Supplementary material

Supplementary file 1 – Description excavated sites

Our investigation includes eight open-air sites of various sizes and characteristics indicating variation in activities and settlement duration. Three of the areas comprise several large find concentrations. Such concentrations are normally seen as separate settlements; however, we argue that these should be considered as large activity areas, possibly with simultaneous or consecutive visits. A detailed presentation of each of the excavated sites is presented her.

At the time of occupation, the sites were situated within a large archipelago. The area were located on the outer coast, while today the area are located at c. 60–90 m a.s.l. and 4 km remote from the coast in Vestfold County on the west side of the Oslofjord.

The sites have been investigated with various intensity, from excavating most of the central lithic scatters to sampling by single squares scattered across the site (Table 1). Because of the varied topography, it has still been possible to identify the main activity area of each site. The sites also have yielded assemblages that can be evaluated in terms of tool inventory and main technological traits, providing a basis for dating and interpretation of the site activities (cf. Supplementary files 2, 3, 4 and 5 for details about artefact material and C14-dates). The settlements are characterised by lithic scatters and in some cases structural remains such as remnants of dwellings and fireplaces. Due to acid and well-drained soils in the area, organic materials such as bones or wood are rarely preserved, hence lithic material combined with environmental data and site location being vital to understand the character of the settlements.

Løvås

The Løvås site (Reitan & Hårstad, in press a) comprises an unusually large settlement area, and includes three sub-areas (1–3), which have been in use within the same timeframe. The sub-areas were located along the ancient shore of what would have been an east-facing bay, sheltered by rocky outcrops in the north and the south, and by forested, rocky hills in the west (Figure S1-1).

Løvås 1 was the southernmost of the three Løvås sub-areas, situated on a level terrace 84–85 m a.s.l. in an east-facing slope. This activity area was limited to the west by rocky, rising terrain, to the east by a steep drop towards the ancient shoreline, and to the north by an elongated rocky outcrop of rhombic porphyry, the local bedrock. Between this outcrop and the rising terrain in the west, Løvås 1 opened up towards the north and the adjacent Løvås 3. Løvås 1 consisted of two evenly sized halves – one northerly and one southerly, together covering a total of c. 850 m^2. The two halves were connected via a narrow corridor along the mentioned outcrop to the north. At Løvås 1 the sub-soil was dominated by pebble gravel. The excavation of Løvås 1 yielded just over 12,000 lithic finds. The finds were distributed throughout the sub-area, but four to five relatively distinct concentrations can be distinguished, each measuring 2–4 m across, and with high tool ratios. Flints constitute 99,3 % of the total inventory, and the flint quality can be characterised as good. As much as 95 % of the tools are made of blades or microblades, and the formal flint tool assemblage is dominated by microliths. The flint core material is clearly dominated by conical or sub-conical cores with negatives demonstrating high regularity. A large number of platform rejuvenation flakes can be associated with the cores. Apart from a small number of finds of quartzite, quartz and rock crystal, the material of local rock at Løvås 1 is limited to grinding slabs and four to six adzes. The adzes have mainly been formed as core adzes, and subsequently thoroughly ground. However, the adzes must have been manufactured elsewhere and brought to the site, as no waste material of the same rock types was retrieved.

At Løvås 1 five hearths and three cultural layers were uncovered, of which two are interpreted as poorly preserved dwellings in the form of hut floors, positioned 4 m apart at the foot of a rocky outcrop. They were oval in shape and covered an area of 12 m^2 (A51) and c. 17 m^2 (A19693), the latter with a central hearth in it. They were lens-shaped in section, and contained large quantities of charred hazelnut shells, charcoal along with formal tools like microliths, scrapers, borers, grinding slabs and adzes as well as fragments of burnt

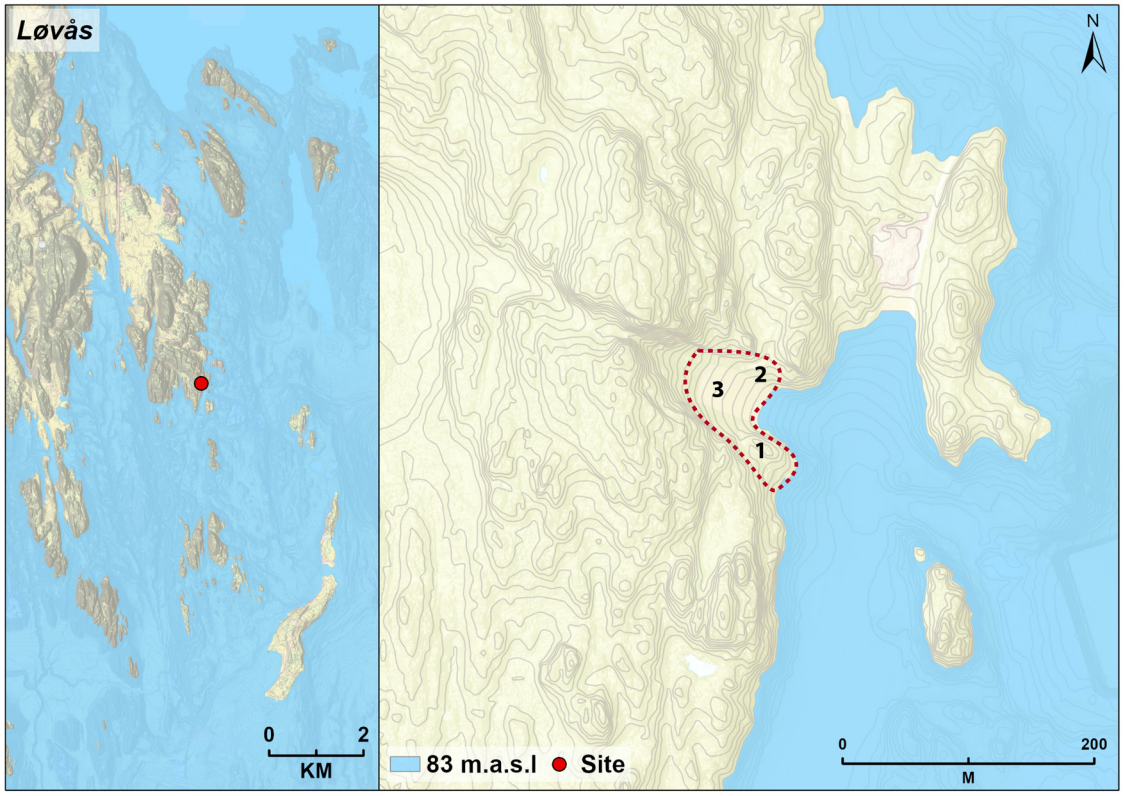

Figure S1-1: Linnea S. Johannessen and I. M. Berg-Hansen, MCH, University of Oslo.

bone and small lumps of birch bark pitch. Eleven radiocarbon dates obtained from the hearths and cultural layers establish the phase of occupation at Løvås 1 to the period c. 8230–7490 cal BCE.

Løvås 2, comprising c. 500 m^2, was the northernmost and smallest activity area within the larger Løvås site, and was situated 85–88 m a.s.l. in a slope facing south. In stark contrast to Løvås 1, the subsoil at Løvås 2 consisted of well-drained, gravel-mixed, fine sand, a quality that continued into the neighbouring sub-area Løvås 3. C14-dating of hazelnut shells and one burnt bone from reindeer, collected from the same horizon as the lithic finds, reflects two phases of occupation – one in the first part of the Middle Mesolithic, around 8000 cal BCE, and one in the Pre-Roman Iron Age. The excavation resulted in >1,600 finds of mainly flint (98 %), with a relatively big share of blades and microblades (27 %). The lack of structures on the site, and the somewhat limited artefact material does not imply recurring, long-lasting habitation. However, a strong topographical, chronological, technological and typological connection to the adjacent Løvås 3 suggests that the two activity areas should be considered in context, and have likely been in use simultaneously.

Løvås 3 was the largest of the three sub-areas, covering an area of c. 2,400 m^2. It was situated between Løvås 1 and Løvås 2 and was in its entirety located on an east-sloping ploughed field 77–89 m a.s.l.. On the top of the slope, the subsoil was continuous with Løvås 2, with gravel-mixed sand. On the lowerlying part, however, the subsoil consisted of compact, fine-grained clean sand, with the sharp transition between the two subsoil types around the 83 m level. Four structures were uncovered – three small fireplaces c. 85 m a.s.l. and one oval structure (c. 13 m^2) c. 88 m a.s.l., which is interpreted as the poorly preserved bottom layer of a hut floor. Although c. 30 cm of the structure must have been removed by ploughing, the fill in the structure contained large quantities of charred hazelnut shells, pieces of bark and a high density of lithic artefacts. The assemblage from this structure comprises a high ratio of tools such as scrapers, borers, microliths and pieces of sandstone grinding slabs along with lumps of birch bark pitch and fragments of burnt mammal bones, including a worked piece, which is probably the shank (31 mm) of a fishhook.

Altogether 1900 lithic artefacts, of which 99 % are flints, were collected from the site. The inventory encompasses a significant portion of blades and microblades, and blades and microblades have been

preferred to flakes for tool production. Conical and sub-conical cores as well as a number of platform rejuvenation flakes confirms a targeted blade production (Sørensen et al., 2013; Damlien, 2016).

Only 5 % of the plough soil at Løvås 3 was sampled, suggesting that the original number of lithic finds at Løvås 3 has amounted to tens of thousands. The finds were quite evenly distributed throughout the slope, and artefacts in the lower part of the site are probably redeposited mainly following modern disturbance. The placement of the structures in the upper part of the site, and the varying subsoil, supports this. Radiocarbon dates obtained from the four structures at Løvås 3 span from 8340 to 7400 cal BCE (tab./fig. #).

The combined lithic assemblage from the three Løvås areas can be described as typologically and technologically homogeneous and standardized. The flint material demonstrates access to high quality flint. There is little evidence of sourcing of local raw materials, with a few exceptions in the form of grinding slabs and rock adzes. All of the three sub-areas demonstrate a material clearly consistent with the conical core pressure blade concept (ref.). The presence of clusters of structures on Løvås 1 and 3 suggests that the layout of and the activities on the site have been subjected to a form of spatial organization. The site's size and the number of collected lithic artefacts suggest, along with the radiocarbon date, a rather intensive phase of occupation at Løvås.

Olsmyren

Olsmyren (Hårstad, in press a), with its mere 50 m^2, was the smallest site excavated in the course of the InterCity project. Situated at about 71 m above current sea level, at the base of what had been a small, north-facing headland on the southeastern tip of a large island, the location would have offered shelter, but also easy access to the sea, the island hinterland, and their respective resources (Figure S1-2).

Based on the shoreline displacement curve the occupation at Olsmyren would have taken place in the timespan between 7300–7050 cal BCE. After this point in time, the shoreline would have reclined, leaving lower-lying areas accessible and more suitable for habitation.

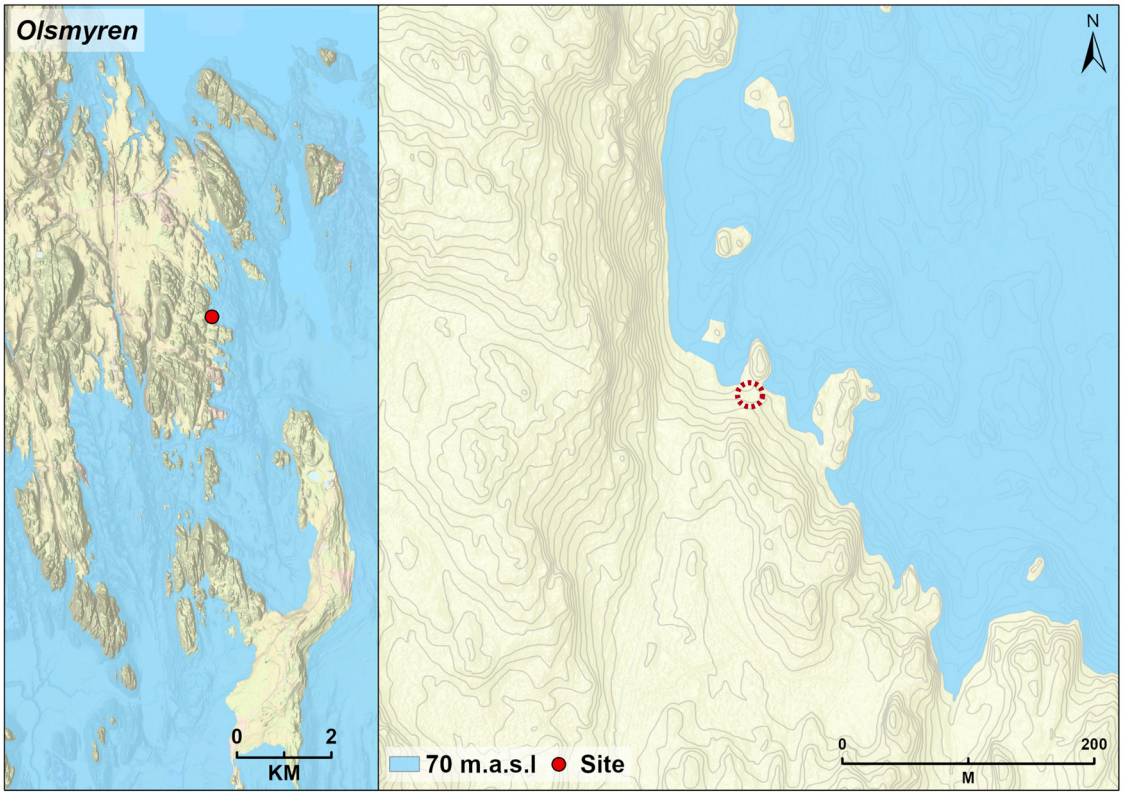

Figure S1-2: Linnea S. Johannessen and I. M. Berg-Hansen, MCH, University of Oslo.

Despite its humble size, Olsmyren proved to have the highest density of lithic artefacts of all the sites. An excavated area of 19 m^2 resulted in more than 2000 artefacts, with the highest concentration being in the central part of the site.

The artefact material comprises two formal tools in the form of a scalene triangle (projectile) and a scraper. In addition to the formal tools, three retouched fragments/flakes, and altogether nine retouched blades and microblades are identified. There are also several unretouched blade and microblade fragments present in the material (21 blades and 28 microblades), some of which show edge damage, suggesting a use as burins. The debitage material makes up the largest category of finds from Olsmyren. Small flakes and fragments (<1 cm in size) are prevalent. There is also a noticeable amount (11 pcs.) of bipolar cores in the material, in addition to two characteristic platform tablets from conical cores.

The assemblage from Olsmyren consists mainly of flint (99.7 % of the material) of a rather coarse type. Combined with core remnants generally being small and exhausted, this point toward limited access to good quality flint, and a maximized utilization of the raw materials available. With the exception of sandstone grinding slabs and hammer/anvil stones there are limited traces of the sourcing and use of local raw materials.

The Olsmyren site seems to represent – based on the site's placement in the landscape, size, and the lithic material – one or a few short and intense, seasonally based occupations, oriented towards the production and use of hunting tools.

Viulsrød 1

Viulsrød 1 (Reitan & Hårstad, in press b) was located on the south end of a low, forested ridge with a rocky outcrop running north–south. At the time of occupation, this ridge would have formed a south-facing headland on the southern tip of a large island, being sheltered by a big peninsula to the south-west, and by skerries and islands to the south (Figure S1-3).

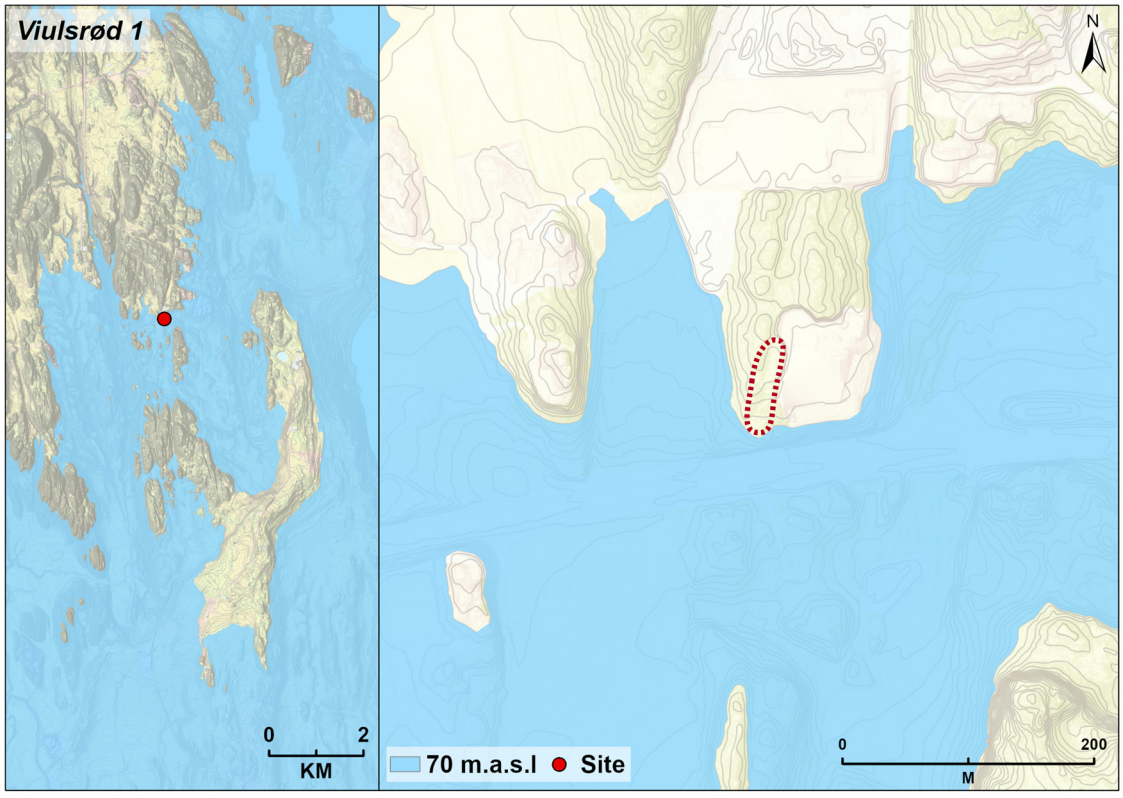

Figure S1-3: Linnea S. Johannessen and I. M. Berg-Hansen, MCH, University of Oslo.

Viulsrød 1 was situated on the east side of the ridge, covering c. 600 m^2 on a narrow terrace, gently sloping between 71 and 74 m a.s.l. The height above the current sea level indicates c. 7500–7200 cal BCE as the time frame for the occupation. The site was only sampled. The 203 collected lithic artefacts, exclusively flints, were evenly scattered throughout the site. The finds concur typologically and technologically with the shoreline date.

The tool inventory is based on blades and microblades, comprising borers, scrapers, possible burins (s.c. rulers), and inserts (intentionally fragmented, and often retouched, blades). Flint chips are prevalent in the material, constituting nearly half of the total assemblage, bearing witness to trimming and preparation of cores and tools. The scarce material and its even distribution over a relatively large area may represent traces of a series of episodic shore-bound stays related to the production and curation of small tools. No structures or dateable organic finds were uncovered.

Viulsrød 2

Situated on the same headland as Viulsrød 1, and on the west side of the same low ridge on the southern tip of a large island, the Viulsrød 2 site covered an area of c. 500 m^2 (Reitan & Hårstad, in press b). The site was situated on a sloping terrace at 67–69 m a.s.l. At the time of the settlement, the terrain dropped from the edge of the terrace towards the shoreline of an ancient cove in the west (Figure S1-4).

Radiocarbon dates, which can pinpoint the use of the site were not obtained, but the SRL curve points to the time span *c*. 7100–6900 cal BCE for shore bound occupations at Viulsrød 2. Most of the lithics were evenly scattered, however two concentrations were identified, each covering 10–15 m^2. Of the in total 750 lithic artefacts, 95 % was made from flint. Even though non-diagnostic debitage in the form of flakes,

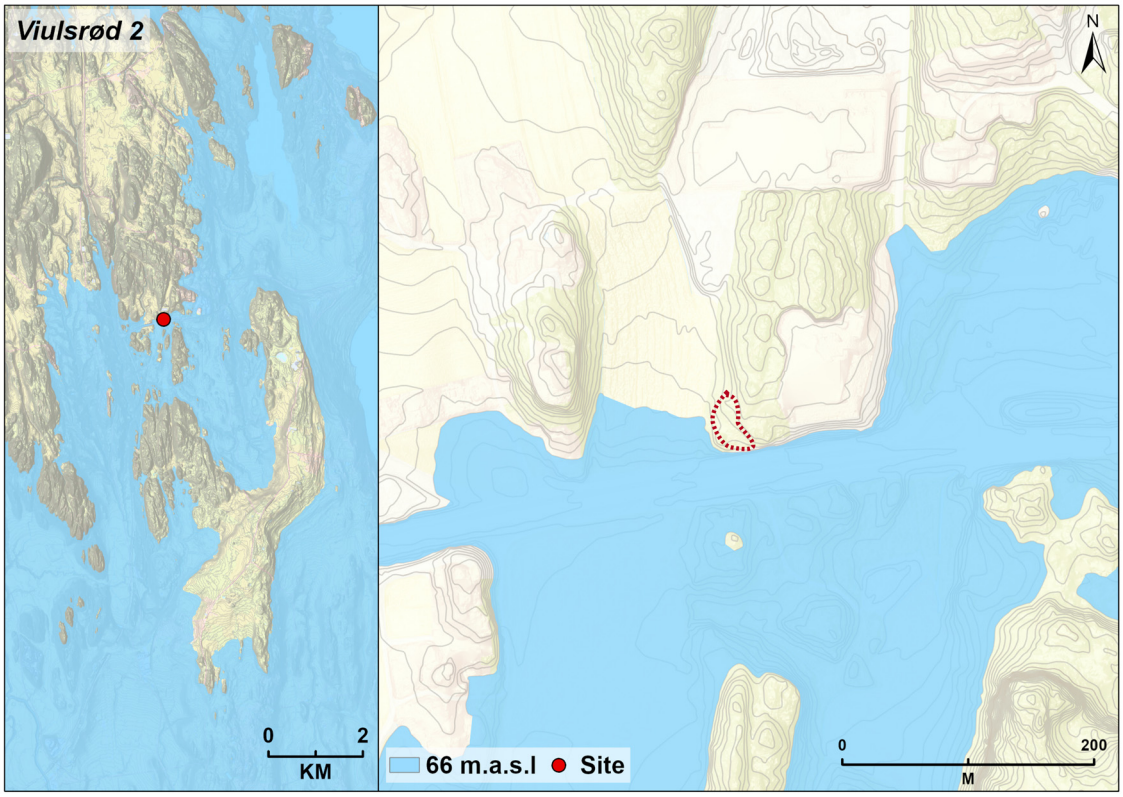

Figure S1-4: Linnea S. Johannessen and I. M. Berg-Hansen, MCH, University of Oslo.

fragments and chips constitute c. 88 % of the flint assemblage, assemblage clearly demonstrates a flint production targeted at the manufacture of blades and microblade tools. This is supported by a small number of backed blades, side fragments of microblade cores and a platform rejuvenation flake. Still, the core material is dominated by bipolar technique. The non-flint material is dominated by rock crystal, which, along with a small number of rock flakes, fragments of sandstone grinding slabs and a fragmented rock adze pre-form also show a certain exploitation of local raw materials. The assemblage can be viewed as traces of one or few short-term stays.

Råen 1

Råen 1 (Hårstad, in press b) was located at about 65 m above current sea level, on what would have been an islet in a sheltered archipelago at the time of occupation. The islet would not have been much larger than about 1,000 m^2, and in short distance from both mainland and nearby islands, where there is known to be other, presumably contemporary sites (Figure S1-5).

The Råen 1 site itself was situated on the southern part of the islet, and with a contemporary shoreline at 64 m above the current, it would have been suitable for occupation 7100–6900 cal BCE. Before 7100, the islet was submerged, and after 6900 cal BCE, due to the land-uplift, the water surrounding the islet would have been shallow and brackish at best.

The find material collected from Råen 1 turned out to be rather scarce, with only 78 finds altogether, comprised of mainly flint (87 %), but also sedimentary rock and quartzite. Among the finds are one borer, one scraper, two retouched fragments, one sandstone knife, four microblade fragments, one blade fragment

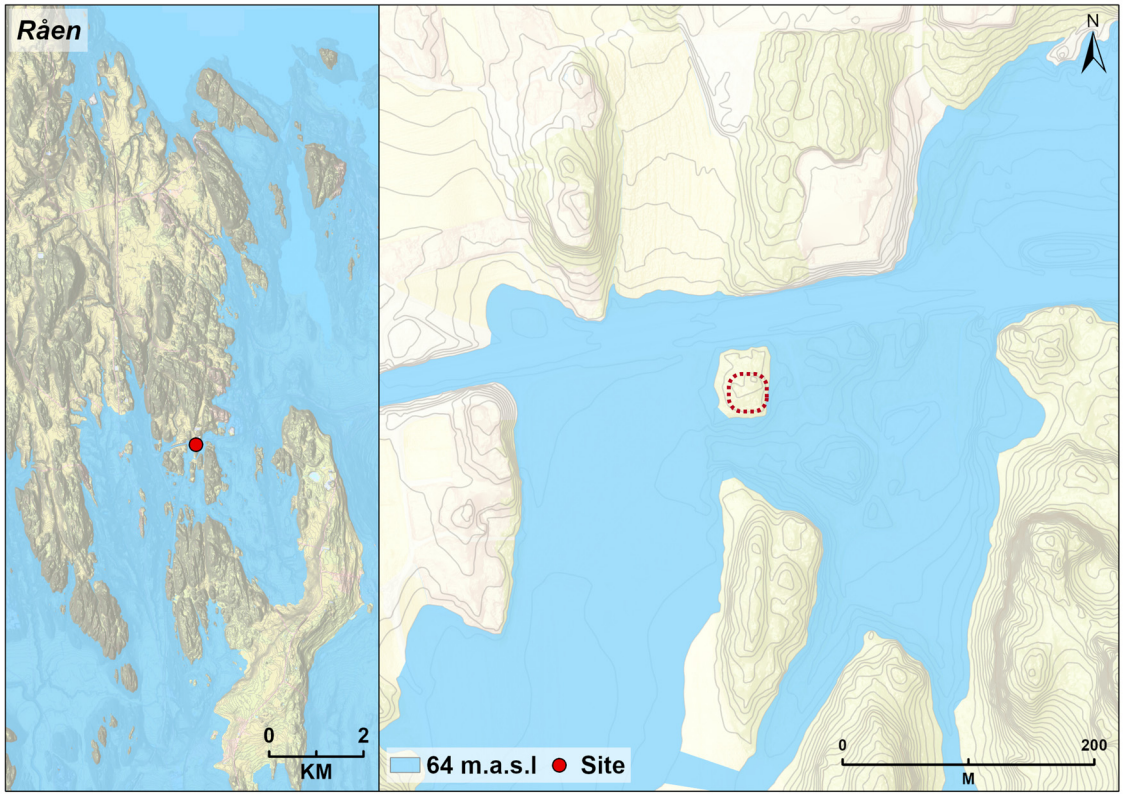

Figure S1-5: Linnea S. Johannessen and I. M. Berg-Hansen, MCH, University of Oslo.

and a hammer stone. The rest of the material is debitage, of which it is worth mentioning the presence of a side fragment from a microblade core, and one possible core tablet. The highly heterogenous flint material contains rather small fragments and flakes, which – with the exception of the production of microblades – points toward the retouching and reworking of flint tools rather than production. The other lithic raw materials used at the site could, however, be linked to tool production, and it seems that local rock has been sourced to a certain degree. The limited lithic assemblage collected from the site suggests that Råen 1 was not a subject of long-term habitation. The modest size, the exposed placement (although sheltered by surrounding topography) in such close proximity to areas more suitable for habitation and the small, varied finds material, suggests that the site was connected to specialized, short term activities performed away from more permanently inhabited areas.

Adal

The Adal site (Granados, in press) comprises two sub-areas (area 1 and 2) positioned on slopes on opposite sides of an outcrop ridge. At Adal 1 the distribution of lithic artefacts covered c. 4,600 m^2, with a concentration of artefacts at the lower parts of the large slope. At Adal 2, the lithic scatter was delimited to a smaller surface, c. 500 m^2. Situated at c. 64 and 65 m above current sea level, the Adal site was positioned on the southern foreland of an island at a narrow sound, giving excellent access to fishing and sea mammal hunting grounds (Figure S1-6). Sea level models demonstrate that both activity areas had good harbour conditions and boat mooring spaces. With a drop in sea level to about 56–58 m, Adal was no longer in direct connection with the seashore, and the adjacent lowland would have been characterised by brackish water and/or swamp-like conditions. In this scenario, the descending seashore would have altered the ecology of the local environment leaving Adal and its vicinity outside the archipelago, and possibly outside main settlement territories.

C14-dates from four charcoal samples collected from four hearths and one sample of charred hazelnut shell dates the activity at Adal to between 7320–6640 cal BCE. This corresponds to the shoreline dating estimated to c. 7000–6800 cal BCE.

Due to poor preservation caused by natural post-depositional processes such as extensive frost activity and root disturbance, only four hearths were identified. Further, at Adal 2 a formation of cobbles, c. 4–5 m Ø that was partly overlapping a lithic concentration, is interpreted as possible weight stones from a tent structure.

The lithic artefact assemblages collected from the two activity areas share similar technological and typological characteristics and similar strategies for raw material exploitation throughout the site. The blade assemblages, including microblades, comprise 13 % of the total lithic assemblage signifying this as the focus of the blank production. However, only a small portion (13 %/n=21) of the 161 cores that were found, comprise platform cores representing the Middle Mesolithic conical core pressure blade concept. Most of the cores (87 %/n=140) were categorized as bipolar cores, while only a few flakes could be identified as diagnostic bipolar debitage. The discrepancy between the high presence of blades, low number of small and exhausted platform cores, and a large number of bipolar cores thereby give good indications that fine-grained raw materials might have been economized at the site, scrapping exhausted conical blade cores by using bipolar percussion on anvil. The blade tool production mostly consists of rectangular blade-/microblade segments with transversal breaks and other blade fragments with secondary modifications such as borers. In addition, a few scalene triangular microliths are present. Several polished- and pecked axes and chisels made from basaltic rock were found together with associated debitage. The basaltic raw materials reflect activities related to the utilization, management and reuse of the macro tools.

Altogether 97 % of the lithic assemblages were made of flint. The remaining 3 % of the raw materials, identified as basaltic rocks and metarhyolite, sandstone and other fine-grained rock- and mineral types (quartz, rock crystal and quartzite), can be further separated into 13 individual types. This raw material

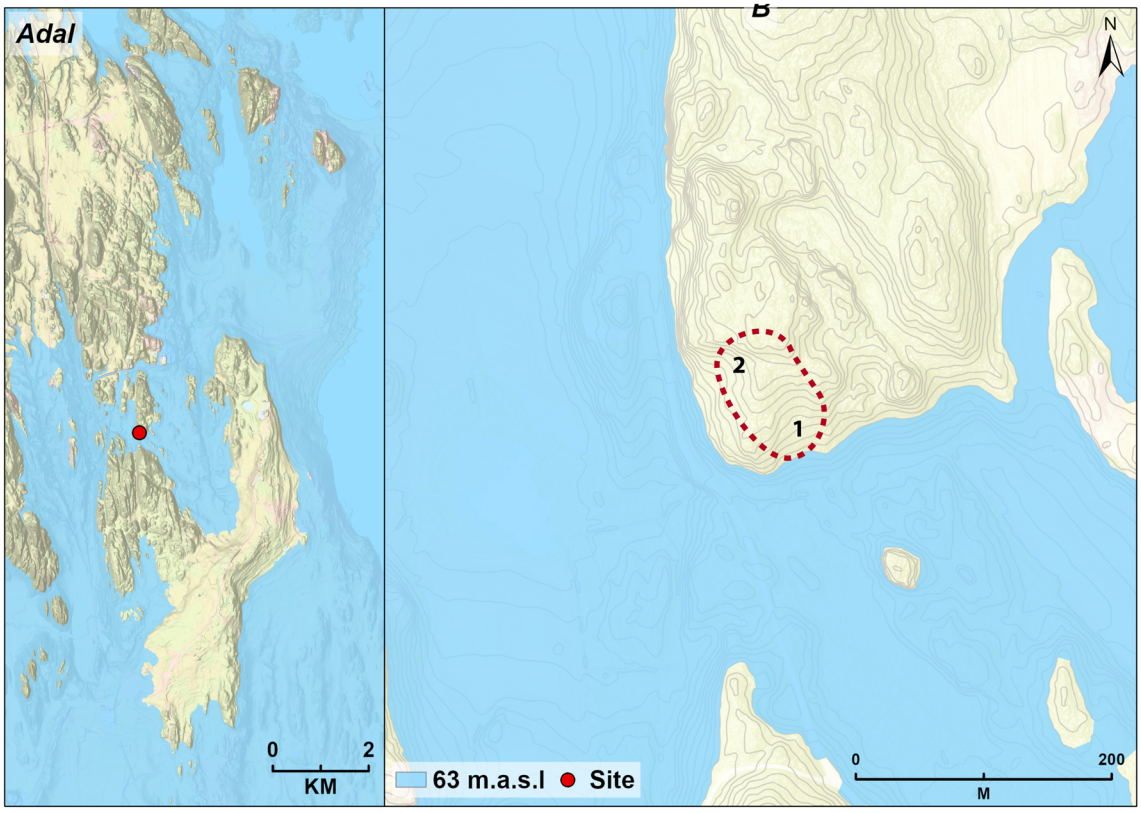

Figure S1-6: Linnea S. Johannessen and I. M. Berg-Hansen, MCH, University of Oslo.

utilization has several elements (metarhyolite and basaltic rocks) indicating relatively proximity to different raw material sources. In general, the raw material utilization at Adal strongly indicates a regional orientation.

To summarize, a large-sized artefact assemblage with close technological similarities was found associated with a few hearths and scattered across a vast area, at Adal. Furthermore, the steep shore displacement curve combined with the positioning of the two activity areas at approximately the same height, strongly suggests that the site was occupied while favourable exposed to the seashore. On these premises, the Adal site represents a settlement area with recurrent visits within a period of a couple of centuries.

Pjonkerød A and B

The two sites (Carrasco & Mjærum, 2015) were situated in sheltered locations at the northeastern end of an elongated island and facing a narrow sound at the time of occupation. Pjonkerød A, comprise two sub-areas placed close to each other, and interpreted as parts of the same site, while Pjonkerød B formed a separate settlement situated 140 m to the south. At a sea level of 60 m above current sea level, the sites were situated close to the shore, enabling easy access with small boats (Figure S1-7).

The excavation of Pjonkerød A uncovered a semi-circular formation of 40 stones, which is interpreted as the remnants of a tent ring measuring c. 4 m Ø. The stones formed a c. 1 m broad band as an irregular circle, indicating some relocation, which might represent traces of several settlement events. Relatively few artefacts were found inside the circle, suggesting that this area was cleared, while the main portion of

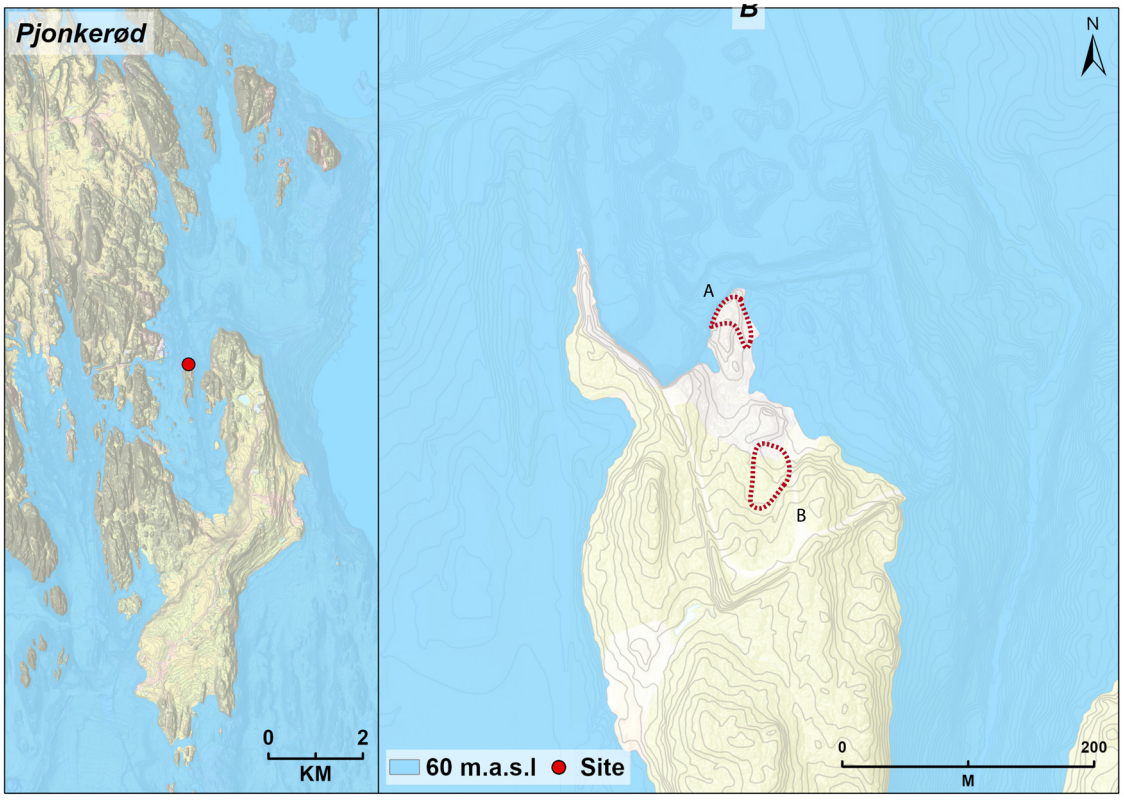

Figure S1-7: Linnea S. Johannessen and I. M. Berg-Hansen, MCH, University of Oslo.

artefacts were scattered across the rest of the site, including several concentrations. Fire-cracked rock where found in association with the stone circle, supporting the suggestion that this represents a wall or boarder.

The artefact inventory from Pjonkerød A, sub-area 1, comprise in total 5100 lithic objects, including a variety of curated tools such as a scraper, two borers, a core axe, a knapping stone and numerous fragments of grinding slabs of sandstone. No projectiles have been identified by certainty; however, some retouched and/or broken blades and microblades indicate production of lithic inserts as part of composite tools. The assemblage show the presence of a specialised blade and microblade production in accordance with the Middle Mesolithic conical core pressure blade concept, and seemingly flake production with bipolar percussion on anvil. Cores are generally exhausted, core remnants are small in size (maximum measure 1.1 – 3.2 cm), and only a few tools and complete blades have been left at the site. Further, the axe has not been produced at the site, the assemblage lacking traces of axe production. These traits combined indicate a raw material economy characterised by frugality, as well as transportation of tools and blanks to and from the site. In all, 90.4 % of the lithic raw material is flint, while the rest comprise quartz, sandstone, and various rocks of local origin. Pjonkerød A, sub-area 2, and Pjonkerød B were only sampled, and no structures were identified here. However, the assemblages display technological and typological traits similar to Pjonkerød A, sub-area 1.

A burnet bone (*mammalia*) from one of the artefact concentrations outside the tent ring at Pjonkerød A is C14-dated to 7040-6775 cal BCE (68.2%). Combined with the shoreline displacement, this indicate a date of the two sites to 7000-6800 cal BCE.

Supplementary file 3

C14-dating and Bayesian modelling

Three sites (Løvås, Adal and Pjonkerød A) produced 26 samples of charcoal and nutshells and 2 samples of burned bone that have been C14-dated to the Middle Mesolithic. In addition, 18 samples of charcoal from Løvås and Adal have been dated to the period Bronze Age to Medieval times; however, since they are not considered relevant to the Stone Age settlements, these dates are not included in the following discussion.

Method

In order to summarize the distribution of radiocarbon dates we produced a Kernel Density Estimate plot (KDE; Bronk Ramsey, 2017). Here, we include all samples dated to the Mesolithic from activity areas at Løvås 1–3, Adal 1–2 and Pjonkerød A (Figure 1 in main text; Supplementary File 2).

Further, we investigate the start and end of activity at Løvås 1–3. By using Bayesian tools available in OxCal v.4.4 (Bronk Ramsey, 2009) we have developed a simple phase model providing posterior density estimates for start and end boundaries.

Results

The KDE plot shows that the dated samples are distributed between c. 10 600 and 8400 calBP (Figure S3-1, and Supplementary File 2). The bimodal distribution indicates two activity phases that relates to an early phase of activity at Løvås, around 10 000 calBP and later activity at Adal and Pjonkerød, around 9000 calBP.

The archaeological assemblage and the radiocarbon dates demonstrate a large degree of contemporaneity in use of the different activity areas at Løvås and Adal respectively. Assuming that the defined activity areas at Løvås are contemporaneous, and to investigate this we produced a Phase model in OxCal including the Løvås-dates (the Adal site produced too few dates and Pjonkerød A only one radiocarbon date).

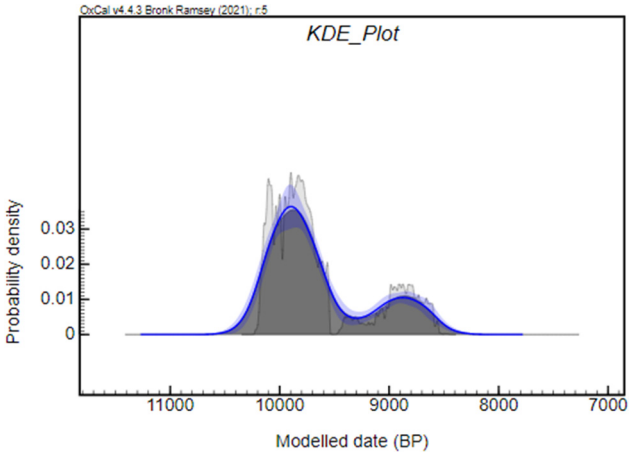

Figure S3-1: KDE-plot of all dates from the InterCity-sites and Pjonkerød show a bimodal distribution reflecting the chronological distribution of dated events and main activity at the sites. Amodel = 100, Aoverall = 99.3.

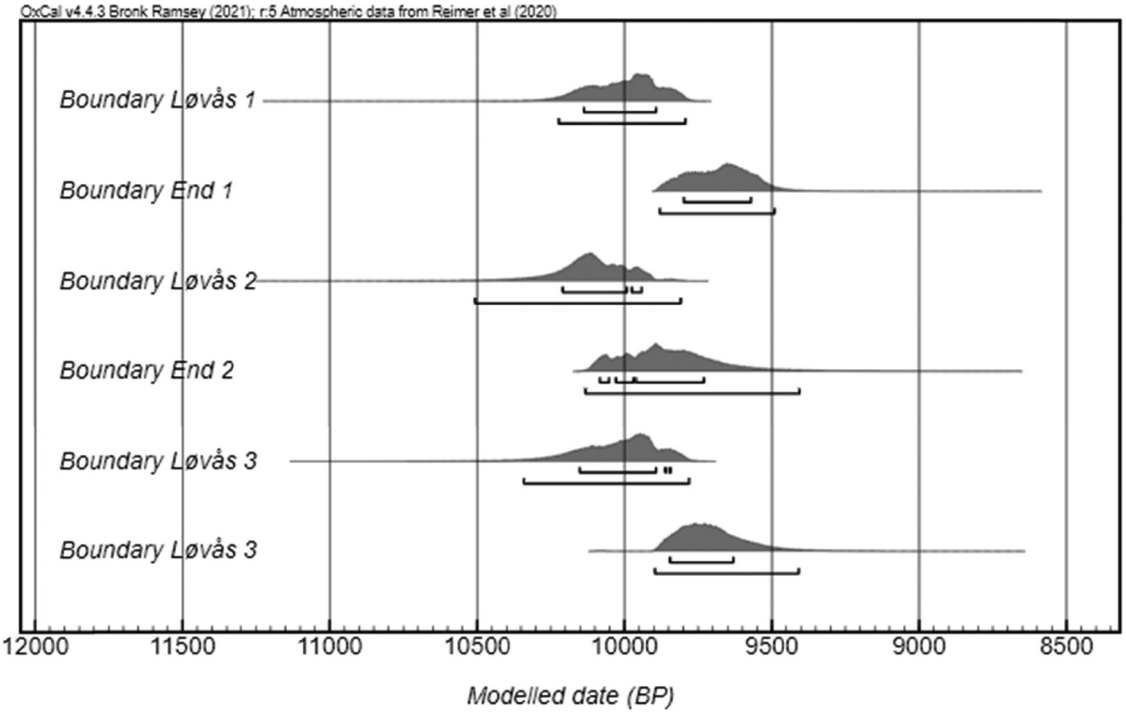

Figure S3-2: Start and end boundaries from Bayesian age model containing dates from Løvås 1–3. The modelled dates indicatethat the different activity areas at Løvås were in use at the same time. Amodel = 100, Aoverall = 99.3.

The estimated start boundaries of the three activity areas are all dated between c. 10 500 and 9400 cal BC (95 % probability), or most probably between c. 10 200 and 9840 calBP (68 % probability), see Table S3-1 and Figure S3-2. The end boundaries are estimated to date between c. 10 090–9400 calBP (95 % probability) or most probably from 9880 to 9630 calBP (68 % probability). There are some variations in the estimated start and end of activity at the Løvås, but we suggest that the Løvås 1–3 were taken in use and that the activity took place at the same time. The site location and elevation above present sea level support this. The Span function in OxCal indicates a duration of activity of up to c. 500 years (68 %).

Table S3-1: Modelled dates (calBP) for start and end boundaries at Løvås

		68.2	95.4
Løvås 1	Start	10 140–9890	10 230–9790
	End	9800–9570	9880–9490
Løvås 2	Start	10 210–9940	10 510–9800
	End	10 090–9730	10 140–9400
Løvås 3	Start	10 160–9840	10340–9780
	End	9850–9630	9900–9400

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