Resource management in Late Mesolithic Eastern Norway? Fishing in the coastal, interior and mountain areas and its socio-economic implications

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Abstract

This chapter addresses the economic and societal importance of coastal and freshwater fishing during the Mesolithic of Eastern Norway. Here, new archaeological evidence of fishbone, fishing gear and site locations from different topographic environments – the coastal zone, the eastern interior zone and the mountain areas – are compiled and discussed. Increased use of aquatic resources is noticeable during the Middle and Late Mesolithic (c. 8200–6350 cal BC), even though the studied organic archaeological record are severely affected by techonomic loss.

Based on general data from the region, selected key sites and comparison with diachronic finds from Western Norway, Sweden, and Southern Scandinavia, we maintain that increased use of temporally and spatially predictable aquatic foods are linked with socio-economic consequences such as reduced mobility, delay return systems, and economic and social differentiation. We further argue that rather than passively adapting to the environment, late Mesolithic populations actively intervened, transformed their landscapes and managed its resources. There is ample ethnographic evidence that indigenous non-agrarian people employed management techniques that allowed them to enhance the productivity of the local environment, and sustain supplies of key species. Based on archaeological evidence we suggest that such resource management included transportation of living trout to the upper part of the large watercourses during the last part of the Mesolithic period.

Introduction and research questions

Eastern Norway is one of the few areas in Europe where the postglacial coastlines are not submerged, and where early maritime subsistence and settlement patterns are well documented already from the Early Mesolithic, c. 9300 cal. BC (Bjerck, 2007, Bjerck, 2008, Solheim and Persson, 2018, see also Fig. 1). A foraging lifestyle, based on aquatic resources and terrestrial hunting and fishing, remained essential to the subsistence economy throughout the Mesolithic, and most parts of the Neolithic (9300–2400 cal. BC) in Norway. Fishing was also an important supplement to the agricultural economy that commenced in the Late Neolithic (c. 2400 cal. BC, Prescott, 2005, 2009). The economic importance of different types of fisheries (see Fig. 2) as a supplement to other forms of sustenance is also well documented throughout historical times (Eknæs, 1979, Dannevig and Eynden, 1986:p.195–196, Hesthagen and Kleiven, 2016b).

Fishing has been considered a key factor for the intense utilization of the landscape by people living by the coast, as well as the interior lowlands of Eastern Norway, during the Mesolithic (c. 9200–3900 cal. BC, eg. Brøgger, 1905:p.68, Hagen, 1959:p.141–143, Mikkelsen, 1989:p.65, 73,

297, Indrelid, 1994:p.263, Glørstad, 2010:p.78), but the lack of faunal evidence has hampered our understanding of the past Mesolithic fishing in the region.

A tremendous taphonomic loss, prompted by a combination of environmental conditions, such as acidic soils, and archaeological recovery procedures like the absence of fine-meshed sieving, have made fishbones and fishing gear severely underrepresented in the archaeological record (Mansrud, 2014, Hufthammer and Mjærum, 2016). Hence, the interpretation of the modes of subsistence in this region relies heavily on the location of the sites. Recently, new archaeological data, as well as reassessments of previously unpublished collections of faunal remains and fishing gear, have made coastal and freshwater fishing a more tangible topic of research in the region (Mansrud, 2014, Mjærum and Wammer, 2016, Mansrud, 2017, Mansrud and Persson, 2018). The main aim of this chapter is to explore the socio-economic importance of fishing in Eastern Norway during the Mesolithic period. Novel finds of fishbone, fishing equipment and site locations from three different habitats will be compared and discussed: the *coastal zone*, *the interior lowland zone* and the *mountain area* (Fig. 1). Furthermore, the results will be considered in relation to new evidence obtained from adjacent areas in Western Norway and Sweden. These findings constitute an important backdrop for evaluating the aquatic component of subsistence livelihoods in Eastern Norway, where the faunal fish remains are fewer and difficult to date directly by 14C-analysis (Mjærum, 2016:p.60–61). Following Knut Andreas Bergsvik and Anne Karin Hufthammer (2009), as well as Peter Rowly-Conwy and Stephanie Piper (2016), the notion of hunter/fisher/gatherers (hereafter termed HFG-societies) is here utilized to capture the Mesolithic way of life in Eastern Norway.

In Western Norway, Sweden, and Southern Scandinavia, the fundamental importance of coastal and freshwater fisheries has been thoroughly demonstrated based on zooarchaeological records (Karsten and Knarrström, 2003, Bjerck, 2007, Fischer, 2007, Bjerck, 2008, Bergsvik and Hufthammer, 2009, Boethius, 2016, Ritchie et al., 2016, Boethius, 2018a). The same conclusions have been drawn based on isotopic analyses of Mesolithic human bone remains from sites along the past coast, and in the interior lowland in large parts of Scandinavia (e.g. Lidén et al., 2004, Fischer et al., 2007, Eriksson et al., 2017, see however Skar et al. 2016 for a discussion of the importance of seal hunting, Boethius and Ahlström, 2018).

Recent excavations, carried out with improved excavation techniques, also demonstrate that *freshwater fisheries* may have been more important for the Early and Middle Mesolithic societies than previously acknowledged. Of particular importance is the site Norje Sunnansund in Blekinge, Southern Sweden (Boethius, 2016, 2018b). Exceptional preservation and methodological aptness, such as fine-meshed sieving of earth samples, resulted in enormous quantities of fishbone – statistic calculations indicate that approximately 60 tons of freshwater species, in particular roach, were caught at the site. Additionally, a presumed fermentation gutter for the preservation of fish was identified. The earliest settlement phase at Norje Sunnansund was dated to 7600–6900 cal. BC. Furthermore, archaeological finds from the Eastern lowland region in Sweden (e.g. Bergstrand, 2005, Nilsson et al., 2018), and other parts of Scandinavia also attest that a wide range of fishing equipment came into use during the Mesolithic period (e.g. Fischer, 2007, see also Fig. 2). Fish traps were previously known from the Late Mesolithic Ertebølle culture (c. 5300–3950 cal. BC), but have now been identified at Middle Mesolithic sites in Southern Scandinavia and in the Southern Baltic region (Boethius, 2018b, with further ref. , Nilsson et al., 2018). This shows that complex technologies for catching, preparing and preserving fish were known much earlier than formerly assumed.

Why is it imperative to expand our knowledge of the prehistoric fisheries in Eastern Norway? The main reason is that inquiries into aquatic adaptations and technologies have been considered vital for understanding early human societal formation, variation and change. It has been strongly argued that a more sedentary utilization of the landscape is only sustainable in bountiful natural environments, which contain sufficient resources to sustain a foraging population throughout the year. Sedentary societies are often associated with reliable aquatic resources (Kelly, 1983, Renouf, 1984). Trap fishing, storage and conservation techniques have been considered important prerequisites for decreased mobility and succeeding social complexity. Social complexity commonly implies larger groups, longer stays, more elaborate technology, intensified subsistence, broader resource utilization and the like. Furthermore, decreased mobility is often coupled with development of inequality and social differentiation (Price, 1985:p.201–202). Recent ethnographic inquiries even suggest that fisheries had enabled hunter-gatherer groups to develop long-lasting social and technological features that are associated with food cultivation and land tenure (Thornton et al., 2015). Hence, a more profound understanding of the nature of prehistoric fishing technologies allows for addressing questions concerning the societal as well as the economic dimensions of fishing.

Geography and topography and the establishment and development of the ichtyfauna

The investigation area presented here in Eastern Norway[1] constitutes 104, 000 km^2 and includes one third of present day Norway (Statistics Norway 2013). The topography is varied, with a large coastal zone with nemoral forest in the South, coniferous forest areas in the interior, and mountain areas up to an altitude of around 2,000 m a.s.l. (Fig.1). Topographic differences and climatic conditions influenced the availability of fish, and the applicability of fishing methods, and is of major importance for understanding past and present fishing in the region (Huitfeldt-Kaas, 1918). The Eastern Norwegian landscape was formed by geological processes,in particular by glacier activity, during the Quaternary time period. The melting and moving glaciers eroded the surface, conveyed sediments, and ultimately created the characteristic landscape of different regions, glacial fjords, rivers and valleys (Fredin et al., 2013:p.6). During the Weichselian Ice Age, the whole region was glaciated, and the ice initially started to retreat from the outer coast approximately 17,000 years ago (Fredin et al., 2015). The main parts of the interior zone became free of ice during at the onset of the Preboreal climate phase (Fig. 3, c. 9300 to 8200 cal. BC). The deglaciation opened up an archipelago that stretched from continental Europe, along the Swedish West coast, to the Oslo Fjord area (Påsse and Andersson, 2005). In the Oslo Fjord area, the initial deglaciation ice sheet led to rapid and continuous isostatic uplift, resulting in considerable elevation of the shorelines and the absence of later transgressions.

Initially after the deglaciation, a north– and westward expansion of people from Southern Scandinavia commenced, and the resource-rich areas along the Norwegian coast were rapidly populated (Bjerck, 2008:p.103, Glørstad, 2016). Today, most of the Mesolithic settlements are far away from the sea, but when the sites were occupied by prehistoric hunter-fisher-gatherers, they were located close to the present shore. The rapid shoreline elevation permits dating by thoroughly scrutinized shoreline displacement curves, which have become important tools for establishing a timeline for the Mesolithic period in the Oslo Fjord area (e.g. Solheim and Persson, 2018). Today, the coastal regions of eastern Norway are characterized by a skerry coastal landscape, with an outer coast exposed to the Skagerrak Sea, and numerous inlets and islands (cf. Puschmann, 2005).

In the newly emerged ice-free areas, the warmer climate enabled the immigration of plants and

[1] The geographical delimitation chosen includes the two regions *Østlandet* and *Sørlandet*, and coincides with the counties that falls under the jurisdiction of the Museum of Cultural History in Oslo (cf. figure 1).

animals (Jonsson, 1995, Hufthammer, 2006:p.193). Concerning the human and animal colonization of Eastern Norway, both a southern and a north-eastern immigration route have been verified. When the first narrow strip of land emerged from the ice, trout, char and three-spined stickleback, species that are tolerant to high salinity, began to migrate into the pristine areas (Huitfeldt-Kaas, 1918:p.23). Fluctuations in salinity, sea currents and water temperatures gradually caused several changes in the coastal ichtyfauna during the Mesolithic period (Fig 3, cf. Jonsson, 1995:p.152, Enghoff et al., 2007). Other species of fish migrated into the interior of Eastern Norway from the Ancylus ice sea, a freshwater lake that existed in the present Baltic Sea area (c. 9000–6900 cal. BC). During the Ancylus Sea stage, several freshwater species of fish – pike, perch and different types of cyprinids - had the opportunity to drift westwards when the ice disappeared (Fig. 3, cf. Jonsson, 1995:p.151). The consequence was the accumulation of a large variety of freshwater fish in the lower interior zones of Sweden and Eastern Norway. Waterfalls and rivers with steep elevation made it impossible for the fish to naturally migrate into the mountain areas (Huitfeldt-Kaas, 1918, Heggenes, 2016, Hesthagen and Kleiven, 2016a, see also Fig. 6 and Fig. 7). However, the mobile Mesolithic populations who initially visited the higher parts of the inland areas in Eastern Norway *encountered large landscapes with lakes and rivers without fish*.

Fishing in the mountain zone

The western part of the mountain areas in Eastern Norway consists of plateaus and plains situated above 1,000 m a.s.l., cut by deeply incised valleys (Puschmann, 2005, cf. Fig. 1). So far, there is no evidence of fishing prior to the Late Mesolithic period (see Fig. 6. Fig 7 and Appendix 1a, cf. Mjærum, 2016). One of the well investigated areas with evidence of early fishing is **Lake Vinstre** (1,030 m a.s.l.; 28 km^2) in the upper part of Gudbrandsdalslågen (Fig. 1 and Fig. 4–6). Today, the area is located above the tree limit, but during the Mesolithic period it was covered by forest (cf. Selsing, 2010:p.113–140). The watercourse forms a bottleneck in the area, through which a reindeer migration route ran in the past (Bergstøl and Friis, In prep.). High numbers of animals passed through this bottleneck formation every spring and autumn. Seasonally migrating elk and reindeer commonly follow river and lake shores in the interior areas, which makes river mouths and outlets excellent hunting grounds (Mjærum, 2016:p.62–64). A large number of sites have been found along the shore of the lake, some of them with up to 1 m thick cultural deposits (see Fig. 5, cf. Mjærum, 2016). The oldest sites are dated to c. 6000 cal. BC, and the hunting activities have been continuous in the area for 5,000 years. Along the shore of Lake Vinstre, a few fragments

of trout bones are found in contexts dated to c. 4500 cal. BC (Fig. 6 and Appendix 1a). Additionally, a presumed fragment of a fishhook and a set of stone sinkers, probably used for gillnet fishing, have been recovered from a site dated to c. 2600 cal. BC, further down the river at **Olstappen** (662 m a.s.l, Fig. 8, Mjærum, 2016:p.245–246). Importantly, these Neolithic finds support the assumption that mountain fishing already took place in the Stone Age.

Both in the past (cf. Appendix 1a) and in the present, the waterways in the mountain zone are dominated by trout, and ecologists and DNA scientists assert that trout must have been *transported to the rivers and lakes by humans* (Heggenes, 2016, Hesthagen and Kleiven, 2016a). Some of the trout transport has happened during the last centuries, and is mentioned in historical records (Hesthagen and Kleiven, 2016a, Severinsen, 2016). The first written records that mention fishing are dated to Medieval times (e.g. Hesthagen and Kleiven, 2016a:p.37–38, Ugulen, 2016). However, as demonstrated here, the archaeological results show that fish were present in many lakes and rivers long before the Middle Ages.

Trout is adaptive, productive, and can survive at high altitudes. It is rich in calories, and easy to catch, especially when it spawns in streams and rivers in the autumn, and is possible to carry in small containers. The locations with high densities of Mesolithic finds in the mountains are topographically well suited for hunting as well as for net fishing and fish traps (see Fig. 2, cf. Hagen, 1959:p.141–143, Mikkelsen, 1989:p.65, 73, 297, Indrelid, 1994:p.263, Mjærum, 2016). Therefore it is difficult to determine which resources primarily attracted people to these areas.

Large game, like elk and reindeer, provided a much greater outcome in terms of meat, calories and raw materials such as bone, antler and hide, and compared to fish it was presumably a more important resource overall. However, big game hunting is also more unpredictable, and fishing could have served as a staple food for hunting crews or mobile families (cf. Kelly, 2013:p.134–135).

Fishbones are small, and difficult to date directly by C14-analyses. Additionally, multiple revisits and a lack of stratigraphy make precise contextual dating problematic. This makes the precise time of the initial transportation of living fish upstream difficult to assess, however, a thorough evaluation of all known contexts of fishbones in the mountain region permits the conclusion that fishing commenced in the Stone Age, most likely in the Late Mesolithic phase (see Appendix 1a,

Fig. 6 and Fig. 7, cf. Mjærum, 2016:p.75–76). New data from the coast and the interior areas will be presented here in order to support this viewpoint.

Fishing in the coastal zone

The coastal settlements in Eastern Norway are clustered along former straits and islands, in sheltered bays and inlets with natural harbours in all parts of the Mesolithic (e.g. Fig. 1 and Fig. 8). This has led to the conclusion that the daily food procurement was largely based on marine resources in the region (e.g. Brøgger, 1905, Glørstad, 2010:p.97–100, Mansrud, 2014, Åstveit, 2014, Mansrud and Persson, 2018). This argument has mainly been based on site location and analogies to present day environments, and to a lesser degree on more systematic landscape analyses (cf. Fischer, 2007: Fig. 5.2). It can be argued that the importance of fishing cannot be deduced from site locations exclusively, because the coastal habitat is characterized by a large variety of species in addition to fish – sea birds, sea mammals, and shellfish - which are also attractive to humans. The finds of fishing gear, fishbone and the indication of the Mesolithic diet, based on C13-values in large parts of Southern and Central Scandinavia, do however support the assumption that fishing was a activity of great importance also in Mesolithic Eastern Norway (cf. Enghoff, 1994, Fischer, 2007, Bergsvik and Hufthammer, 2009, Boethius, 2016, Solheim and Persson, 2016, Boethius, 2018b, a, Boethius and Ahlström, 2018, Mansrud and Persson, 2018).

The recurring settlements and the lack of transgressions make the coastal zone of the Oslo Fjord particularly well suited for investigating long-term trends in the Mesolithic coastal settlement, and tangible evidence of fishing, in terms of zooarchaeological remains and fishhooks, is most frequently encountered here. The location of the Early Mesolithic sites (c. 9300–8200 cal. BC) is linked with the marine biotopes, and some researchers have claimed that the marine bioproductivity in the Skagerrak was particularly high during the Preboreal (e.g. Schmitt et al., 2006, see discussion in Mansrud and Persson, 2018:p.134–135). No faunal remains are preserved at any Eastern Norwegian coastal site dated to the earliest pioneer phase in Norway, but capelin, herring, whiting and ling have been identified in late Glacial non-antropogenic deposits (Jonsson, 1995:p.150–151, Sørensen et al., 2014:p.210–211, see also Fig. 3). After 9000 cal. BC, the sites are no longer exclusively found at the coastlines and outer fjord basins, but also in the newly ice-free hunting grounds in the interior and the mountain areas, thus pointing to differentiated subsistence strategies being used (Bang-Andersen, 2012, Breivik and Callanan, 2016).

During the Middle Mesolithic period, which started at the onset of the boreal climate period (Fig. 2), several coastal faunal assemblages are preserved in the Oslo Fjord area, and along the Swedish West coast (Glørstad, 2010, Mansrud and Persson, 2018).[2] These assemblages encompass a large variety of species, and a variable proportion of fishbone, which is suggestive of a mixed subsistence practice. Fish remains are reported from nine sites dated to the Middle Mesolithic period in the south-eastern Skagerrak area. Six bone assemblages are from transgressed localities in Western Sweden, and four are located in South-eastern Norway (Appendix 1b). In total, 27 different species of fish have been identified, but their distribution varies considerably among the sites (Appendix 1b). Marine species like cod, ling, saithe, haddock, pollock and whiting are the most numerous, but a few fragments of flatfish, also freshwater species like pike, salmon and trout also occur. Food from the sea apparently made up a significant part of the diet, although this is difficult to assess, based on highly fragmented faunal material (Glørstad, 2010:p.78, Mansrud and Persson, 2018:p.154–155). With the exception of ling, which prefer deep water, the marine fish from the Middle Mesolithic sites are demersal species, which may have been caught with a line and hook, or nets. During the Middle Mesolithic phase, in particular from c. 7500 cal. BC onwards, a systematic and varied utilization of a wide range of biotopes commenced (Bjerck, 2008:p.104, Solheim and Persson, 2016, Mansrud and Persson, 2018). At the same time the first traces of more permanent dwellings appear (Solheim and Olsen, 2013, Fretheim, 2017).

For the Late Mesolithic period (c. 6350–3900 cal. BC), fishbones have been found at six coastal sites in Eastern Norway (Appendix 1b), and five sites from the Swedish West coast (Glørstad, 2010:p.80–84, whith further ref.). A particularly interesting Late Mesolithic site is **Skoklefald** in the inner part of Oslo Fjord (Fig. 8), where a cultural layer containing periwinkles, oysters and animal bones was excavated in 2001. 75 percent of the bones were unburnt, an extremely rare situation in this region. Three C14-samples date the site within the timeframe c. 5900–5600 cal. BC (Jaksland, 2001:p.17–18). The site was interpreted as a small kitchen-midden, measuring approximately 30 m^2 (Fig. 9). 509 fragments of fishbone were found, of which 228 fragments were identified as herring. Cod, pollock and sea eel are also represented (Appendix 1b). The Skoklefald midden only yielded 257 lithic finds and a small fireplace, and the site was interpreted as the result of a single or several shorter visits over an extended period of time (Jaksland,

[2] The material culture along the Oslo Fjord area of south eastern Norway and the west coast of Sweden is similar and closely related throughout the Mesolithic period, both in terms of artifact types and technologies. These areas are commonly regarded as a coherent cultural area, often referred to as *the north eastern Skagerrak area* (see Mansrud and Persson, 2017; Solheim and Persson, 2016).

2001:p.19). In this respect, Skoklefald differs from large Late Mesolithic coastal settlements, of which several comprise dwelling structures and large amounts of lithic debris. These larger sites are often interpreted as marine-based residential sites in a logistical settlement system, where a wide spectrum of activities took place (Glørstad, 2010:p.64, with further ref.).

The Havsjødalen site complex is a recently excavated example of a large Late Mesolithic coastal settlement (Fig. 8). At Havsjødalen 3, a sunken dwelling hut was identified. The floor of the dwelling measured 6 x 3 metres, and was visible as a dark cultural layer (Fig. 10). 61,500 lithic artefacts were recovered from the site. This points to intensive use, and the site was interpreted as a residential unit used for a longer period. Unfortunately, only a few fragments of burnt animal bone were preserved. Amongst them were unidentified mammal bones, one bird bone and a possible fish tooth. Cultural deposits from a another excavated site in Havsjødalen, which were chemically analyzed, turned however out with calcium-phosphorus-fluorine values that correspond with a high content of decomposed bone, possibly from fish (Macphail and Linderholm, 2016).

The location of the site complex gives better ground for a discussion of the resource base for the people that lived there. The Havsjødalen site was situated at the south-eastern side of Nesodden, which was a large island when the sea levels were 50 metres higher than the present day (Fig. 8). Such locations are known to generate superior conditions for fishing (Bergsvik, 2001). The stream between this island and the mainland was probably ideal for fishing, especially using weirs, a method well known from Southern Scandinavia (Fischer, 2007). Havsjødalen, and other similar residential sites of the time, point towards fish as a central resource harvested in the coastal zone during the Late Mesolithic period, whilst smaller sites like Skoklefald may have functioned as specialized locations for fishing and the gathering of molluscs (Glørstad, 2010:p.79).

Several studies of fishhooks from Middle and Late Mesolithic sites have been conducted during recent years (Bergsvik and David, 2015, Mansrud, 2017, Mansrud and Persson, 2018). The archaeological finds of Mesolithic fishing equipment in the coastal zone is limited to fragments of bone fishhooks and debitage from fishhook manufacture, although other fishing methods were probably also in use. The fishhooks are similar throughout a large region in the Middle Mesolithic period. They are relatively small (approximately 3 cm long on average), made without barbs, and the shanks have notches for fastening the line (see Fig. 11, cf. Mansrud, 2017). Two fishhooks

and a fragment of debris from fishhook manufacture were found in the cultural layer at Skoklefald (Fig. 4). Unlike the Middle Mesolithic fishhooks, this shank does not have a notch, but a small bulb for tying the line, similar to an undated fishhook from Sande in Vestfold (Fig. 11). Small stone sinkers are found in large numbers at Late Mesolithic sites in Western Norway (Ritchie et al., 2016, Bergsvik, 2017). Despite the large number of Mesolithic sites excavated in South-eastern Norway, such stone artefacts are uncommon here, except for a few examples from Lista, close to the West coast region (Appendix 1b). Presumably, small pebbles not recognisable as sinkers must have been used. Nicely crafted stone sinkers must thus be considered a regional phenomenon in Western Norway (Bergsvik, 2017).

Fishing in the interior zone

Zooarchaeological analysis show that elk and beaver were the most important animals hunted in the interior boreal forest areas throughout the Mesolithic (Ekman and Iregren, 1984, Mansrud, 2009, Hertell and Tallavaara, 2011, Mjærum, 2018). Thus, the interior settlements contrast with the broad and varied faunal economy observed in the coastal zone. However, what these zones do have in common is the availability of fish as a stable resource. Previous studies concerning the fisheries in the interior areas have emphasized the importance of pike, perch and different types of cyprinids (Ekman and Iregren, 1984). The earliest site with preserved fishbones in the interior zone is Almeö in Western Sweden, situated along the large Hornborga lake, and dated to the Preboreal climate phase. Fishbones, mainly pike and perch, constitute 30 percent of the faunal assemblage (Kindgren, 1995:p.173). No fishhooks have been identified at Almeö. Pike may have been caught with leisters, but the presence of perch indicates that nets or fishhooks had also been used. The use of leisters for lake fishing is documented throughout the Mesolithic (cf. Vankina, 1999, Johansson, 2006, Carlsson, 2007, Gummesson, 2018:p.53–54), and large amounts of sinkers also point to the use of fishnets (cf. Carpelan, 2008, Sjöström and Hammarstrand Dehman, 2010:p.13, 42–43). Stone sinkers, most likely used to weight down gillnets, have a wide distribution in the eastern interior zone, but as stray finds they are difficult to date (Broadbent, 1979:p.127–128, Lannerbro, 1997:p.25–26, Stene et al., 2010:p.516). One of the most common types, Indreko (1956) type A, are flat stones with notches at the sides. They are often dated to the Middle Neolithic, but this type, as well as other types of net sinkers, were also in use during the Mesolithic (Mjærum, 2016:p.60, 72–73, with further ref.).

Finds of fishing weirs make fishing evident in the interior lowland areas of Sweden from around

7500 cal. BC (Boethius, 2018b), and from c. 7000 cal. BC in the Southern Baltic area (Nilsson et al., 2018). It is likely that this practice commenced not much later in Eastern Norway. From the Oslo Fjord area, several large rivers extended into the interior, and Middle and Late Mesolithic sites are frequently encountered at the outlets or along these riverine systems (e.g. Fuglestvedt, 1992, Boaz, 1997, Stene, 2010). Bones of trout have been found at some of them (Appendix 1a, see also Mjærum, 2016:p.60). Most of the sites with finds of fishbones in the lower interior zone are, however, located along large lakes (Ekman and Iregren, 1984:p.33), such as Lake Osen (44 km^2) in Hedmark county, Norway (438 m a.s.l.). The site **Osneset,** situated at the northern shore, is positioned at a promontory at the mouth of the river Osa (Fig. 12 and Fig. 13). The site is one of the largest settlement areas in the whole region (c. 44,000 m^2), and like many other sites in the interior, it had been visited repeatedly throughout the Stone Age. Lithic material, large amounts of fire-cracked stones and bones have been found during surveys and small test-pit and trench excavations (Winther and Persson, 2016). Artefacts and radiocarbon dating demonstrate human activity at the site on several occasions, from the last part of the Middle Mesolithic until the Bronze Age (c. 6500–1500 cal. BC). 1,432 cremated fishbones can be related to the initial phase of activity, together with mammals (428 pcs.), undetermined bones (1627 pcs.) and two parts of a fishing spear (Fig 13). The material includes pike, perch and different types of cyprinids, and must have been caught in large quantities (Appendix 1c). Large and reliable recurring species of fish was most likely a key factor for the activity at Lake Osen. Great amounts of fire-cracked stones, such as those found in the cultural deposits at Osneset, have been commonly interpreted as evidence of heating during winter occupation (cf. Lundberg, 1997, Fretheim, 2017:p.36). Pike and perch are species that are well suited for drying and storage (Eknæs, 1977), and we may speculate that the heaps of fire-cracked stones stem from the drying of fish, although this cannot be directly proven.

The **Sandholmen** site is located on a small islet in Norway's longest and largest river; Glomma (fig. 14). The Sandholmen site is renowned because of the large number of depressions interpreted as Mesolithic pit-dwellings – in all, 25 depressions have been registered on the islet (Fuglestvedt, 2006, Eigeland et al., 2016, see also Fig 15). Two of the depressions were situated at the brink of the islet, and were highly exposed to erosion from the annual floods of the river Glomma. In 2015, a small rescue excavation was undertaken, in order to protect the site from further damage (Eigeland et al., 2016). The investigation verified that the depressions were indeed Mesolithic pit-houses, dug into the moraine sediments (see Mansrud and Persson, 2016:p. for details). Their

construction must have demanded a considerably temporal and organized effort. Three C14-samples from one of the test pits inside one of the dwellings showed Middle/Late Mesolithic dates. New studies of the local shore level displacement indicate that the islet was shore-bound around 7800 cal. BC (Sørensen, 2015). The oldest C14-sample from Sandholmen is dated to c. 7500 cal. BC. During this time, the site would have been located near the shore. Soon afterwards, the area was transformed from seabed to dry land. The youngest sample is dated to the earliest part of the Late Mesolithic (c. 6100 cal. BC). In the later phase, it would have been situated between 16 and 41 m above past sea level at the time of occupation, and therefore not shorebound, but situated close to the river (Mansrud and Persson 2016, 17). Salmon can be caught in the lowermost parts of Glomma today but make it impossible for the fish to reach higher areas like Sandholmen (Fig. 14). When the sea level was higher, during the Middle Mesolithic period, salmon must however have been able to reach the waterfalls close to the area with numerous pit-dwellings. This could tentatively imply that *seasonal fisheries of salmon and other species have been a key factor for the location* during the early phase. Underwater investigations outside Sandholmen in 2007 identified traces of what may well have been permanent fish traps in the narrow stream close to the site (Nævestad, 2007). Fish traps aimed at specific species have been widely used on a large scale during modern times (Dannevig and Eynden, 1986:p.48, Hesthagen and Kleiven, 2016b), and we do not know the age of the traps in Glomma. However, based on the local topography, and by an analogy with Mesolithic finds from Sweden and Finland, it is likely that fish traps and weirs were in use, and these fishing technologies may have been utilized for catching salmon.

A large number of Mesolithic sites are known in the vicinity of Sandholmen (Lindblom, 1984) and further up the Glomma river (e.g. Fuglestvedt, 1992, see also Fig. 1 and Fig. 14, Boaz, 1997, Stene, 2010). At some of these sites, fishbones from trout, and possibly salmon, have been recovered (Appendix 1c). Hence, we find it likely that the large-scale activity at Sandholmen and nearby sites may have been related to fishing, at least until the time around 7200 cal. BC, when the migration of spawning salmon was stopped further down the river, as the waterfalls became too steep for the fish to pass due to the Post-glacial rebound.

The socio-economic implications of Mesolithic fishing – discussion and conclusions

Based on new findings of fishbones, fishing gear, and the locations of the settlements, we have

shown that fishing was important in subsistence from at least the beginning of the Middle Mesolithic period in Eastern Norway. The overall faunal composition at the Middle (8200–6350 cal. BC) and Late Mesolithic (6350–3900 cal. BC) coastal sites display a great variety of species from marine and terrestrial habitats, and a large variety of demersal and pelagic species have been identified in the coastal areas. Both seasonal pelagic species of fish, such as mackerel and herring, which move in large schools, and more stationary species have been identified. Bone fishhooks were in use throughout the Middle and Late Mesolithic periods, and based on the location of sites close to tidal currents, such as the Havsjødalen site complex, similar coastal adaptations have been suggested for Western Norway during the Late Mesolithic (Bergsvik, 2001).

For the interior lowland zone, freshwater fish such as perch, pike, trout and salmon have been identified at riverine sites and lakes. We have suggested that the intense activity documented from the Middle Mesolithic period onwards in the Glomma estuary, might have been connected to the exploitation of spawning salmon, at least until c. 7200 cal. BC, when the migration of spawning fish most likely stopped further down the river. Access to several sources of water, such as freshwater lakes, streams and the sea is considered to be of primary importance for the development of a sedentary way of life (Boethius, 2017:p.157–158). Mesolithic settlements are often placed in ecotone environments, bordering between different biomes, and thus enabling the optimal exploitation of different habitats and reducing the risk of food depletion. As an overall tendency, from around 7500 cal. BC, there is evidence of a greater differentiation in the resource utilization, stronger attachment to local areas, and more labor energy invested in the landscape, as shown by the construction of pit houses in the ecotonal interior zone at Sandholmen, and along the coast at Havsjødalen. Large-scale semi-permanent residential camps were now established along the shores, at the coast as well as in the interior (Glørstad, 2010:p.87–91). Additionally, Bayesian modelling of C14-dates, from a large number of excavated sites and surveys in Eastern Norway, indicate a population peak around 7500 cal. BC, followed by a stable settlement throughout the Mesolithic area (Solheim and Persson, 2018).

As stated in the introduction, it has been maintained that the commitment to temporally and spatially predictable aquatic foods (including coastal, freshwater and anadromous fish) are linked with socio-economic consequences such as reduced mobility, delay return systems, larger group size, population growth, decreased territories, complex technologies, increased economic and social differentiation, and more intense and wide-ranging gift exchange and ritual activity (e.g.

Woodburn, 1982, Paulin, 2007, Marean, 2014, Bergsvik et al., 2016, Boethius, 2017). By ethnographic analogy with the Northwest Coast tribes of Northern America, T. Douglas Price (1991:p.231) and others have argued the Late Mesolithic coastal groups in Southern Scandinavia were sedentary. The Northwest Coast tribes differ from the other hunter-gatherer peoples in the northern coniferous forest area. Their settlements were situated at the outskirts of rivers, where salmon fishing was a regular and stable resource. Additionally, their coastal adaptation was based on fishing, shellfish and hunting for marine mammals. The rich fisheries and the predictable resources formed the basis for permanent settlements, and the rich seasonal food resources were conserved and stored. Through preservation and storage techniques, the fisheries created the basis for accumulation of surplus (Renouf, 1984:p.18–19). Excavations at well preserved sites such as Tågerup in Scania show unequivocal evidence of a large and sedentary coastal settlement in the Late Mesolithic Ertebølle phase (c. 5400 cal. BC, Karsten and Knarrström, 2003:p.131, 160–165).

The emphasis on social inequality, power and consumption control has also been suggested for the Mesolithic period in Norway. Several researchers have advanced the idea that the Late Mesolithic communities in Western and eastern Norway developed into 'big-man-societies' (Fuglestvedt, 1999, Bergsvik, 2002, 2006, Glørstad, 2010:p.193–197), that is, societies socially structured as clans rather than as mobile bands, who controlled the aquatic resources within more confined territories, and which were socially characterized by logistical mobility, task-group organization, inter-group alliances and gift exchange. It has also been proposed that a longstanding tradition of socially complex, (semi-)sedentary and aquatically dependent populations may have extended as far back as the Middle Mesolithic period (Bergsvik and Hufthammer, 2009, Glørstad, 2010:p.187, Boethius, 2017). Our interpretation of the socio-economic structures in Eastern Norway, based on site locations, new archaeological evidence of fishbone and fishing gear, and analogies with neighboring areas, has principally supported previous explanation models, emphasizing a socio-material development leading to aquatic adaptations, reduced mobility and larger degree of social complexity during the Middle and Late Mesolithic in Eastern Norway.

As contended by Bill Finlayson and Graeme Warren (2017:p.57), *complexity* is a relative term and phenomenon, and urges archaeologists to acknowledge different forms of complexity, that allows us to discuss a wider range of social formations within the Mesolithic period. The indigenous HFG-societies, that are commonly utilized as ethnographic analogies for interpreting

the social organization of past societies, had wide-ranging and varied subsistence economies and social organizations (Rowley-Conwy and Piper, 2016, Grier, 2017). This provides opportunities to assess the prehistoric situation from a different perspective, and we will close this discussion by pointing out some alternative approaches to the social significances of the term complexity, and its archaeological implications.

Fishing with stationary tools like fish traps can be considered as a form of collection, rather than active pursuit of prey, and a limited amount of energy is needed in terms of subsistence strategy. For example, salmon are abundant and easy to catch, during short and intense spawning seasons, and knowledge of fish life cycles and seasonal movements enables an easily accessible, high return catch. At such communal gathering places, centered on joint food production, forms of social dynamics, other than competition, may have come into play. The exploitation of large catches of fish, documented from different aquatic habitats in ethnographic accounts, point to *the need for communal cooperation* (Swezey and Heizer, 1977:p.21, Paulin, 2007). The manufacture of fishing gear such as seines, nets, and lines, is particularly time consuming, and constant maintenance of the equipment is required (Stewart, 1982 [1977], Paulin, 2007:p.21–23). Chris D. Paulin (2007:p.21–24) describes how the Māoris of New Zealand made nets that measured several thousand meters in length. The manufacture, utilization, maintenance and repair of these were communal tasks that could preoccupy a whole village. Technologies tend to generate and maintain social relationships and a society relying on fishing as a stable and predictable resource facilitated the communal engagement of all members of society in food procurement. It has also been argued that permanent trap systems for elk were in use in Eastern Norway from the Late Mesolithic period (a system is dated to c. 6100-5500 cal. BC, Bergstøl, 2015). This adds to the emerging picture of an increased investment in the landscape.

Societal changes following increased societal complexity can also affect the relationships between humans, animals and the environment. Fish maintenance can be considered as resource management (Grøn and Turov, 2007), even as a type of low-scale *food production*. There is ample evidence that indigenous non-agrarian people employed management techniques that allowed them to enhance the productivity of the specific local environment, and sustain supplies of key species (Grøn and Turov, 2007, Thornton et al., 2015:p.189). for example, tribes of the North West coast of America were harvesting, burning, weeding, transporting and seeding plants to improve their environment; they kept clam gardens, bird and marine mammal rookeries, and made

spawning beds for herring. Salmon was particularly central to these cultivation practices, and included multigenerational community linkages to salmon fishery locations, dismantling of weirs when they were not in use to avoid unintentional catches, and transplantation of eggs, smolt and adult fish between streams to address shortages (Thornton et al., 2015:p.190, 192–193). Detailed examinations of well-preserved faunal remains from Southern Scandinavia, Siberia and Ireland also show that the resource utilization and hunting strategies among Mesolithic hunter-fishers was well planned, and also possibly conscious of sustaining certain key species (Eriksson and Magnell, 2001, Magnell, 2005, Losey et al., 2008, Warren et al., 2014, Boethius, 2018b). A premise for this type of hunter-fisher-gatherer situation was long-term physical and conceptual relationships with specific places in the landscape, and deep historical connections to particular places. Based on what we have discussed here, we believe that Late Mesolithic population in Eastern Norway were well organized, accomplished hunter-fishers-gatherers, with extensive knowledge of the behavior of fish, and with the know-how, skills and motivation to transport trout to the upper part of the large watercourses in Eastern Norway during the last part of the Mesolithic period, and thus to "cultivate" the mountain waters that hitherto had been without fish. Trout was the most likely fish to have been transported, and subsequently became a key resource in the mountain zone. Rather than apassive adaptation to the constraints of the environment, Mesolithic people actively intervened, transformed, and affected their landscape.

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Mjærum & Mansrud- Captions

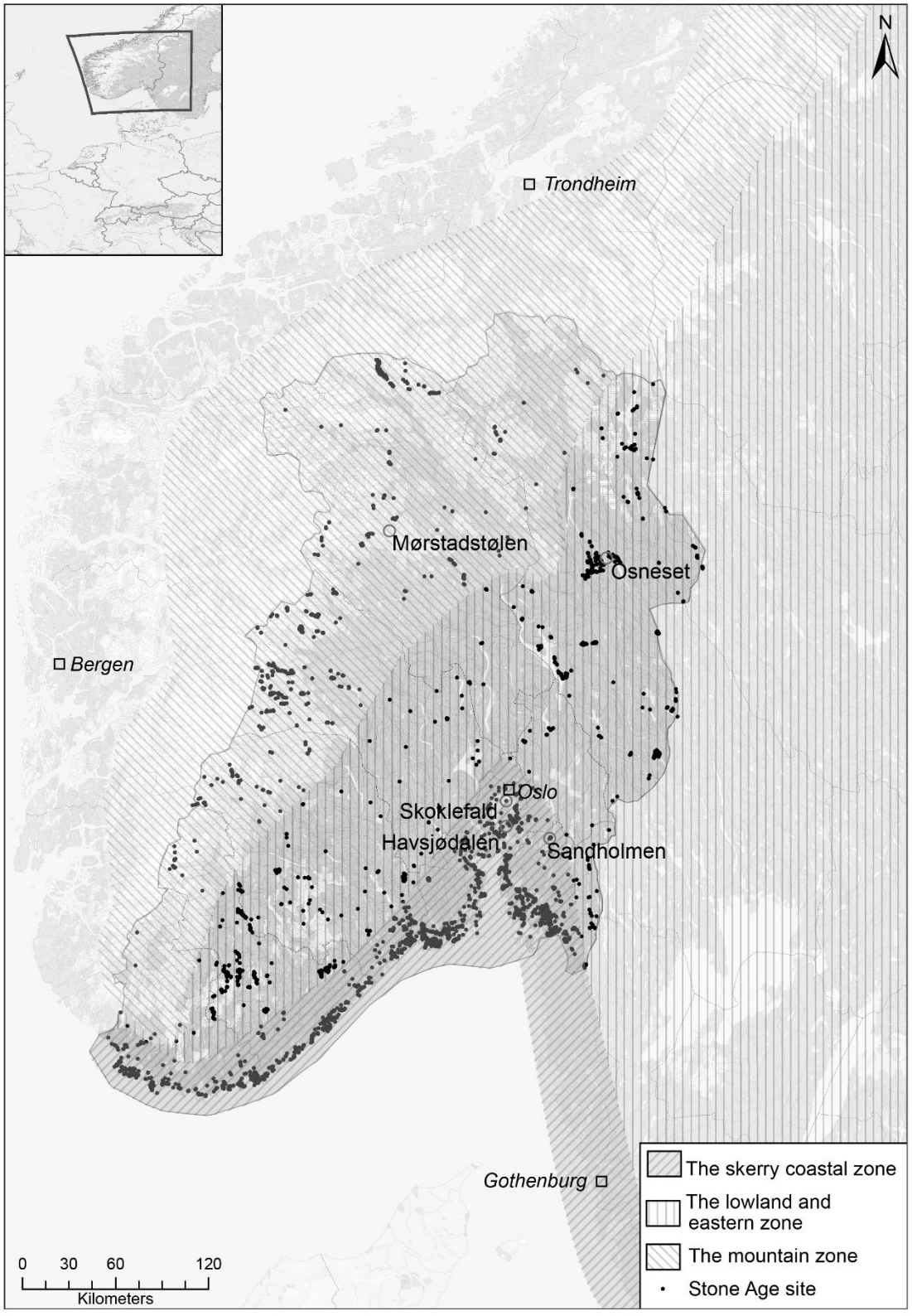

Figure 12.1. South-eastern Norway with recorded Stone Age sites (Askeladden) and the three major regions discussed in the article: The coastal zone, the lowland and eastern zone, and the mountain areas, which provided different natural conditions for past fishing. Map: A. Mjærum, Museum of Cultural History, University of Oslo.

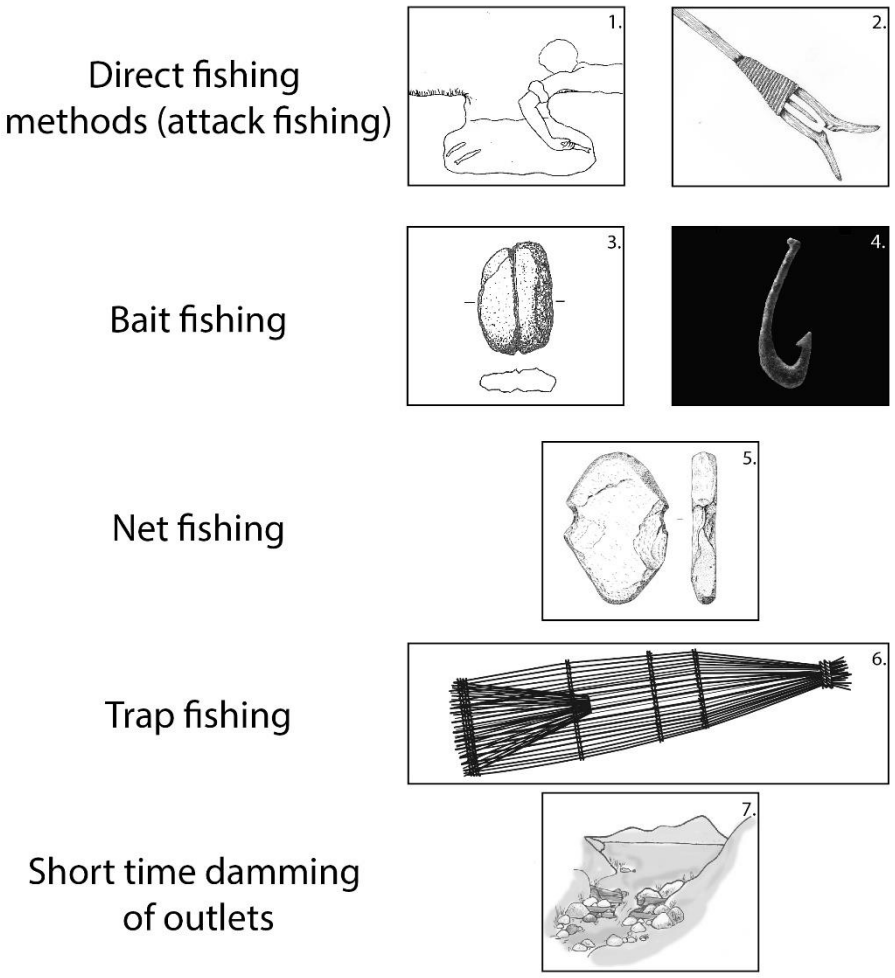

Figure 12.2. A large range of fishing methods have been utilized during the last centuries in Scandinavia (Eknæs 1979; Dannevig & van Eynden 1986, Hesthagen & Kleiven 2016a), and most of these were most likely applied in the Mesolithic period. 1. Fishing by hand (illustration: NFS Ord og Sed, no. 27, reprinted with permission); 2. Fishing leister from Sylthom, Denmark (illustration © Anne Vibeke Knöchel Christensen, Museum Lolland-Falster, reprinted with permission); 3. Line-sinker from Farsund, Vest-Agder (Ballin & Lass Jensen, 1995:192; length 3 cm); 4. Fish hook from Sande, Vestfold (photo: Kirsten Helgeland; Museum of Cultural History, length 3,3 cm); 5. Net-sinker from Åmot, Hedmark (illustration by S. Thingnæs; Damlien 2010:420; length 13 cm.); 6. Reconstruction of a Mesolithic fishing trap (illustration: Axel Mjærum, Museum of Cultural History); 7. Short-term damming of an outlet (illustration: © Sigrid Skoglund, NINA, reprinted with permission).

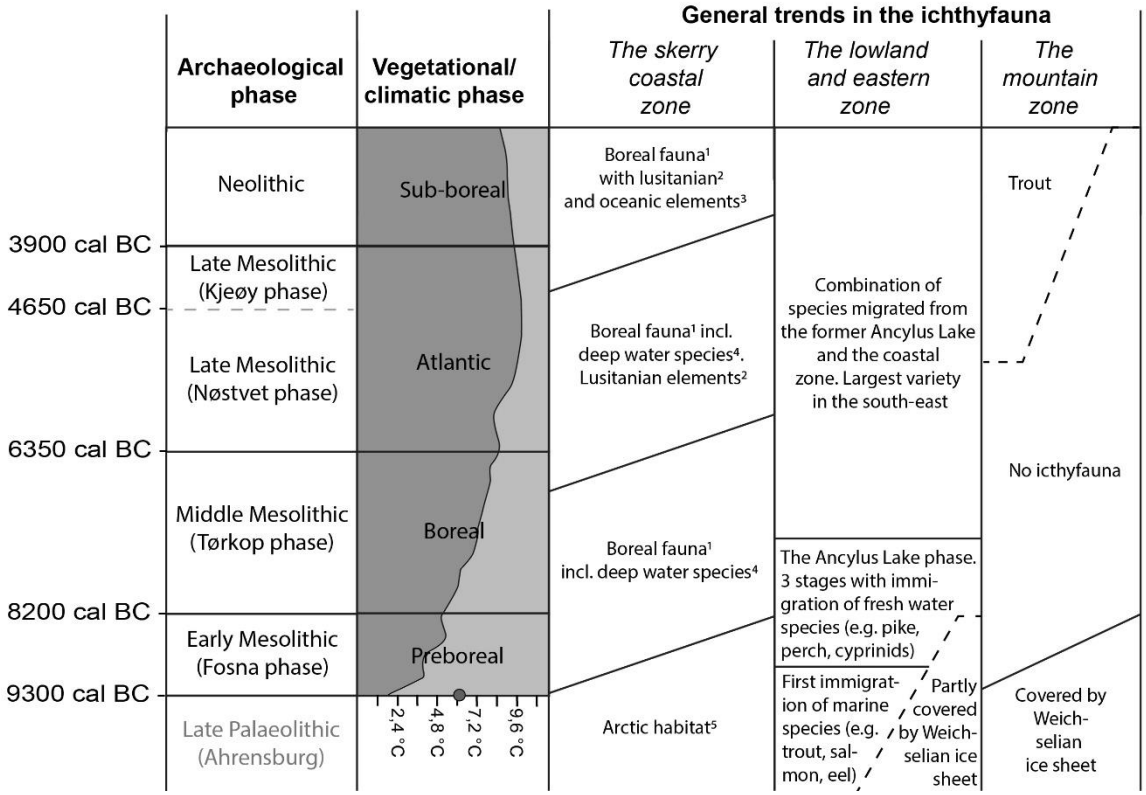

Figure 12.3. Archaeological and vegetational/climatic phases (based on climate reconstructions from Bohuslän, southwest Sweden, in an area where the modern mean annual temperature is 6.1 °C. Based on Antonsson & Seppä 2008:fig. 5). The figure also includes the main developments in fish fauna in the three regions discussed in the text. The fish fauna from the skerry coastal zone is based on records from Denmark (Enghoff et al. 2007) the Swedish west coast and Norway (Appendix 12.1b; Hufthammer 2006). 1) Boreal fauna include cod, saithe, pollock and herring. 2) Lusitanian (southern) fauna include bogue, anchovy and sea bass. 3) Oceanic fauna include mackerel, bluefin tuna and swordfish. 4) Deep water fish fauna include ling, redfish and halibut. 5) Arctic fish fauna include capelin, herring, whiting, ling and char. Eel, trout and salmon has also been present in the Skagerrak area as well as in the lowland and eastern zone since the earliest parts of Preboreal. Illustration: A. Mjærum, Museum of Cultural History, University of Oslo.

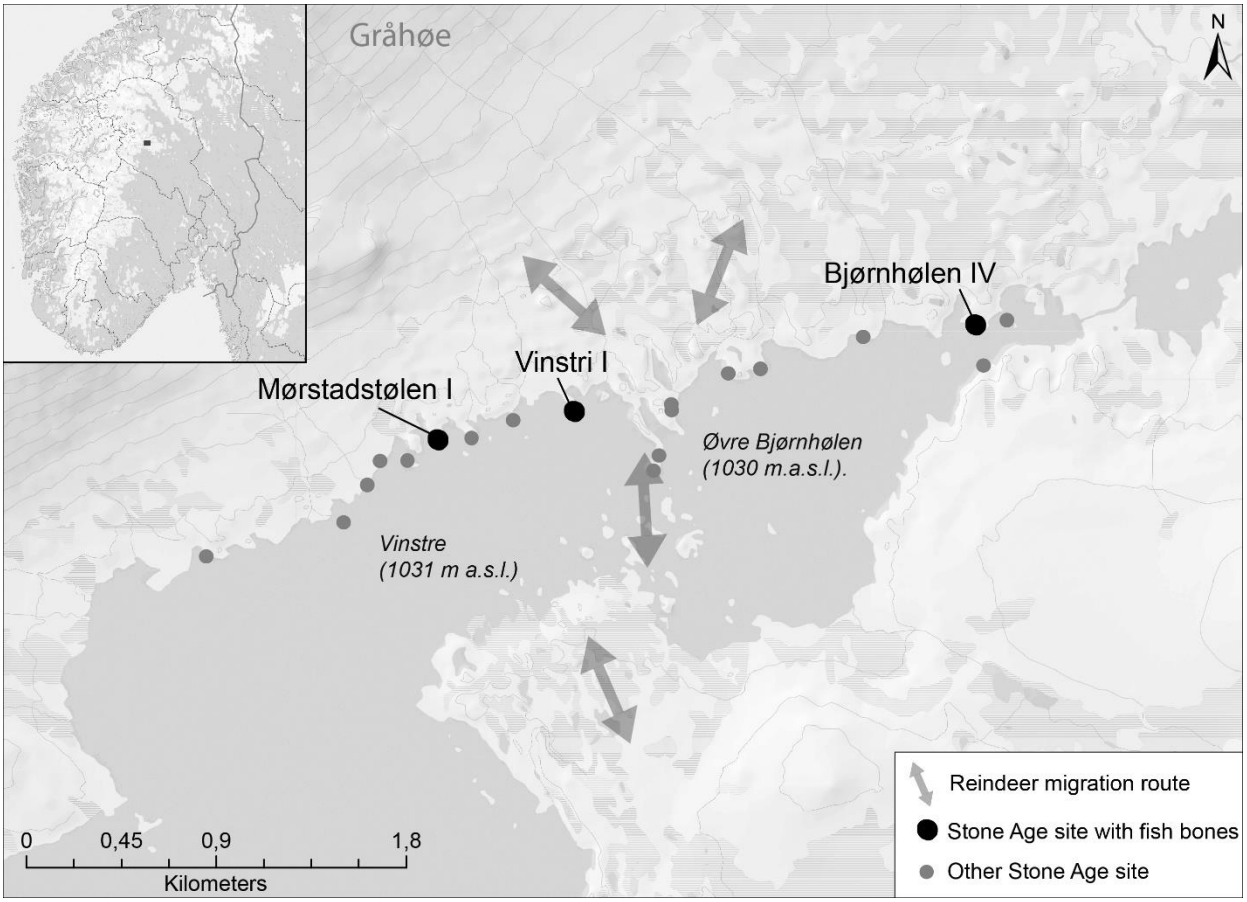

Figure 12.4. A large number of small headlands stretch out into Lake Vinstre. Many of these were settlement areas in the Late Mesolithic period. Photo: K.~~irsten~~ Helgeland, Museum of Cultural History, University of Oslo.

Figure 12.5. A migration route for reindeer crossed Lake Vinstre, and may have contributed to the intense activity which is reflected in the Stone Age sites along the lake. Illustration: A. Mjærum, Museum of Cultural History, University of Oslo.

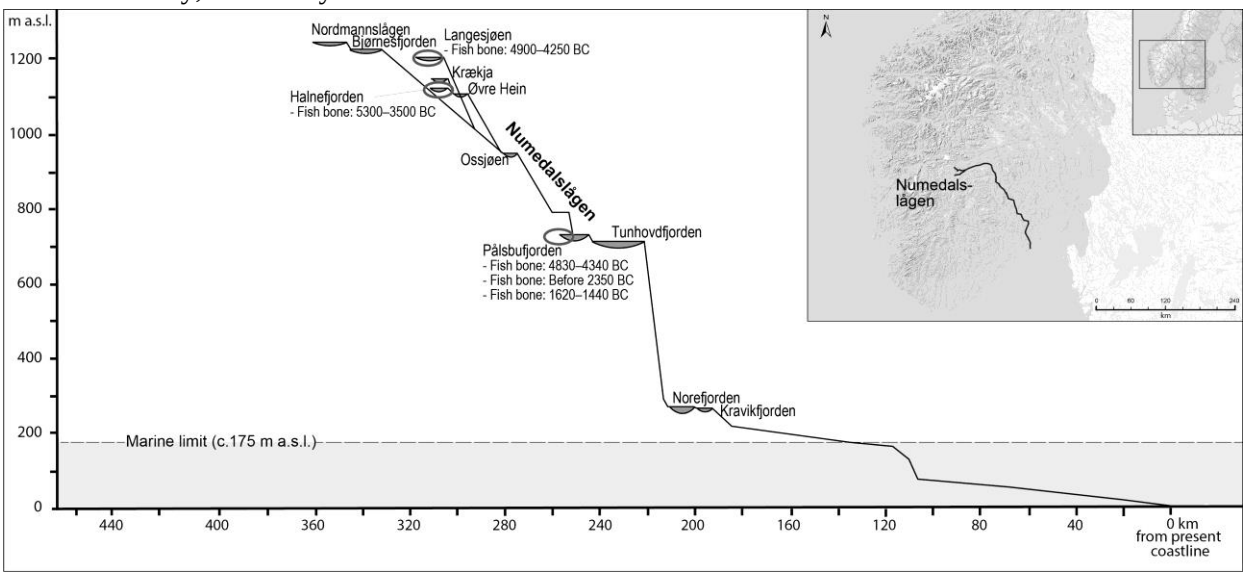

Figure 12.6. Sites with burnt bone of trout in Numedalslågen, one of the main watercourses in the mountain areas. The figures also show the steep elevation of the rivers, thus demonstrating why it was impossible for fish to naturally migrate into these areas. Illustration: A. Mjærum, Museum of Cultural History, University of Oslo.

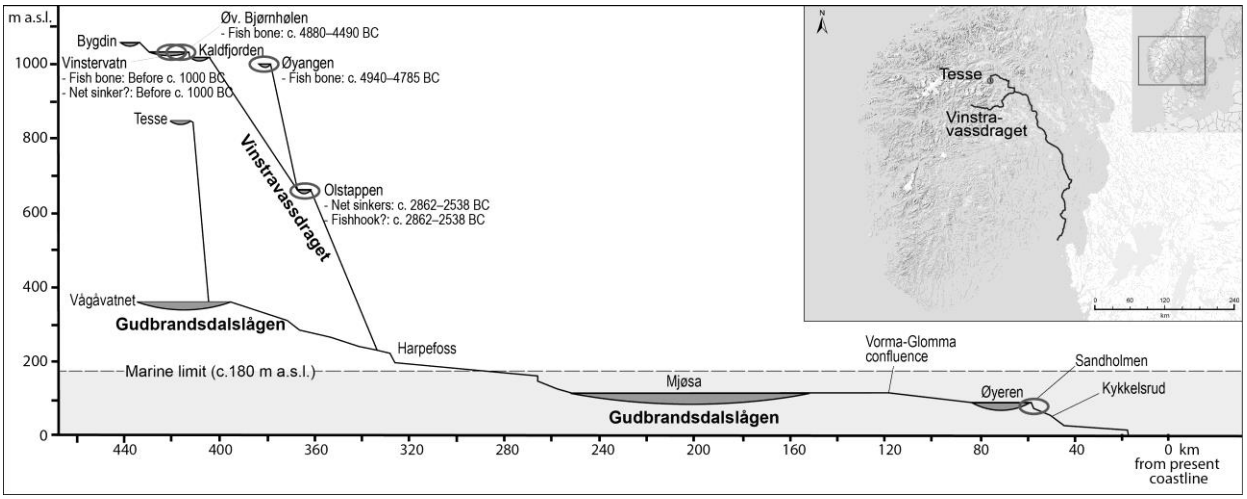

Figure 12.7. Sites with burnt bone of trout in Gudbrandsdalslågen, one of the main watercourses in the mountain areas. The figures also show the steep elevation of the rivers. Illustration: A. Mjærum, Museum of Cultural History, University of Oslo.

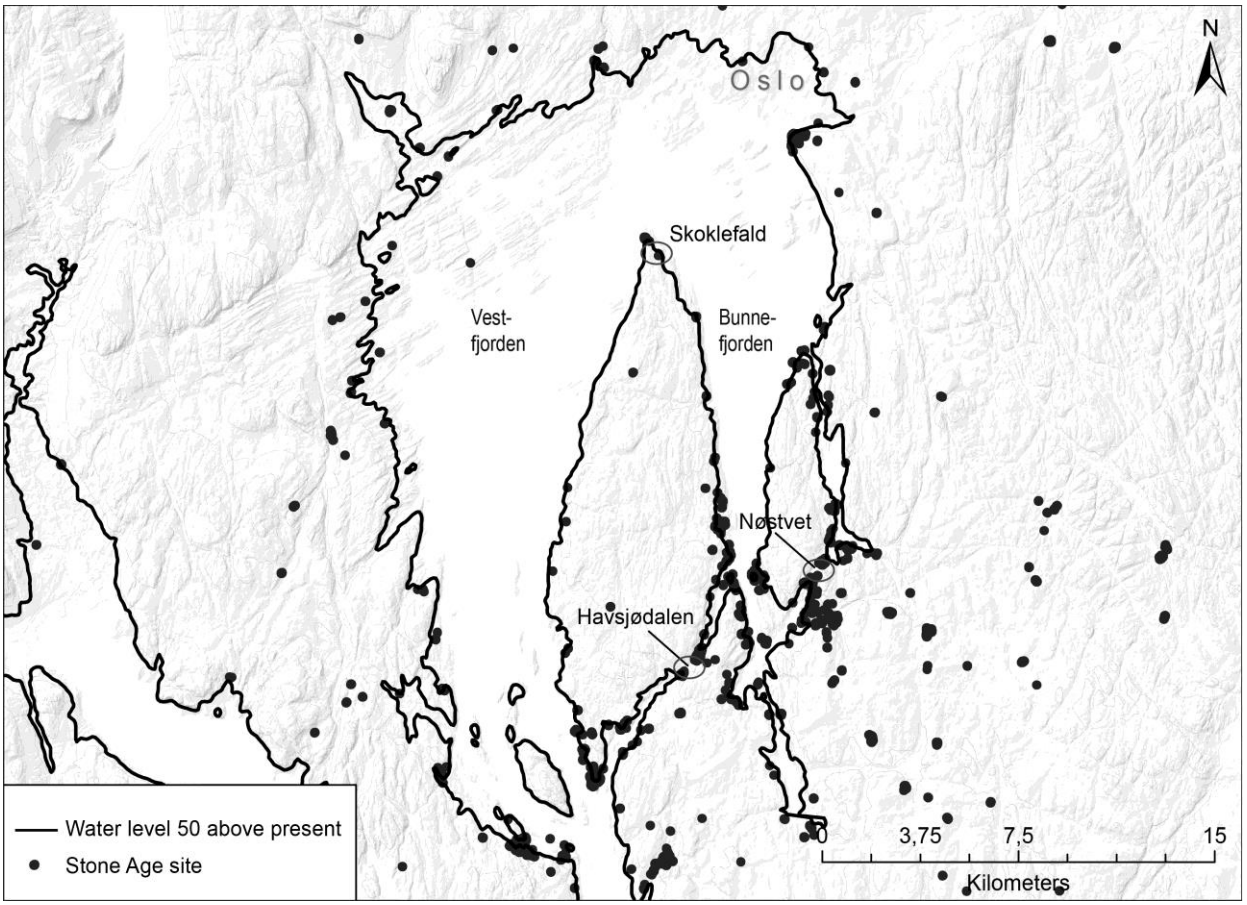

Figure 12.8. The inner part of the Oslo Fjord with modelled sea level, 50 m above the present, as it was approximately around 5000 cal. BC. At this time, numerous sites were located along the straits at Havsjødalen and in the Nøstvet area, while the kitchen-midden site Skoklefald was situated at the northern end of a large island in the inner part of the fjord. Map: A. Mjærum, Museum of Cultural History, University of Oslo.

Figure 12.9. Skoklefald is the only known Mesolithic kitchen–midden in Eastern Norway. An approximately 30 m^2 area with molluscs, bones and lithic artefacts was superimposed by later deposits. Photo: L. Gustafson, Museum of Cultural History, University of Oslo.

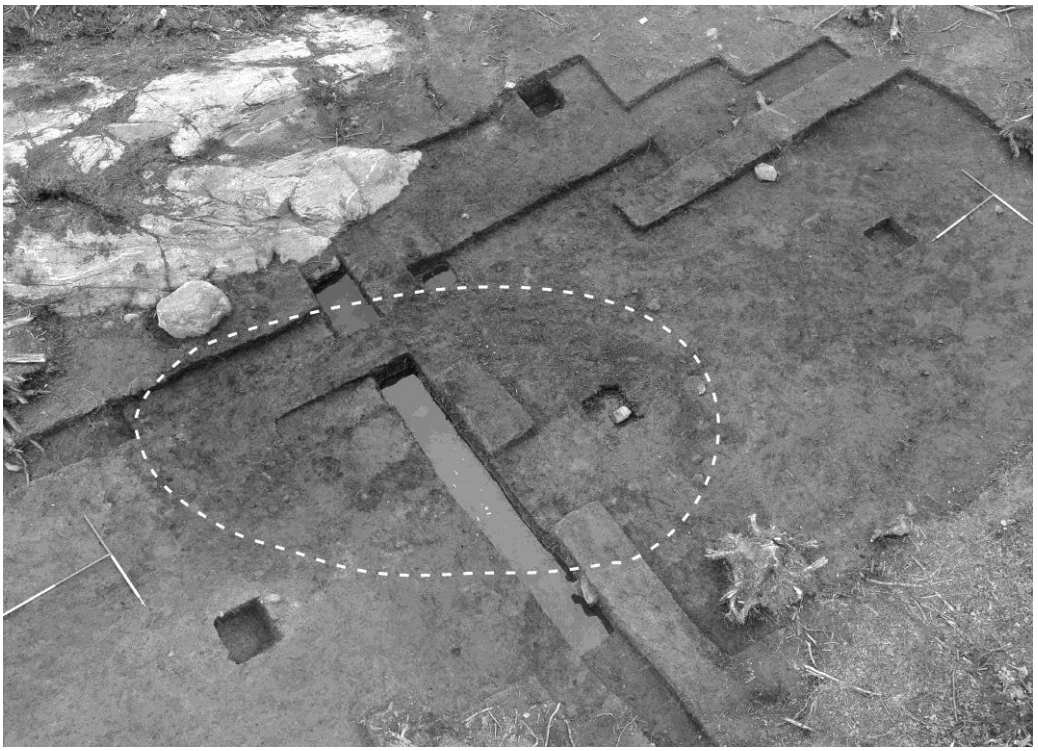

Figure 12.10. At the site Havsjødalen 3, a sunken hut floor was identified. The floor measured 6x3 m and was visible as a dark cultural layer. 61 500 lithic artefacts were recovered. This points to intensive use, and the site is interpreted as a residential unit used over a longer period. Photo: C. Eymundsson, Museum of Cultural History, University of Oslo.

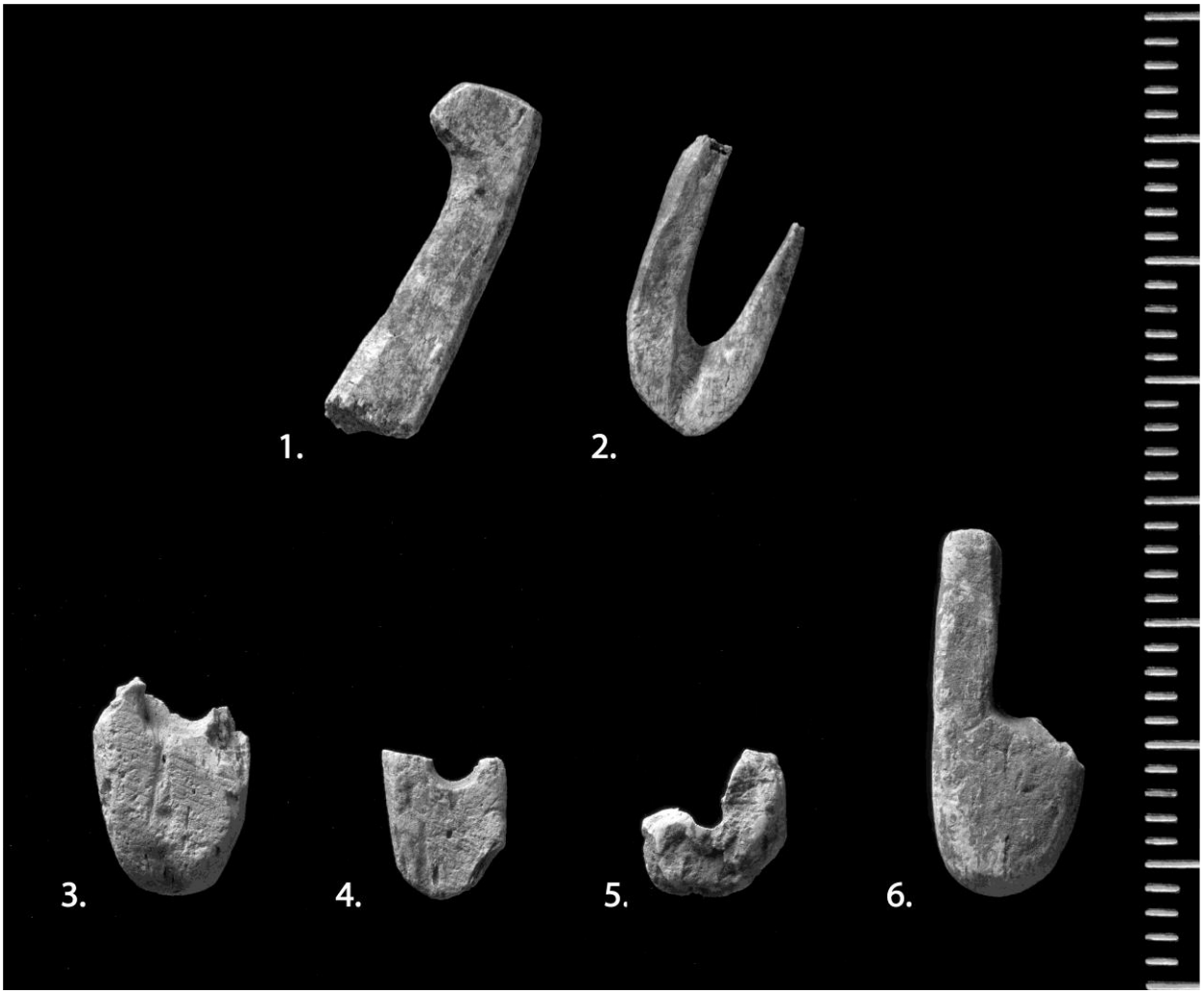

Figure 12.11. Fragments of Middle and Late Mesolithic fishhooks from coastal sites in the Oslo Fjord area. 1. Shank with bulb for fastening the line. 2. Bend of fishhook, both Skoklefald. 3.-4. Bends of fishhooks, Prestemoen 1. 5. Bend of fishhook, Vinterbro 3. 6: Bend of fishhook, Skutvikåsen 3. Photo 1 and 2: Ellen C. Holte, Museum of Cultural History. Photo 3–6: K.~~irsten~~ Helgeland, Museum of Cultural History, University of Oslo.

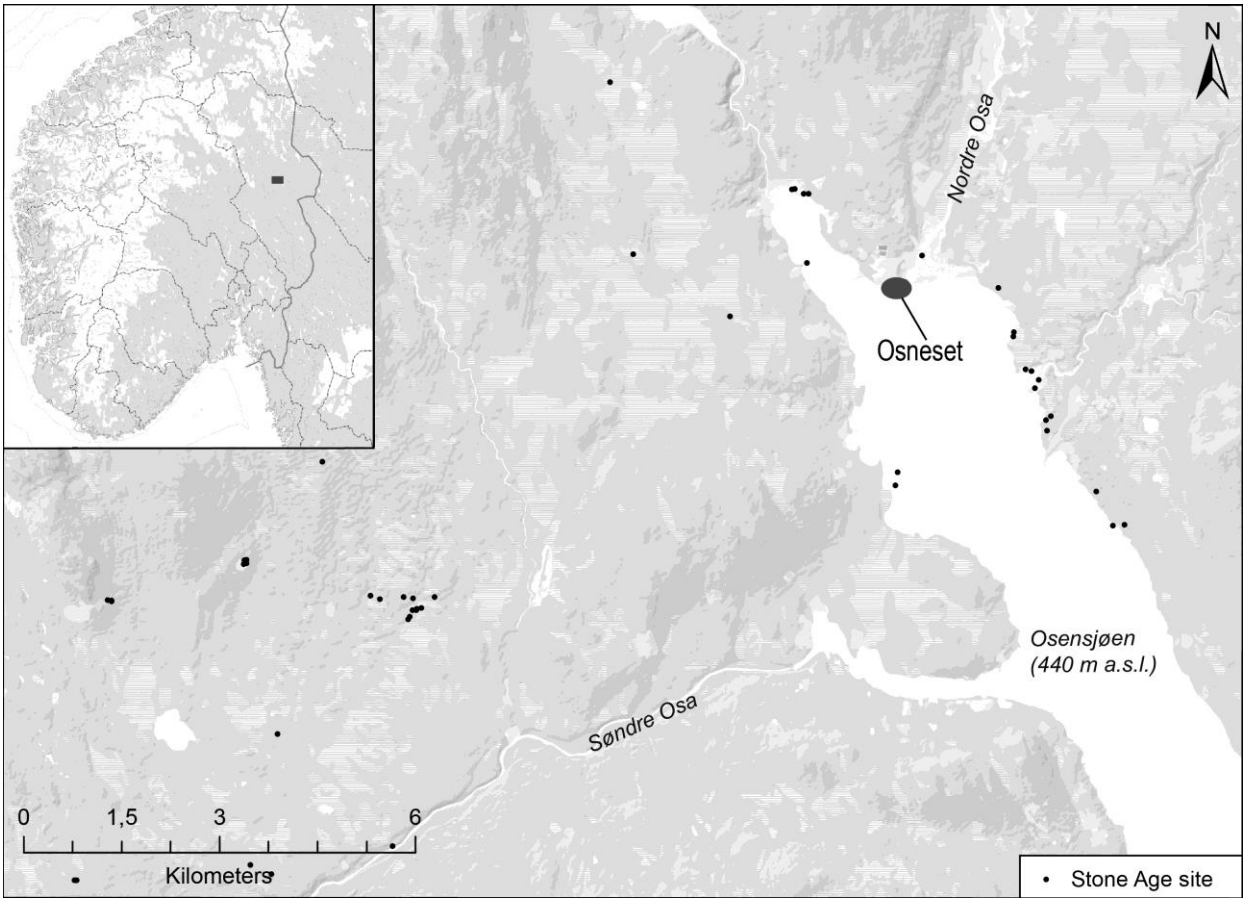

Figure 12.12. Osneset has a prominent location in the northern part of Lake Osen, in the lowland of Hedmark, close to the boarder of Sweden. Map: A.~~xel~~ Mjærum, Museum of Cultural History, University of Oslo.

Figure 12.13. Osneset is located at the shore outlet of the river. The shallow, sandy lakebed in front of the headland is well suited for gillnet fishing. Two small pieces of bone with serrations were found among the fish bones at the site (top right). The fragments could have been part of a fishing spear. Photo: T. Winther, Museum of Cultural History. Illustration: P. Persson, Museum of Cultural History. Map: A. Mjærum, Museum of Cultural History, University of Oslo.

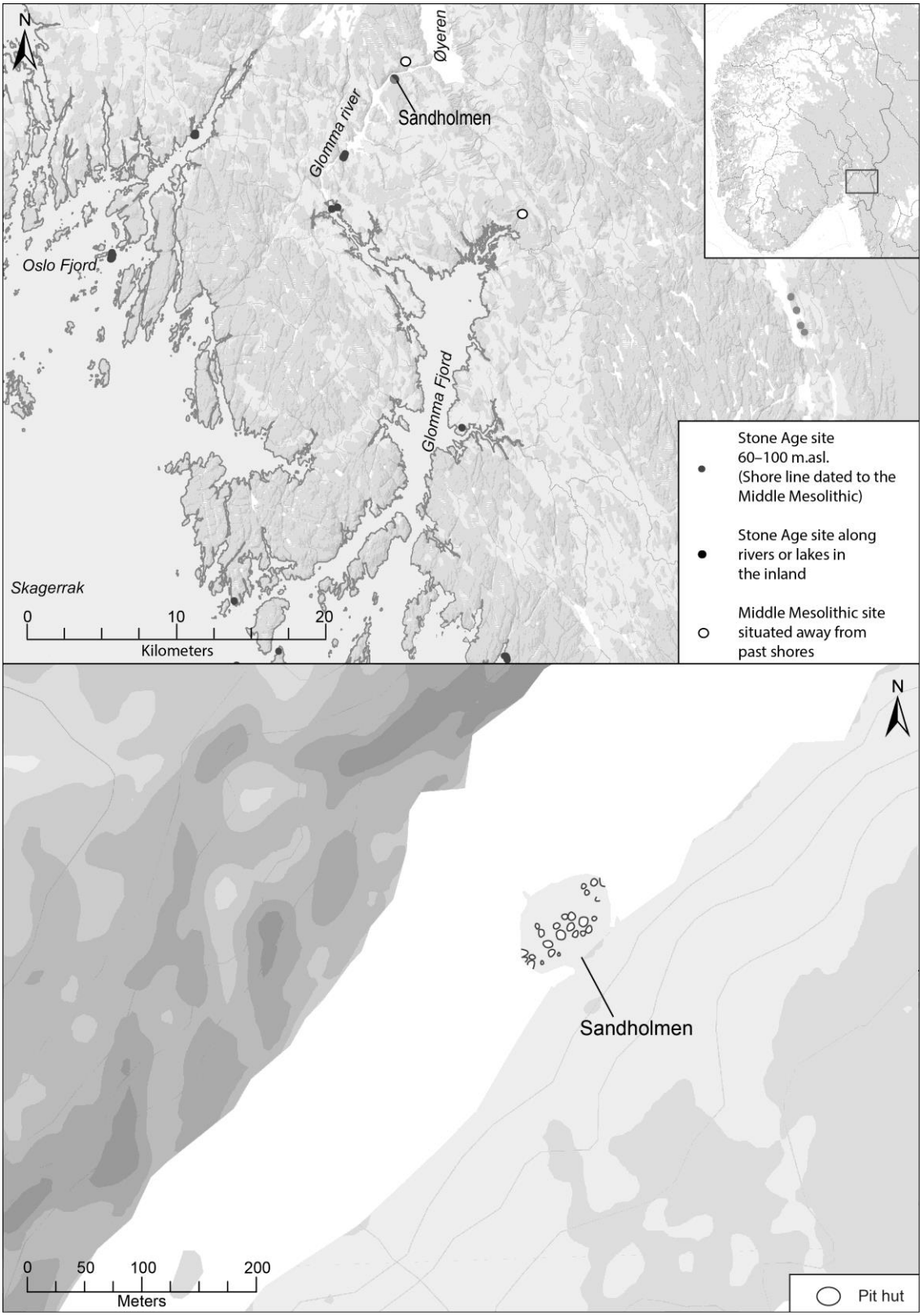

Figure 12.14. The pit huts are located at the small islet Sandholmen. Some of them could have been constructed when the sea was nearby (c. 7800 cal. BC). The area was also in use when the large river Glomma passed nearby, and most likely offered excellent conditions for salmon fishing. Illustration: P. Persson, Museum of Cultural History, University of Oslo.

Figure 12.15. One of the 25 pit huts at the south-eastern part of Sandholmen. Photo: A Mansrud, Museum of Cultural History, University of Oslo. Drawing: P. Persson, Museum of Cultural History, University of Oslo.