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Content

Summary

A total of 10,932 samples of wild, semi-domesticated and captive Norwegian cervids were analysed in 2024. Of these, two moose (*Alces alces*) tested positive for CWD, old females culled in Nore and Uvdal, and Notodden municipalities.

The cases detected had disease characteristics as described for the species in previous reports, i.e. PrP^{Sc} were only detected in brain tissue, and no prions were detected in lymphoid tissues with diagnostic tests. In the Nordic countries, CWD have shown sporadic appearance in moose and red deer, whilst in reindeer the disease has been contagious and with lymphoid detections in routine diagnostics.

Introduction

Chronic Wasting Disease (CWD) was for the first time detected in Europe in 2016, in Norway [1]. This was also the first detection of a natural CWD infection in reindeer (*Rangifer tarandus*) worldwide. The index case in reindeer was located in Nordfjella management area in Southern Norway, and all subsequent positive reindeer until 2020 were found in this area (Figure 1). The Nordfjella sub-population was eradicated in 2018 [2]. In 2020, one reindeer CWD case was discovered at Hardangervidda, which is the neighbouring area/population to Nordfjella. Another case in reindeer was detected at Hardangervidda in 2022.

CWD is a transmissible spongiform encephalopathy (TSE) or prion disease of cervids [3]. It is an invariably fatal neurodegenerative disease. Well-known in North America, CWD has since the 1960's gradually spread to an increasing number of states and provinces (April 2025: 36 states in USA and five provinces in Canada), both in captive and free-ranging cervids [4]. The republic of Korea has also diagnosed the disease after importation of infected elk (*Cervus elaphus nelsoni*) from Canada [5]. With the disease emergence in Norway, naturally susceptible species also include reindeer. Norway has by now three affected species; reindeer, moose (*Alces alces*) and red deer (*Cervus elaphus*).

CWD in the Nordic cervids has shown different epidemiology according to species. Reindeer cases have by routine diagnostics detectable prions both in brain and lymphoid tissues, whilst moose and red deer cases only in brain, and the geographic distribution suggests a contagious character of the disease in reindeer. The disease in moose and red deer occurs sporadically, has only been found in older animals, and there is little support for contagiousness and horizontal spread between live animals. Since 2018, old moose has also been diagnosed with sporadic CWD in Finland and Sweden [6,7]

Four cervid species are prevalent in natural free-ranging populations in Norway: moose, red deer, roe deer (*Capreolus capreolus*) and reindeer. Red deer predominate along the west coast, whereas moose and roe deer mainly inhabit other areas of the country. The wild reindeer is found in fragmented sub-populations in the remote alpine regions of Southern Norway [8]. In addition, Norway has populations of semi-domesticated reindeer that live in a herded condition, though free-ranging. Most semi-domesticated reindeer are found in the Northern part of Norway as part of the Sami culture, particularly in the county Finnmark.

The official numbers (April 7th, 2025) of hunted cervids were in the 2024-2025 season: 26,384 moose, 54,216 red deer, 27,551 roe deer and 3,269 free-ranging wild reindeer (numbers per December 12, 2024) [9]. Additionally, the semi-domesticated reindeer population counts about 250,000 animals [10]. There are approximately 100 deer farms in Norway; most of them keep red deer, but some farms have fallow deer (*Dama dama*) and occasionally both species.

Testing wild cervids for CWD was initiated in 2002 through the National Health Surveillance Program for Cervids and muskox (*Ovibos moschatus*), operated by the Norwegian Veterinary Institute (NVI) on behalf of the

Norwegian Environmental Agency. From 2003, there has been running a passive surveillance programme for CWD in Norwegian wild and captive cervids, coordinated by NVI and financed by the Norwegian Food Safety Authority. In addition, samples from slaughtered semi-domesticated reindeer from several regions in the country have been tested in the program. In 2006 and 2007 the European Commission (decision 2007/182/EC) initiated a survey for CWD where Norway took part, like the EU member-states, testing 700 cervids. A similar testing was performed in EU in the years 2018-2020 (reg. 2017/1972), covering six member states in addition to Norway. Shown in Table 1 is the total number of cervids tested for CWD in Norway from 2002-2024.

Since there is no separate program to report surveillance of TSE in muskox, such testing is included in this publication. TSE has never been reported in that species.

Table 1. Number and species of cervids tested for CWD in Norway 2002-2024. Additional 61 wild reindeer from Svalbard are not included in the table, all of these from 2018 - 2022 and 2024

Year	Moose (*Alces alces*)	Red deer (*Cervus elaphus*)	Reindeer (*Rangifer tarandus*)		Roe deer (*Capreolus capreolus*)	Fallow deer (*Dama dama*)	Unknown Species	Total
			Semi-domesticated	Wild				
2002-15	142	825	966	10	203	13	0	2,159
2016	4,403	2,582	1,750	831	484	15	87	10,152
2017	5,468	4,083	10,942	2,920	1,955	20	271	25,659
2018	6,705	8,428	12,051	3,645	2,124	48	655	33,656
2019	5,936	5,758	12,949*	3,322	1,695	37	450	30,147
2020	6,200	4,274	6,517	3,208	1,832	92	405	22,528
2021	4,525	4,939	6,154	3,507	1,885	28	623	21,661
2022	3,151	2,641	6,658	3,079	1,817	17	221	17,584
2023	2,026	2,221	5,571	2,176	2,124	5	95	14,218
2024	1,727	1,917	3,502	2,003	1,702	27	54	10,932
Total	40,283	37,668	67,060	24,701	15,821	302	2,861	188,696

Aim

The aim of the program is to document the occurrence of CWD in the Norwegian cervid populations.

Materials and methods

The CWD surveillance program includes testing of slaughtered semi-domesticated reindeer (above 12 months in Southern Norway and above 24 months in Northern Norway), slaughtered farmed deer (above 24 months), euthanized animals and fallen stock of captive deer and semi-domesticated reindeer (above 24 months) and wild cervids (above 12 months), or any animal showing clinical signs, as well as wild cervids submitted for necropsy at the NVI. In addition, since the discovery of CWD in 2016, extensive testing of hunted cervids has been implemented. The program is owned and financed by the Norwegian Food Safety Agency (NFSA), run by the NVI and is in sample collection a cooperation between the NFSA, the Norwegian Environmental Agency, the Norwegian Institute for Nature Research (NINA), and NVI. Apart from cervids, available wild muskoxen found

dead/or killed are also enrolled in the Norwegian surveillance of animal TSE. These animals live in the Dovre Mountains, as the only free-ranging muskox population in Norway.

The routine diagnostics of CWD require testing of brain tissue (*Medulla oblongata* as a minimum). Due to early detection of prions in lymphoid tissue of reindeer in Norway, the retropharyngeal lymph nodes have, since 2016, been included in the testing of all cervid species and muskoxen when available.

A rapid test (IDEXX HerdChek BSE-Scrapie AG Test, IDEXX Laboratories, Westbrook, USA) is used to screen samples from pooled brain and lymph nodes for detection of PrP^{Sc}.

Initially, positive ELISA results are retested in brain and lymph node separately, before confirmatory western-blot (TeSeE® WESTERN-BLOT, Bio-Rad, Marnes-la-Coquette, France), according to the manufacturer's instructions. All the samples are analysed at NVI, being the national reference laboratory for animal TSEs and a WAOH (founded OIE) reference laboratory for CWD.

PRNP variation

PRNP is the gene encoding the cellular prion protein (PrP^{c}). Variation within this gene is associated to CWD susceptibility and development [11,12]. In Norwegian cervids PRNP variation differs between species, reindeer being most polymorphic, followed by red deer, moose and roe deer respectably. The latter being monomorphic [13]. All animals detected positive for CWD in the current surveillance programme have been sequenced and PRNP variation has been recorded (Table 2). The PRNP allele nomenclature/genotype presented in this report follows Güere et al. [12] [13].

Table 2. Genotype variation in Norwegian cervids diagnosed with CWD. For each species, the genotype nomenclature is in accordance with Güere et al. [12,13].

Genotype	**Reindeer**					**Moose**		**Red deer**
	A/A	A/B	A/C	A/D	B/C	109KK	109QQ	226EE
Variation at codon	wild type* / wild type	wild type / [S225Y]	wild type / (83-91del)	wild type / [N176D]	[S225Y] / (83-91del)			
Year								
2016	2		2			2		
2017	5	3			1	1		1
2018	3	1	2				1	
2019						1	1	
2020				1		1		
2021						2		1
2022	1					1	1	1
2023						1		
2024						2		
Total	11	4	4	1	1	11	3	3

* Wild type, sequence in accordance to Rangifer tarandus granti prion protein (Prnp) gene, GenBank accession number DQ154293.1.

Results

In total, samples from 10,932 individual cervids were analysed in 2024 (Table 1), of which two wild moose tested positive for PrP^{Sc}. These animals shared diagnostic characteristics previously described for Nordic moose [14,15], with detectable prions only in the brain tissue.

Semi-domesticated reindeer (3,502) contributed with about 32% of the total of analysed cervids. Moose samples counted 1,727 and red deer 1,917, being the two larger subgroups beside slaughtered semi-domesticated reindeer. The number of tested roe deer, fallow deer and wild reindeer, was 1,702, 27 and 2,003, respectively. In addition, there were 54 animals, whose species were not registered, and 6 muskoxen that were tested and found to be negative.

A total of 71% of the animals were tested by analysing both lymphoid tissue and brain tissue. From the remaining animals only brain or lymphoid tissue was received. From 29% of the animals, only brain tissue were tested, and only lymphoid tissue were tested from 0.5% of the animals. Table 3 and Figures 2-9 give the numbers, species and geographical distribution of cervids tested for CWD in 2024.

Table 3. Number of cervids tested in the Norwegian surveillance programme for CWD 2024, distributed on species and reason for submission. Additional 6 muskoxen are not included in the table.

Species	Wild			Captive and semi-domesticated		Total
	Hunted	Diseased, injured or traffic killed	Unknown	Slaughtered	Diseased, injured or traffic killed	
Moose	859	574	294	0	0	1,727
Red deer	1,090	303	302	216	6	1,917
Reindeer	1,795	29	179	3,396	106	5,505
Roe deer	25	1,489	188	0	0	1,702
Fallow deer	0	0	0	26	1	27
Unknown	6	2	43	0	3	54
Total	3,775	2,397	1,006	3,638	116	10,932

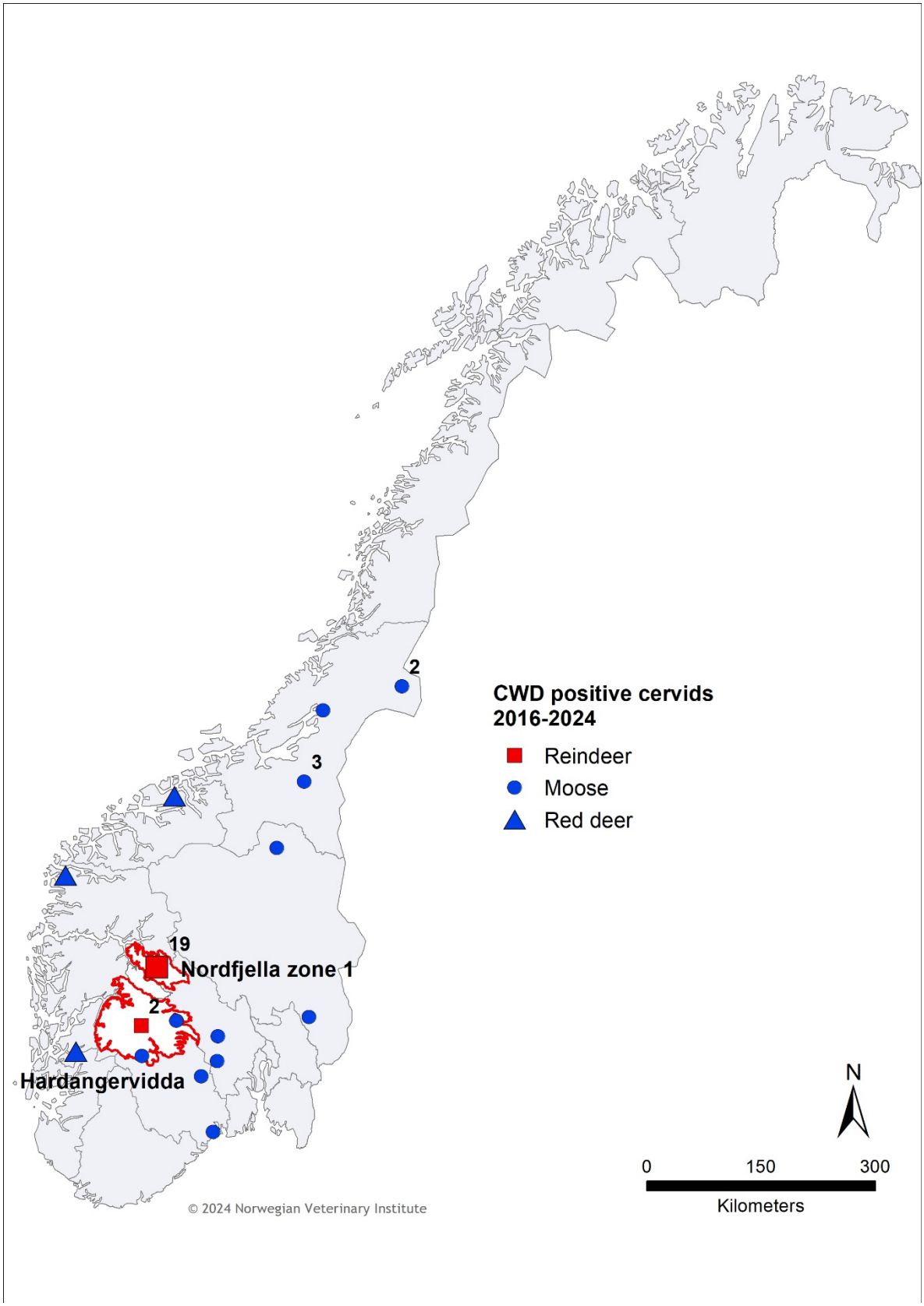

Figure 1. Geographical location of Nordfjella and Hardangervidda (encircled in red), and municipalities in which the total number of CWD positive cervids have been detected through the Norwegian surveillance programme for CWD. Unless a single case, the number of animals at each location is given.

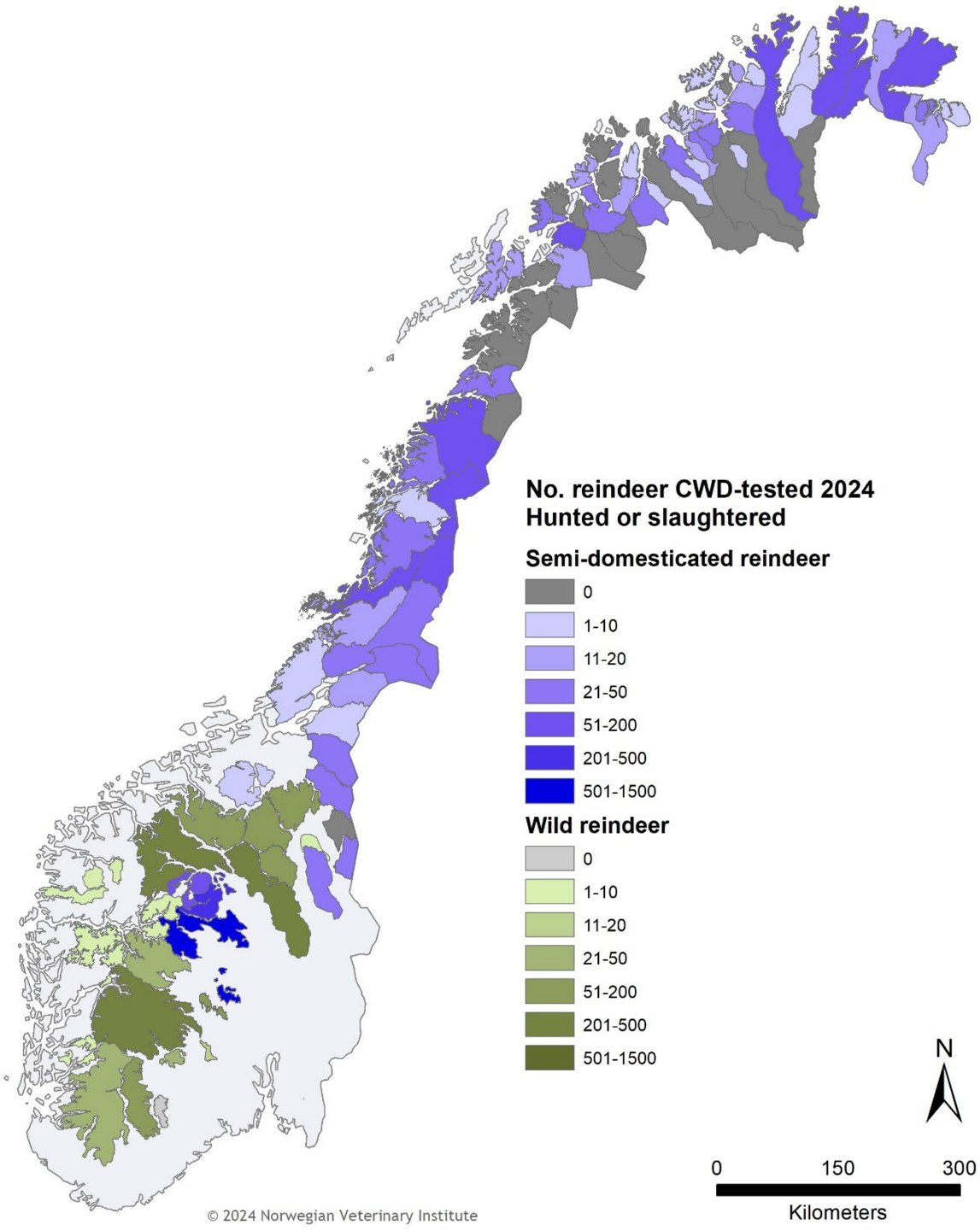

Figure 2. Number and geographical distribution of hunted free-ranging (green) and slaughtered semi-domesticated (blue) reindeer (Rangifer tarandus) tested in the Norwegian surveillance programme for CWD in 2024.

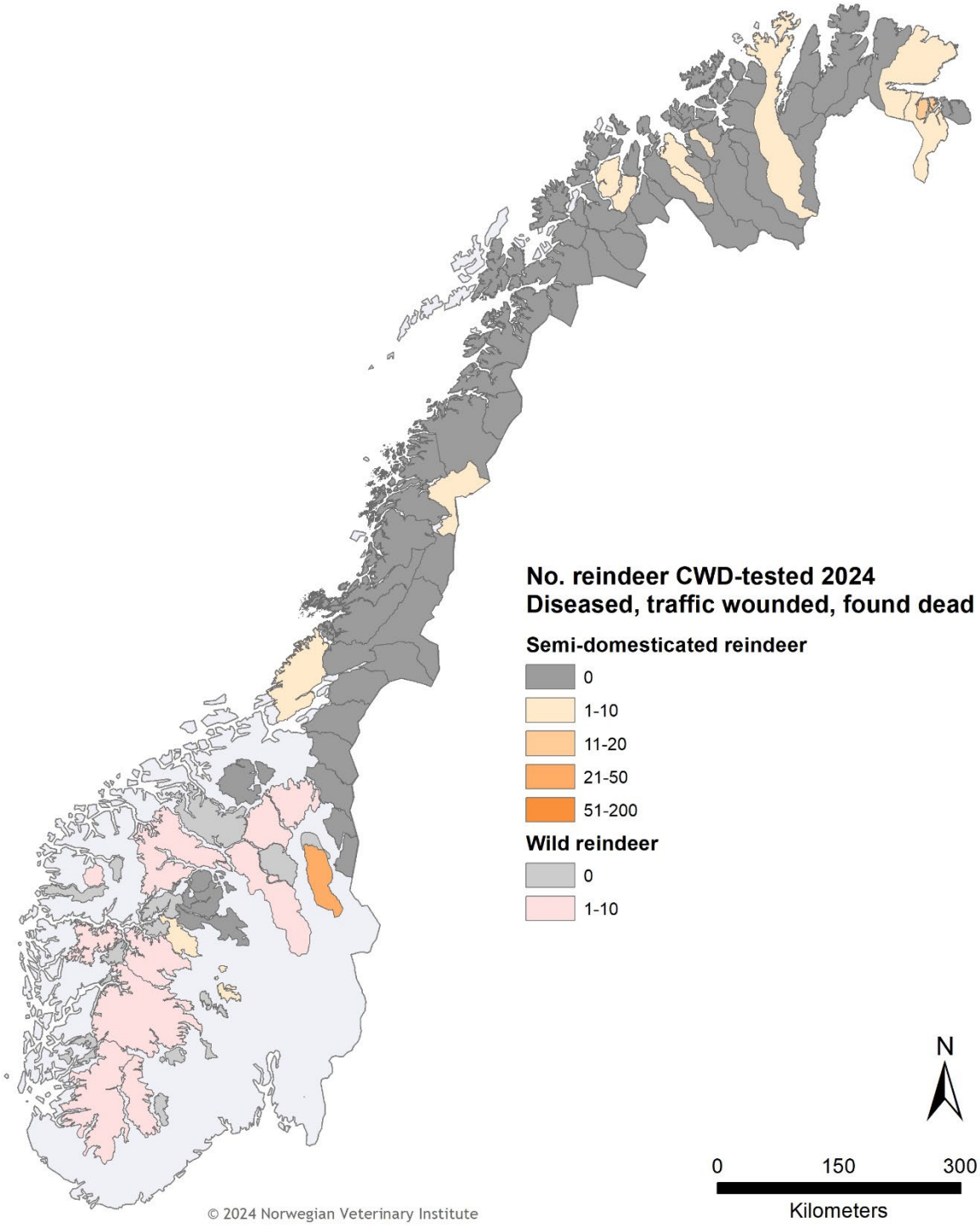

Figure 3. Number and geographical distribution of reindeer (Rangifer tarandus), both free-ranging and semi-domesticated, found diseased and euthanised, traffic wounded or dead and tested in the Norwegian surveillance programme for CWD in 2024.

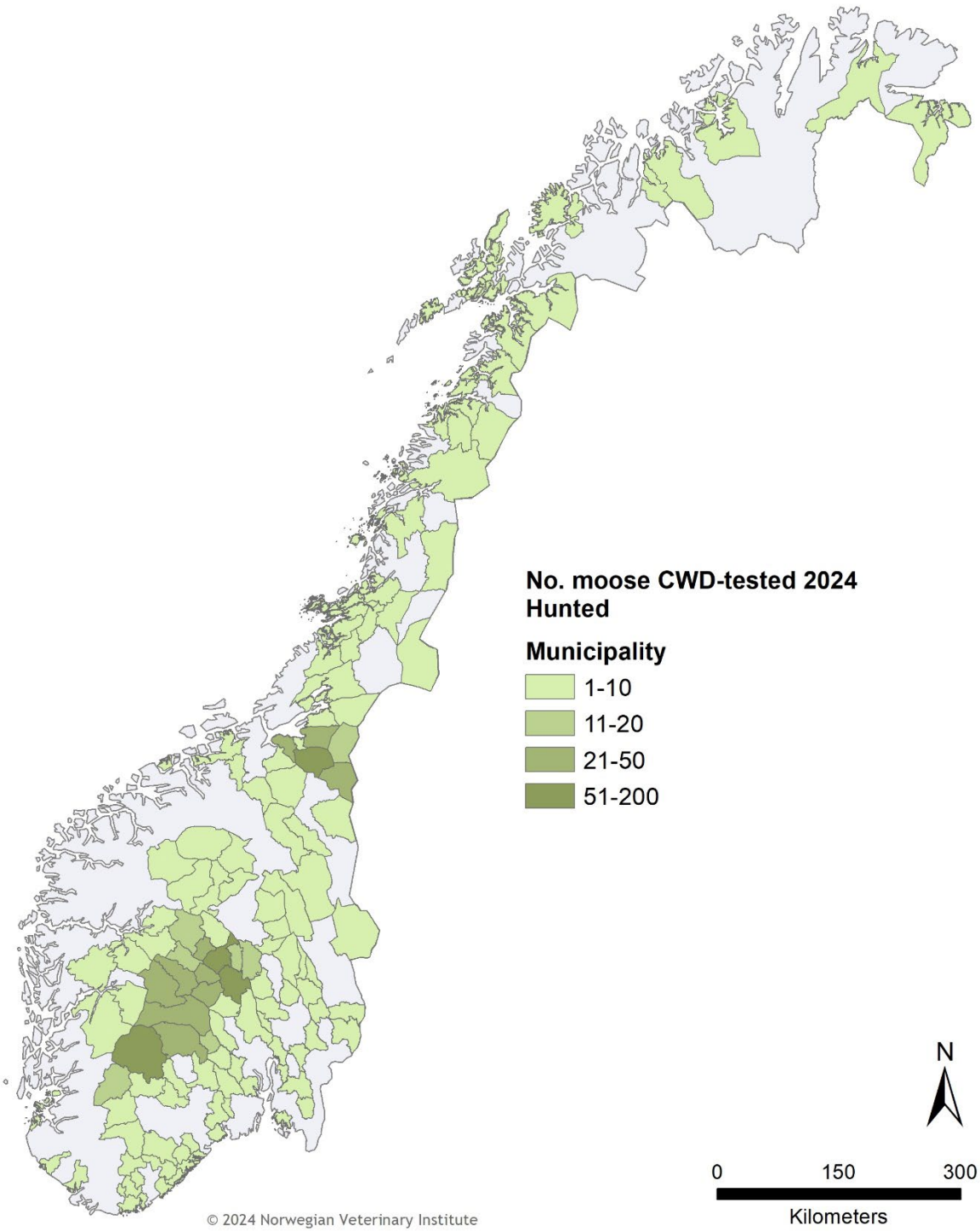

Figure 4. Number and geographical distribution of hunted free-ranging moose (Alces alces) tested in the Norwegian surveillance programme for CWD in 2024.

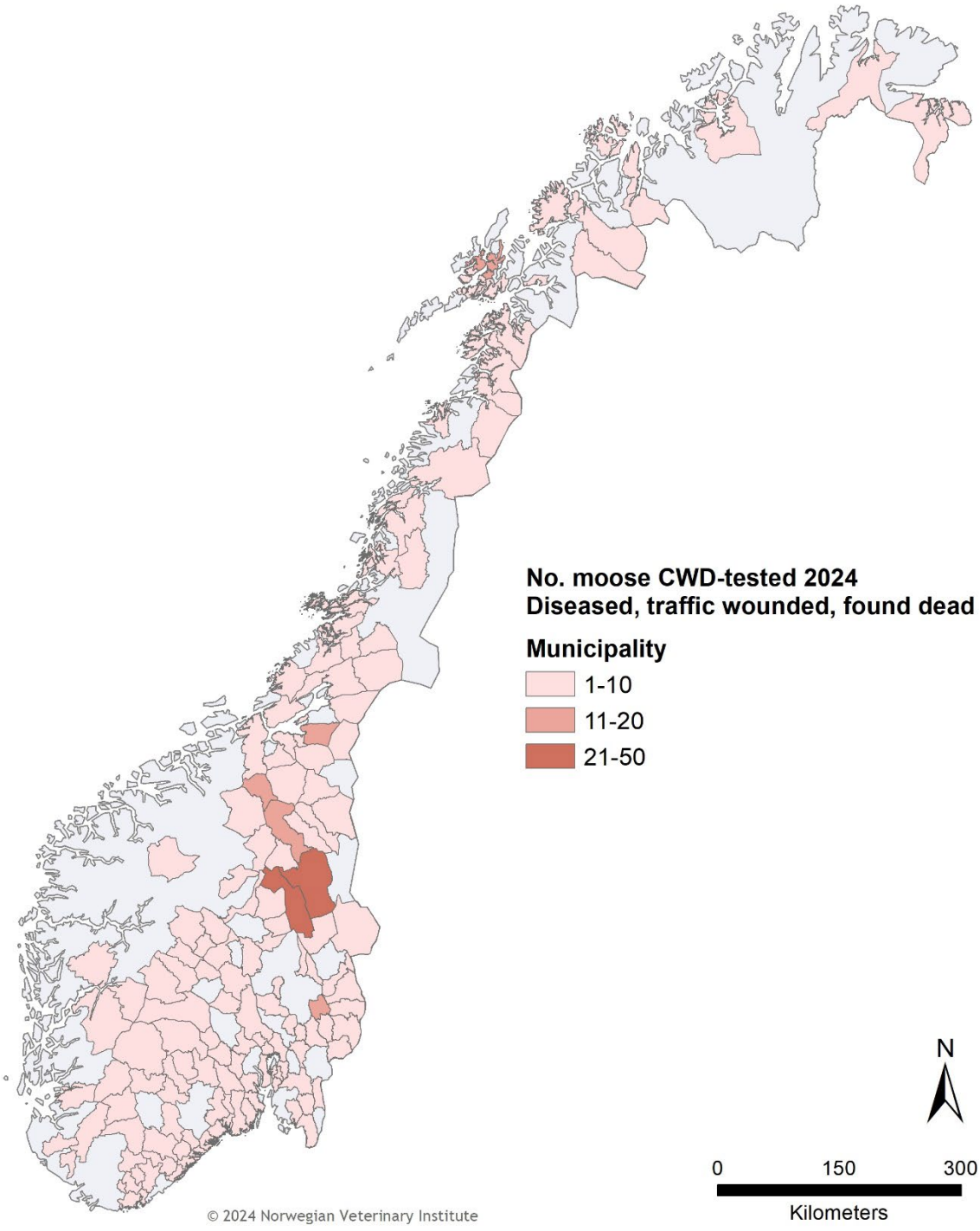

Figure 5. Number and geographical distribution of free-ranging moose (Alces alces) found diseased and euthanised, traffic wounded or dead and tested in the Norwegian surveillance programme for CWD in 2024.

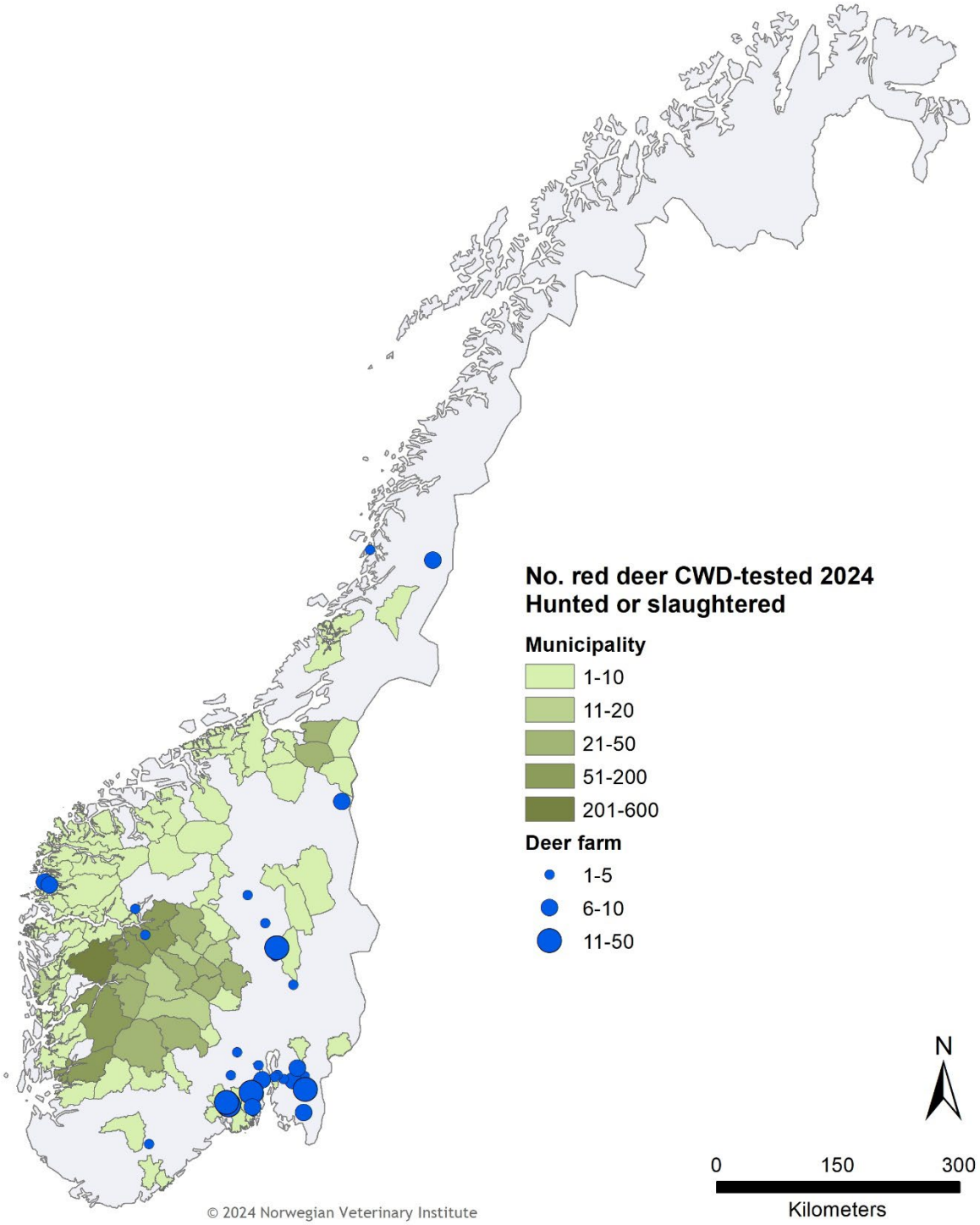

Figure 6. Number and geographical distribution of hunted free-ranging (green) and slaughtered captive (blue dots) red deer (Cervus elaphus) tested in the Norwegian surveillance programme for CWD in 2024.

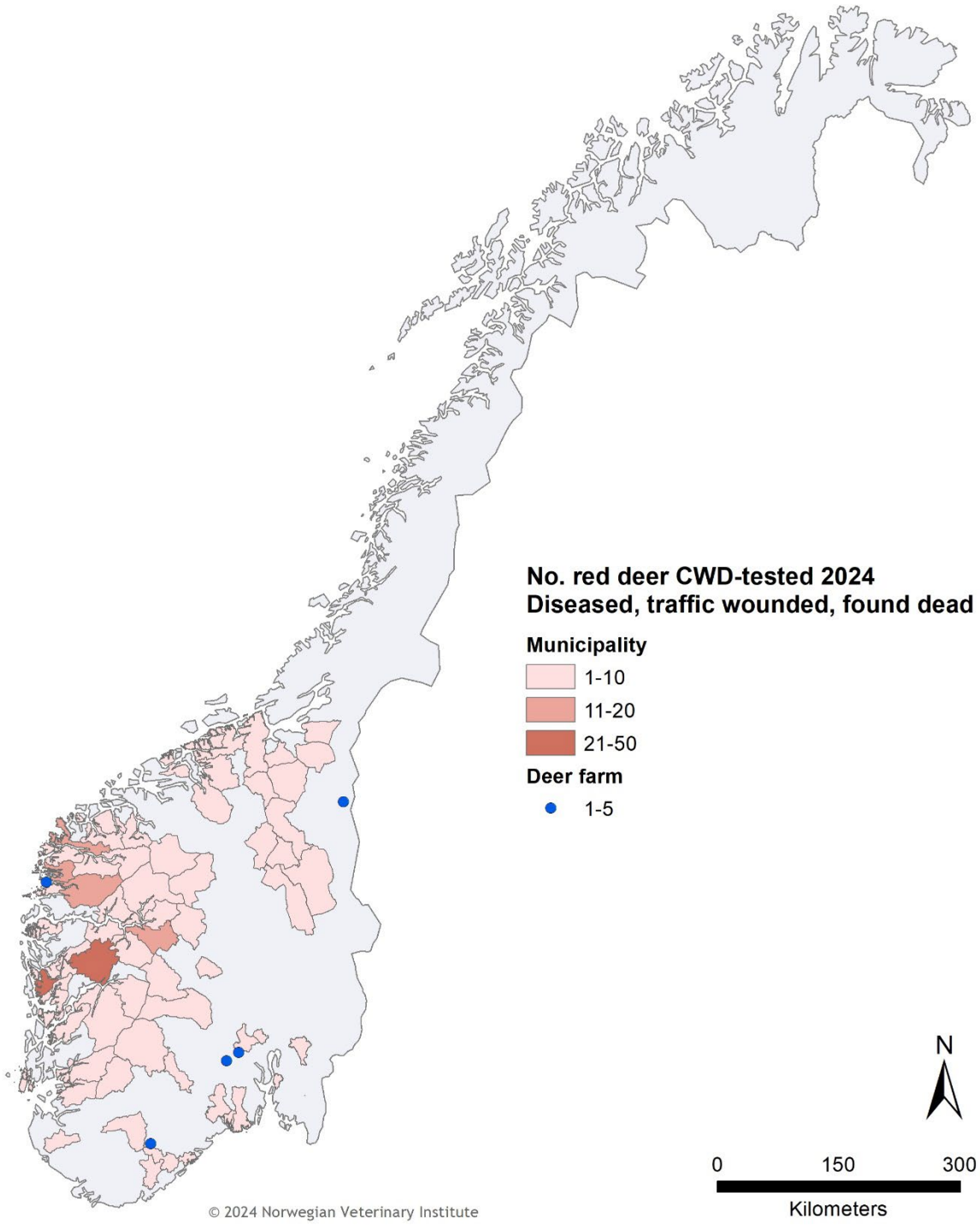

Figure 7. Number and geographical distribution of free-ranging (red) and captive (blue dots) red deer (*Cervus elaphus*) found diseased and euthanised, traffic wounded or dead and tested in the Norwegian surveillance programme for CWD in 2024.

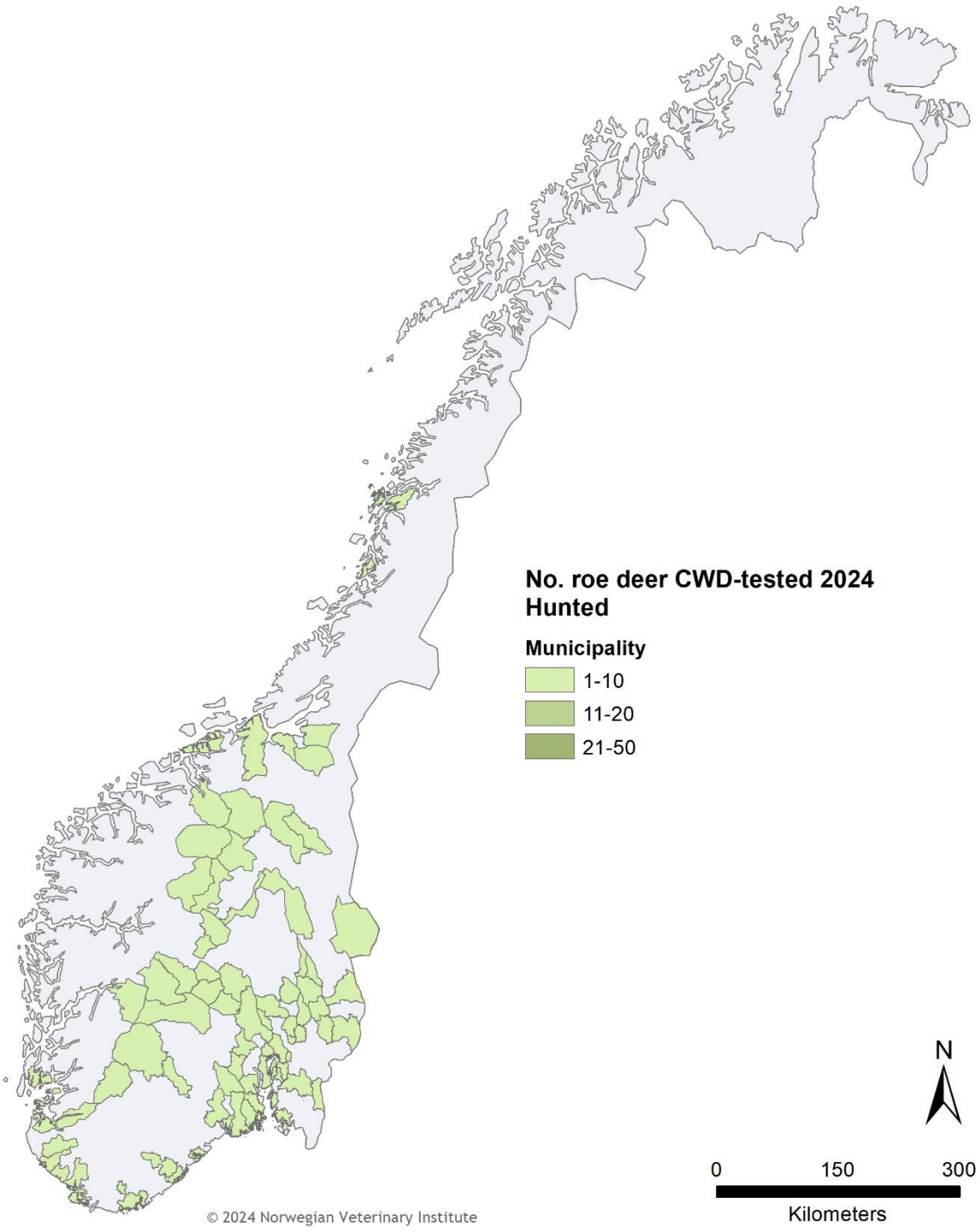

Figure 8. Number and geographical distribution of hunted free-ranging roe deer (Capreolus capreolus) tested in the Norwegian surveillance programme for CWD in 2024.

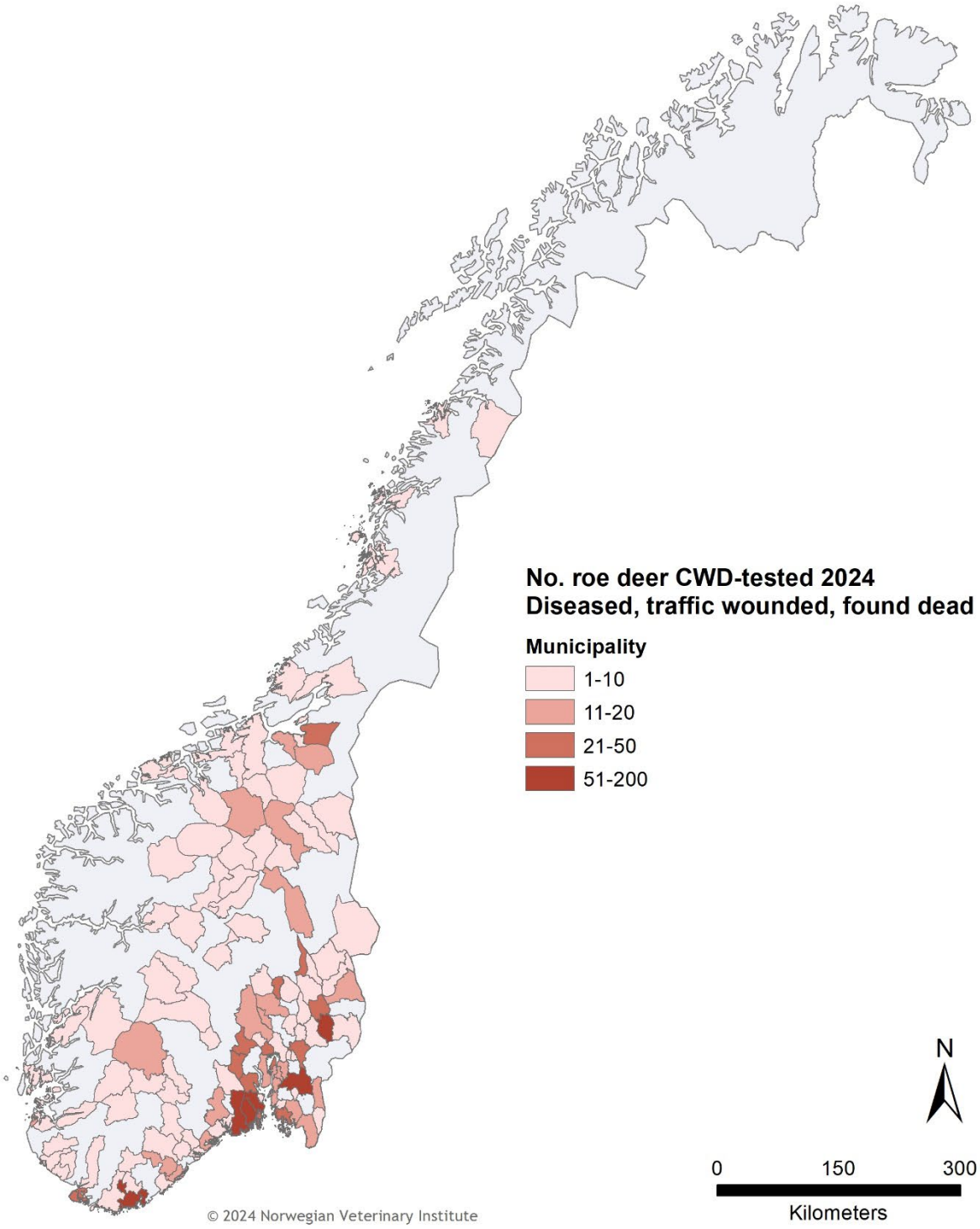

Figure 9. Number and geographical distribution of free-ranging roe deer (Capreolus capreolus) found diseased and euthanised, traffic wounded or dead and tested in the Norwegian surveillance programme for CWD in 2024.

Discussion

In 2016, CWD was for the first time detected in Europe, in six free-ranging cervids in Norway. In total, the CWD testing has revealed 21 reindeer, fourteen moose and three red deer positive for the disease in the period 2016-2024. The first 19 reindeer cases were detected within the outbreak zone 1 of Nordfjella wild reindeer management area. The affected population was culled in 2018. Two additional cases have been diagnosed in reindeer hunted at Hardangervidda in September 2020 and September 2022. This last discovery of CWD in a second reindeer area challenge the prospect of eradicating the contagious disease in the reindeer populations.

Hardangervidda holds the largest sub-population of wild reindeer in Europe, and the area is much less confinable than Nordfjella in the aspect of disease spreading. Nevertheless, so far no additional reindeer cases have been detected outside Nordfjella and Hardangervidda despite the testing of more than 91,500 reindeers. This indicates a limited infection in this species. Nevertheless, the probability of freedom as estimated using scenario tree modelling, varies a lot between different wild reindeer management areas or semi-domesticated reindeer districts depending on population size and number of tested animals per area or district. From the extended surveillance of cervids, there is a confidence that CWD is not present at high prevalence (5%) in cervids in Norway [16]. For a lower prevalence (below 1%), there is less confidence. Only a few wild reindeer management areas have obtained a 95 % probability of freedom for a design prevalence of 0.5 % [17]. The reindeer district of Filefjell, with around 3000 semi-domesticated reindeer during the winter and summer pastures sharing border to the Nordfjella area, has obtained a high probability of freedom for a design prevalence less than 0.5 % [18]. Analysis of surveillance data from Norwegian and Swedish semi-domesticated reindeer districts used a scenario tree model, and at the national level the mean probability of disease freedom was 87.0 % in Norway by 2021 [19].

Further research studies aiming at characterizing prion strain differences have shown that the strain found in reindeer is different from those of the two other cervid species. The reindeer cases were indistinguishable, in results of diagnostic test methods, from cases of CWD from North America. The positive European moose and red deer have shown atypical characteristics [6,7,14], contrasting with the reindeer and cervids from North America, with no detectable prions in the lymphoid tissues using diagnostic tests. Nevertheless, applying sensitive research methods (PMCA) show low detectable levels of PrPSc also in peripheral tissues [20]. Strains analysed from the Norwegian cases, across three species, were demonstrated by inoculation studies as multiple and all different from North American cases. Nevertheless, the reindeer strain has many similarities with strains isolated from cases from North America [21,22] and is expected to harbor similar epidemiological properties.

The positive CWD animals other than reindeer are 14 cases in more than 40,000 tested moose and three cases in more than 37,500 tested red deer, indicating low levels of horizontal spreading, if any, between live animals in these species [6]. TSE in domestic animals, with Nor98 / atypical scrapie in sheep and atypical BSE in cattle, have prion strains showing similar sporadic nature. Nor98 / atypical scrapie and atypical BSE have a prevalence of about eight per 10,000 found dead adult sheep and about two per 1,000,000 tested cattle, respectively.
The number of tested cervids in Norway is not enough to assure knowledge of accurate prevalence nor to give complete understanding of CWD epidemiology. For other European countries there is even much more uncertainty as the surveillance levels are still very moderate [7].

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