I. Bathymetry and sediment distribution in Lake Nerfloen

In order to confirm that the coring site was representative, surveys of the bathymetry and sediment distribution in Lake Nerfloen were performed using an EdgeTech 3100-P seismic sub-bottom profiling system. The EdgeTech system utilizes a high-resolution, Frequency Modulated (FM) full spectrum chirp technology, where an FM pulse is transmitted and linearly swept over a full spectrum frequency range (e.g. 2-16 kHz for 20 ms). The return signal is passed through a pulse compression filter, which generates high-resolution images of the lake sub-bottom stratigraphy. All chirp data were visualized and interpreted using the SeiSee software. An average water column velocity of 1500 m/s was used for depth calculations from the seismic data. Resulting depth calculations were checked against independent measurements performed with a Garmin Fishfinder 160C echosounder.

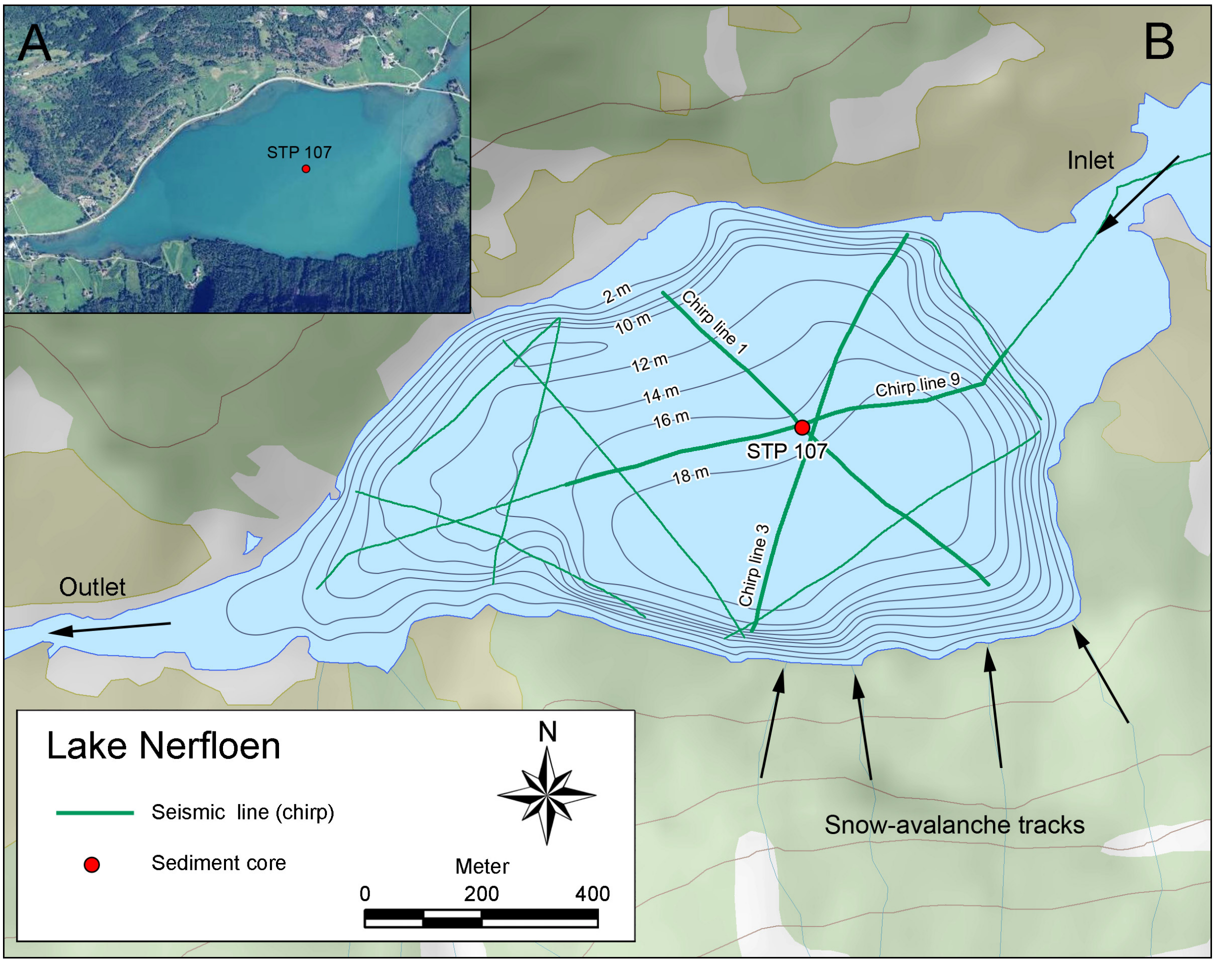

Figure S1. (A) Air photograph of Lake Nerfloen with location of the coring site marked. Note the distinct sediment plume entering the lake from the adjacent Oppstrynsvatnet lake through the inlet in the North-East. (B) Bathymetric map of Lake Nerfloen showing locations of the coring site and seismic lines (green). Thick, labelled seismic lines are shown in Figure S2.

As shown in the bathymetric map (Figure S1), the lake floor slopes steeply down to a depth of 10 m along the northern shore, after which it slopes gently (c. 2 m per 100 m) southwards into the middle of the basin. From the southern shore the slope is much steeper, going to a depth of 18 m over a distance of 100-200 m. This leaves an area of about 600x200 m in the southern half of the lake where the lake floor is almost completely flat. Towards the outlet in the western end of the lake, the bathymetry becomes somewhat undulating.

Two main units were indentified in the seismic stratigraphy of the lake, although the present paper deals only with the upper unit, which is shaded green in Figure S2. The unit is acoustically layered with horizontal bands of equally spaced, medium amplitude reflections and drapes the underlying topography; a type of seismic facies that is typically interpreted as a result of continuous sedimentation through settling of suspended sediment (e.g. Fanetti et al., 2008; Waldmann et al., 2010). The thickness of the unit is near uniform (~2-3 m) across the areas where the lake floor is flat or gently sloping and single reflections can be continually traced over large distances, reflecting an uncomplicated sedimentation pattern. From this it was concluded that a sediment core retrieved from within a radius of ~200 m of the lake centre would provide a representative picture of the post-glacial, continuous lake sedimentation. In the two transverse chirp lines (1 and 3; Figure S2) it is observed that the penetration of the acoustic signal becomes gradually more shallow towards the southern shore. This is interpreted as a result of a gradually higher content of coarse-grained sediment brought into the lake by snow-avalanche activity along the southern shore where several snow-avalanche tracks can be seen (Figure S1). Unusually strong seismic reflections can be traced from the avalanche-area towards the middle of the lake and probably reflect large-scale avalanche events. Because of this the sediment core was retrieved some distance north of the deepest part of the lake where these strong reflections dissipate.

The lower seismic unit forms distinct lens-shapes over large areas where it features a chaotic, transparent seismic facies, whereas in other areas it is seen only as a single strong seismic reflection (Figure S2). This unit is very interesting and will be treated in detail in a forthcoming paper. In short it is most probably related to an inundation by the Storegga tsunami around 8100 cal. yr BP, which produced a large and complex deposit both in Nerfloen and the adjacent lake Oppstrynsvatnet. This deposit is here termed a 'Rapidly Deposited Layer', or RDL (Figure S2).

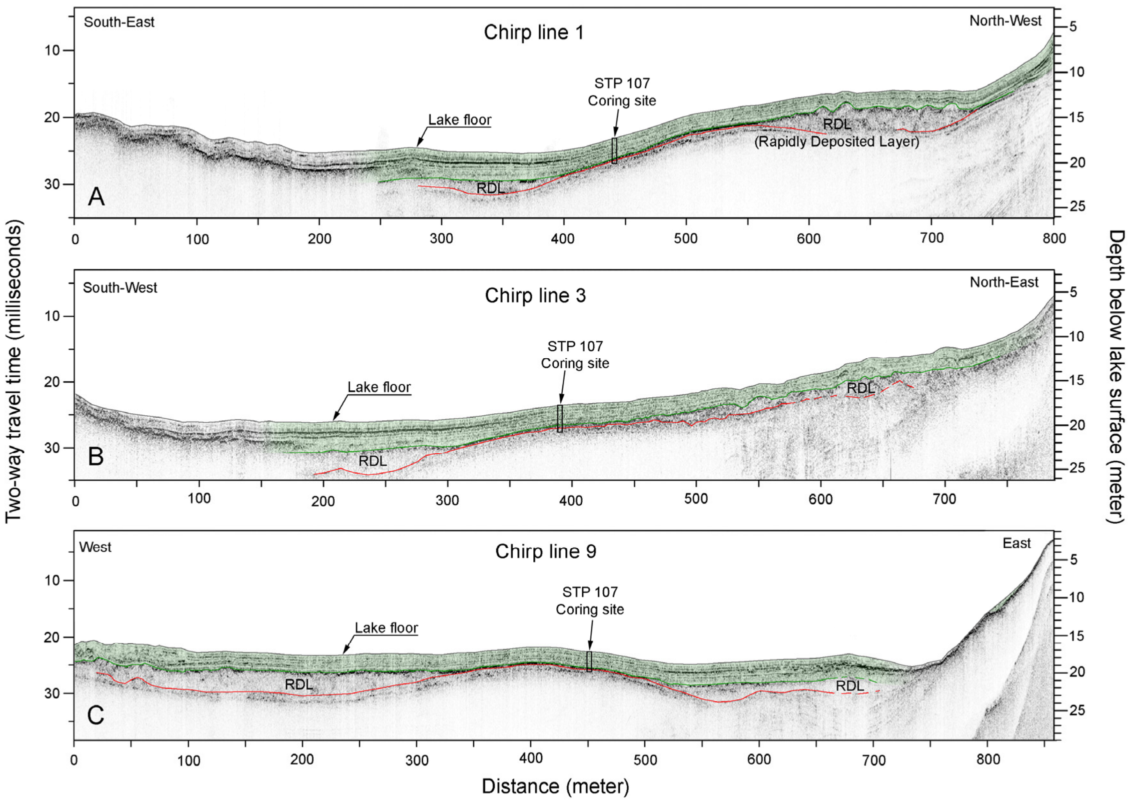

Figure S2. Seismic (chirp) lines collected from Nerfloen. See Figure S1 for locations. (A) Chirp line 1, running from the south-eastern to the north-western part of Nerfloen through the coring site (black square denotes the STP 107 core). (B) Chirp line 3, running from the south-western to the north-eastern part of Nerfloen. The STP 107 core is projected ~20 m perpendicularly onto the chirp line (black square). (C) Chirp line 9, running from west to east through the coring site. Note the differing horizontal scales from A-C. The upper 184 cm of the STP 107 core is correlated to the upper ~2m thick seismic unit (shaded green). RDL = Rapidly Deposited Layer.

II. Identification and removal of episodic sedimentation events

Episodic sedimentation events such as floods and snow-avalanches are known to play an important role in the sedimentation regime of fjord lakes in western Norway, and a number of methods may be employed to identify them in sediment cores (e.g. Støren et al., 2008, 2010; Vasskog et al., 2011). Here we have employed an approach similar to the method developed by Støren et al. (2010), although the Rate of Change (RoC) is calculated from the change in mean grain-size over depth rather than magnetic susceptibility over time. The RoC of mean grain-size is seen as a well-suited parameter for reflecting the grain-size perturbations related to episodic sedimentation events such as avalanches and severe floods.

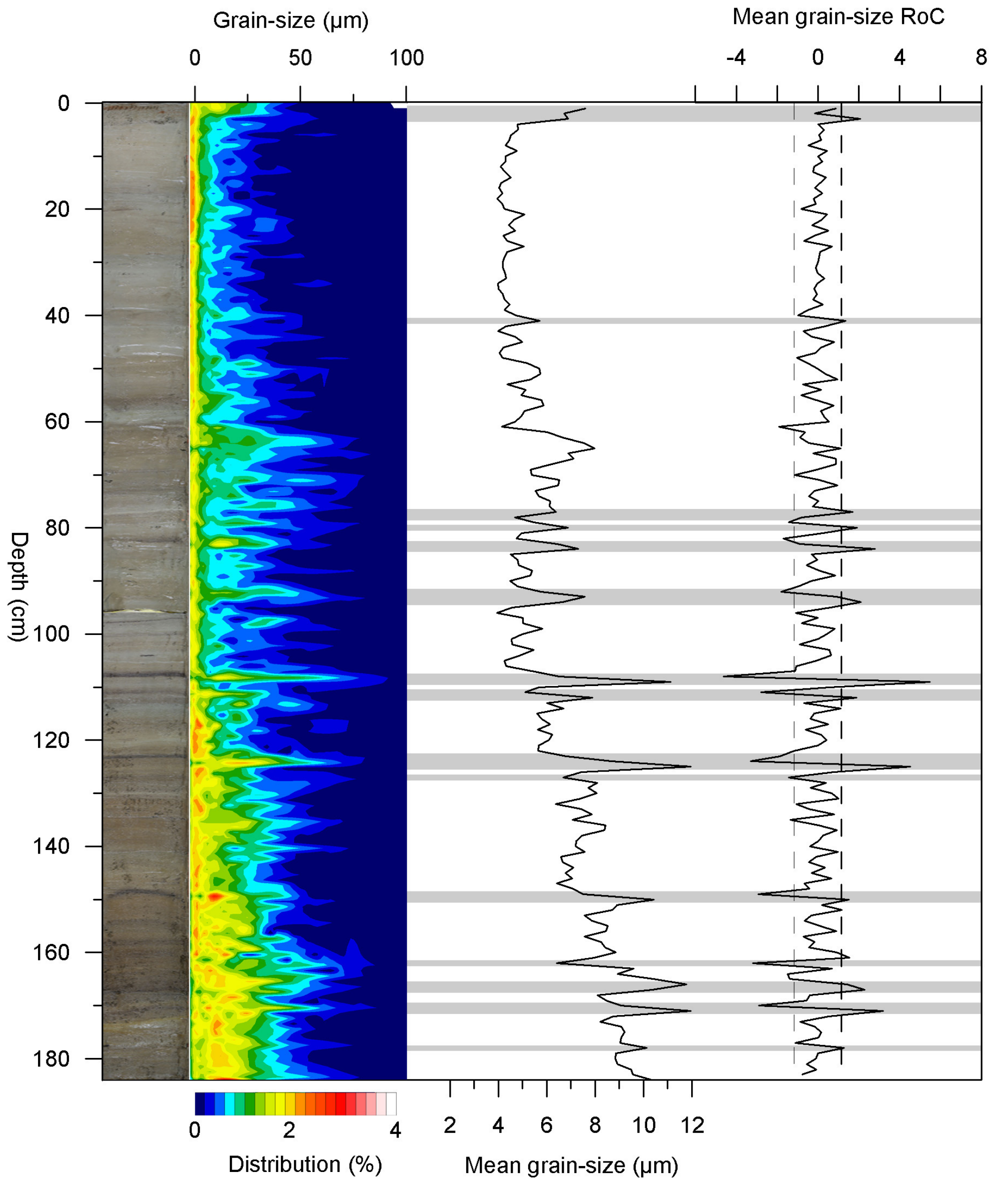

Figure S3. Identification of 'event layers' (shaded grey) in the STP 107 core from the Rate of Change (RoC) in mean grain-size. One standard deviation in RoC is indicated by dashed lines.

In order to define an 'event layer' and subsequently distinguish it from the 'background sedimentation', a certain threshold value in the RoC needs to be defined. Here, one standard deviation was chosen following Støren et al. (2010). At this level the RoC is seen to highlight all of the event layers in the core that are possible to distinguish visually by their high macrofossil content (brown layers, Figure S3), and also additional layers connected to perturbations in other sedimentary parameters such as magnetic susceptibility (Figure 3, main paper). As seen in the grain-size surface plot (Figure S3), 'spikes' of relatively coarse-grained sediment that could well reflect episodic sedimentation events can also be observed in intervals of the core not highlighted by the RoC approach. However, as they are not able to affect the mean grain-size beyond the level of one standard deviation in the RoC, it is considered here that they represent events that are too small to affect significantly the sedimentary signal within the considered 1-cm interval. This implies that flood events up to certain size are considered as part of the background sedimentation. Note that the negative spike of the RoC at c. 60 cm depth is ignored because it seemingly reflects a rapid change towards a more fine-grained sediment composition in the background sediment.

III. Catchment samples

In all, sediment from seven different catchment sites were sampled, including two 'glacial' sites (till), two 'non-glacial' sites (soil and slope material), and three 'mixed' sites (fluvial/glaciofluvial), whereas parallel samples (EB2, S2 and L2) were collected within 50-100 meters from the original sample for three of the sites (EB1, S1 and L1) in order to check that the analysed samples were representative.

Sampling sites

Samples EB1/EB2:
Site description: Moraine ridge deposited approximately AD 1980. Sparse vegetation cover. Low grade of soil development.
Stratigraphic context: Surface (0-10 cm)
UTM position: 32 V 405899 6856295 (EB1); 32 V 405880 6856258 (EB2)
Altitude: 900 m a.s.l.

Sample S1:
Site description: Basal till deposit of pre-Holocene to early-Holocene age. Moderate vegetation cover. Low grade of soil development.
Stratigraphic context: Surface (0-10 cm)
UTM position: 32 V 388373 6870352
Altitude: 530 m a.s.l.

Sample S2:
Site description: Basal till deposit of pre-Holocene to early-Holocene age. Vertical section exposed by slumping along river.
Stratigraphic context: ~2 m depth
UTM position: 32 V 388394 6870302
Altitude: 515 m a.s.l.

Sample H:
Site description: Calm backwater site in the main river running through the Hjelledalen valley (Hjelledøla).
Stratigraphic context: Surface (0-10 cm)
UTM position: 32 V 401355 6866062
Altitude: 40 m a.s.l.

Sampe SV:
Site description: Glaciofluvial floodplain situated downstream from small cirque glacier. Some moss growth. Low grade of soil development.
Stratigraphic context: Surface (0-10 cm)
UTM position: 32 V 411349 6873664
Altitude: 830 m a.s.l.

Sample EE:
Site description: Glaciofluvial floodplain situated just outside the LIA maximum moraine of Erdalsbreen, a large outlet glacier from the Jostedalsbreen ice cap. Some moss growth. Low grade of soil development.
Stratigraphic context: Surface (0-10 cm)
UTM position: 32 V 404667 6857131
Altitude : 550 m a.s.l.

Samples L1/L2:
Site description: 1-2 m deep trench dug by excavator in slope deposits. The area is prone to spring flooding from snow-dammed meltwater. Moderately dense forest. Moderate soil development.
Stratigraphic context: ~50 cm below surface (L1); ~100 cm below surface (L2)

UTM position: 32 V 387560 6867745 (L1); 32 V 387519 6867715 (L2)

Altitude: 70 m a.s.l.

Sample N:

Site description: 10-20 cm highly organic soil overlying bedrock. Dense, productive forest with strong soil development.

Stratigraphic context: Surface (0-10 cm)

UTM position: 32 V 388733 6867879

Altitude: 80 m a.s.l.

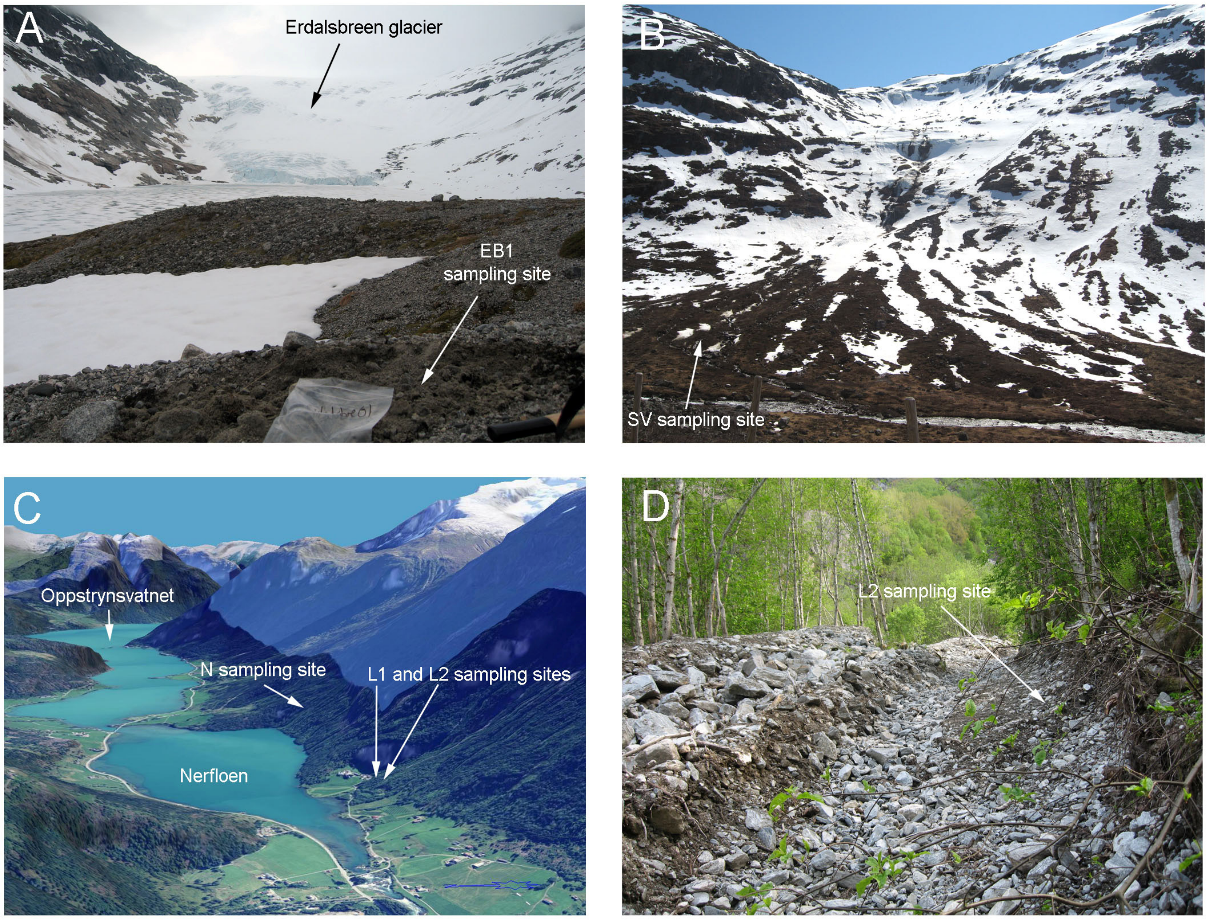

Figure S4. Sampling sites for some of the catchment samples. (A) Moraine ridge about 1 km from the present position of Erdalsbreen (sample EB1 and EB2). (B) Floodplain between glaciofluvial streams in Svartebardskaret (sample SV) (a small cirque glacier is situated above the ridge in the upper right part of the photo). (C) Picture created at www.norgei3d.no from air-photographs projected onto a 3-dimensional terrain-model. Sampling sites for samples N, L1, and L2 are indicated. (D) Excavated trench which allowed sampling of slope material at different depths (sample L1 and L2).

III B. Catchment sample grain-size characteristics

The <125 µm fraction of all catchment samples were analysed for grain-size distribution using a Sedigraph 5100. In general the till samples show a unimodal distribution within this fraction, whereas the (glacio-)fluvial, slope- and soil samples are more complex, showing bimodal and polymodal distributions (Figure S5).

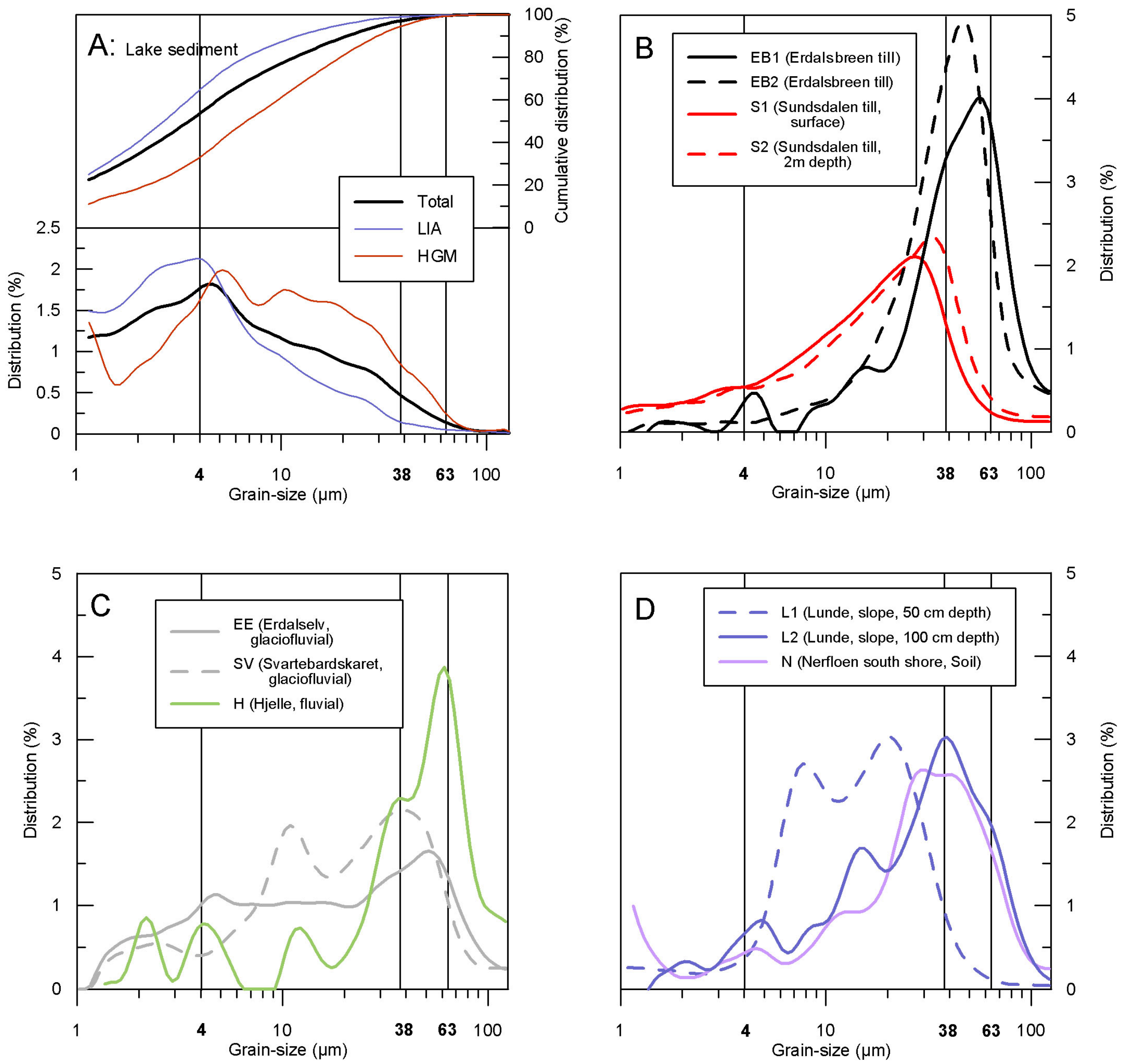

Figure S5. A) Grain-size distributions for the entire STP 107 lake core (black line), lake core samples from the 'Little Ice Age' (LIA) time interval (blue line) and the Holocene Glacier Minimum (HGM) time interval (red line), shown as cumulative percentage (above) and percentage (below) distributions. B) Grain-size distributions of till samples from the Oppstrynsvatnet catchment. C) Grain-size distributions of fluvial and glaciofluvial samples from the Oppstrynsvatnet catchment. D) Grain-size distributions of slope- and soil samples from the local Nerfloen catchment.

The main mode of the early- to pre-Holocene till samples from Sundsdalen (samples S1 and S2) are more fine-grained (20-40 µm) than the recent till samples from the Erdalsbreen glacier forefield (30-75 µm). With the exception of the L2 sample, all of the 'non-glacial' catchment samples also display a strong mode within the same range as the till samples (20-75µm), indicating that till may be an important parent material for all of the analyzed samples.

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