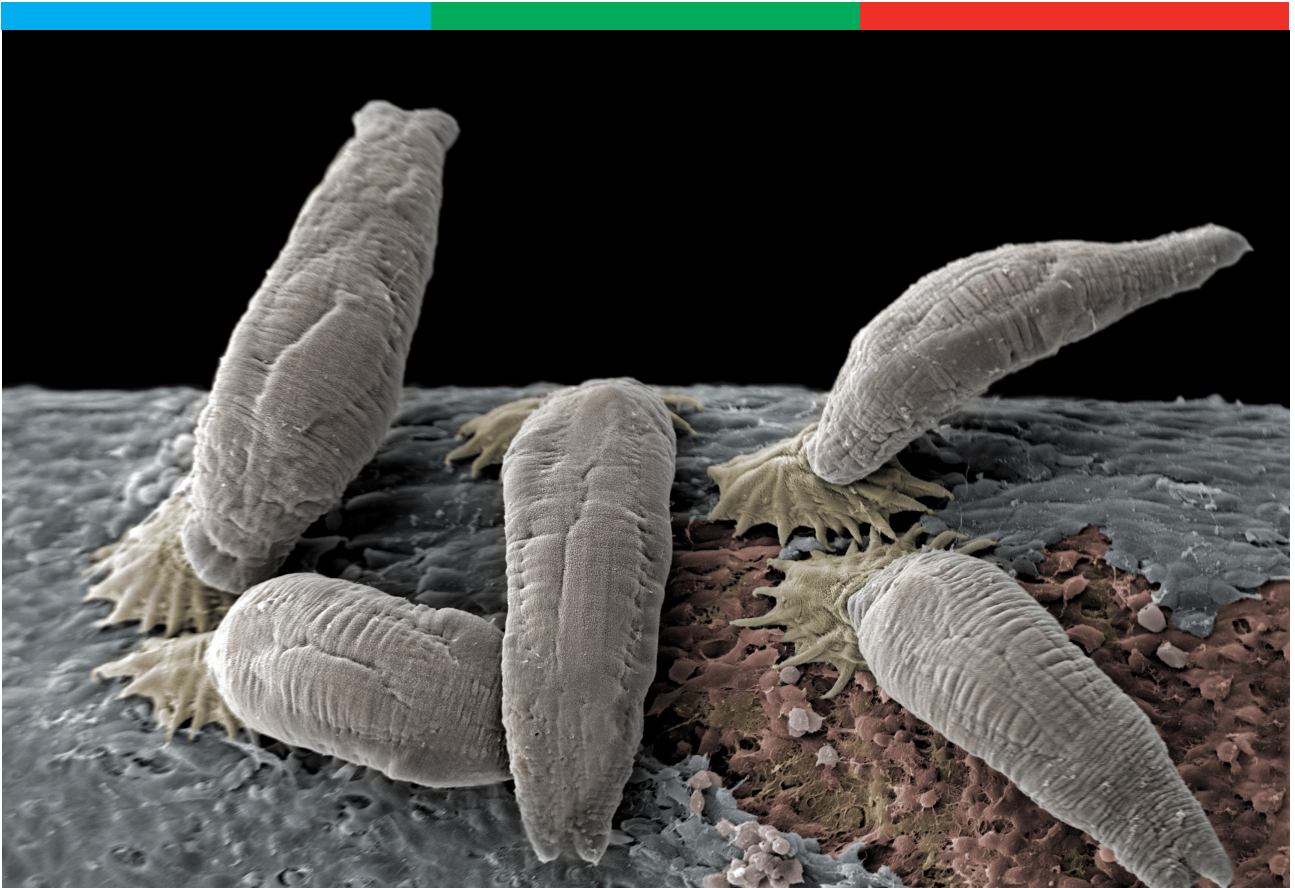




The surveillance programme for *Gyrodactylus salaris* in Atlantic salmon and rainbow trout in Norway 2023



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The surveillance programme for *Gyrodactylus salaris* in Atlantic salmon and rainbow trout in Norway 2023

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Summary

Altogether, 2273 specimens of Atlantic salmon from 71 rivers and 3006 specimens of Atlantic salmon and rainbow trout from 86 hatcheries/farms were examined in the surveillance program for *Gyrodactylus salaris* in 2023. *Gyrodactylus salaris* was not detected in any of the samples in the surveillance programme. However, *G. salaris* was detected in two new rivers in 2023; Gylelva (watercourse code 109.7Z) and Ebbestadelva (watercourse code 012.2Z)¹. Both these detections were done in connection with investigation of the infection status in watercourses in regions with known infection. Both watercourses are small and do not harbour a permanent reproductive population of salmon.

The status as of 31.12.23 is that *G. salaris* is confirmed present in ten Norwegian river systems.

Introduction

In the period from 1975 until the start of 2023, pathogenic strains of *Gyrodactylus salaris* had been detected on Atlantic salmon (*Salmo salar*) fingerlings/parr in 51 rivers, 13 hatcheries/farms with Atlantic salmon parr/smolts and 26 hatcheries/farms with rainbow trout (*Oncorhynchus mykiss*). In addition, both pathogenic and non-pathogenic strains of *G. salaris* have been found on Arctic char (*Salvelinus alpinus*).

The policy of the Norwegian authorities is to eradicate *G. salaris* from infected watersheds and farms (Anon 2014). If *G. salaris* is detected in a farm, eradication is carried out by eliminating the hosts (Atlantic salmon and/or rainbow trout). This also ensures elimination of the parasite since it lacks specialised free-living stages and does not use intermediate hosts in its life cycle. In rivers, the eradication is done by chemical treatment. In most instances rotenone has been the preferred chemical, but one exception to this is the treatment of River Lærdalselva in 2011-2012, where acidified aluminium sulphate was used to eradicate the parasite (Hindar et al., 2015). Recently, full-scale treatment using chlorine as the main chemical has been carried out in river Driva, Møre og Romsdal county (Olstad et al., 2024). In contrast to rotenone treatment, treatment with aluminum sulfate and chlorine will kill the parasite, but not the host.

By the entrance to 2023, *G. salaris* was confirmed eradicated from 41 rivers and from all hatcheries/fish farms. An additional one river system were in the post-treatment surveillance program awaiting confirmation of eradication (Hansen et al., 2023). At the end of 2022, the parasite was still confirmed present in eight Norwegian river systems: Drammenselva (012.Z)

¹ This detection was originally erroneously reported as Knemsbekken (water course code 012.22X2) due to a misunderstanding. While Ebbestadelva is the correct name of the river, the name Knemsbekken has also been used for the same river.

and Lierelva (011.Z) in county Viken, Vesleelva (Sandeelva)(013.Z) and Selvikvassdraget (013.1Z) in county Vestfold og Telemark, and Batnfjordselva (108.3Z), Driva (109.Z), Litledalselva (109.5Z) and Usma (109.4Z) in county Møre og Romsdal.

Gyrodactylus salaris is included in the list F of nationally listed and notifiable diseases, and Norway has implemented national measures for the parasite which comply with Regulation (EU) 2016/429, article 226 (3). *Gyrodactylus salaris* is also listed as a notifiable aquatic animal disease by the World Organization for Animal Health (WOAH). Surveillance for *G. salaris*, aiming to declare freedom from the parasite in treated rivers, has been ongoing since the early 1980s. The Norwegian Veterinary Institute (NVI) coordinates the surveillance programme on behalf on the Norwegian Food Safety Authority (NFSA) and publishes the overall results in annual reports available on the NVI website (www.vetinst.no).

NFSA is responsible for the sampling in fish farms. NVI is responsible for the sampling in the rivers, but County Environmental Departments and other institutions/companies are commissioned to do the actual sampling. NVI is responsible for examination of the fish samples and the subsequent species identification, if *Gyrodactylus* is detected.

Aims

The surveillance programme aims to document freedom of *G. salaris* in Norwegian farms and rivers, and to detect and trace any spread of the parasite to new river systems or fish farms.

Materials and methods

The selection of rivers for inclusion in the surveillance programme follow specified criteria which takes into account the risk of infection with *G. salaris* (see text box 1). In general, a total of 30 wild Atlantic salmon juveniles are sampled from each selected river, preferably from three different sites located far apart. To increase the sensitivity of the surveillance for the River Rana (Nordland county), where the source of the infection detected in 2014 remains unknown, an additional sample of 30 fish is taken one month after the first sample. In Tana (Troms and Finnmark county), 150 salmon are sampled from 15 sites due to the large size of this watercourse. Fingerlings/parr/smolt of an age of 1+ or older (preferred size ranging from 7 - 12 cm) are caught by means of electrofishing. The fish are killed and then preserved whole in 96% ethanol.

In farms and hatcheries, either 30 Atlantic salmon or 60 rainbow trout are sampled by seine net. The fish are killed and all fins (except the adipose fin) are cut off and preserved in 96% ethanol. Each farm/hatchery is examined every second year.

All samples are sent to the NVI for examination under a stereo microscope at 10 - 15 times magnification. For wild Atlantic salmon, the whole surface of the fish, including the skin, head, fins and gills, is examined, while only the fins from farmed fish are examined.

When *Gyrodactylus* specimens are detected, species determination is performed by NVI. NVI is the WOAHA reference laboratory for “Infection with *Gyrodactylus salaris*” and the methods used for species identification follow those given by the WOAHA Manual of Diagnostic Tests for Aquatic Animals:

https://www.woah.org/fileadmin/Home/eng/Health_standards/aahm/current/2.3.03_G_salaris.pdf

Criteria for inclusion of rivers in the surveillance program for *Gyrodactylus salaris* in short*.

- 1. Rivers declared free from infection after treatment.** This criteria states that when a watercourse is declared free from infection with *G. salaris*, it should be included in the surveillance program for a minimum of five (5) years. After five years, a watercourse can be excluded from the surveillance program unless it fulfils other risk factors for their continued inclusion (see below).
- 2. Large salmon rivers in terms of spawning targets.** This criteria states that the 30 largest salmon rivers in terms of spawning targets should be included in the surveillance program.
- 3. Rivers with a high risk of inter-river dispersal of *G. salaris*.** This criteria states that rivers with a high risk of being infected via inter-river (brackish-water) dispersal of *G. salaris* should be included in the surveillance program. Due to the decreasing numbers of infected rivers in Norway, the number of rivers included based on fulfilment of this criteria has decreased, and will continue to decrease, when further rivers are declared free from infection.
- 4. Rivers with other risk of infection:** this criteria overlaps somewhat with criteria 3, but the main focus is on the threat from areas bordering other countries.
- 5. Geographic coverage:** This criteria states that a minimum of two (2) rivers from each county where salmon rivers are present should be included in the surveillance program.

*For further details please consult the following document: Reply from the Norwegian Veterinary Institute (NVI) to the Norwegian Food Safety Authority (NFSA) 5th February 2020: FSA reference number 2020/173134, alt. NVI reference number 20/12419.

Results and discussion

Altogether, 2273 specimens of Atlantic salmon from 71 rivers and 3006 specimens of Atlantic salmon and rainbow trout from 86 farms were examined in 2023 (Table 1). Originally, 89 farms/hatcheries were included in the surveillance program, but samples from three of these were discarded due to low quality fixative (EtOH) (see Appendix B). *Gyrodactylus salaris* was not detected in any of the samples examined in the surveillance programme.

In samples collected outside the surveillance programme in 2023, *G. salaris* was detected in two previously uninfected rivers (Gylelva, watercourse code 109.7Z and Ebbestadelva (watercourse code 012.2Z) in 2023. These rivers were included in an investigation of the infection status in watercourses in regions with known infection. The status at the end of the year 2023 is thus that *G. salaris* is confirmed present in ten Norwegian river systems, two more than the previous year.

Table 1: Number of rivers, farms and fish examined for *Gyrodactylus salaris* in 2023.

County	Rivers				Farms/hatcheries			
	n rivers	species ¹	n examined	positive	n farms	species ¹	n examined	positive
Innlandet	-	-	-	-	7	RT	421	0
Viken	5	AS	150	0	1	AS	31	0
Akershus	1	AS	0 ²	0	-	-	-	-
Oslo	1	AS	30	0	-	-	-	-
Vestfold og Telemark	2	AS	61	0	1	AS	30	0
Agder	4	AS	120	0	-	-	-	-
Rogaland	3	AS	90	0	7	AS	213	0
Vestland	5	AS	150	0	26	AS/RT	965	0
Møre og Romsdal	7	AS	211	0	12	AS	366	0
Trøndelag	9	AS	276	0	14	AS	435	0
Nordland	13	AS	438	0	11	AS	335	0
Troms og Finnmark	21	AS ³	747	0	7	AS	210	0
Total	71		2273		86⁴		3006	

¹AS = Atlantic salmon, RT = rainbow trout. ²No salmon caught during electrofishing, ³In one river only Arctic char was caught, n=2, but these are not included in total number, ⁴89 farms/hatcheries were included in the surveillance program, but samples from were discarded due to low quality fixative (EtOH). See Appendix B for details).

Acknowledgements

The authors would like to especially thank Vidar Ahlsen Brevig and his colleagues at the section for Substrate Production and logistics for excellent support with the logistics. Moreover, the authors would like to thank all personnel from the Norwegian Food Safety Authority for collection and submission of samples from the farms/hatcheries.

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Appendix A

Watercourses examined for *Gyrodactylus salaris* in 2023 sorted by watercourse code. ND = Not detected.

County	Watercourse	Watercourse code	No of Atlantic salmon examined	<i>G. salaris</i>
Viken	Enningdalselva	001.1Z	30	ND
Viken	Glomma	002.Z	30	ND
Viken	Hølenelva	004.Z	30	ND
Akershus	Årungselsva	005.3Z	0*	ND
Oslo	Lysakerelva	007.Z	30	ND
Viken	Sandvikselva	008.Z	30	ND
Viken	Årosvassdraget	009.Z	30	ND
Vestfold og Telemark	Aulieelva	014.z	30	ND
Vestfold og Telemark	Numedalslågen	015.Z	31	ND
Agder	Arendalsvassdraget	019.Z	30	ND
Agder	Tovdalselva	020.Z	30	ND
Agder	Otra	021.Z	30	ND
Agder	Mandalselva	022.Z	30	ND
Rogaland	Bjerkreimselva	027.Z	30	ND
Rogaland	Figgjo	028.Z	30	ND
Rogaland	Suldalslågen	036.Z	30	ND
Vestland	Vosso	062.z	30	ND
Vestland	Lærdalselva	073.Z	30	ND
Vestland	Gaula	083.Z	30	ND
Vestland	Nausta	084.7Z	30	ND
Vestland	Loen	088.2Z	30	ND
Møre og Romsdal	Måna	103.1Z	30	ND
Møre og Romsdal	Innfjordelva	103.2Z	30	ND
Møre og Romsdal	Brevikelva	103.4Z	30	ND

Møre og Romsdal	Isa (Henselva)	103.4AZ/103.4Z	31	ND
Møre og Romsdal	Skorgeelva	103.5Z	30	ND
Møre og Romsdal	Rauma	103.Z/103.A1Z	30	ND
Møre og Romsdal	Surna	112.Z	30	ND
Trøndelag	Orkla	121.Z	30	ND
Trøndelag	Gaula	122.Z	31	ND
Trøndelag	Nidelvassdraget	123.Z	30	ND
Trøndelag	Stjørdalsvassdraget	124.Z	31	ND
Trøndelag	Verdalsvassdraget	127.Z	32	ND
Trøndelag	Steinkjervassdraget	128.Z	31	ND
Trøndelag	Stordalselva	135.Z	30	ND
Trøndelag	Årgårdsvassdraget	138.Z	30	ND
Trøndelag	Namsen	139.Z	31	ND
Nordland	Hestdalselva	149.61Z	30	ND
Nordland	Halsaelva	149.6Z	30	ND
Nordland	Hundåla	151.1Z	30	ND
Nordland	Vefsna	151.Z	30	ND
Nordland	Drevja	152.2Z	30	ND
Nordland	Dagsvikelva	153.11Z	30	ND
Nordland	Nylandselva	153.1Z	30	ND
Nordland	Leirelva	153.22Z	30	ND
Nordland	Stillelva	153.3Z	30	ND
Nordland	Røssåga	155.Z	30	ND
Nordland	Sletterelva	156.4Z	30	ND
Nordland	Ranavassdraget	156.Z	78	ND
Nordland	Saltdalselva	163.Z	30	ND
Troms og Finnmark	Salangselva	191.Z	32	ND
Troms og Finnmark	Målselvassdraget	196.Z	34	ND
Troms og Finnmark	Nordkjøselva	198.Z	31	ND
Troms og Finnmark	Kitdalselva	204.8Z	2*	ND
Troms og Finnmark	Signaldalselva	204.Z	30	ND
Troms og Finnmark	Skibotnelva	205.Z	33	ND
Troms og Finnmark	Manndalselva	206.1Z	33	ND
Troms og Finnmark	Reisavassdraget	208.Z	34	ND
Troms og Finnmark	Altavassdraget	212.Z	34	ND
Troms og Finnmark	Repparfjordvassdraget	213.Z	31	ND
Troms og Finnmark	Stabburselva	223.Z	30	ND
Troms og Finnmark	Lakselvassdraget	224.Z	30	ND
Troms og Finnmark	Børselvassdraget	225.Z	30	ND
Troms og Finnmark	Storelva	228.Z	30	ND
Troms og Finnmark	Tana	234.Z	150	ND
Troms og Finnmark	Komagelva	239.Z	30	ND
Troms og Finnmark	Vestre jakobselv	240.Z	31	ND
Troms og Finnmark	Munkelva	244.4Z	30	ND
Troms og Finnmark	Neidenvassdraget	244.Z	33	ND
Troms og Finnmark	Karpelva	247.3Z	28	ND
Troms og Finnmark	Grense jakobselv	247.Z	33	ND

* The number of fish from Ranavassdraget includes 18 fish sampled from Ytterbekken, a small stream draining into the same estuary as Ranavassdraget and with a previous history of infection

Appendix B

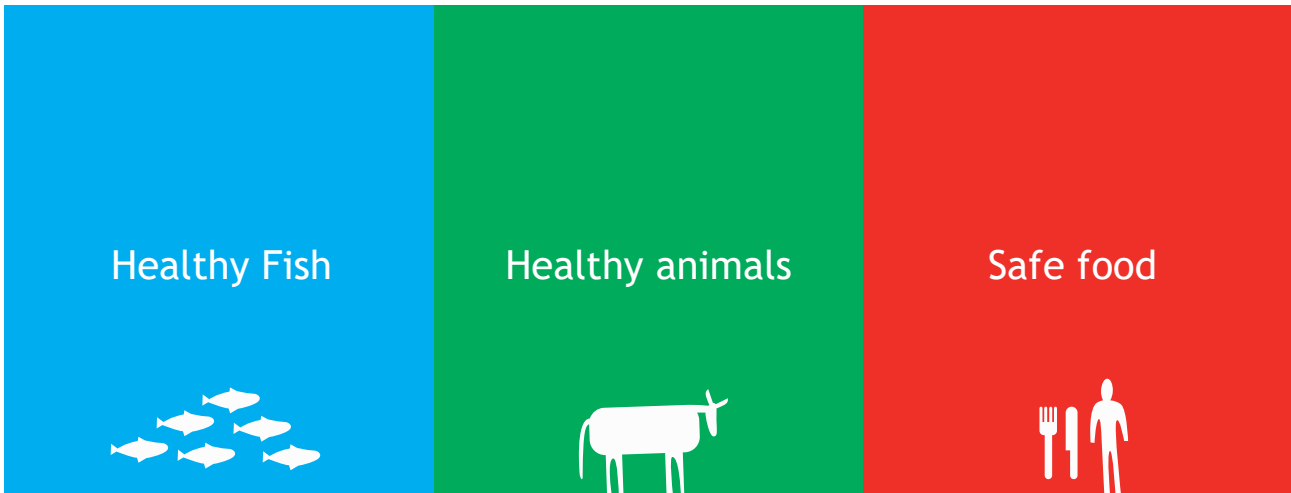
Farms and hatcheries examined for *Gyrodactylus salaris* in 2023 grouped by county from south to north. AS= Atlantic salmon, RT= Rainbow trout, ND = Not detected, NA = Not Available

County	Farm/Hatchery	Hatchery code	Fish species	No. of AS/RT examined	<i>G. salaris</i>
Innlandet	Noraker Gård	10364	RT	61	ND
Innlandet	Lomen Slidrefjorden	12341	RT	60	ND
Innlandet	Lofoss Mølle	12342	RT	60	ND
Innlandet	Haadem fisk	12517	RT	60	ND
Innlandet	Nedre Hande	13716	RT	60	ND
Innlandet	Ferisfjorden	13881	RT	60	ND
Innlandet	Fasle	33977	RT	60	ND
Viken	Hamang klekkeri	NA	AS	31	ND
Vestfold og Telemark	Kjølebrønn	12961	AS	30	ND
Rogaland	Fister	10123	AS	30	ND
Rogaland	Fjellsæ I	10581	AS	30	ND
Rogaland	Vågafossen	11892	AS	34	ND
Rogaland	Lerangsvågen-land 2	11927	AS	30	ND
Rogaland	Øyerhamn	12032	AS	30	ND
Rogaland	Fjæra	12073	AS	29	ND
Rogaland	Tytlandsvik	35857	AS	30	ND
Vestland	Sævareid	10141	AS	31	ND
Vestland	Sande	10170	AS	30	ND
Vestland	Kjærelva	11493	AS	30	ND
Vestland	Skålevik	11540	AS	30	ND
Vestland	Industrilab, HIB	11555	AS	33	ND
Vestland	Gjeravågen	11589	AS	30	ND
Vestland	Eidesvik	11606	AS	30	ND
Vestland	Strømsnes	11648	AS	30	ND
Vestland	Gjølanger	11795	AS	30	ND
Vestland	Skogseidvatnet	12042	AS	30	ND
Vestland	Ljonesvågen	12079	AS	30	ND
Vestland	Ænes	12084	AS	30	ND
Vestland	Femangervågen	12112	AS	30	ND
Vestland	Hermansverk	12165	RT	62	ND
Vestland	Bjølvfossen	12172	AS	36	ND
Vestland	Arnafjord Settefisk	12173	RT	60	ND
Vestland	Ljøsne Klekkeri	12343	AS	30	ND
Vestland	Herand	13157	AS	30	ND
Vestland	Kvernhusvika	13327	RT	33	ND
Vestland	Flatråker	13826	RT	64	ND
Vestland	Barlindbotten	13843	AS	35	ND
Vestland	Midneset	18336	RT	71	ND

Vestland	Sagvåg	28216	AS	30	ND
Vestland	Saltverket	28516	AS	60	ND
Vestland	Marineholmen Forskningspark	36577	AS	30	ND
Vestland	Suldal	NA	AS	30	ND
Møre og Romsdal	Barstadvik	10183	AS	30	ND
Møre og Romsdal	Aunvågen	10221	AS	31	ND
Møre og Romsdal	Dale	12217	AS	30	ND
Møre og Romsdal	Steinsvik	12222	AS	30	ND
Møre og Romsdal	Videild	12223	AS	31	ND
Møre og Romsdal	Urke	12269	AS	30	ND
Møre og Romsdal	Moltustranda	12325	AS	30	ND
Møre og Romsdal	Kjørsvikbugen	12415	AS	31	ND
Møre og Romsdal	Sætre	13671	AS	31	ND
Møre og Romsdal	Hjelvik	13672	AS	30	ND
Møre og Romsdal	Haukvik genbank for villaks	NA	AS	31	ND
Møre og Romsdal	Herje Genbank	NA	AS	31	ND
Trøndelag	Årvika	10406	AS	30	ND
Trøndelag	Røyklibotn	10412	AS	0	Not examined*
Trøndelag	Bessaker	12596	AS	30	ND
Trøndelag	Survik	12672	AS	30	ND
Trøndelag	Kvernvikvatnet	12686	AS	30	ND
Trøndelag	Lonet I Naustbukta	12719	AS	0	Not examined*
Trøndelag	Moldtua	12737	AS	30	ND
Trøndelag	Olden	12745	AS	42	ND
Trøndelag	Nernesset	13178	AS	30	ND
Trøndelag	Lensvik	13179	AS	30	ND
Trøndelag	Skorstad	13739	AS	0	Not examined*
Trøndelag	Lennavika	13742	AS	30	ND
Trøndelag	Follafoss	13958	AS	30	ND
Trøndelag	Belsvik	13964	AS	30	ND
Trøndelag	Sunnskjør	23735	AS	30	ND
Trøndelag	Slira	NA	AS	27	ND
Trøndelag	Stjørdalsvassdraget klekkeri	NA	AS	36	ND
Nordland	Framnes	10496	AS	30	ND
Nordland	Mo Industripark	11064	AS	30	ND
Nordland	Brenna	11180	AS	30	ND
Nordland	Dyping	13191	AS	30	ND
Nordland	Breivika	13811	AS	30	ND
Nordland	Nyksund	13940	AS	34	ND
Nordland	Mastermovika	15315	AS	30	ND
Nordland	Glomfjord 2	24016	AS	30	ND
Nordland	Forsan	33217	AS	31	ND
Nordland	Reppen	34097	AS	30	ND

Nordland	Statkraft Genbank Bjerka	NA	AS	30	ND
Troms- og Finnmark	Adamselv	10665	AS	30	ND
Troms- og Finnmark	Jøvik	11333	AS	30	ND
Troms- og Finnmark	Hellaren	11335	AS	30	ND
Troms- og Finnmark	Sørfjorden	13946	AS	30	ND
Troms- og Finnmark	Salangsverket	36357	AS	30	ND
Troms- og Finnmark	Sandøra	36477	AS	30	ND
Troms- og Finnmark	Vinterneset	39737	AS	30	ND

* Samples discarded due to low quality EtOH in sample.



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