Environmental conditions limit the distribution of *Lepidurus arcticus* (Branchiopoda, Notostraca) in lakes on the Hardangervidda mountain plateau, Southern Norway

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The Arctic tadpole shrimp *Lepidurus arcticus* has a circumpolar distribution where the Hardangervidda mountain plateau in Norway marks its southernmost limit. Within this area, we searched for *L. arcticus* in 238 lakes in 27 catchments. On Hardangervidda, the distribution pattern of *L. arcticus* is highly skewed. In the 16 catchments located in the central and eastern parts, *L. arcticus* was recorded in 70% of all the lakes studied (n=191). The remaining 11 catchments located in western areas, are almost free of lakes with *L. arcticus* (n=47). The most striking difference between these two areas is the significantly higher level of snow deposition in the western areas. This delays the ice break-up, which results in lower water temperatures and a shorter growing season. The water of lakes in western areas (N=36) is also more dilute than those in the central and eastern areas (N=201), with mean calcium concentrations of 0.81±0.48 and 1.62 ± 1.12 mg L^{-1}, respectively. In the lakes in the central and eastern areas hosting *L. arcticus* (N=95), the mean value was slightly higher (1.67 ± 1.14 mg L^{-1}). The combination of low water temperature, a short growing season and dilute water low in calcium may explain the near total absence of *L. arcticus* in the western part of Hardangervidda. All lakes contain brown trout *Salmo trutta*, and as *L. arcticus* is heavily sought for as food, the analyses of fish stomachs are the most reliable method of detecting the species. However, this prey-predator relationship may severely reduce the population of *L. arcticus,* and their presence may also be a function of the proximity of species refugia. This is evident in the context of fish predation, but also of water quality. Hence, in the central and eastern parts of the plateau, where *L. arcticus* is common, their occurrence increased significantly with lake size, being found in 54% of the lakes <1.0 km^2, as opposed to 97% in the bigger lakes. Furthermore, *L. arcticus* is most frequently found in lakes at altitudes between 1100 and 1299 m a.s.l. We conclude that environmental constraints limit the distribution of *L. arcticus* on Hardangervidda. The projected increase in temperature towards the end of this century may exterminate *L. arcticus* from the lower parts of Hardangervidda, especially in the most shallow lakes. Many of the lakes have water quality with pH <6.0 and calcium concentration <1.0 mg L^{-1}. In such lakes *L. arcticus* is living on the edge of its survival, and the projected increase in precipitation may dilute the waters even further, pushing *L. arcticus* nearer to its extinction threshold.

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INTRODUCTION

The Arctic tadpole shrimp *Lepidurus arcticus* (Pallas, 1793) has a circumpolar distribution and occurs in both shallow moraine ponds and large lakes in subarctic areas (Hessen *et al.* 2004). In its central circumpolar area, *L. arcticus* is mainly found in ponds and fishless shallow lakes (Jeppesen *et al.* 2001; Lakka 2013). However, in Scandinavia it has been described as a boreo-alpine relict species that occurs at sea-level in the Arctic region, and at progressively greater altitudes towards the south (S. Sømme 1934; Økland & Økland 2003). On the Norwegian mainland, it is a typically alpine species, mainly co-existing with fish (S. Sømme 1934; Aass 1969). In ponds and small shallow lakes in its southern outreach on the Scandinavian peninsula, which is often fishless, *L. arcticus* seems to be absent (S. Sømme 1934; Berg 1954; Blomkvist 1995; Klausen 2012).

The Hardangervidda mountain plateau in Southern Norway is the largest peneplain (eroded plain) in Europe (Anonymous 1974). This plateau marks the southernmost outreach of *L. arcticus* (S. Sømme 1934; Økland & Økland 2003). The first to describe *L. arcticus* from this mountain plateau was Huitfeldt-Kaas (1911), who offered only a general description of the species as being an important food item for brown trout *Salmo trutta* Linnaeus, 1758. He used the name *Apus glacialis* (Braem, 1893) which together with *Lepidurus glacialis* (Packard, 1883) was commonly used in the early decades of the 20th century (Økland & Økland 2003). Other synonym names from this period were *Monoculus arcticus* (Pallas, 1793), *Lepidurus spitzbergensis* (Bernard, 1882), *Apus productus var. glacialis* (Braem, 1893) and *Lepidurus ussuriensis* (Sidorov, 1927). No Norwegian name was known for *L. arcticus* at that time. The Norwegian name "skjoldkreps" ("scale shrimp") was introduced by Dahl (1913). This is astonishing as *L. arcticus* is quite conspicuous due to its large size and archaic appearance, and it was well known by local fishermen. On the other hand, the other large crustacean, the amphipod *Gammarus lacustris* G.O. Sars, 1863, had a variety of Norwegian local names such as "marflo, matflo, grunnåte, nettskjær, etc." (Dahl 1915).

The brown trout on Hardangervidda are of good size and quality and support a number of traditional fisheries (I. Sømme 1941). Their main crustacean food items are *L. arcticus*, *G. lacustris* and *Eurycercus lamellatus* A.F.M (Huitfeldt-Kaas 1911; Dahl 1917; I. Sømme 1941). Information regarding their occurrence has long been fragmentary and incomplete, and not until the beginnings of the 1970s did a rough distribution pattern appear that included almost all the records from the central and eastern parts of the plateau (Anonymous 1974).

The geology of Hardangervidda is highly variable and this is reflected in the water chemistry of the lakes, many of whose waters are low in pH and calcium (Skjelkvåle & Henriksen 1998). *Lepidurus arcticus* is highly sensitive to acid water (Borgstrøm & Hendrey 1976; Lakka 2013) becoming extinct in waters with a pH below 5.5 (Fjellheim & Raddum 1990). The lowest ambient calcium concentration in lakes in which *L. arcticus* are reported is 1.52 mg L^{-1} (Borgstrøm *et al.* 1976). However, only three lakes were investigated and hence, the lower lethal threshold for calcium demand has yet to be established for *L. arcticus*. Rapid postmoult calcification of the exoskeleton is essential for all crustaceans, and lack of calcium may limit their success in localities with such water quality (Rukke 2002).

The water temperature is also vital to all aquatic crustaceans. The thermal conditions of lakes are not only a result of summer temperatures, but also related to snow accumulation during the winter. Snow deposition and spring temperature are the main drivers of ice break-up, and determine the water temperature regime (Kvambekk & Melvold 2010). In catchments with heavy snowfall, the ice break-up may be delayed and thus lead to a thermal deficit that impedes the development of *L. arcticus* (Qvenild *et al.* 2018). Snow deposition on Hardangervidda is highly variable, with an almost fourfold increase in an east to west gradient (Qvenild *et al.* 2018).

In this study we hypothesised that the combination of low water temperature, short growing season and dilute water may impede ecdysis in *L. arcticus.* Furthermore, this particular crustacean is a large food item and is heavily fed upon by fish (Dahl 1920; Aass 1969; Borgstrøm *et al.* 1985; Jeppesen *et al.* 2001; Qvenild & Rognerud 2018; Presthus Heggen *et al.* 2010). Species "living on the edge" may be exterminated by reinforced vectors such as fish predation (Aass 1969; Jeppesen *et al.* 2001; Presthus Heggen *et al.* 2010). Our key question is whether the distribution pattern of *L. arcticus* may be explained by these environmental variables. Furthermore, alpine ecosystems are expected to suffer severely from the effects of global warming (Lindholm *et al.* 2012, 2015) and climate change may be a threat to *L. arcticus* (Hessen *et al.* 2004; Lakka 2013; Qvenild *et al.* 2018; Väinölä *et al.* 2019). Detailed mapping of *L. arcticus* is therefore an essential aspect of identifying future range retractions.

METHODS AND MATERIAL

Study area

The Hardangervidda landscape is characterized by barren, treeless moorland interrupted by numerous pools, lakes, rivers and streams. The plateau covers an area of about 9800 km^2, of which the most remote areas account for about 8000 km^2 (Anonymous 1974). In this area we included 27 catchments that cover 6569 km^2 (Figure 1, Table 1). We have divided these catchments into two groups. Of the "11 western catchments", ten drain to the west, while of the "16 central and eastern catchments", nine drain to the east and seven to the west. The extent of these catchments was calculated using the NEVINA procedure (NVE Atlas, nve.no). Within this area, we have identified 930 named lakes covering 656 km^2 with a median size 0.162 km^2 (range 0.004 – 78.77 km^2). These localities also included 27 reservoirs for hydropower production ranging in surface area from 0.48 to 78.77 km^2 (Appendix 1). In addition,

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there are approximately 11,600 unnamed lakes and ponds covering 157 km^2 (range 0.0006 – 0.7035 km^2). Most of the 36 natural lakes with bathymetric maps on Hardangervidda have mean depths <10 m (Appendix 1). Most of the lakes within the study area are situated at altitudes of 1100 – 1399 m a.s.l. (85%), while 11% and 4% are located at lower and higher altitudes, respectively.

The western area is dominated by rocky terrain and expanses of bare rock with thin or no moraine-covered bedrock of Precambrian gneisses and granites and sparse or no vegetation. Some catchments in the central part comprise bedrock of Cambro-Silurian sedimentary origin. The bedrock in the eastern areas also covers gneisses and granites but has deeper layers of moraine. The water chemistry on Hardangervidda closely reflects the local bedrock geology (Skjelkvåle & Henriksen 1998). Hence, the lakes are highly variable in water chemistry, ranging from lakes being practically free of electrolytes to lakes with high ionic strength. The content of total organic carbon (TOC) is very low, with <2.0 mg C L^{-1} in almost all lakes (Appendix 1).

Calcium concentration and pH are vital variables in the survival of *L. arcticus*. There are significant intermediary and seasonal variations in calcium concentration within a lake. The highest values of calcium are usually measured in the spring when the concentration may be more than twice the minimum values registered later in the season (Fjellheim *et al*. 2002, 2007, 2018). This variability is most prominent in small lakes and brooks. In bigger lakes the variation follows the same pattern but within a much more limited range. On the other hand, the lowest pH values are measured in the run-off period in the spring. However, we assume that the low ambient pH-levels encountered throughout the growth period in summer is most critical for *L. arcticus* as the run-off period is normally short and their resting eggs are very resistant to external stresses (Longhurst 1955; Blomquist 1995; Lakka 2013). Hence, we have used the minimum values of calcium and the concurrent pH-value in summer-autumn when water quality series are available for assessing the occurrence of *L. arcticus*. Almost all

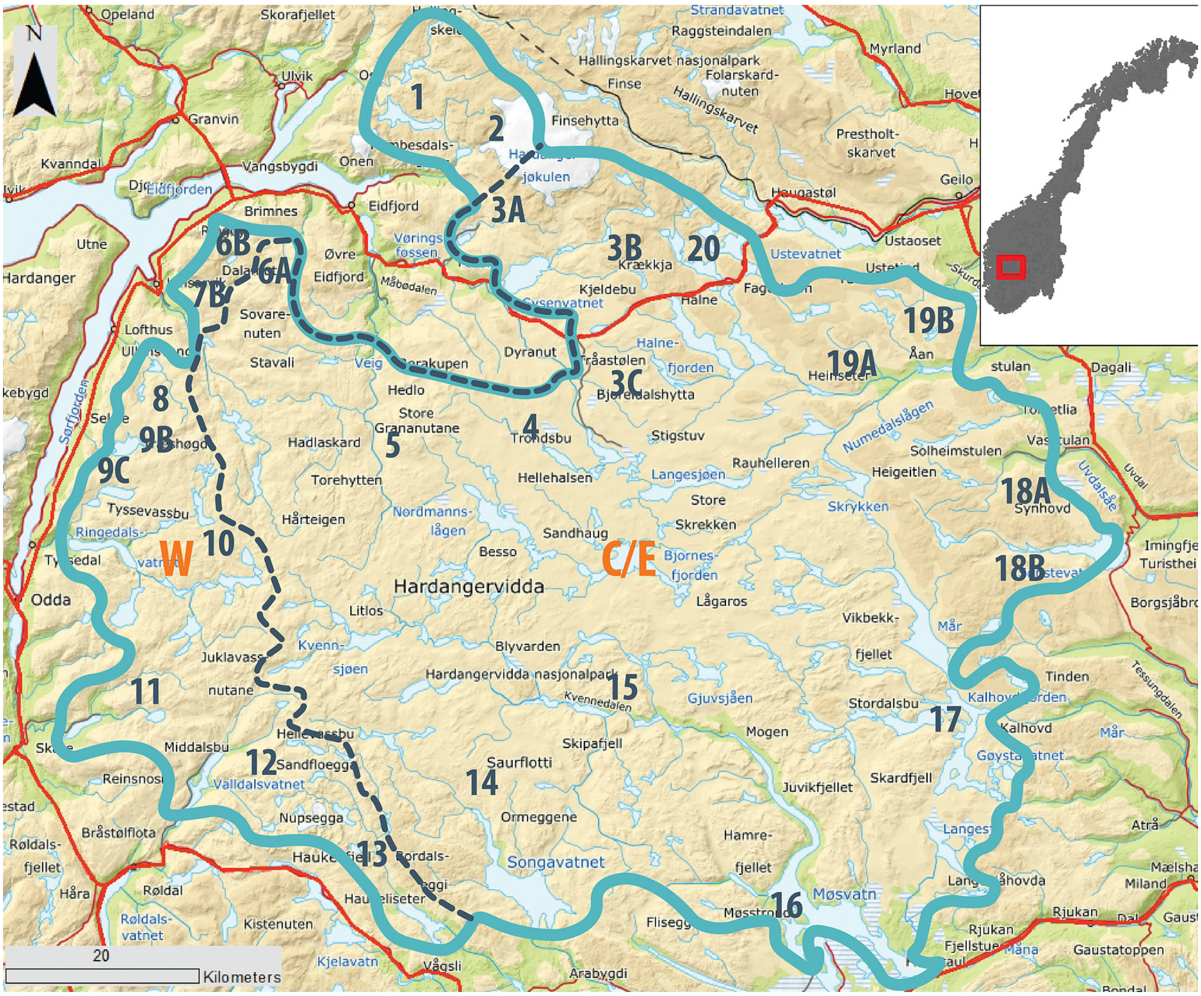

Figure 1. Map of the Hardangervidda with the 27 catchments indicated. The boundary of the study area is marked by a blue line. Details of the catchments are shown in Table 1. The study area is divided into two groups with 11 western catchments (W) and 16 central and eastern catchments (C/E). These areas are divided by a dotted line. Norwegian Mapping Authority CC BY 4.0.

Table 1. The 27 catchments surveyed for *Lepidurus arcticus* on Hardangervidda (W – 11 western catchments, C/E – 16 central and eastern catchments). The statistics were provided by the Norwegian Water Resources and Energy Directorate (nve.no). The vital statistics of the catchments were calculated using the NEVINA procedure (NVE Atlas, nve.no). Details of the specific lakes are given in Appendix 1.

Region	Catchment no.	Catchment name	Limits of catchment	Mean winter deposition mm	Mean summer eposition mm	Mean winter temp. °C	Mean summer temp. °C	Catchment km^2	Lake area km^2	No. of lakes	No. of lakes examined	No. of lakes with *L. arcticus*	Proportion (%) of lakes with *L. arcticus*
W	1	Austdøla	Confluence of Austdøla and river from Lake Langvatnet	1000	594	-4.2	4.3	121	13	22	10	2	20
W	2	Sima	Confluence of Skykkjedalselvi/ Nordelvi	832	504	-5.1	3.1	121	4	14	1	0	0
C/E	3A	Isdølo	Upstream Stakseng	725	434	-4.5	4.1	55	2	6	1	1	100
C/E	3B	Leiro	Upstream outflow Lake Sysenvatn reservoir	571	406	-6.1	3.7	211	18	22	8	5	63
C/E	3C	Svinto	Upstream Nybu	497	356	-7.9	4.3	35	0	2	1	1	100
C/E	4	Bjoreio	Upstream Nybu	527	356	-6.9	4.2	150	9	14	3	3	100
C/E	5	Veig	Upstream Valursfossen	669	375	-5.9	4.4	395	10	37	19	10	53
C/E	6A	Erdalsvassdr.	Upstream Erdalsstølen	809	387	-1.8	6.0	63	1	2	2	2	100
W	6B	Bjotveitelvi	Upstream Tverrlii	944	447	-1.4	6.4	16	1	2	1	0	0
C/E	7A	Kinso	Upstream Søtefossen	900	435	-4.0	4.5	210	14	31	15	6	40
W	7B	Vivippo	Confluence with Kinso	919	423	-1.6	5.7	39	1	4	3	0	0
W	8	Opo	Upstream confluence of Opo/ Skrikjo	984	460	-2.0	5.2	63	4	10	4	0	0
W	9A	Espeelvi	Upstream Brattespe	938	489	-2.7	5.1	9	0	1	1	0	0
W	9B	Vendo	Upstream outflow Lake Vetle Vendevatnet	1013	518	-3.3	4.0	29	4	2	1	0	0
W	10	Tysso	Upstream outflow Lake Ringedalsvatnet reservoir	1062	590	-4.2	4.1	381	44	46	20	0	0
W	11	Austdølo/ Ljoso	Upstream outflow Lake Reinsnosvatnet	1151	614	-3.2	4.5	120	9	13	3	0	0
W	12	Suldalsvassdr.	Upstream outflow Lake Valldalsvatnet reservoir	984	586	-5.3	3.9	217	10	7	1	0	0
W	13	Bora	Upstream outflow Lake Bordalsvatnet reservoir	742	442	-5.9	4.5	171	18	34	2	0	0
C/E	14	Songa	Upstream outflow Lake Songa reservoir	582	400	-5.8	4.8	379	42	44	9	3	33
C/E	15	Kvenna	Upstream Mogen	571	390	-7.8	4.5	828	61	99	42	29	69
C/E	16	Møsvatn	Tributaries upstream Lake Møsvatn reservoir ecscl. Kvenna	434	380	-6.1	4.7	525	104	103	7	2	29

Table 1. Continued.

Region	Catchment no.	Catchment name	Limits of catchment	Mean winter deposition mm	Mean summer eposition mm	Mean winter temp. °C	Mean summer temp. °C	Catchment km²	Lake area km²	No. of lakes	No. of lakes examined	No. of lakes with *L. arcticus*	Proportion (%) of lakes with *L. arcticus*
C/E	17	Gøyst/ Mår	Upstream Lake Gøyst reservoir	304	339	-6.7	4.8	732	102	156	14	13	93
C/E	18A	Uvdalselvi	Upstream confluence Tøddøla/ Jønndølå	292	332	-6.6	5.1	196	10	39	3	2	67
C/E	18B	Ølmosåi	Upstream outflow Lake Sønstevatn reservoir	314	355	-6.8	4.8	188	22	37	6	5	83
C/E	19A	Lågen	Upstream outflow Lake Orsjoren	511	344	-8.1	4.7	1179	134	154	52	43	83
C/E	19B	Ufysja	Upstream confluence Ufysja/ Ljosevassåi	322	323	-5.8	5.0	61	3	10	5	5	100
C/E	20	Ørteråni	Upstream outflow Lake Ørteren reservoir	404	339	-7.4	4.6	76	16	19	4	4	100
		TOTAL						6569	656	930	238	136	57

water chemistry data (97%) are from the period July – October (Appendix 1). In many lakes, however, only single values of calcium are available. We have obtained water chemistry data (concurrent values of calcium concentration and pH) from the literature for 237 lakes on Hardangervidda (Appendix 1).

The climatic conditions on Hardangervidda are highly variable (Qvenild *et al.* 2018). We used the NEVINA procedure to compute winter and summer deposition and winter and summer temperatures as mean values for the normal period 1961 – 1990 (NVE Atlas, nve.no). The winter deposition (October – April) differs substantially between the western and eastern parts of the plateau, being 1151 mm in Austdølo/Ljoso catchment and 292 mm in Uvdalselvi catchment, respectively (Table 1). Mean summer deposition values (May – September) are less divergent, being 614 and 332 mm, respectively.

In most Hardangervidda lakes and rivers, brown trout is the only fish species present. Arctic char *Salvelinus alpinus* (Linnaeus, 1758) and European minnow *Phoxinus phoxinus* (Linnaeus, 1758) are coexisting with brown trout in some of the lakes (Appendix 1). Arctic char is found in 3.1% (N=29) of the 930 named lakes, mainly due to stockings in the 20th century. In the Lågen catchment, they were stocked in Lake Breidvatnet, a headwater lake in the tributary Æanåi in 1910 (Dahl 1920), from where they spread downstream and to some neighbouring lakes in the following years. A dense population of Arctic char that emerged in Lake Breidvatnet affected the local crustacean community (Dahl 1920). More recently, Arctic char have also established themselves in the Leiro catchment (Rognerud *et al.* 2003). The European minnow has been introduced to 4.5% (N=42) of the 930 lakes since the 1970s. It was first observed in Lake Ørteren reservoir in 1973 (Anonymous 1974), from where it spread to many of the lakes in the north-eastern part of the plateau.

Mapping of *Lepidurus arcticus*

Data on the presence or absence of *L. arcticus* were screened from technical reports of varying standards and from some scientific papers (Appendix 1). Animals like *L. arcticus* may be difficult to detect using conventional benthic sampling equipment at low densities and/or patchy distribution (Fjellheim *et al.* 2007). Methods used in sampling *L. arcticus* on Hardangervidda include the Ekman bottom sampler (Dahl 1917; Amundsen 1976), Petersen sampler (Amundsen 1976), plankton sieves (Halvorsen 1973), artificial substrates (jute bags) and benthic littoral kick samples (Walseng *et al.* 1994; Walseng *et al.* 1996; Fjellheim *et al.* 2007). However, in most publications, the occurrence of *L. arcticus* is mainly based on brown trout stomach analyses.

Many reports contain only a note referring to a finding of *L. arcticus*. In more detailed investigations, the occurrence of different food items is normally given as volume % based on stomach analyses. In this study, the occurrence of *L. arcticus* is only noted as presence or absence of the species. In this context, we assume viable populations of *L. arcticus* in lakes where the species have been noted at least once. In lakes with negative findings of *L. arcticus* they may still occur as findings are highly sensitive to the method used (Amundsen 1976; Fjellheim *et al.* 2007), time of sampling (Aass 1969; Hesthagen 1979; Qvenild *et al*. 2018), thermal conditions (Aass 1969; Simonsen & Valderhaug 1994; Borgstrøm 2016; Qvenild *et al.* 2018), and predation from dense fish populations (Dahl 1920; Aass 1969; Borgstrøm *et al.* 1985; Qvenild & Rognerud 2018). This is emphasised by results from lakes repeatedly examined that produced both positive and negative findings (Hesthagen 1979; Qvenild & Rognerud 2018). As most of the findings of *L. arcticus* are from stomach analyses, the records concern adult specimens. With hauls, different instar stages and nauplius larvae were also detected (Halvorsen 1973; Walseng *et al.* 1996).

RESULTS

Distribution of lakes hosting *Lepidurus arcticus*

Lepidurus arcticus was detected in 136 of 238 lakes (57%) within the 27 catchments studied (Appendix 1, Table 1). Their pattern of distribution is highly skewed, with almost all the records coming from the 16 central and eastern catchments (Figure 2). In this area, 775 named lakes were identified. In the 181 natural lakes examined, *L. arcticus* was detected in 69% (N=124). *Lepidurus arcticus* occurred in all ten reservoirs in this area.

In the 11 western catchments, 155 named lakes were identified. Here, *L. arcticus* was searched for in 47 lakes, but recorded in only two (4.0%), both in the Austdøla catchment in the north-western region (Lake Langvatnet and Lake Austdalsvatnet). Thus, in the remaining ten catchments in this region, *L. arcticus* has never been recorded.

The significance of altitude and lake size

We analysed the occurrence of *L. arcticus* in relation to altitude and lake size from natural lakes within the 16 catchments in the central and eastern parts of the plateau. The 124 lakes that contain *L. arcticus* in this area lie at altitudes between 832 and 1386 m a.s.l., most of them (77%) between 1100 – 1299 m a.s.l.

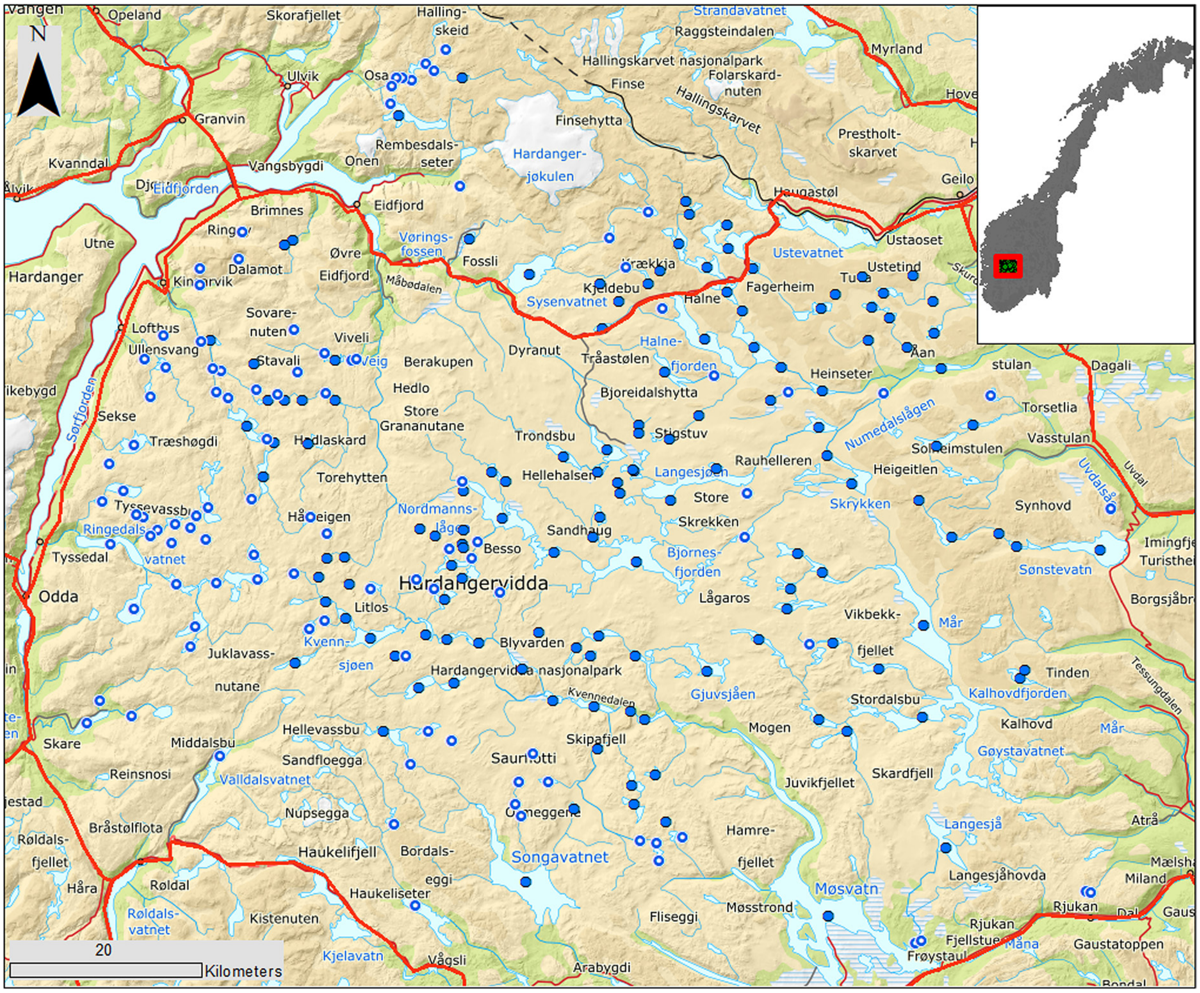

Figure 2. Lakes surveyed for the presence of *Lepidurus arcticus* are shown by dots, with positive findings shown by filled dots. Details of the localities are given in Appendix 1. Norwegian Mapping Authority CC BY 4.0.

(Table 2). From an altitude of 900 m a.s.l., the proportion of lakes containing *L. arcticus* rose to its highest level at 1100 – 1199 m a.s.l., where 80% contained *L. arcticus*. In total, 50 and 72% of the lakes lower and higher than 1100 m a.s.l. hosted *L. arcticus*, respectively. Lake Kolsnutgryslane at 1386 m a.s.l., in the Kvenna catchment, is the highest known locality hosting *L. arcticus* on Hardangervidda. Of the 26 lakes at higher altitudes, only two lakes have been surveyed for *L. arcticus*, and both returned negative findings. Of the 19 lakes located at altitudes below 1000 m a.s.l., ten were surveyed, and five of them contained *L. arcticus*.

The 765 natural lakes in this area ranged in size from 0.004 to 18.38 km^2, most of them covered an area <1.0 km^2 (90%). The probability of occurrence of *L. arcticus* increased significantly with lake size as shown by a logistic regression: p(occurrence) = $(1+exp\ (1.380 + 2.026 \cdot log\ \text{Area}))^{-1}$ (likelihood-ratio chi-square test=31.12, p<0.0001) (Figure 3). Of the 181 lakes examined, *L. arcticus* was found in 97% of the 62 lakes ≥1.0 km^2, while the species was found in only 54% of the 119 lakes <1.0 km^2. The smallest lake with *L. arcticus* was Lake Nedre Vivevatn (0.023 km^2).

Table 2. Frequency (%) of lakes with *Lepidurus arcticus* at different altitudes in the 16 central and eastern catchments on Hardangervidda.

Altitude m a.s.l.	No. of natural lakes	Examined lakes	Lakes with *Lepidurus arcticus*	Proportion of *Lepidurus arcticus* lakes (%)
<900	4	4	3	75
900-999	15	6	2	33
1000-1099	59	18	9	50
1100-1199	264	66	53	80
1200-1299	270	57	42	74
1300-1399	141	30	15	50
≥1400	12	0	0	0
	765	181	124	69

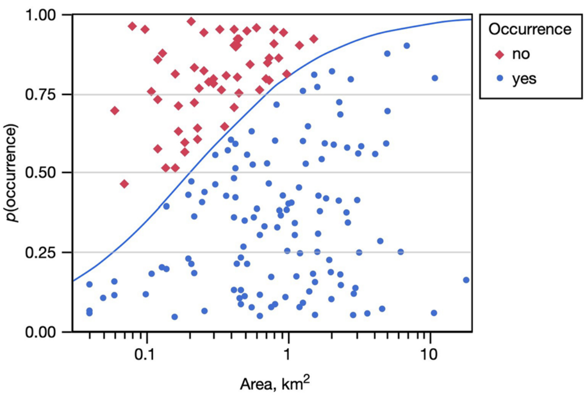

Figure 3. Logistic regression curve showing the probability of occurrence of *Lepidurus arcticus* as a function of lake surface area. Of the 181 lakes studied, *Lepidurus arcticus* was found in 97% of the 62 lakes ≥1.0 km^2, while the species was found in only 54% of 119 lakes <1.0 km^2.

Occurrence of *Lepidurus arcticus* in relation to climate conditions and water chemistry

The 11 catchments in the western part of the plateau with scarcely any *L. arcticus* had high winter depositions of snow, with a mean value of 961±109 mm (Table 1). Lakes in these catchments were consistently low in calcium, with a mean concentration of 0.81±0.48 mg L^{-1} (range 0.32 – 2.62 mg L^{-1}, N=36) (Appendix 1). Calcium concentrations in the two localities with *L. arcticus* in this area, lakes Langvatnet and Austdalsvatnet, were 0.32 and 1.20 mg L^{-1}, respectively. Of the 36 localities, 72% had calcium concentrations <1.0 mg L^{-1}. The concurrent pH in these lakes ranged from 5.35 to 7.00, with 19% lying below 6.0. The TOC values are extremely low, with all values ≤0.6 mg C L^{-1}.

On the other hand, in the 16 catchments in central and eastern areas in which *L. arcticus* is common, the mean winter deposition is 527±183 mm (Table 1). Concurrent values of calcium concentration and pH were available from 201 lakes (Appendix 1), with a mean calcium concentration of 1.61±1.12 mg L^{-1}. The minimum and maximum calcium values for the lakes in this area were measured in Lake Svartavasstjørni (Lågen catchment) and Lake Nøkkatjørni (Bjoreio catchment), with 0.28 and 5.73 mg L^{-1}, respectively. In this area, 37% of the lakes had a calcium concentration <1.0 mg L^{-1}. The concurrent pH varied from 5.19 to 7.28, with 10% <6.0. In this area, *L. arcticus* is recorded in 95 lakes in which the mean calcium concentration was 1.67±1.14 mg L^{-1} (range 0.28 – 5.54 mg L^{-1}). The concurrent pH values ranged from 5.49 to 7.26 also with 11% of the values <6.0. Also in this area, the TOC values are low, as 85% (N=52) of the localities were below 2.0 mg C L^{-1}.

Winter deposition and calcium concentration were significantly different between the western and the central/eastern areas (likelihood-ratio chi-square test=120.91 (p<0.0001) and 20.61 (p<0.0001)), respectively (Figure 4). At calcium concentrations <1.0 mg L^{-1}, no positive findings of *L. arcticus* were found in areas with snow deposits >700 mm.

Both winter deposition (Wd) and calcium concentration (Ca) could be used to characterise the western and central/eastern areas respectively. The probability of being categorised as a lake in the central/eastern area could be modelled by a logistic regression: $p = 1 - (1 + exp\ (15.158 + 4.278 \cdot log\ Ca - 0.019 \cdot Wd))^{-1}$ (likelihood-ratio χ^2 test = 169.7, p<0.0001).

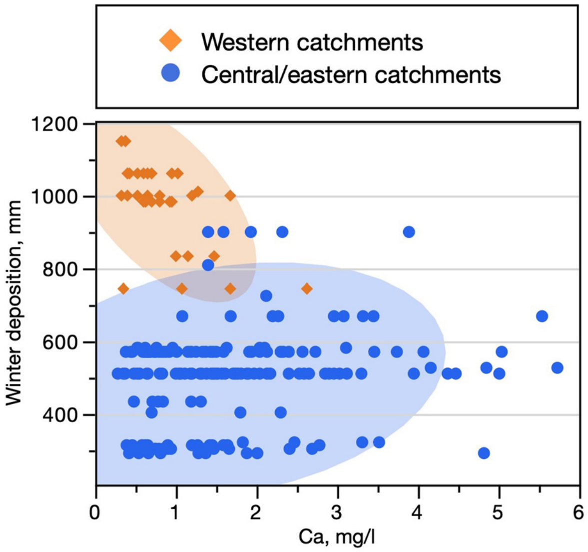

Figure 4. Scatter plot of calcium concentration (mg L^{-1}) and winter deposition (mm) for the lakes in the two catchment areas. Bivariate 90% confidence ellipses are shown for each of the two areas.

DISCUSSION

In 1910, the first six localities with *L. arcticus* in the north-eastern part of Hardangervidda were documented (Dahl 1917), and by 1940, only 20 lakes with *L. arcticus* had been identified (Dahl 1917; S. Sømme 1934). This came to 50% of all Norwegian lakes that were known to host *L. arcticus* at that time. In the 1970s, enough investigations had been conducted to trace a rough distribution pattern on Hardangervidda (Anonymous 1974). *Lepidurus arcticus* is well established in the southern mountain range in Norway in the alpine zone (zone above the tree line) and to some extent in the subalpine zone (mainly the birch zone), indicating that temperature preferences limit its distribution. However, in the western part of Hardangervidda it must be additive vectors. This study focuses on the environmental conditions, in order to elucidate why *L. arcticus* is missing in this region.

The significance of the sampling method

In many lakes, different kind of bottom samplers are used simultaneously with fish sampling (Dahl 1917; Amundsen 1976; Fjellheim *et al.* 2007). In a test-fishing programme that covered 15 lakes hosting *L. arcticus*, bottom samplers (Ekman or/and Petersen) were used simultaneously with test fishing (Amundsen 1976). In only one lake (7%), *L. arcticus* was detected by the bottom samplers, compared with 12 lakes (80%) from which stomachs were analysed. In a monitoring programme with benthic littoral kick sampling in 18 lakes hosting *L. arcticus* in 1978, repeated in 1994, *L. arcticus* was detected in only one lake in each of the sampling periods (Walseng *et al.* 1994, 1996). In the 1994 investigation, brown trout were also sampled with multimesh gillnets in six lakes, five of which provided *L. arcticus*. In a similar study in two lakes, artificial substrate (jute bags) and benthic littoral kick sampling were used in addition to stomach sampling (Fjellheim *et al.* 2007). In these lakes, where *L. arcticus* appeared in low numbers, only fish stomach analyses had positive findings. Stomach analyses thus proved to be far the most effective method to detect the presence of *L. arcticus*, especially when *L. arcticus* appears in low number and/ or has a patchy distribution.

Even though adult *L. arcticus* is a big food item, it is not necessarily easy to catch for the brown trout, especially not to the small sizes. It was a significant positive correlation between the frequency (%) of *L. arcticus* in the fish stomachs and fish size (Qvenild *et al.* 2018). In fishery investigations, multimesh gillnets are frequently used. In clear water mountain lakes, small brown trout tends to pose the dominant part of the catch in such gears. If so, the probability to detect *L. arcticus* may be lower.

In our material, 423 investigations can be properly dated, 102 of which delivered negative findings in lakes known to host *L. arcticus*. This may be due to timing (early sampling), methods used, low density and/ or patchy distribution of *L. arcticus*. As 44% (N=102) of these studies took place in June – July, timing seems to be crucial. Most fish investigations in high mountain lakes where *L. arcticus* is expected as a food item take this into account. Of the 423 investigations, 80% took place in August to October.

Although *L. arcticus* may thrive at low temperatures, a minimum thermal input is needed for their growth into adult stages (Qvenild *et al.* 2018). This is emphasized in cold summers where *L. arcticus* has a delayed appearance as brown trout food (S. Sømme 1934; Aass 1969; Pedersen & Scobie 1990; Simonsen & Valderhaug 1994; Borgstrøm 2016). In cold summers such as those of 2012 and 2015 they may not be seen until September, if at all (Borgstrøm 2016; Qvenild *et al.* 2018). In an extensive study covering 236 fishing events from five lakes on Hardangervidda in 2003 – 2016, the fishing events with positive findings covered a period from 27 July (in 2009) to 2 October (in 2006). In the surveyed literature (cf. references in Appendix 1), 10% of those with positive findings were from July. Only in one investigation was *L. arcticus* detected earlier than 18 July (11 July in Lake Isdalsvatnet; Lehman & Wiers 2004). This confirms existing experience that *L. arcticus* basically contributes to the brown trout diet in August – September on Hardangervidda (Dahl 1917; I. Sømme 1941).

In the 16 central and eastern catchments, *L. arcticus* was recorded in 70% of the 191 lakes examined (including the ten reservoirs). *Lepidurus arcticus* was recorded in 55% of the 124 lakes sampled once or twice. With more than two repeat samplings, almost all gave positive records (99%). This was also emphasized in an extensive study in Lake Sandvatn in Kvenna catchment in 2003 – 2016 (Qvenild & Rognerud 2018), where, *L. arcticus* contributed significantly as brown trout food in August in most years. However, in some years they were scarcely ever observed. This was partly due to cold summers

(2012, 2015) and partly to predation pressure from brown trout (2006, 2007). Thus, repeated sampling is essential in detecting *L. arcticus*.

Fish predation may serious reduce *L. arcticus* populations. On Hardangervidda this has been shown for brown trout (Qvenild & Rognerud 2018), Arctic char (Dahl 1920; Aass 1969) and European minnow (Rognerud *et al.* 2003). When one or more of these species are present, *L. arcticus* may be difficult to detect.

The distribution pattern and potential for new observations of *Lepidurus arcticus*

Hardangervidda marks the southernmost distribution limit of *L. arcticus,* although a few localities in the neighbouring mountain area further south are known (S. Sømme 1934; Borgstrøm *et al.* 1976; Økland & Økland 2003; Artsdatabanken.no). This study revealed 136 lakes hosting *L. arcticus* (cf. Table 1). Almost all the lakes are located in the central and eastern part of the mountain plateau. Our study has thus confirmed the pattern of distribution seen in the beginning of the 1970s (Anonymous 1974). However, it is now based on far more localities.

In the 16 catchments at the central and eastern part of the plateau where *L. arcticus* is common, 25% of the named lakes (N=775) have so far been properly surveyed. This particular crustacean can be difficult to catch, and investigations that include more than two repeat samplings may be needed to be certain of detecting it. Of the 191 lakes, only 35% have been examined more than twice and the potential for new findings of *L. arcticus* is obvious. Hence, the estimate that at least 136 localities host *L. arcticus* in this area should easily be increased by more targeted surveys.

The distribution of *L. arcticus* throughout the Norwegian mountain range, which decreases to the north, is mainly explained by their temperature preferences (S. Sømme 1934; Aass 1969; Økland & Økland 2003). The general drop in air temperature, which falls by about 0.6°C per 100 m altitude correlates with a corresponding drop in water temperature (Kvambekk & Melvold 2010; Lindholm *et al.* 2015; Qvenild *et al.* 2018). Hence, a thermal deficit in the input needed to complete its reproductive cycle may limit the species at high altitudes (cf. Aass 1969: Qvenild *et al.* 2018). This may be reflected in the maximum frequency of *L. arcticus* found in lakes at altitudes of 1100 – 1299 m a.s.l (cf. Table 2). On Hardangervidda the highest lake hosting *L. arcticus* is Lake Kolsnutgryslane at 1386 m a.s.l. However, they may exist at higher altitudes as the species has been recorded up to 1518 m a.s.l. nationwide (Økland & Økland 2003). On Hardangervidda only 26 lakes (3.4%) are sited at higher altitudes than 1386 m a.s.l. and only two of them have so far been examined.

Lepidurus arcticus normally reach their maximum abundance in the alpine zone in Southern Norway (S. Sømme 1934; Aass 1969; Økland & Økland 2003). However, their distribution may extend into the subalpine zone, especially in lakes regulated for hydropower production (Dahl 1932; Aass 1969). The resting eggs of *L. arcticus* tolerate both freezing and drying (Dahl 1932; Longhurst 1955; Aass 1969; Blomkvist 1995). Thus, they are well adapted to the unstable conditions in the littoral zone in reservoirs with variable water levels. However, in this context, temperature conditions seem to be crucial, as was revealed in Lake Pålsbufjorden at 749 m.a.s.l. lower in the Lågen catchment (Dahl 1932). The regulation regime turned the lake into a colder habitat suitable for the development of *L. arcticus* (Aass 1969).

The water level amplitude in hydropower reservoirs does not seem to be decisive (Aass 1969). All the ten reservoirs in the central and eastern parts of Hardangervidda still host *L. arcticus* despite water amplitudes up to 66 m (Lake Sysenvatn). In the western catchments, no records of *L. arcticus* after impoundment are known. Consequently, there must be other factors that limit their occurrence in reservoirs in this part of the plateau.

The presence of a species is a function of the proximity of suitable refugia. In this study, the occurrence of *L. arcticus* increased significantly with lake size, which demonstrates that this is a factor of great significance, as access to refugia in larger and deeper lakes tends to be better. In this context, this seems to be a crucial factor, relative to both water quality and fish predation (Fjellheim *et al.* 2007; Qvenild & Rognerud 2018).

In addition to the 930 named lakes on Hardangervidda, there are large numbers of unnamed lakes and ponds. In the high Arctic, *L. arcticus* is common in such localities although they may freeze solid throughout the winter (Lakka 2013). *Lepidurus arcticus* have also been recorded in some small lakes and ponds on the Scandinavian peninsula (Berg 1954; Hesthagen 1979; Blomkvist 1995; Walseng *et al.* 1996). Even in such localities, *L. arcticus* seems to be an exception (S. Sømme 1934; Halvorsen 1973; Blomkvist 1995; Klausen 2012; Walseng *et al.* 1996). In most small lakes and ponds, the environmental conditions may be too variable and lack the necessary refugia to provide survival conditions for *L. arcticus*. Both temperature and acid water may have detrimental impacts in such localities (Olofsson 1918 cited in Blomkvist 1995; Fjellheim *et al.* 2001; Lakka 2013). Another branchiopod, *Branchinecta palludosa* O.F.Müller, 1758, has been extinct in many ponds on its southernmost border in the Dovrefjell mountain area since the 1970s, which was related to elevated summer temperatures (Lindholm *et al.* 2012, 2015). *Lepidurus arcticus* may also be susceptible to rises in temperatures in the upper part of their thermal range (Arnold 1966; Klausen 2012; Lakka 2013).

Environmental constraints on the distribution of *Lepidurus arcticus*

On Hardangervidda, the western area is extremely barren with only a thin layer of moraine or glacio-fluvial deposits on Precambrian bedrock, almost without vegetation and with a bedrock of granitic and dioritic gneisses, giving dilute water low in calcium (0.81±0.48 mg L^{-1}). The catchments in the central and eastern areas where *L. arcticus* commonly occurs, has a thicker moraine cover with more vegetation, and the water quality is much better with respect to calcium (1.61±1.12 mg L^{-1}). In the western and central/ eastern part, 72% and 38% of the lakes have calcium concentrations <1.0 mg L^{-1}, respectively.

The lower lethal threshold for calcium demand has yet to be established for *L. arcticus*. The species is also highly sensitive to acid water, becoming extinct in waters with pH below 5.5 (Borgstrøm & Hendrey 1976; Fjellheim & Raddum 1990; Lakka 2013). Rapid postmoult calcification of the exoskeleton is essential to all crustaceans, and low calcium concentrations may impede ecdysis (Rukke 2002). This effect may be reinforced by low pH levels, which often interfere with low calcium concentrations. Almost all the 29 lakes with pH <6.0, ten of which hosted *L. arcticus* (cf. Appendix 1) had calcium concentrations <1.0 mg L^{-1}. In these lakes, *L. arcticus* may cope with such extremes and must be regarded as "living on the edge" of survival. At such critical levels, access to proximity refugia is assumed to be crucial. In Lake Svartevatnet in Lågen catchment, *L. arcticus* was not recorded until the water quality was improved by a liming programme that started in 1994 (Fjellheim *et al.* 2001). This was assumed not to be an effect of the stocking of *L. arcticus*, but rather of access to refugia within the lake with better water quality. Hence, the lower thresholds to pH and calcium should exceed the measured level in Lake Svartevatnet in 1993, i.e. prior to liming. In that year, the summer calcium concentration and pH were 0.35 mg L^{-1} and 5.69, respectively. This indicates that ambient calcium concentration levels ~0.5 mg L^{-1} is near to the lower lethal threshold for *L. arcticus*.

This study has clearly shown that *L. arcticus* can thrive in waters lower in calcium than <1.0 mg L^{-1} and also with pH <6.0. Even though the lakes in the two areas have quite different levels of calcium, many of them with positive findings of *L. arcticus* in the central/ eastern area lie within the lower range of the scale, with 35 lakes having calcium concentrations <1.0 mg L^{-1}, and seven of them <0.5 mg L^{-1}. Thus, the calcium concentration in most of the lakes in the western area should not be critical to *L. arcticus* survival and in this part of Hardangervidda, additional vectors determine their absence or presence.

There is a steep gradient in snow deposition from west to east, with 1151 mm in the Austdøla/Ljoso catchment in the west, compared to 292 mm in the Uvdalselvi catchment in the east (cf. Table 1). All the western catchments have snow deposits >700 mm. Heavy snow deposits seriously affect the thermal conditions in the lakes (Borgstrøm 2016; Qvenild *et al.* 2018). The large amounts of snow deposited in western areas imply that the ice break-up usually takes place much later than in eastern areas (Borgstrøm 2016; Qvenild *et al.* 2018). Hatching of *L. arcticus* normally coincides with snow melt and ice break-up (Halvorsen 1973; Simonsen & Valderhaug 1994; Fjellheim *et al.* 2007; Borgstrøm 2016). Though low temperature is not a problem to an arctic species like *L. arcticus*, a minimum thermal input is needed for development into adults (Qvenild *et al.* 2018). High winter deposition, late ice break-up and low water temperatures in a short growing season may seriously impede the growth and development of *L. arcticus*. Evidence for this was documented for a number of individual years on Hardangervidda (Pedersen & Scobie 1990: Simonsen & Valderhaug 1994; Borgstrøm 2016; Qvenild *et al.* 2018). Thus, the combination of low thermal input and dilute waters in this area may result in excessively hostile conditions to *L. arcticus*. When calcium concentrations are <1.0 mg L^{-1}, *L. arcticus* was not found in areas with snow deposits >700 mm. (cf. Figure 4). However, *L. arcticus* may maintain viable populations even in some lakes in areas with snow deposition >700 mm. Lake Busetevatn in the Erdalsvassdraget catchment and lakes in the Kinso catchment host *L. arcticus* despite winter depositions of ~900 mm. However, these lakes have relatively high calcium concentrations (>1.4 mg L^{-1}). Hence, *L. arcticus* is able to complete its life cycle even with snow deposits >700 mm, if calcium levels are sufficiently high.

Climate change – what will be the consequences for *Lepidurus arcticus*?

For the Norwegian mainland as a whole, there has been a general increase in precipitation since the 1980s (Hanssen-Bauer *et al.* 2017). This pattern has also been observed on Hardangervidda, where the annual winter deposition has increased, including an increase in the number of snow-rich winters with a decrease in the difference from west to east (Qvenild *et al.* 2018). In addition to later ice break-up and colder waters, elevated precipitation levels will result in higher run-off and more dilute waters (Presthus Heggen *et al.* 2010.

A similar significant increase in summer air temperatures since the 1980s has also been documented on Hardangervidda (Qvenild *et al.* 2018), and a further increase is projected toward the end of the century. As water temperature is closely linked to air temperature this will also affect the aquatic biota (Kvambekk & Melvold 2010; Lindholm *et al.* 2015; Qvenild *et al.* 2018). In shallow lakes and ponds, the water temperature may exceed the upper tolerance limit of *L. arcticus,* which is estimated to be 19 – 20 °C (Arnold 1966; Klausen 2012; Lakka 2013), although it may be higher for short duration exposures. In deeper lakes, the water temperature seldom passes these tolerance limits for more than a few days, and only in the epilimnion (Qvenild *et al.* 2018). Hence, lake size would appear to be important for *L. arcticus* survival in a future warmer climate.

The ecological sensitivity is high in mountain areas, where many species are living at the thresholds of their tolerance and close to their geographical limits. Hence, protracted warm periods may be problematic for a cold-adapted species like *L. arcticus* at the southernmost outreach of its distribution range. Even though *L. arcticus* may tolerate high temperatures for some time, the accumulated thermal input may exceed the upper thermal threshold and result in mismatches between environmental conditions and life-cycle events. This may force range retractions of *L. arcticus* from the lower part of their distribution area, as has already been experienced by another crustacean species, *B. paludosa* (Lindholm *et al.* 2012, 2015). From a conservation point of view, detailed mapping of the present distribution of *L. arcticus* on Hardangervidda should be highly rewarding.

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Appendix 1. Specific information about 367 lakes in 27 catchments, 238 of which were surveyed for the occurrence of *Lepidurus arcticus* (W – 11 western catchments, C/E – 16 central and eastern catchments). **Reg** indicates that a lake is regulated. The number of examinations is specified together with any associated positive records. The numbered references are given below the table.

Region	Catchm. no.	NVE ID	Lake	Catchment	Reg.	Altitude m a.s.l.	Area km^2	Min. depth m	Max. depth m	*S. alpinus*	*P. phoxinus*	EPSG:25833		No. exam.	No. pos. rec.	Date	pH	Ca mg L^{-1}	TOC mg C L^{-1}	References
W	1	1917	Austdølnutvatnet	Austdøla	x	1040	0.63					70590	6742742	2	0					55, 124
W	1	1918	Rundavatnet	Austdøla	x	1040	1.28					72020	6744428	2	0					55, 124
W	1	1921	Langvatnet	Austdøla	x	1158	6.40					69287	6739016	3	2	06.08.71	6.90	0.32		51, 86, 124
W	1	1922	Kvilinganutvatn	Austdøla		1140	0.53					74117	6745937	1	0	09.09.68	6.00	0.40		124
W	1	1923	S. Grøndalsvatnet	Austdøla		1153	1.05					73417	6747708	0		07.09.68	5.60	0.64		124
W	1	16623	Floskefonnvatnet	Austdøla		1081	0.19					70313	6745100	0		11.09.68	6.10	0.80		124
W	1	16637	V. Memorgevatn	Austdøla		1263	0.16					80149	6743690	0		09.08.71	7.00	1.68		51
W	1	16656	Austdalsvatnet	Austdøla		1059	0.08					72907	6743724	1	0					51, 55
W	1	16664	Austdalsvatnet	Austdøla		1163	0.32					75886	6742930	1	1	08.08.71	6.90	1.20		51, 55
W	1	16677	Rossevatni	Austdøla		954	0.09					69545	6743018	1	0					55
W	1	16682	Rossevatni	Austdøla		936	0.06					68971	6743002	2	0					55, 124
W	1	16712	Austdølvatnet	Austdøla		907	0.13					68552	6742080	2	0					55, 124
W	1	16747	Olbogavatnet	Austdøla		1194	0.35					70461	6741101	0		07.08.71	6.80	0.52		51
W	1	16781	Reipstjørnane	Austdøla		1192	0.13					72883	6740013	0		08.08.71	6.90	0.32		51
W	1	16787	Grasbotntjørni	Austdøla		1107	0.12					68354	6740315	1	0					55
W	2	1914	Rembesdalsvatn	Sima	x	905	1.29					76463	6735115	0		27.07.67	6.90	1.16		124
W	2	1915	Holmavatn	Sima		1216	0.45					76822	6740581	0		16.08.67	6.70	1.00		124
W	2	17050	Skykkjedalsvatn	Sima		837	0.43					75584	6731638	2	0	13.09.08	6.65	1.48		56, 71
C/E	3A	1906	Isdalsvatnet	Isdølo		832	1.07					76533	6726176	2	1	14.06.88	6.52	2.12		1, 56, 67
C/E	3B	1907	Sysenvatn	Leiro	x	880	10.42			x		82835	6722461	3	2	29.07.67	6.60	0.88		56, 67, 124
C/E	3B	17070	Finsbergvatnet	Leiro		1190	1.23			x		95280	6728945	1	0	01.06.98	6.02	0.82		120, 121
C/E	3B	17084	Lassheldretjørni	Leiro		1227	0.15			x		90932	6729452	0						not conf.
C/E	3B	17092	Lassheldretjørni	Leiro		1165	0.06			x		92115	6729200	0						not conf.
C/E	3B	17095	Lassheldretjørni	Leiro		1165	0.10			x		91807	6729101	0						not conf.
C/E	3B	17114	Lassheldretjørni	Leiro		1154	0.26			x		91182	6728526	0						not conf.

Appendix 1. Continued.

Region	Catchm. no.	NVE ID	Lake	Catchment	Reg.	Altitude m a.s.l.	Area km^2	Min. depth m	Max. depth m	*S. alpinus*	*P. phoxinus*	EPSG:25833		No. exam.	No. pos. rec.	Date	pH	Ca mg L^{-1}	TOC mg C L^{-1}	References
C/E	3B	17149	Langavatnet	Leiro		1124	0.74			x		91211	6726281	1	0	05.08.99	6.03	0.62		121, 122
C/E	3B	17289	Halnetjørni	Leiro		1259	0.16					96421	6722876	1	1					79
C/E	3B	17291	Dalboretjørni	Leiro		1153	0.12					92974	6723206	1	0	04.08.97	6.38	0.85		25, 79
C/E	3B	17305	I. Olavsbuvatni	Leiro		1175	0.64					95206	6721531	2	1					79
C/E	3B	17322	Skardstjørnane	Leiro		1125	0.29					91140	6721561	0		04.08.97	6.51	1.91		25
C/E	3B	17369	Svartetjørni	Leiro		1141	0.14					90234	6721458	1	1	04.08.97	6.46	0.92		25
C/E	3B	17370	Skardstjørnane	Leiro		1126	0.12					90854	6721189	0		17.08.04	7.00	4.07		25
C/E	3B	17402	Dyratjørnane	Leiro		1173	0.25					92219	6719647	2	1	04.08.97	5.93	0.75		25, 79
C/E	3C	17720	Stigstutjørni	Svinto		1220	0.05					94317	6706801	2	1					42, 86
C/E	4	1910	Langavatnet	Bjoreio		1222	2.65					86436	6703503	4	3	09.10.97	7.10	4.85	1,2	79, 83, 86, 100
C/E	4	17673	Nøkkatjørni	Bjoreio		1353	0.12					80895	6710029	0		09.10.97	7.26	5.73	1,5	100
C/E	4	17865	Kleivshovdtjørna	Bjoreio		1215	0.82					89929	6701871	4	4					79,83,86
C/E	4	27430	Tinnhølen	Bjoreio		1213	4.54					90972	6704204	6	6	12.10.97	7.05	4.16	1,2	27, 67, 79, 83, 86, 100, 119
C/E	5	17531	Vassdalsvatni	Veig		1222	0.42					58355	6716740	1	0	09.10.97	7.00	1.68	<0,2	79, 100
C/E	5	17614	Reinavatnet	Veig		1082	0.26	6,7	21,0			61500	6714260	1	0					129
C/E	5	17616	Vasslivatn	Veig		1041	0.85	5,5	26,4			62549	6713510	3	2	27.07.67		0.96		79, 124, 129
C/E	5	17620	Vivetjørnane	Veig		1009	0.16					64265	6713570	1	0	27.07.67		1.00		124
C/E	5	17668	Langavatnet	Veig		1195	0.44	7,7	30,0			58651	6712245	2	0	09.10.97	7.03	1.67	1,0	79, 100, 129
C/E	5	17710	Nautavad	Veig		1060	0.11					61616	6710060	1	0					79
C/E	5	17715	Vatnalivatnet	Veig		1045	0.64					62617	6709369	3	2	09.10.97	7.23	3.45	1,2	10, 79, 100
C/E	5	17730	Hanasteinsvatnet	Veig		1196	0.07	5,9	11,0			56589	6709950	2	0					79, 128
C/E	5	17735	Skinhovda	Veig		1152	0.50	12,3	33,0			59177	6709412	2	1					79, 128
C/E	5	17737	Tresnutvatnet	Veig		1193	0.22	5,5	14,5			57334	6709418	2	1					79, 128
C/E	5	17849	Bersavikvatnet	Veig		1231	1.65	8,6	34,0			59771	6704861	2	2	09.10.97	7.26	3.32	0,4	79, 100, 128

Appendix 1. Continued.

Region	Catchm. no.	NVE ID	Lake	Catchment	Reg.	Altitude m a.s.l.	Area km^2	Min. depth m	Max. depth m	*S. alpinus*	*P. phoxinus*	EPSG:25833		No. exam.	No. pos. rec.	Date	pH	Ca mg L^{-1}	TOC mg C L^{-1}	References
C/E	5	17975	Vierslatjørn	Veig		1244	0.12					75911	6700837	2	0					19, 79
C/E	5	17997	Heisantjørnane	Veig		1244	0.20					76015	6699894	3	2	17.07.96	6.50	2.20		19, 25, 79, 86
C/E	5	18002	Øvre Solvatnet	Veig		1320	0.26					59097	6701176	0		09.10.97	7.28	2.96	0,4	100
C/E	5	18103	Langgrøvatnet	Veig		1347	0.32					65266	6698738	0		09.10.97	6.73	2.27	0,2	100
C/E	5	18157	Meinsvatnet	Veig		1371	0.28					62964	6697312	0		28.09.89	6.53	1.08	0,5	100
C/E	5	18224	Herrevatnet	Veig		1367	0.46					73027	6695197	3	1	09.10.97	7.11	5.54	0,4	79, 86, 100
C/E	5	18228	Nykktjørnane	Veig		1317	0.14					71445	6695987	1	1					79
C/E	5	18287	Grytevatnet	Veig		1396	0.34					61722	6695491	1	0					79
C/E	5	18409	Grøndalsvatni	Veig		1268	0.56					63593	6693034	4	2					15, 48, 53, 82
C/E	5	18434	Grøndalsvatni	Veig		1281	0.22					61784	6692865	2	1	09.10.97	7.15	3.08	0,3	48, 79, 100
C/E	5	67665	Nedre Vivevatn	Veig		1009	0.02					64814	6713675	2	0					124
C/E	6A	17300	Busetevatnet	Erdalsvassdr.		884	0.43	6,7	22,5			58125	6726003	3	1	30.07.67	6.90	1.40		79, 124, 129
C/E	6A	27433	Vetlevatnet	Erdalsvassdr.		884	0.06					57341	6725553	1	1					129
W	6B	27428	Vatnosetvatnet	Bjotveitelvi		869	0.44	7,8	27,0			52863	6726935	2	0					79, 129
C/E	7A	1912	Veivatnet	Kinso		1172	4.68	16,0	53,4			53384	6706672	4	2	05.08.67		3.16		79, 124, 128
C/E	7A	1913	N. Omkjelsvatnet	Kinso		1199	2.39					55086	6701409	2	1	07.08.67		2.32		79, 124
C/E	7A	17878	Kinsevatnet	Kinso		1184	0.26					56181	6704912	2	1	10.08.67		3.32		79
C/E	7A	18214	Sandvatnet	Kinso		1363	0.87					59963	6697198	1	0	09.10.97	7.16	2.32	0,3	79, 100
C/E	7A	27475	Trollavatnet	Kinso		1280	0.23					54314	6715304	0		31.10.95	6.60	1.40	0,5	100
C/E	7A	27476	Rjuvavatnet	Kinso		889	0.30					48598	6715537	2	0	26.08.67		2.24		79, 124
C/E	7A	27478	Stavalivatnet	Kinso		900	0.69	5,4	23,8			49566	6715667	3	2	26.08.67		2.12		79, 124
C/E	7A	27495	Lonavatnet	Kinso		1125	0.52					54075	6713136	2	1	09.10.97	6.79	1.59	0,4	79, 100
C/E	7A	27500	Kinsevatnet	Kinso		940	0.21					49818	6712693	2	0					79
C/E	7A	27510	Fodnastølsvatnet	Kinso		955	0.33					50687	6712409	2	0	09.10.97	7.22	3.89	1,2	79
C/E	7A	27523	Austmannavatnet	Kinso		1170	0.19	4,4	13,3			54407	6710520	3	0					79, 128

Appendix 1. Continued.

Region	Catchm. no.	NVE ID	Lake	Catchment	Reg.	Altitude m a.s.l.	Area km^2	Min. depth m	Max. depth m	*S. alpinus*	*P. phoxinus*	EPSG:25833		No. exam.	No. pos. rec.	Date	pH	Ca mg L^{-1}	TOC mg C L^{-1}	References
C/E	7A	27527	Gravdalsvatnet	Kinso		1012	0.12					50169	6710198	1	0					79
C/E	7A	27533	Holmavatnet	Kinso		1186	0.56	3,4	15,0			55661	6709363	3	1					79, 128
C/E	7A	27534	Nasavatnet	Kinso		1057	0.19					51466	6709620	1	0					79
C/E	7A	27573	Sperrådalsvatn	Kinso		1179	0.14					55531	6705279	1	0	10.08.67		2.44		124
C/E	7A	27637	Ø. Omkjelsvatnet	Kinso		1202	0.55					53915	6699113	2	0	09.10.97	7.07	1.93	0,2	79, 82, 100
W	7B	27436	Birgesdalsvatnet	Vivippo		1183	0.66					52528	6724099	1	0					79
W	7B	27444	Vassdalsvatnet	Vivippo		1122	0.43					48533	6723050	1	0					79
W	7B	27450	Grytingsvatn	Vivippo		700	0.24					48434	6721377	3	0					79
W	8	1904	Opesjovatnet	Opo		1014	1.25	8,8	36,0			44930	6712854	1	0	02.10.97	6.65	0.94	0,6	100, 124
W	8	27472	Kjølevatni	Opo		1108	0.28					44724	6716168	1	0					79
W	8	27473	Kjølevatni	Opo		1109	0.05					44306	6716792	0		02.10.97	6.14	0.71	0,5	100
W	8	27504	Skriksetvatn	Opo		1016	0.19					42663	6713653	1	0					79
W	8	27528	Yskjebotnvatnet	Opo		1105	0.75					43328	6709676	1	0	02.10.97	6.59	0.93	0,4	79, 100
W	9A	27611	Mostjørn	Espeelvi		1238	0.25					39059	6702750	1	0					85
W	9B	1903	St. Vendevatnet	Vendo	x	1268	3.64					41667	6704733	2	0	01.08.10	6.80	1.28		67, 69
W	10	1889	Ringedalsvatnet	Tysso	x	464	7.25					39127	6694395	6	0					18, 67, 91, 125
W	10	1890	Øvre Tyssevatn	Tysso	x	1333	2.92					49307	6698163	4	0	01.08.10	6.38	0.64		67, 69, 85, 125
W	10	1892	Nonskardvatnet	Tysso		1284	1.39					54087	6693281	2	0	09.10.97	6.67	0.95	0,2	85, 100, 125
W	10	1893	Øvre Bersåvatnet	Tysso	x	1106	3.37					40547	6699937	3	0					67, 85, 125
W	10	1894	Nibbehølen	Tysso	x	1191	2.06					46031	6690183	4	0	01.08.10	6.40	0.64		67, 69, 85, 125
W	10	1897	Øvre Nybuvatnet	Tysso		1191	0.68					50202	6690302	3	0					67, 85, 125
W	10	1898	N. Håvardsvatn	Tysso	x	1264	5.46					54458	6690703	5	0	01.08.10	6.67	1.03		67, 68, 69, 85, 125

Appendix 1. Continued.

Region	Catchm. no.	NVE ID	Lake	Catchment	Reg.	Altitude m a.s.l.	Area km^2	Min. depth m	Max. depth m	*S. alpinus*	*P. phoxinus*	EPSG:25833		No. exam.	No. pos. rec.	Date	pH	Ca mg L^{-1}	TOC mg C L^{-1}	References
W	10	1900	N. Bersåvatnet	Tysso	x	1029	0.88					38299	6698844	3	0					67, 85, 125
W	10	1901	Langevatnet	Tysso	x	1190	6.36					41622	6687621	5	0	01.08.10	6.28	0.53		67, 68, 69, 85, 125
W	10	1902	Breidavatn	Tysso	x	1232	3.35					47989	6685761	3	0					67, 85, 125
W	10	18713	Jukletjørn	Tysso		1431	0.52					56089	6688253	0		15.09.97	6.23	0.59	0,3	100
W	10	18887	Juklevatni	Tysso		1430	0.38					56982	6684844	0		09.10.97	6.31	0.41	<0,2	100
W	10	27600	Illakleivløkene	Tysso		1362	1.28					50388	6701774	0		09.10.97	6.29	0.43	<0,2	100
W	10	27650	Nedre Tyssevatn	Tysso		1317	0.43					48130	6697391	3	0					67, 85, 125
W	10	27661	Hadletgrøna	Tysso		1264	0.35					42541	6697205	1	0					85
W	10	27662	Hadletgrøna	Tysso		1349	0.04					41824	6697460	4	0					85
W	10	27663	Holmevatn	Tysso		1271	0.84					45895	6696516	4	0	01.08.10	6.36	0.64		67, 69, 85, 125
W	10	27668	Selsløken	Tysso		1323	0.56					52128	6695930	0		09.10.97	6.51	0.53	0,2	100
W	10	27669	N. Veidedalsvatn	Tysso		1312	0.15					47503	6696107	1	0					85
W	10	27672	Stednesvatnet	Tysso		1213	0.15					44070	6695812	2	0					67, 85
W	10	27677	Ø. Veidedalsvatn	Tysso		1333	0.22					49095	6694926	1	0					85
W	10	27680	Tyssehølen	Tysso		1162	0.11					43332	6695188	1	0					67
W	10	27682	Reinakolltjørn	Tysso		1359	0.18					45595	6694481	1	0					85
W	10	27758	Hattasteinsvatnet	Tysso		1287	0.92					47553	6683669	1	0					85
W	10	27762	Løkene	Tysso		1309	0.16					49829	6683280	0		09.10.97	6.08	0.69	<0,2	100
W	11	1702	Reinsnosvatnet	Austdølo		594	3.35					36722	6675691	1	0					79
W	11	1703	Isvatnet	Austdølo		1223	1.78					44738	6676790	0		21.09.95	5.35	0.38	<0,2	100
W	11	23143	Ljosevatn	Austdølo		630	0.57					38106	6678046	1	0					79
W	11	23161	Svartavatn	Austdølo		813	0.26					41372	6676488	1	0					79
W	11	23168	Raudnosvatnet	Austdølo		978	0.23					42015	6675600	0		02.10.97	5.95	0.37	0,3	100
W	11	27797	Søre Blåvatnet	Austdølo		1219	0.62					44889	6681121	0		09.10.97	5.66	0.33	<0,2	100

Appendix 1. Continued.

Region	Catchm. no.	NVE ID	Lake	Catchment	Reg.	Altitude m a.s.l.	Area km^2	Min. depth m	Max. depth m	*S. alpinus*	*P. phoxinus*	EPSG:25833		No. exam.	No. pos. rec.	Date	pH	Ca mg L^{-1}	TOC mg C L^{-1}	References
W	12	1866	Valldalsvatnet	Suldals-vassdr	x	745	7.33					50628	6672273	2	0	01.08.11	6.33	0.63		67, 69, 70
W	12	11783	Vivassvatnet	Suldals-vassdr		930	0.48					52601	6675590	0		02.10.97	6.17	0.79	0,4	100
W	12	23154	Grønhellervatn	Suldals-vassdr		1006	0.11					50924	6676616	0		02.10.97	5.93	0.60	0,2	100
W	13	55	Bordalsvatnet	Bora	x	891	7.69				x	70888	6656673	3	0	15.09.83	6.50	2.62		50, 77, 80, 105
W	13	85	Holmasjøen	Bora		1261	1.89					63572	6667242	0		21.09.95	5.84	0.36	0,2	100
W	13	12118	Åremotvatni	Bora	x	1180	1.13					68743	6665138	1	0	15.09.83	5.90	1.08		50, 106
W	13	12157	N. Poddevatnet	Bora	x	1203	0.39					66134	6665519	0		15.09.83	6.50	1.68		50
C/E	14	10	Songa	Songa	x	974	30.01				x	82524	6659180	13	7	12.09.84	6.40	1.63		2, 20, 50, 76, 86, 96, 104, 107, 112
C/E	14	25	Storhellervatnet	Songa		1108	0.56					72762	6664387	0		12.09.04	6.20	0.76		50
C/E	14	11734	Store Urevatnet	Songa		1255	1.00					72331	6674883	1	0	15.09.83	6.60	3.11		50, 79
C/E	14	11743	Hedlevatnet	Songa		1161	2.07					67627	6674859	1	1	02.10.97	6.75	2.04	0,3	50, 100
C/E	14	11786	Bamsetjørn	Songa		1348	0.12					74737	6673951	1	0					50
C/E	14	11904	Filleherbergvatn	Songa		1149	0.37					70429	6671441	1	0					50
C/E	14	11933	Øvre Berutjørni	Songa		1307	0.42					81745	6669624	2	0	12.09.84	6.00	0.62		50, 76
C/E	14	12024	Midtre Berutjørni	Songa		1289	0.23					81376	6667306	1	0	02.10.97	6.22	0.52	0,5	50, 100
C/E	14	12029	Gjevdøltjørni	Songa		1285	0.19					85697	6667223	0		13.09.83	6.03	0.62		101
C/E	14	12030	Ugletjørni	Songa		1195	0.88					87497	6666718	1	1	02.10.97	6.30	0.53	1,2	100
C/E	14	12092	Nedre Berutjørni	Songa		1242	0.13					81943	6665987	1	0	15.09.83	5.80	0.96		50
C/E	14	19129	Tangasjøen	Songa		1401	0.41					64777	6678455	0		02.10.97	6.82	2.10	<0,2	100

Appendix 1. Continued.

Region	Catchm. no.	NVE ID	Lake	Catchment	Reg.	Altitude m a.s.l.	Area km^2	Min. depth m	Max. depth m	*S. alpinus*	*P. phoxinus*	EPSG:25833		No. exam.	No. pos. rec.	Date	pH	Ca mg L^{-1}	TOC mg C L^{-1}	References
C/E	15	12	Vollevatnet	Kvenna		1030	1.66	3,3	11,5			94853	6676114	5	2	13.09.83	6.63	1.33		59, 60, 88, 101, 126
C/E	15	13	Briskevatnet	Kvenna		1068	2.62	8,2	22,1			89550	6677403	4	3	15.09.83	6.60	3.74		50, 58, 60, 88
C/E	15	14	Gunleiksbuvatnet	Kvenna		1071	1.29	1,6	7,2			85362	6678032	5	4	15.08.95	6.62	1.59		60, 88, 126, 127
C/E	15	15	N. Bjørnavatnet	Kvenna		1136	2.13					75023	6679965	2	1	02.10.97	6.78	2.13	0,6	100, 126, 127
C/E	15	16	Ø. Bjørnavatnet	Kvenna		1147	2.92					71335	6679440	5	4	15.08.95	6.53	1.46		62
C/E	15	17	Sandvatn	Kvenna		1112	1.57	2,6	13,0			82122	6681359	15	13	12.09.84	6.40	1.15		50, 60, 90, 92, 93
C/E	15	18	Nedre Krokavatn	Kvenna		1141	1.16					77610	6684108	2	1	03.07.78	6.70	2.73		62,126
C/E	15	19	Kvennsjøen	Kvenna		1166	5.00					66324	6684631	4	4	15.08.95	6.62	1.43		62, 82, 86, 126, 127
C/E	15	38	Skardvatnet	Kvenna		1149	0.97					93901	6682778	2	2					61
C/E	15	39	Fjellsjåen	Kvenna		1195	2.31	8,1	26,0			90148	6684863	7	6	16.08.95	6.37	0.74		61, 90, 127
C/E	15	40	Urdevatnet	Kvenna		1329	1.55					93521	6669198	3	2	16.08.95	6.00	0.44		86, 126, 127
C/E	15	41	Store Meinsvatn	Kvenna		1384	1.40					93738	6667249	4	2	12.09.84	5.90	0.59		50, 64, 86, 126
C/E	15	42	Valgardsvatni	Kvenna		1319	1.84					74012	6688631	4	3	16.08.95	6.36	1.42		79, 82, 86, 126, 127
C/E	15	43	Litlosvatnet	Kvenna		1170	1.52	10,2	25,0			63673	6686656	8	5	15.08.95	6.56	1.19		17, 48, 62, 82, 86, 99, 126, 127
C/E	15	78	Gjuvsjåen	Kvenna		1210	5.11					101369	6681191	1	1	21.09.95	6.44	0.66	1,4	86, 100
C/E	15	11729	Brutjørnane	Kvenna		1250	0.29					82473	6674617	0		02.10.97	6.67	1.37	2,1	100
C/E	15	11763	Møruvatnet	Kvenna		1163	0.47					89964	6673078	1	1	02.10.97	6.22	0.82	0,5	58, 100
C/E	15	11808	Merakktjørni	Kvenna		1291	0.46					83274	6672489	1	0					50

Appendix 1. Continued.

Region	Catchm. no.	NVE ID	Lake	Catchment	Reg.	Altitude m a.s.l.	Area km^2	Min. depth m	Max. depth m	*S. alpinus*	*P. phoxinus*	EPSG:25833		No. exam.	No. pos. rec.	Date	pH	Ca mg L^{-1}	TOC mg C L^{-1}	References
C/E	15	11836	V. Meinsvatnet	Kvenna		1353	0.57					96007	6670387	4	3	16.08.95	6.05	0.46		86, 126, 127
C/E	15	11937	Ormetjørni	Kvenna		1273	0.73					84810	6669553	1	0	24.09.86	5.92	0.61	0,6	100
C/E	15	12053	Kolsnutgrysline	Kvenna		1386	0.50					97056	6665449	3	2	15.09.83	5.50	0.79		50, 86, 126
C/E	15	12135	Hokkebrotvatnet	Kvenna		1383	0.52					94405	6663497	1	0	13.09.83	5.81	0.69		50, 64, 101
C/E	15	12153	Kostveitvatnet	Kvenna		1383	0.28					96143	6663200	2	0					50, 64, 101
C/E	15	12173	Kostveitvatnet	Kvenna		1390	0.93					96393	6661411	2	0	13.09.83	5.78	0.64		50, 64, 101
C/E	15	18495	Grottjørnanene	Kvenna		1322	0.44					71055	6690732	1	0	10.07.78	6.60	3.46		126
C/E	15	18511	Reinavatnet	Kvenna		1327	0.63					79782	6689329	2	0	31.07.03	6.96	2.40		25, 79
C/E	15	18523	Elsjåen	Kvenna		1233	0.08					95298	6688551	0		21.09.94	6.76	1.94		117
C/E	15	18545	Sledalsvatnet	Kvenna		1288	0.43					58269	6691313	1	0					63
C/E	15	18556	Valgardsvatni	Kvenna		1322	0.80					72971	6689771	1	0					79
C/E	15	18558	Krokavatnet	Kvenna		1236	0.42	8,6	16,0			60847	6691012	8	2	06.07.78	6.80	2.57		8, 54, 63, 82, 102, 126
C/E	15	18581	Ambjørsvatnet	Kvenna		1269	0.81					66343	6689682	2	0	11.09.97	6.60	2.33	0,4	11, 48, 100
C/E	15	18597	Skavatn	Kvenna		1249	0.47	5,7	15,0			64063	6690187	4	2	08.07.78	6.70	5.04		48,49,63,126
C/E	15	18660	Storhellertjørni	Kvenna		1270	0.15					101243	6685788	0		21.09.94	6.16	0.38		117
C/E	15	18700	Kollsvatnet	Kvenna		1182	0.61	6,5	13,0			61644	6688435	12	9	11.09.97	6.70	1.50	0,7	16, 17, 48, 49, 63, 82, 86, 87, 100, 102
C/E	15	18735	Kollstjørn	Kvenna		1332	0.59					58549	6688256	0		15.09.97	6.31	0.65	<0,2	100
C/E	15	18770	Blånuttjørnane	Kvenna		1310	0.31	6,1	31,0			83830	6685129	1	1	09.10.97	6.72	2.30	1,1	95, 100
C/E	15	18773	Krokavatni	Kvenna		1150	1.21					72085	6684881	1	1					62
C/E	15	18782	Vassdalsvatni	Kvenna		1282	0.45					61466	6686400	2	0	15.09.97	6.26	1.25	0,4	48,63,100
C/E	15	18827	Dargesjåen	Kvenna		1205	0.64	4,7	15,0			87775	6683553	7	4	17.08.95	6.30	0.67		61, 90, 98, 126, 127
C/E	15	18831	Vassdalsvatni	Kvenna		1299	0.74					59870	6685608	1	0					63

Appendix 1. Continued.

Region	Catchm. no.	NVE ID	Lake	Catchment	Reg.	Altitude m a.s.l.	Area km^2	Min. depth m	Max. depth m	*S. alpinus*	*P. phoxinus*	EPSG:25833		No. exam.	No. pos. rec.	Date	pH	Ca mg L^{-1}	TOC mg C L^{-1}	References
C/E	15	18854	Kringlesjåen	Kvenna		1255	0.72	4,5	14,0			89249	6682690	5	4	17.08.95	6.31	0.64		61, 90, 126, 127
C/E	15	18894	Mjågevatn	Kvenna		1148	0.70					95370	6680696	0		02.10.97	6.64	1.01	1,5	100
C/E	15	18910	Tjønndalstjønnan	Kvenna		1205	0.35					90674	6681005	0		15.09.83	6.30	2.04		50
C/E	15	18919	Tuevatni	Kvenna		1282	0.36					69955	6682678	1	0					82
C/E	15	18923	Tuevatni	Kvenna		1288	0.26					68807	6682727	1	1					82
C/E	15	18954	Holmavatnet	Kvenna		1204	1.75					58483	6682042	1	1					Artsdata-banken.no
C/E	15	19079	Honserudvatnet	Kvenna		1045	0.38					93458	6676917	2	1					59, 88
C/E	15	19228	Vollenuttjørnan	Kvenna		1303	0.20					95786	6674151	0		02.10.97	6.39	0.73	0,9	100
C/E	15	66946	Midtre Krokavatn	Kvenna		1141	0.93					74249	6684438	1	1					62
C/E	16	3	Møsvatn	Møsvatn	x	919	78.77			x	x	114017	6655587	2	1	15.09.83	5.90	0.84		2, 50
C/E	16	37	Langesjå	Møsvatn		1145	6.99					126347	6662765	1	1	12.09.84	6.80	1.31		50
C/E	16	11881	Mortåtjørni	Møsvatn		1241	0.86					106073	6668293	0		12.09.84	5.40	0.48		50
C/E	16	12032	Bukketjørn	Møsvatn		1240	0.25					117722	6664058	0		13.09.83	6.05	0.71		101
C/E	16	12040	Reinarvatnet	Møsvatn		1394	0.31					107009	6665028	0		13.09.83	5.19	0.78		101
C/E	16	12073	Grunnostjørni	Møsvatn		1208	0.42					121236	6662626	0		15.09.83	6.20	1.19		50
C/E	16	12106	Kolsnutgrysline	Møsvatn		1352	0.61					98755	6663772	1	0					64
C/E	16	12146	Tuddøltjørn	Møsvatn		1237	0.63					116638	6661056	0		13.09.83	5.67	0.70		101
C/E	16	12178	Landsetvatnet	Møsvatn		1077	0.22					140859	6658142	1	0					9
C/E	16	12188	Middøltjønne	Møsvatn		1072	0.06					141341	6658117	1	0					9
C/E	16	12268	Bågåfjelltjørni	Møsvatn		1003	0.08				x	121187	6657991	0						Artsdata-banken.no
C/E	16	12395	Hondletjørni	Møsvatn		924	0.24				x	123124	6652780	1	0					50
C/E	16	12409	Finnerottjørni	Møsvatn		923	0.17					123664	6653003	1	0					50

Appendix 1. Continued.

Region	Catchm. no.	NVE ID	Lake	Catchment	Reg.	Altitude m a.s.l.	Area km^2	Min. depth m	Max. depth m	*S. alpinus*	*P. phoxinus*	EPSG:25833		No. exam.	No. pos. rec.	Date	pH	Ca mg L^{-1}	TOC mg C L^{-1}	References
C/E	17	36	Mår	Mår/ Gøyst	X	1121	20.55					123922	6685973	12	10	12.09.84	6.10	0.94		2, 50, 57, 91, 109
C/E	17	73	Nedre Grottetjørn	Mår/ Gøyst		1064	0.79			x		133315	6667777	0						Artsdata-banken.no
C/E	17	74	Øvre Grottetjørn	Mår/ Gøyst		1069	1.10			x		131592	6668643	0						Artsdata-banken.no
C/E	17	75	Gøystvatnet	Mår/ Gøyst	x	1087	31.26				x	123821	6676361	8	7	15.09.83	6.00	0.67		2, 50, 57, 109
C/E	17	92	Rosjå	Mår/ Gøyst		1174	2.03					134023	6680450	1	1	12.09.84	6.80	2.41		9, 50
C/E	17	93	Vråsjåen	Mår/ Gøyst		1115	2.68					113053	6676124	1	1	12.09.84	6.10	0.64		50, 66, 86
C/E	17	94	Kallungsjåen	Mår/ Gøyst		1246	3.17					106784	6684434	1	1	02.10.97	6.49	0.57	1,6	86, 100
C/E	17	96	Eidsjoren	Mår/ Gøyst		1229	2.05					110808	6693400	1	1	21.09.94	6.44	0.90		78, 117
C/E	17	103	Reksjå	Mår/ Gøyst		1207	2.81					119289	6681420	1	1	13.09.83	5.68	0.75		86, 101
C/E	17	104	Hettefjorden	Mår/ Gøyst		1228	2.33					113371	6691453	1	1	21.09.94	6.39	0.74		78, 117
C/E	17	107	Store Saure	Mår/ Gøyst		1120	1.63					115955	6674870	3	2	15.09.83	5.80	0.79		50, 66, 74
C/E	17	108	Kalven	Mår/ Gøyst		1294	1.35					110072	6689697	1	1	21.09.94	6.09	0.42		78
C/E	17	109	Viuvatnet	Mår/ Gøyst		1324	3.03					109773	6687654	1	1	15.08.00	6.12	0.47	2,2	86, 97
C/E	17	11750	Prestevatnet	Mår/ Gøyst		1078	0.36			x		131775	6669784	0						Artsdata-banken.no
C/E	17	17925	Skjortetjørnan	Mår/ Gøyst		1161	0.16					117274	6698507	0		21.09.94	6.50	1.66		117
C/E	17	18132	Austre Søltjørni	Mår/ Gøyst		1197	0.60					128236	6692302	0		21.09.94	6.24	0.50		117
C/E	17	18133	Kosadalsvatnet	Mår/ Gøyst		1136	0.55					116563	6693404	0		21.09.94	6.65	1.47		117
C/E	17	18187	Vestre Søltjørni	Mår/ Gøyst		1182	0.38					125474	6691715	0		21.09.94	6.29	0.56		117
C/E	17	18456	Melrakktjørnane	Mår/ Gøyst		1278	0.14					118023	6687392	0		21.09.94	6.55	1.33		117
C/E	17	18562	Tangetjørnan	Mår/ Gøyst		1261	0.23					101792	6687524	0		21.09.94	6.19	0.43		117
C/E	17	18642	Viktjørn	Mår/ Gøyst		1354	0.40					118551	6684136	0		24.09.95	6.02	0.44	0,5	100
C/E	17	18661	Sletteidvatni	Mår/ Gøyst		1303	0.13					114440	6684637	0		15.09.83	5.80	0.51		50

Appendix 1. Continued.

Region	Catchm. no.	NVE ID	Lake	Catchment	Reg.	Altitude m a.s.l.	Area km^2	Min. depth m	Max. depth m	*S. alpinus*	*P. phoxinus*	EPSG:25833		No. exam.	No. pos. rec.	Date	pH	Ca mg L^{-1}	TOC mg C L^{-1}	References
C/E	17	18679	Sletteidvatni	Mår/ Gøyst		1302	0.99					114495	6684111	1	1	13.09.83	5.76	0.55		101
C/E	17	18698	Sletteidvatni	Mår/ Gøyst		1306	0.42					112017	6683971	1	0	15.09.83	5.60	0.65		50, 101
C/E	17	18721	Ljostjørn	Mår/ Gøyst		1178	0.42					134529	6681268	1	1					9
C/E	17	18845	Bakketjørn	Mår/ Gøyst		1155	0.35					122801	6679611	0		13.09.83	6.05	0.84		101
C/E	17	19044	Torstjørni	Mår/ Gøyst		1220	0.38					109305	6676249	0		21.09.95	6.25	0.53	1,0	100
C/E	17	19068	Lontjørnane	Mår/ Gøyst		1160	0.11			x		134889	6673742	0						Artsdata-banken.no
C/E	17	19072	Reinstjørni	Mår/ Gøyst		1200	0.03			x		124648	6674654	0						Artsdata-banken.no
C/E	17	19104	Ormtjørnane	Mår/ Gøyst		1119	0.03			x		134753	6672967	0						Artsdata-banken.no
C/E	17	19121	Store Vålåsjå	Mår/ Gøyst		1110	0.52			x		135987	6672308	0						Artsdata-banken.no
C/E	17	19131	Vesle Saure	Mår/ Gøyst		1147	0.99					113143	6673633	0		12.09.84	6.00	0.66		50
C/E	17	19132	Langtjørn	Mår/ Gøyst		1089	0.04			x		132602	6672530	0						Artsdata-banken.no
C/E	17	19152	Nålvatnet	Mår/ Gøyst		1082	0.17			x		133373	6671998	0						Artsdata-banken.no
C/E	17	19162	Store Nivstjørn	Mår/ Gøyst		1082	1.50			x		133015	6670974	0						Artsdata-banken.no
C/E	17	36649	Haraldsjå	Mår/ Gøyst		1080	1.02			x		131505	6671824	0		15.09.83	6.70	2.69		50
C/E	18A	385	Skarvsvatnet	Uvdalselvi		1117	3.68					125273	6704599	1	1	21.09.94	6.76	1.37		86, 117
C/E	18A	411	Tøddølvatnet	Uvdalselvi		1101	1.29					129152	6706737	1	1	12.10.97	7.20	4.82	2,0	86, 100
C/E	18A	427	Store Ormetjørni	Uvdalselvi		1187	0.71					130989	6709879	1	0	21.09.94	6.85	2.01		47, 117
C/E	18A	17543	Tjørngrøtjørnane	Uvdalselvi		1195	0.05					133342	6710378	0		29.10.95	6.19	0.81	3,8	100
C/E	18A	17773	Bollatjørni	Uvdalselvi		1181	0.72					126457	6701741	0		21.09.94	6.61	1.37		117

Appendix 1. Continued.

Region	Catchm. no.	NVE ID	Lake	Catchment	Reg.	Altitude m a.s.l.	Area km^2	Min. depth m	Max. depth m	*S. alpinus*	*P. phoxinus*	EPSG:25833		No. exam.	No. pos. rec.	Date	pH	Ca mg L^{-1}	TOC mg C L^{-1}	References
C/E	18A	17790	Kruketjørna	Uvdalselvi		1137	0.17					131680	6700934	0		21.09.94	6.55	1.28		117
C/E	18A	17796	Fiskeløktjørni	Uvdalselvi		1184	0.86					129576	6700826	0		21.09.94	6.27	0.66		117
C/E	18A	17823	Langetjørni	Uvdalselvi		1149	0.48			x	x	130951	6699604	0		21.09.94	6.08	0.54		117
C/E	18A	17868	Gryttjørni	Uvdalselvi		1206	0.29					133127	6698172	0		21.09.94	6.76	1.88		117
C/E	18A	17887	Gråvårtjørn	Uvdalselvi		1213	0.20					129358	6698072	0		21.09.94	5.98	0.42		117
C/E	18B	409	Vikvatn	Ølmosåi		1064	1.22					133668	6694102	4	3	21.09.94	6.68	1.45		75, 86, 110, 115
C/E	18B	410	Smågefjorden	Ølmosåi		1172	2.37					126931	6695185	1	1	21.09.94	6.33	0.58		86,117
C/E	18B	426	Damtjørn	Ølmosåi		1223	0.44					143460	6698024	1	0					115
C/E	18B	17810	Mjågesjoren	Ølmosåi		1205	0.25					136935	6699369	0		21.09.94	6.95	2.78		117
C/E	18B	17837	Falkenuttjørnane	Ølmosåi		1271	0.13					127220	6699829	0		21.09.94	5.97	0.46		117
C/E	18B	17848	Ø. Halstjørnane	Ølmosåi		1190	0.11					122882	6699607	0		29.10.95	6.56	1.64	2,1	100
C/E	18B	17867	Halstjørn	Ølmosåi		1190	0.42					123493	6698934	1	1	21.09.94	6.54	1.20		86, 117
C/E	18B	17935	Dragøytjørni	Ølmosåi		1172	0.23					124531	6697263	0		21.09.94	6.35	0.90		117
C/E	18B	17949	Sønstevatnet	Ølmosåi	x	1060	12.53					142350	6693775	4	3	21.09.94	6.55	1.27		75, 86, 115, 117
C/E	18B	17979	Kvonneviertjørni	Ølmosåi		1103	0.11					131830	6695521	1	1					86
C/E	18B	18052	N. Afdalstjørni	Ølmosåi		1102	0.27					131663	6693752	0		21.09.94	6.29	0.65		117
C/E	18B	18055	N. Holstadtjørni	Ølmosåi		1198	0.28					124708	6694234	0		21.09.94	6.15	0.39		117
C/E	18B	18089	S. Holstadtjørni	Ølmosåi		1199	0.25					125832	6693465	0		21.09.94	6.32	0.62		117
C/E	18B	18191	N. Nutetjørnane	Ølmosåi		1217	0.19					134645	6690674	0		21.09.94	6.64	1.59		117
C/E	18B	18264	Store Gryttjørni	Ølmosåi		1234	0.39					137346	6688573	0		21.09.94	6.63	1.42		117
C/E	19A	390	Orsjoren	Lågen		951	2.37			x	x	125791	6712627	5	4	21.09.94	6.73	1.57		3, 21, 23, 114, 117
C/E	19A	391	Veslekrækkja	Lågen		1148	1.98	4,3	15,5		x	103447	6720601	4	3	21.09.94	6.27	0.64		3, 52, 116, 117, 124

Appendix 1. Continued.

Region	Catchm. no.	NVE ID	Lake	Catchment	Reg.	Altitude m a.s.l.	Area km^2	Min. depth m	Max. depth m	*S. alpinus*	*P. phoxinus*	EPSG:25833		No. exam.	No. pos. rec.	Date	pH	Ca mg L^{-1}	TOC mg C L^{-1}	References
C/E	19A	392	Storekrekkja	Lågen		1151	4.18	8,0	26,5		x	101435	6723196	1	1	21.09.94	6.09	0.48		116, 117
C/E	19A	393	Dragøyfjorden	Lågen		1180	3.33	10,0	42,0			98419	6725710	13	9	31.05.93	5.49	0.65		79, 116, 123
C/E	19A	394	Geitsjøen	Lågen		1112	3.22	7,0	22,8			113050	6706544	4	3	22.07.67	6.90	1.32		3, 23, 124
C/E	19A	395	Langesjøen	Lågen		1210	11.04	4,0	16,0			97530	6698934	8	7	29.10.95	6.61	1.56	1,6	6, 23, 84, 100, 108, 109, 113
C/E	19A	396	Geitvatnet	Lågen		1197	1.55	2,8	11,8			105307	6695177	2	0	21.09.94	6.52	1.18		28, 34, 117
C/E	19A	414	Øvre Hein	Lågen		1113	6.33				x	106335	6714906	4	2	21.09.94	6.56	1.11		3, 116, 117, 124
C/E	19A	415	Halnefjorden	Lågen		1130	13.70				x	101185	6715697	15	12	21.09.94	6.72	1.81		2, 3, 52, 72, 94, 109, 116, 117, 124
C/E	19A	416	Skrykken	Lågen		1158	5.09					116530	6700686	4	3	21.09.94	6.51	1.30		3, 23, 117
C/E	19A	417	Krossvatnet	Lågen		1165	1.69					111939	6699586	0		21.09.94	6.59	1.29		117
C/E	19A	418	Bjornesfjorden	Lågen		1223	18.38					93966	6692522	7	7	21.09.94	6.55	1.38		4, 5, 7, 65, 108, 113, 117
C/E	19A	419	Lakjen	Lågen		1243	3.12					85395	6693471	3	3	02.10.97	6.93	3.03	1,0	25, 79, 83, 100
C/E	19A	420	Nordmannslågen	Lågen		1244	10.88					79991	6697139	7	5	30.07.98	6.87	2.40		25, 79, 83, 86
C/E	19A	421	Dimmedalsvatnet	Lågen		1334	1.70					75845	6690862	5	3	11.07.78	6.80	2.53		79, 82, 86, 126
C/E	19A	428	Skaupsjøen	Lågen		1155	2.95				x	96915	6712322	3	1	21.09.94	6.85	2.59		26, 94, 117
C/E	19A	17018	Svartevasstjørni	Lågen		1237	0.40	4,8	18,0			99168	6730136	15	8	25.07.93	5.74	0.28		14, 41, 43, 44, 45, 46, 118
C/E	19A	17040	Svartevatnet	Lågen		1233	1.13	6,9	28,0			99538	6728768	14	4	25.07.93	5.69	0.35		41, 43, 44, 46, 79, 118

Appendix 1. Continued.

Region	Catchm. no.	NVE ID	Lake	Catchment	Reg.	Altitude m a.s.l.	Area km^2	Min. depth m	Max. depth m	*S. alpinus*	*P. phoxinus*	EPSG:25833		No. exam.	No. pos. rec.	Date	pH	Ca mg L^{-1}	TOC mg C L^{-1}	References
C/E	19A	17318	Langetjørni	Lågen		1201	0.31					114730	6720445	1	1					23
C/E	19A	17320	Sandtjørni	Lågen		1167	0.02				x	117391	6720331	0						40
C/E	19A	17332	Båtstjørni	Lågen		1157	0.71				x	102267	6721178	0		21.09.94	6.66	1.47		117, 40
C/E	19A	17336	Urdetjørni	Lågen		1164	0.11			x	x	117501	6719802	0						40
C/E	19A	17343	Breidvatnet	Lågen		1162	1.00			x	x	118578	6719115	2	2					23, 24
C/E	19A	17364	Korta	Lågen		1163	0.26			x	x	117084	6718774	0						40
C/E	19A	17366	Nedre Bjørkevatn	Lågen		1161	0.84			x	x	120435	6717924	4	4	21.09.94	6.84	2.13		3, 117
C/E	19A	17397	Heinumgen	Lågen		1138	0.37				x	105066	6718724	2	1	21.09.94	6.34	0.80		3, 116, 117, 124
C/E	19A	17411	Hetjørni	Lågen		1162	0.22				x	96712	6718971	1	0					79
C/E	19A	17422	Raudtjørn	Lågen		1156	0.15			x		122037	6716573	0						40
C/E	19A	17454	Bjordalsvatn	Lågen		1121	0.52			x		118134	6715599	3	3	21.09.94	6.97	3.12		3, 109, 117
C/E	19A	17456	Herbutjørnan	Lågen		1183	0.18					114588	6715696	0		12.10.97	7.21	5.01	2,8	100
C/E	19A	17460	Orsjøtjørni	Lågen		1079	0.43			x	x	122190	6714827	1	1	21.09.94	6.80	1.88		3, 117
C/E	19A	17477	Skiftesjøen	Lågen		1236	0.82					90493	6716874	7	7					43, 44
C/E	19A	17492	Grønenuttjørnan	Lågen		1180	0.10					111175	6714372	0		12.10.97	7.14	4.47	2,7	100
C/E	19A	17565	Lometjørni	Lågen		1225	0.28					99207	6712469	0		21.09.94	6.57	1.06		117
C/E	19A	17583	Nedre Hein	Lågen		1075	1.23				x	113349	6710330	5	1	26.07.92	6.61	1.50		3, 52, 116, 124
C/E	19A	17584	Skaupungen	Lågen		1150	0.17				x	102161	6711896	1	0	14.07.67		1.76		124
C/E	19A	17591	Halstjørni	Lågen		1022	0.08					119782	6710045	1	0					3
C/E	19A	17612	Vesle Selstjørni	Lågen		1128	0.10					109866	6710191	2	0					3
C/E	19A	17617	Store Selstjørni	Lågen		1135	0.49					107988	6709350	3	1	21.09.94	6.96	2.96		3, 86, 117, 124
C/E	19A	17624	Skaupsjøtjørnan	Lågen		1157	0.34					100267	6710074	0		21.09.94	6.68	1.97		117
C/E	19A	17653	Nordskarvet	Lågen		1123	1.70					120711	6706344	0		21.09.94	6.39	1.00		117

Appendix 1. Continued.

Region	Catchm. no.	NVE ID	Lake	Catchment	Reg.	Altitude m a.s.l.	Area km^2	Min. depth m	Max. depth m	*S. alpinus*	*P. phoxinus*	EPSG:25833		No. exam.	No. pos. rec.	Date	pH	Ca mg L^{-1}	TOC mg C L^{-1}	References
C/E	19A	17682	Kalvetjørnan	Lågen		1170	0.43				x	100511	6707809	1	1					86, 117
C/E	19A	17685	Kalvetjørnan	Lågen		1170	0.06				x	99694	6708108	0		21.09.94	6.84	2.40		117
C/E	19A	17746	Stigstuvtjørni	Lågen		1212	0.06				x	94207	6705959	1	1					86
C/E	19A	17750	Holmetjørnane	Lågen		1207	0.77				x	97434	6705361	1	1					86
C/E	19A	17800	Dagfisketjørni	Lågen		1167	0.88					112359	6701694	0		21.09.94	6.72	1.71		117
C/E	19A	17807	A Bakkatjørn	Lågen		1213	0.60					94866	6703502	0		21.09.94	6.60	1.77		117
C/E	19A	17826	Flotatjørni	Lågen		1209	0.77					102363	6702249	2	2	21.09.94	6.76	2.03		84, 117
C/E	19A	17843	V. Bakketjørn	Lågen		1211	1.63					93717	6702002	1	1	21.09.94	6.35	1.10		86, 117
C/E	19A	17898	Nordvatnet	Lågen		1256	1.02					78918	6701916	3	3	29.10.95	6.52	3.30	1,0	79, 83, 86, 100
C/E	19A	17899	Kleivshovdtjørn	Lågen		1214	0.44					92044	6700797	1	1	21.09.94	6.51	1.20		86, 117
C/E	19A	17908	Langesjøtjørni	Lågen		1209	0.26					105566	6699604	2	0	21.09.94	6.66	1.74		84, 117
C/E	19A	17959	Holmavatn	Lågen		1260	0.10					80443	6700892	1	1					79
C/E	19A	17965	Skrovstjørni	Lågen		1222	0.13					92249	6699618	1	1					86
C/E	19A	17981	Brutjørnan	Lågen		1220	0.59					93030	6698601	0		21.09.94	6.68	1.52		117
C/E	19A	17999	Lomavikan	Lågen		1210	0.21					95448	6698337	0		21.09.94	6.57	1.44		117
C/E	19A	18023	Storfisktjørni	Lågen		1235	1.13					90270	6697238	1	1	21.09.94	6,77	2,17		86, 117
C/E	19A	18050	Torjustjørnan	Lågen		1220	0.63					98330	6696625	0		21.09.94	6.59	1.61		117
C/E	19A	18076	Torjustjørnan	Lågen		1220	0.69					96849	6695359	0		02.10.97	6.74	2.03	3,5	100
C/E	19A	18086	Reinsmyrtjørni	Lågen		1294	0.06					85109	6697360	0		30.07.98	6.84	2.90		25
C/E	19A	18096	Veisetjørnan	Lågen		1237	0.21					94612	6695944	0		21.09.94	6.55	1.32		117
C/E	19A	18164	Ø. Krakavadtjørn	Lågen		1225	0.74					89462	6695153	1	1					108
C/E	19A	18199	Nottartjørni	Lågen		1223	0.54					98972	6693651	0		21.09.94	6.35	1.04		117
C/E	19A	18208	Gravagjelstjønn	Lågen		1346	0.21					75958	6695803	2	1	24.07.01	6.65	2.85		25, 79, 83
C/E	19A	18211	Feitfisktjørnan	Lågen		1230	0.27					107376	6692928	0		12.09.97	6.37	0.55	1,7	100
C/E	19A	18239	Bakketjørnan	Lågen		1240	0.10					106117	6692561	0		21.09.94	6.30	0.83		117

Appendix 1. Continued.

Region	Catchm. no.	NVE ID	Lake	Catchment	Reg.	Altitude m a.s.l.	Area km^2	Min. depth m	Max. depth m	*S. alpinus*	*P. phoxinus*	EPSG:25833		No. exam.	No. pos. rec.	Date	pH	Ca mg L^{-1}	TOC mg C L^{-1}	References
C/E	19A	18257	Bessvatnet	Lågen		1303	0.30					77497	6694635	1	0	02.10.97	7.07	2.84	0,4	79,100
C/E	19A	18274	Øvre Bessvatnet	Lågen		1313	0.06					76469	6694619	0		17.07.96	6.56	2.04		25
C/E	19A	18289	X-tjørn	Lågen		1326	0.04					75897	6694381	1	1					83
C/E	19A	18290	Høgevardetjørn	Lågen		1357	0.23					74515	6693954	1	0	17.07.96	6.32	2.13		25
C/E	19A	18305	Y-tjørn	Lågen		1330	0.04					75917	6693986	1	1					83
C/E	19A	18336	Dimmedalstjørni	Lågen		1325	0.16					76839	6692957	1	0	28.07.95	5.90			25, 79
C/E	19A	18338	Steintjørni	Lågen		1307	0.87					105369	6690638	0		21.09.94	6.01	0.37		117
C/E	19A	18374	Bismarvatnet	Lågen		1331	1.88					74729	6692150	7	4	28.07.95	6.00			25, 79, 82, 86
C/E	19A	18445	Vegarhovdtjørna	Lågen		1255	0.19					102718	6689092	0		21.09.95	6.20	0.52	1,6	100
C/E	19A	18466	Langebutjørnan	Lågen		1246	0.47					87396	6688826	0		21.09.94	6.44	1.11		117
C/E	19A	18469	Sørtjørn	Lågen		1225	0.58					98746	6688587	0		21.09.94	6.21	0.51		117
C/E	19A	18478	Lakadalstjørnane	Lågen		1268	0.15					82119	6690318	0		02.10.97	6.82	3.95	0,6	100
C/E	19A	18536	Langebutjørnan	Lågen		1235	0.14					88840	6688873	0		02.10.97	6.44	2.03	1,3	100
C/E	19A	18612	Lakadalstjørnane	Lågen		1285	0.14					81147	6688201	0		31.07.03	6.83	2.65		25
C/E	19A	18650	Holbergtjørnane	Lågen		1314	0.21					82385	6687575	0		31.07.03	6.93	1.90		25
C/E	19A	66935	Heintjønne	Lågen		1112	0.58				x	109162	6712787	2	1	17.07.67	6.60	0.80		124
C/E	19A	66954	Hølen	Lågen		1157	0.47					113891	6703571	1	1	21.09.94	6.55	1.31		23, 117
C/E	19A	67633	Andersosen	Lågen		1308	0.12					76272	6705286	0		09.10.97	7.00	4.37	0,4	100
C/E	19A	276916	Danemannstjønni	Lågen		1166	0.25					110914	6701192	0		21.09.94	6.63	1.46		117
C/E	19A	279619	V. Bakketjørn	Lågen		1212	1.29					93632	6702161	1	1					86
C/E	19B	17222	Tindevatnet	Ufysja		1265	0.19					121472	6722322	0		21.09.94	6.62	3.52		117
C/E	19B	17224	Tobakkstjørni	Ufysja		1237	0.04					122888	6722372	1	1					23
C/E	19B	17244	Tuvetjørni	Ufysja		1236	0.20					117562	6722207	3	3	21.09.94	6.90	2.47		22
C/E	19B	17281	Holværvatnet	Ufysja		1183	1.43	8,9	28,0	x		119750	6720539	3	3	21.09.94	7.11	3.31		3, 23, 117
C/E	19B	17297	Svantjørni	Ufysja		1129	0.21					124886	6719724	1	1					3

Appendix 1. Continued.

Region	Catchm. no.	NVE ID	Lake	Catchment	Reg.	Altitude m a.s.l.	Area km^2	Min. depth m	Max. depth m	*S. alpinus*	*P. phoxinus*	EPSG:25833		No. exam.	No. pos. rec.	Date	pH	Ca mg L^{-1}	TOC mg C L^{-1}	References
C/E	19B	17401	Ljosevatnet	Ufysja		1182	0.90					125104	6716355	6	6	21.09.94	6.79	1.83		3, 23, 109, 117
C/E	20	553	Ørteren	Ørteråni	x	1147	9.44				x	103584	6725146	9	6	26.08.05	6.53	1.80		13, 29, 30, 31, 33, 89
C/E	20	17104	Øvre Trestiklan	Ørteråni	x	1149	0.48				x	103408	6727693	3	2	28.08.05	6.43	0.70		29, 30, 31
C/E	20	17283	Veslevatnet	Ørteråni		1162	0.15				x	107583	6721906	0						Own data
C/E	20	17312	Lonin	Ørteråni		1169	0.19				x	108533	6720705	0						Own data
C/E	20	17319	Håkonstjørnane	Ørteråni		1220	0.12				x	111069	6720862	0						Own data
C/E	20	17327	Grønehølen	Ørteråni		1240	0.02				x	112980	6720646	0						Own data
C/E	20	17356	Steintjørni	Ørteråni		1176	0.07				x	109068	6720017	0						Own data
C/E	20	17363	Urdavatnet	Ørteråni		1193	0.13				x	112034	6719472	0						Own data
C/E	20	17371	Skjerjavatnet	Ørteråni		1192	1.57	1,7	6,0		x	113282	6718885	9	8					35, 36, 37, 38, 39, 81
C/E	20	17372	Grønehølen	Ørteråni		1180	0.35				x	109729	6719422	0						Own data
C/E	20	17381	Underhaugtjørn	Ørteråni		1197	0.10				x	115187	6718655	0						Own data
C/E	20	17395	Grønevatnet	Ørteråni		1190	1.21				x	111304	6718009	0						Own data
C/E	20	67975	Lægreidvatnet	Ørteråni	x	1147	1.74				x	106124	6723166	3	3	23.08.05	6.77	2.30		29,30,89

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