institute (NVI) was tasked with freshwater surveillance, while the responsibility of the Institute of Marine Research is the marine phase.

The Norwegian Veterinary Institute examined 500 wild salmonids and detected *R. salmoninarum* by PCR in three fish, all from River Orkla: two wild adults and one escaped farmed salmon genetically traced to the 2024 Reitholmen escape. Attempts to culture the bacterium were unsuccessful. Follow-up investigations are planned for 2026.

Introduction

On assignment from the Norwegian Food Safety Authority (Mattilsynet), the Norwegian Veterinary Institute and the Institute of Marine Research have conducted health monitoring of wild salmonids since 2012. The Veterinary Institute has been assigned responsibility for health monitoring in freshwater (juvenile fish and returning adult fish). The Institute of Marine Research's responsibility is monitoring in the marine phase (out-migrating smolt and salmonids at sea). The Veterinary Institute publishes the results in annual reports available on https://www.vetinst.no/overvaking/health-monitoring-of-wild-fish.

The aim of the surveillance has evolved over time to ensure that it consistently targets pathogens of current relevance. Bacterial kidney disease (BKD) in salmonids is a serious, notifiable category F disease caused by infection with the gram-positive bacterium *Renibacterium salmoninarum*. BKD may cause acute mortality, particularly in juvenile fish, but most often occurs as a chronic disease. A lifelong carrier state may occur, and in addition to horizontal transmission between individual fish (horizontal transmission), the bacterium can also be transmitted from one generation to the next via infected eggs (vertical transmission).

Known susceptible native species include Atlantic salmon (*Salmo salar*), brown trout/sea trout (*Salmo trutta*), Arctic charr (*Salvelinus alpinus*), grayling (*Thymallus thymallus*), whitefish (*Coregonus laveratus*) and sea lamprey (*Petromyzon marinus*) (Rimaila-Pärnänen, 2002, Eissa et al., 2006). Among the introduced salmonids, rainbow trout (*Oncorhynchus mykiss*), pink salmon (*Oncorhynchus gorbuscha*), brook trout (*Salvelinus fontinalis*) and lake trout (*Salvelinus namaycush*). *R. salmoninarum* susceptibility has also been shown in some non-salmonid species.

After two decades with three or less BKD cases per year in farmed and wild fish, an epidemic comprising farmed fish emerged from production area 6 in 2022, followed by a separate epidemic in production area 4. From 2022 to April 2026, a total of 24 aquaculture sites, mainly sea sites, have been affected by epidemics from PO4 to PO6 (Moldal et al. 2026). The latest outbreaks comprised two sea sites in Hitra municipality where salmon from several sea cages were affected by advanced disease, accordingly the epidemic is still ongoing.

From one of the BKD-affected sea sites, 8400 Atlantic salmon escaped on May 5th, 2024. Due to the timing of the escape and the size of the fish (mean 7.3 kg, range 2–12 kg), The Directorate of Fisheries and the Norwegian Food Safety Authority expected that the escaped salmon would ascend the rivers and spawn. The fish farming company and associates initiated extensive measures to capture the escapees (Kanstad Hansen et al., 2025, Sporbarhet AS/ Klungland 2024). Despite the efforts, farmed fish remained in some rivers when the response efforts were concluded in late autumn 2024. NVI assessed the occurrence of BKD in the escapees by qPCR and concluded that *R. salmoninarum* prevalence of among escapees was 2.04 % (Garseth et al., 2025).

The general BKD situation in aquaculture, combined with the escape of infected salmon, led the Norwegian Food Safety Authority to prioritize *R. salmoninarum* in the 2025 health monitoring program for wild salmonids. The overall objective is to investigate infection status and potential impacts on wild salmonids, and the starting point is to investigate the occurrence in wild salmonids.

Aim

The aim of the health monitoring program of 2025 is to investigate the occurrence of *Renibactrium salmoninarum* in wild salmonids in freshwater in Norway.

Material and Methods

Material

A total of 528 wild-caught salmonids (Atlantic salmon, sea trout and pink salmon) from 27 rivers or locations were included in the surveillance program (Figure 1). Tables A1a-c in the Appendix displays detailed information. The core target area was Production Area (PA) four to seven (Figure 1), although salmonids obtained through the notification system for disease in wild fish, from locations outside the target area were also included.

In addition to samples from diseased fish, samples were obtained from several other sources, including biobank material, parr captured during river surveys for the *Gyrodactylus salaris* surveillance program, as well as pink salmon, sea trout, and both wild and farmed escapees from the river owner associations.

Methods

During post-mortem examination of adult fish, body weight and body length were recorded, and scales were collected in a scale-sampling envelope. Internal organs were inspected for BKD-related lesions, and kidney tissue, and occasionally other relevant tissues, were sampled for further analysis. From each fish, a kidney sample was preserved in RNAlater™ for PCR-analysis, and an additional fresh kidney sample was frozen at −20 °C to enable cultivation if *R. salmoninarum* specific PCR was positive. In juvenile fish, a kidney sample was preserved in RNAlater, while the remainder of the fish was frozen whole.

PCR analyses

Kidney samples were stored frozen in RNAlater until processing. Nucleic acids were then extracted with an automated MagNA Pure 24 or 96 system (Roche) and further analyzed by real-time PCR targeting the *msa2* gene of *R. salmoninarum*, with an assay modified from Bruno et al. 2007.

Cultivation of *Renibacterium salmoninarum*

Fresh frozen kidney samples from PCR-positive fish were inoculated on kidney disease medium (KDM) and selective kidney disease medium (KDMS) and incubated at 15°C for at least 12 weeks and were inspected to identify suspicious colonies.

Scale analyses and genetic tests

Atlantic salmon were classified as wild, farmed or of uncertain origin based on visual scale analyses at NVI (Antere & Ikonen 1983, Fiske P Lund RA & Hansen LP 2004, Lund RA & Hansen LP 1991). All PCR positive salmon were further genetically tested by NINA to determine the genetic origin of the salmon (Karlsson et al. 2011).

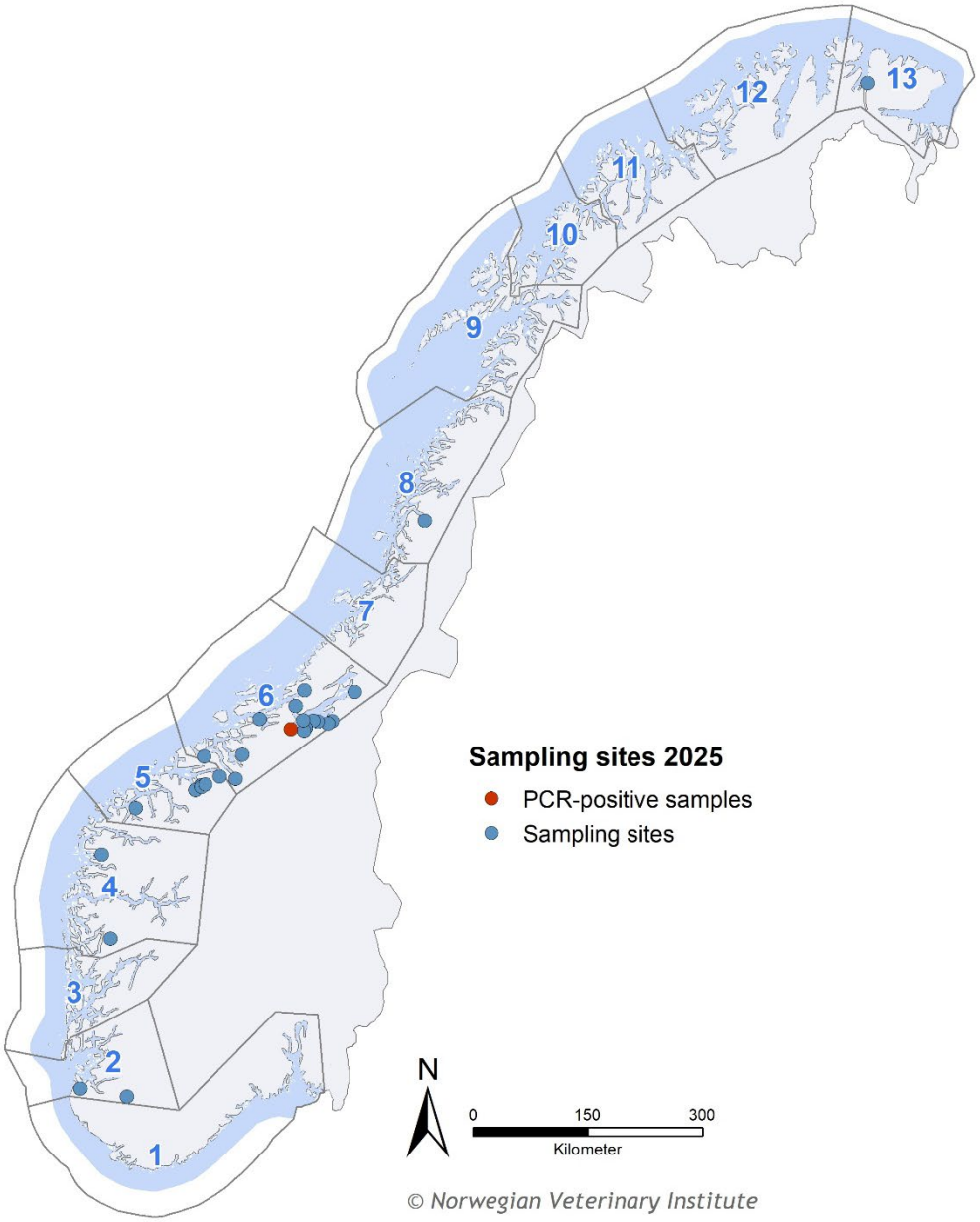

Figure 1. Map of Norway with Production Areas (PA) 1-13 and 27 sampling sites marked as blue and red circles. The PCR-positive samples were detected in River Orkla in PA 6 (red circle). Illustration: Attila Tarpai, Norwegian Veterinary Institute.

Results and discussion

Altogether 528 wild-caught salmonids (farmed and wild Atlantic salmon, sea trout and pink salmon) were included in the health monitoring program and tested by real-time PCR.

Two adult wild Atlantic salmon and one escaped farmed salmon, all captured in River Orkla, were PCR-positive for *R. salmoninarum* (Table 1). Attempts to cultivate the bacterium in the three PCR-positive salmon failed.

Table 1. Presents detailed information about the three Atlantic salmon that were PCR-positive for *Renibacterium salmoninarum* in the 2025 health monitoring program in freshwater.

ID no.	**101** **Escaped farmed salmon**	**106** **Wild salmon**	**118** **Wild salmon**
River	Orkla	Orkla	Orkla
Catch date	June 6th 2025	August 13th 2025	June 21st 2025
Gender	Female	Female	Female
Wild or farmed	Farmed according to scale analysis and traced to 13887 Reitholmen	Wild according to scale analysis P(wild) 0.966	Wild according to scale analysis P(wild) 0.975
Length mm	900	870	940
Weight (g)	7000	5600	Missing data
Smolt length mm	-	163	143
Smolt age	-	3	3
Winter-sea age	-	3	3
Spawning 2024	No	Yes	Yes
Comments	Abdominal cavity full of eggs from 2024 season	Found dead in river	Sampled by kitchen personnel at Meldal Helsetun
Ct value (R. salmoninarum)	**Kidney: 34.7** **Liver: 35**	**Kidney: 24**	**Kidney: 30**

Sporbarhet AS traced the PCR-positive farmed Atlantic salmon to the 13887 Reitholmen escape in May 2024. Interestingly, more than one year after the escape, and more than half a year after the spawning season, the abdominal cavity of this female escapee was filled with old eggs that should have been spawned during the autumn of 2024. The gills were heavily infested by gill maggots (*Salmincola salmoneus*) (Figure 2 & 3).

Two similar escaped female salmon from 13887 Reitholmen were captured in River Nidelva in June 2025, whereof one was available for inclusion in the health monitoring program and found to be PCR-negative for *R. salmoninarum*.

Figure 2. The photo shows the PCR-positive farmed salmon (ID.no 101) that escaped from 13887 Reitholmen in May 2024. It was captured more than one year after the escape and had old eggs in the abdominal cavity (Photo: Åse Helen Garseth, Norwegian Veterinary Institute).

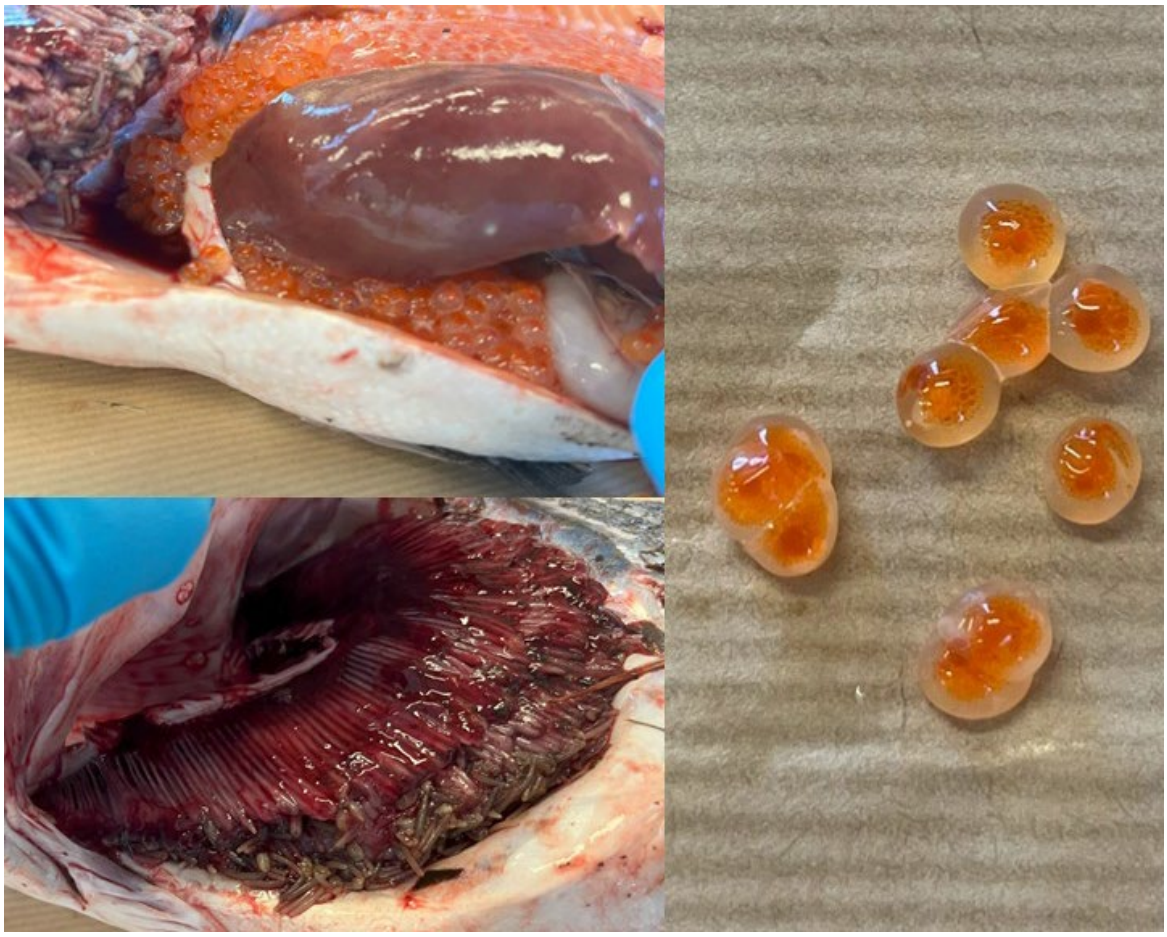

Figure 3. This photo also shows the PCR-positive farmed salmon (ID.no 101). It was heavily infested by gill maggots and had a white spot on the liver (Photo: Åse Helen Garseth, Norwegian Veterinary Institute).

The presence of *R. salmoninarum* in recaptured farmed salmon one year after the escape highlights the serious nature of escapes of infected farmed fish. In this case, however, the Ct-values indicate low levels of the bacterium, and in addition the farmed salmon had not spawned, i.e. it has not been involved in vertical transmission of the bacterium.

Two of the PCR-positive Atlantic salmon were of wild origin (Table 1, Figure 4 and 5). River Orkla is one of less than 20 Norwegian rivers where *R. salmoninarum* has been detected in wild salmonids since 1980. The first detection in Orkla was by researchers from the Norwegian Institute of Nature Research (NINA) during fieldwork in spring of 1997. White nodules were observed in out-migrating smolt of Atlantic salmon. According to the medical history submitted by NINA, approximately four of 1500 smolt had white nodules in their kidneys. One of the affected smolts was sent to NVI for diagnostic work, and BKD was confirmed by cultivation of *R. salmoninarum*. BKD was detected again in Orkla in 2000, this time in two male broodfish that were donors of milt for cryopreservation in the gene bank program for wild Atlantic salmon. Again, *R. salmoninarum* was detected by cultivation from both salmon. Both salmon from 2000 were wild according to visual scale analyses and P(wild) analyses. The scale analysis also showed that one of the adult wild salmon returning to spawn in 2000 left the river as smolt in 1997, i.e. together with the infected cohort identified by NINA.

All three historic *R. salmoninarum* isolates from Orkla are included in the whole genome sequencing (WGS) of Villamil-Alonso and co-workers (2026). Unfortunately, attempts to cultivate the bacterium in the three PCR-positive salmon identified in 2025 failed, accordingly it is not possible to perform WGS and phylogenetic analyses in this case. The investigation will therefore continue in 2026.

Figure 4. The photo shows a wild PCR-positive Atlantic salmon (ID.no 106) found dead in River Orkla in August 2025. As seen in the photo, the salmon exhibited substantial post-mortem degradation, but also signs of disease, although none that are specific for BKD. (Photo: Åse Helen Garseth, Norwegian Veterinary Institute).

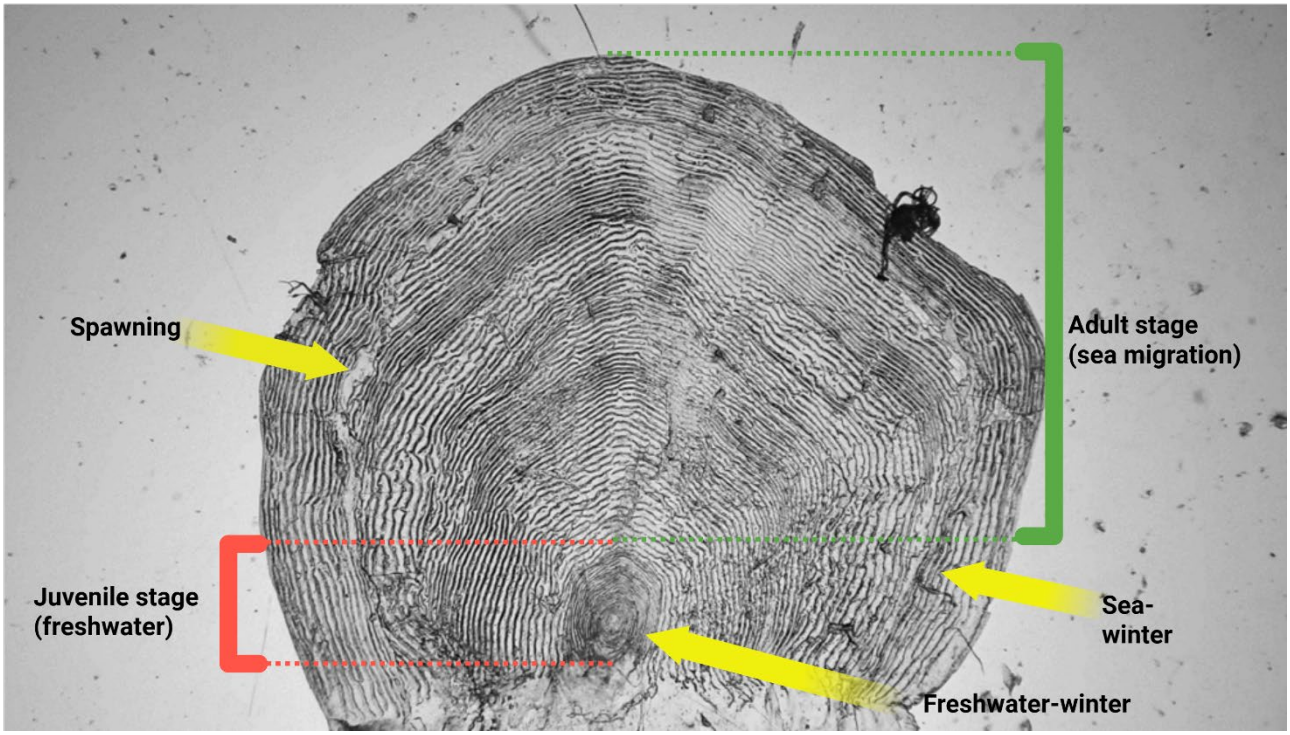

Figure 5. Shows a scale from the PCR-positive wild Atlantic salmon (ID no. 118) captured in Orkla in 2025. The scale exhibits a distinct freshwater zone indicating reduced growth during the riverine phase, followed by increased growth after sea migration, consistent with the typical growth pattern of wild Atlantic salmon. This individual has spent three winters in freshwater and three winters at sea. Spawning marks on the scale indicate that it participated in spawning during the 2024 season. Photo: Norwegian Veterinary Institute. Created with BioRender.com.

Conclusion

The health monitoring program showed that escaped farmed salmon can still be present and act as carriers of *R. salmoninarum* one year after the escape. The unexpected finding of female escapees with intact egg-sacs more than six months after expected spawning should be investigated further.

The detection of wild adult salmon from River Orkla carrying *R. salmoninarum* may suggest that an endemic infection has sustained within this wild population. Alternatively, that the infection has been reintroduced by escapees from infected farms. The genome of *R. salmoninarum* is highly conserved, with minimal genetic variation across isolates, which limits the resolution of genomic epidemiology. Nevertheless, it is a methodology that could possibility shed light on the interaction between wild and farmed reservoirs.

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Appendix

Table A1a. Overview of Atlantic salmon (*Salmo salar*) sampled and tested for *Renibacterium salmoninarum* by real-time PCR. The table includes river name, life stage, purpose of sampling (random or disease Investigation = Disease), the number of PCR-positive samples and the total number of individuals examined.

County	River	Life stage	Year	Pos./tested	Sampling purpose	Comment
Finnmark	Tana/Tenu	Adult	2025	0/1	Disease	Disease
Nordland	Vefsna	Adult	2025	0/1	Random	Angling
Trøndelag	Verdal	Adult	2024	0/11	Disease	Saprolegniosis
Trøndelag	Stjørdalselva	Adult	2023	0/2	Disease	
Trøndelag	Stjørdalselva	Adult	2025	0/11	Random	Smokery
Trøndelag	Stjørdalselva	Adult	2025	0/27	Random	Smokery
Trøndelag	Homla	Adult	2022	0/8	Disease	Saprolegniosis
Trøndelag	Homla	Parr	2025	0/1	Disease	Papillomatosis
Trøndelag	Homla	Adult	2025	0/1	Disease	Saprolegniosis
Trøndelag	Vikelva	Adult	2025	0/1	Disease	Saprolegniosis
Trøndelag	Nidelva	Adult	2025	0/1	Random	Escaped farmed
Trøndelag	Nidelva	Adult	2025	0/8	Random	Wild
Trøndelag	Gaula	Adult	2023	0/1	Disease	Unknown
Trøndelag	Gaula	Adult	2025	0/26	Random	Wild
Trøndelag	Gaula	Adult	2025	0/1	Random	Escaped farmed
Trøndelag	Gaula	Adult	2025	0/1	Disease	Saprolegniosis
Trøndelag	Vigda, Skaun	Smolt	2025	0/12	Random	Research
Trøndelag	Vigda, Skaun	Smolt	2023-24	0/11	Random	Research
Trøndelag	Byneset	Adult	2024	0/1	Disease	Unknown
Trøndelag	Orkla	Adult	2025	1/1	Random	Escaped farmed
Trøndelag	Orkla	Adult	2024	0/1	Disease	
Trøndelag	Orkla	Adult	2025	2/50	Random /disease	
Trøndelag	Orkla	Adult	2025	0/17	Random	
Trøndelag	Skauga	Adult	2024	0/1	Disease	Saprolegniosis
Trøndelag	Skauga	Adult	2025	0/27	Disease	Bacterial
Trøndelag	Nordelva/Stjørnfjord	Adult	2025	0/12	Random	Angling/fisheries
Møre og Romsdal	Surna	Parr	2025	0/9	Random	*G. salaris* surveillance
Møre og Romsdal	Driva, Holsbekken	Parr	2024	0/3	Random	
Møre og Romsdal	Batnfjord	Parr	2025	0/31	Random	*G. salaris* surveillance
Møre og Romsdal	Rauma	Parr	2025	0/8	Random	*G. salaris* surveillance
Møre og Romsdal	Innfjord	Parr	2025	0/5	Random	*G. salaris* surveillance
Møre og Romsdal	Ørstaelva	Adult	2024	0/18	Random	Broodfish
Vestland	Vosso	Parr	2024	0/29	Disease	Investigation fin erosions
Rogaland	Storåna	Parr	2025	0/10	Disease	Contaminated water
Total tested				**3/348**		

Table A1b. Summary of sea trout/brown trout (*Salmo trutta*) sampled and tested for *Renibacterium salmoninarum* by real-time PCR. The table includes county, river name, life stage, purpose of sampling (random or disease Investigation = Disease), and the total number of individuals examined. None of the tested sea trout were PCR-positive.

County	River	Life stage	Year	No tested	Sampling purpose	Comment
Trøndelag	Verdal	Adult	2024	1	Disease	Saprolegniosis
Trøndelag	Verdal	Adult	2025	1	Disease	Saprolegniosis
Trøndelag	Vigda, Skaun	Smolt	2023-24	2	Random	Research
Trøndelag	Vigda, Skaun	Smolt	2025	3	Random	Research
Trøndelag	Åelva, Heim	Adult	2025	1	Disease	Saprolegniosis
Trøndelag	Gaula	Adult	2025	2	Disease	Saprolegniosis
Trøndelag	Gaula	Adult	2025	2	Disease	Saprolegniosis
Trøndelag	Gaula	Adult	2025	4	Disease	Saprolegniosis
Møre og Romsdal	Surna	Parr	2025	21	Random	*G. salaris* surveillance
Møre og Romsdal	Eira	Adult	2024	1	Disease	
Møre og Romsdal	Driva	Parr	2025	30	Random	*G. salaris* surveillance
Møre og Romsdal	Rauma	Parr	2025	17	Random	*G. salaris* surveillance
Møre og Romsdal	Innfjord	Parr	2025	13	Random	*G. salaris* surveillance
Møre og Romsdal	Istra	Parr	2025	8	Random	*G. salaris* surveillance
Møre og Romsdal	Isa	Parr	2025	13	Random	*G. salaris* surveillance
Vestland	Hovlandsbekken	Parr	2025	10	Disease	Contaminated water
Vestland	Vosso	Parr	2024	25	Disease	Investigation fin erosions
Rogaland	Storåna, Sandnes	Parr, mixed	2025	13	Disease	Contaminated water
Agder	Omlidbekken, Sirdal	Parr, mixed	2025	4	Disease	Fish kill due to contaminated water
Total tested				**171**		

Table A1c. Overview of pink salmon (*Oncorhynchus gorbuscha*) sampled and tested for *Renibacterium salmoninarum* by real-time PCR. The table includes river name, life stage, purpose of sampling (baseline or disease Investigation (Disease)), and the total number of individuals examined. None of the tested pink salmon were PCR-positive.

County	River	Life stage	Year	No tested	Sampling purpose	Comment
Trøndelag	Stjørdalselva	Adult	2025	4	Random	Extermination
Trøndelag	Nidelva	Adult, spawned	2025	2	Random	Extermination
Trøndelag	Nidelva	Adult	2025	1	Random	Extermination
Møre og Romsdal	Ørstaelva	Adult	2025	2	Random	Extermination
Total tested				**9**		

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