Chapter 5
The Late Mesolithic Site of Falden, Denmark: Results from Underwater Archaeological Fieldwork and a Strategy for Capacity-Building Based on the SPLASHCOS Mission

Otto Uldum, Jonathan Benjamin, John McCarthy, Frederick Feulner, and Harald Lübke

Abstract In 2010, a submerged Late Mesolithic settlement site was discovered near the hamlet of Falden during a week-long archaeological dive survey of Helnæs Bay, Denmark. The survey was carried out as part of a training exercise, funded by the SPLASHCOS network. The discovery was a rare occurrence in recent years because priority has been given to rescue investigation of sites affected by the threat of erosion or otherwise potentially destructive modern development. This was not the case at Falden. Two short field seasons subsequent to the site's discovery (2011–2012) yielded a large inventory of worked flint, faunal remains and various other archaeological materials. The site is presented here within a larger discussion surrounding issues in training and capacity building, as well as management and research strategies concerned with prehistoric underwater cultural heritage. The fieldwork was based on methods used for many years by Langelands Museum as part of a combined survey and public outreach programme, with the additional integration of SPLASHCOS participants, mainly Early Stage Researchers. The lessons learned during this integrated dual-purpose capacity-building and archaeological research mission serve as a valuable experience for a proposed training centre with the aim of providing the opportunity for researchers and practitioners of underwater archaeology to gain the necessary experience to properly undertake research and advise (or themselves become) competent authorities working in underwater heritage management.

O. Uldum (✉)
Langelands Museum, Jens Winthersvej 12, 5900 Rudkøbing, Denmark
e-mail: otul@langelandkommune.dk

J. Benjamin • J. McCarthy
Department of Archaeology, Flinders University, PO Box 2100, Adelaide 5001, Australia
e-mail: jonathan.benjamin@flinders.edu.au; john.mccarthy@flinders.edu.au

F. Feulner
Department of Archaeology, University of York, The King's Manor, York Y01 7EP, UK
e-mail: freder@palaeome.org

H. Lübke
Centre for Baltic and Scandinavian Archaeology, Schleswig-Holstein State Museums, Schloss Gottorf, 24837 Schleswig, Germany
e-mail: harald.luebke@schloss-gottorf.de

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5.1 Introduction

The importance of the coast to Stone Age hunter-gatherer populations has been addressed by many prehistorians (e.g., Rowley-Conwy 1983; Van Andel 1989, 1990; Larsson 1990; Bailey 2004) and should not be understated. Advantages of coastal living are (simplified from Bailey 2004) as follows: (1) Ease of travel and communication for people and cultural ideas, including trade, social interaction, movement of people and material culture, and travel by sea; (2) Access to food resources, specifically the high availability and variety of marine and terrestrial plants and animals; (3) Access to other (non-food) resources, including fresh water in high water-table environments and at coastal river-mouths, and raw materials including pebbles, river rocks, driftwood, and other organic materials for structures, tools and fuel. The coastal prehistoric archaeological resource in the Baltic offers some of the clearest evidence of this relationship and more prehistoric sites have been discovered and excavated from submarine environments in southern Scandinavia than anywhere else in the world.

In this chapter, we summarise the development of underwater prehistoric archaeology in southern Scandinavia and then present the results of a SPLASHCOS training mission that resulted in the discovery of a previously unknown late Mesolithic underwater settlement, the site of Falden, in Helnæs Bay, Funen. We set out the methods used in the survey and excavation of the Falden site, including experimentation with novel photogrammetry techniques, present the results and discuss their wider significance. We use this case study to reflect on the tensions between cultural heritage management and research, and highlight the need to provide opportunities for gaining experience and training in underwater prehistoric archaeology both for researchers and cultural heritage managers.

5.2 Underwater Prehistoric Archaeology in Southern Scandinavia

Underwater archaeological methodology has been practised on prehistoric sites in southern Scandinavia since the 1970s (Larsson 1983, Chap. 11, Andersen 1987), and survey methods for submerged site discovery have proved, in certain cases, to be adaptable to other coastal locations (Fischer 1993a, b, 1995; Benjamin 2010). As a result of the richness and preservation of archaeological material and a sustained programme of research and investigation, archaeologists in southern Scandinavia have set a standard for underwater methodology and its application to Stone Age archaeology. Material from such sites has been used to address a variety of research questions within the wider field of prehistory including subsistence (Pedersen 1995, 1997), trade and social stratification through prestige goods (Klassen 2000; Fischer and Kristiansen 2002), Mesolithic dwellings (Grøn 2003), settlement patterns (Schilling 1997) and early prehistoric seafaring (Andersen 1987, 2011).

The Western Baltic is shallow, sandy and almost brackish with a salinity of less than 0.1%. Its shores are predominantly sandy beaches, and many bays and coves offer sheltered waters. Late glacial and postglacial climate and landscape have been a focus of Quaternary geologists and archaeologists in the Baltic region for over a century (Björck 1995; Fischer and Kristiansen 2002). Even prior to the 1920s, attempts were made to reconstruct the late glacial and postglacial palaeoenvironments of the Baltic region (Antevs 1922, Fig. 5.1), illustrating the rich history of scientific interest in the region. Discussions related to the late Quaternary climate and environment of southern Scandinavia include geology, topographic change, temperature fluctuations, eustatic and regional sea-level change, isostasy and hydrology, with particular emphasis on the development of the Baltic Sea, which went through multiple transitions (Björck 1995; Christensen et al. 1997). All of these variables have had an effect on the landscape of southern Scandinavia, and therefore impacted the human populations inhabiting the region during times of rapid change (Larsson 1990; Price 1991; Fischer 1995). Climatic indicators used to study these physical changes include seismic records, pollen data, macrofossil

Fig. 5.1 Map of Denmark with the location of the Falden site indicated. West of Kattegat is the Swedish coast, south of the Jutland peninsula is Germany (Graphics: Langelands Museum)

analysis and the presence of microorganisms, the latter with particular reference to distinguishing freshwater deposits from brackish deposits (Bennike et al. 1998, 2004).

The landscape of Denmark and the Baltic coastal regions of Germany and Poland is generally characterised by low moraine hills on land, and a sea that rarely exceeds 30 m depth. The shallow topography means that changes in sea level have a major impact on the position of shorelines (see Chiocci et al. Chap. 3), and the Jutland Peninsula and the Danish Isles looked markedly different in the Boreal and Atlantic periods. This expanded terrain was densely forested with predominantly deciduous species, offering habitats for a wide spectrum of fauna. The Mesolithic populations in the low-lying areas that make up present-day Denmark are thought to have been relatively dense during

Fig. 5.2 Historic vessel 'Mjølner' with the 2011crew. Standing: Arne Jensen, Kieran Westley, Freder Feulner, Ehud Galili, Radek Szmelak, Hans Toft Nielsen (skipper), sitting: Anne Margrethe Walldén, Jonathan Benjamin, Otto Uldum, Flemming Sørensen (Photo: Langelands Museum)

the Atlantic period (Brinch-Petersen et al. 1998). A large proportion of this land was inundated during the Atlantic period, and extensive hunting grounds and coastal habitats were submerged (cf. Mathiassen 1997, Fig. 2).

Since coastal Mesolithic peoples in the Atlantic period lived during a period of dramatically changing environments, they had to contend, physically and mentally, with constant adaptation (Larsson 1990). Settlement directly on and adjacent to the shore was frequent, due to a subsistence strategy that relied heavily on marine resources and stationary fishing structures (Pedersen 1997). The relationship between inland and coastal settlements is still not very well established, because the inland dwellings have suffered poor conditions of preservation, while the coastal settlements have been relatively well preserved, often under sediments in shallow water. Equally, sea-level change would have inundated coastal settlements, and affected soils and vegetation while creating new environments, including those valued for their fishing potential. This process submerged Early and Middle Mesolithic sites, but also affected later Mesolithic (Ertebølle) sites (Malm 1995).

Pioneering investigations on submerged Mesolithic sites took place in Denmark in the early 1970s. Among the first to be professionally excavated were Møllegabet on the Island of Ærø, undertaken by Langelands Museum (Skaarup 1995; Skaarup and Grøn 2004) and Tybrind Vig on Funen, led by Moesgaard Museum (Andersen 1987, 2013, see also Uldum 2011). The waters surrounding Funen have proven to be among the richest in Denmark—and the world—with regards to the amount of preserved settlements and inundated Mesolithic landscapes. Although relative sea-level change is a complex and regional process, dropping the water level by 1–4 m gives a rough estimate of the past shoreline, which corresponds with the location of coastal settlements of the late Ertebølle culture.

The Ertebølle culture (c. 5600–3950 cal BC) is known for its use of flint blades, its simple flake industry and pursuit of intense coastal-resource subsistence and near-shore habitation sites (Price

1991). Ertebølle people carved bone and antler, lived in houses and buried their dead close to their everyday living space (Larsson 1990; Grøn 2003). Though there may have been knowledge of food production and agricultural peoples of neighbouring regions, the Ertebølle maintained a highly productive use of marine resources (Pedersen 1995). This shows a diversity of food resources, which, in terms of quantity of species, was much greater than in the earlier Kongemose and Maglemose cultures (Price 1991) and was perhaps sufficient to deter the introduction of animal husbandry (Fischer and Kristiansen 2002). Importantly, the Ertebølle represents a transitional Mesolithic culture, which adopted and used ceramics from neighbouring Neolithic groups around 4600 cal BC and lived in permanent or semi-permanent sedentary communities. However, the Eretebølle did not adopt agricultural subsistence and continued as a hunter-fisher society for several hundred years despite the presence of agriculture in neighbouring regions to the south and east.

The inventory of submerged sites from this period is now approaching 500 entries in the National Finds & Monuments database for the Fyn area, managed by the Langelands Museum. This consists of finds and sites ranging from a few pieces of worked flint (sometimes out of context), to large areas of in situ settlement or refuse layers. In particular the Møllegabet and Tybrind Vig sites both show excellent conditions of preservation resulting from the compact layers of peat and gyttja that have encapsulated every detail. Small, fragile organic specimens and a range of hitherto unknown artefacts have been excavated in both sites, such as paddles, shafted axes and textiles (Andersen 2013, see also Skriver et al. Chap. 8).

5.3 The Helnæs Bay Survey and Discovery of the Falden Site

In 2010 a site was discovered in the Helnæs Bay on the South-western part of the island of Funen (Fig. 5.1). The Bay had been visited previously by Langelands Museum with the aim of locating previously unknown Mesolithic sites, and also to search for remnants of an early Medieval pole blockage, a military defensive construction, which had been investigated by the Danish National Museum in the early 1970s. The Bay, both in its present form, and as part of the Atlantic period archipelago, forms a distinct sheltered marine environment, and up to modern times has been the source of livelihood and port of departure for the local population. For the most part, the underwater prehistoric sites found in the area were those that were clearly undergoing erosion, and seemingly without the presence of any peat or gyttja layers, but the general potential of the inner Danish waters for locating submerged Mesolithic sites is illustrated by the fact that a handful of sites were found in the Bay during a few days of diving in 1995.

On a reconnaissance project in 2003 the museum located a site near the south-eastern shore of the bay which contained layers of brown peat. Embedded in the organic material were preserved tree trunks from the transgressed Mesolithic forest, and considerable amounts of worked flint including many unpatinated and sharp pieces, which suggested a primary deposit. The new site discovered in 2010 during the SPLASHCOS training mission off the hamlet of Falden, south of the village of Faldsled, also contained peat layers, and worked flint in very good condition in quantities previously not seen in Helnæs Bay.

5.3.1 Rationale: Strategic Research and Active Heritage Management

Although Danish waters have yielded some of the world's most spectacular submerged Mesolithic sites, the number of investigations carried out by archaeologists is quite limited. Apart from the few extensively excavated sites such as Møllegabet I–II, and Tybrind Vig, the many hundreds of dots on the Sites & Monuments Inventory (compiled into a digital database/GIS) are mainly the result of only single-day reconnaissance dives. Only very limited information can be gathered from a few hours of diving, typically spent by swimming over the patches of eroded settlement or collecting worked flint. Often, very little can be done to gather information about sedimentation, and even the spatial extent of the site in question is often not systematically confirmed. In the absence of a remit and budget to secure material for absolute dating, the possibility of dating such a site depends on chance finds of artefacts with diagnostic characteristics suitable for typologically-based sequence dating. Although it is significantly better than nothing, this method of limited reconnaissance diving also carries a number of inherent biases or even faults. It is a superficial approach to archaeological survey that establishes and perpetuates an inventory with biased data. Because heritage management seeks not only to quantify its resource, but rather qualify the significance for public benefit, such a superficial approach is insufficient and does too little to promote scientific and archaeological advancement given the demonstrated international importance of this resource.

Adding to the further bias of survey results, only sites that are actively eroding will be discovered by reconnaissance missions alone. There is no correlation between this near-shore erosion and the preserved Mesolithic shoreline, and as such the settlements that are surveyed are dictated by modern conditions; they are not necessarily representative of prehistoric activity centres themselves or, as a dataset, an accurate distribution of prehistoric sites. The Falden site, on the other hand, is rare in that it was only found because it was actively sought through test excavation justified by and based on existing information and local knowledge.

The difference between a single day and a couple of weeks of field investigation at a site is dramatic. After a site is discovered and the initial information is gathered, a research plan must be devised. All submerged prehistoric sites in Denmark are protected by law. Therefore it is a prerequisite to obtain permission to carry out any intrusive methods (such as test pitting) from the Agency of Culture, the central government agency responsible for cultural heritage. Often in cases of newly discovered sites, preliminary research goals will be to establish the basic elements of the site: age/date(s), extent/size, state of preservation, characterisation of the site activities and, where possible, site function. In most cases, while a brief visual survey does help to establish the most basic of records, it is insufficient to document with confidence the core archaeological information needed to establish the significance of the site. For an inventory of underwater cultural heritage to be useful, the data on which it is built must be reliable and substantial. Strategic research must go beyond the minimum prerequisites needed to 'put a dot on the map'. Of course, similar challenges are faced in terrestrial archaeology; however, the challenges of working in the underwater environment magnify this problem, resulting in large databases of poorly understood sites, as discussed by Adams (2014) with specific reference to shipwreck studies.

Although the discussion above highlights the low percentage of in-depth site investigations undertaken in recent years, the long history of submerged prehistoric site investigation in the Baltic has resulted in the evolution of an efficient and practical methodology. Wherever possible, a firm date should be obtained, ideally by radiometric techniques, to secure an age-range of an artefact, or from clearly cultural material provenanced from an intact (settlement or refuse) layer, which is sequentially related to other preserved layers. To achieve this, some intrusive methods are necessarily involved. Similarly the spatial extent of the site needs to be based on thorough documentation of the stratigraphy; samples may be obtained by hand-coring and test trenches, and at spatial intervals to demonstrate appropriate coverage within the site. Trenches should reveal the state of preservation, and where they yield artefacts, evidence of past activity. Remote sensing, which can be very useful in understanding a landscape on the regional scale, still cannot yet provide the resolution obtained by observation during traditional, diver-based underwater archaeological field practices (but see Bailey et al. Chap. 1, Missiaen et al. Chap. 2). This is especially the case where sites are known or considered likely to exist at a local scale, and certainly there is no way to replicate excavation remotely. Remote sensing and sampling techniques (such as geotechnical coring and grab-sampling) have, however, proved useful in surveying and establishing potential for the discovery of new sites, especially at the medium or large (regional) scale where sites are not necessarily expected, or where limited data have demonstrated some possibility of discovery (e.g., Plets et al. 2007, Tizzard et al. 2011, Westley et al. 2011, Missiaen et al. Chap. 2).

5.4 A Programme of Community Engagement: Langelands Museum

Local knowledge has been cited as being the primary resource for archaeological discovery. More submerged sites in Denmark were discovered by members of the public than by any other means during the heyday of discovery in the 1970s and 1980s (Smed 1987).

Langelands Museum has taken a proactive approach to community engagement. Since the start of its underwater activities in 1972, when surveying for submerged Mesolithic sites was initiated, the museum has acted in cooperation with amateur divers interested in archaeology (Skaarup and Grøn 2004). The investigations of the Møllegabet I site began in 1976, and the majority of excavators were not qualified archaeologists, though they were directed by professionals.

In more recent times, an annual 'cruise' (in the humblest sense) with the aim to survey for submerged Mesolithic sites has taken place since 2000, with the museum's (active) historic vessel 'Mjølner' used as a research platform (Fig. 5.2). The vessel is suitable for up to eight people as a liveaboard, but can accommodate another six on board during a day's work. The participants are required to demonstrate adequate dive qualification and skills, but need not have any formal qualification in archaeology. A short introduction addressing ethics, protocols and diving safety sends the new amateur archaeologist off on a first non-disturbance, visual survey. The sites are chosen in advance, mainly based on Fischer's (1993a, 1995) predictive model for stationary fishing sites, and are marked with buoys enclosing the area in a square formation.

During the time Langelands Museum has hosted these tours, more than 100 one-week slots have been offered, but since a core group of participants has taken part in more than one tour, this roughly equates to 60 different individuals. More than a dozen have been undergraduate archaeology students who have taken this opportunity to gain their first hands-on experience with underwater archaeology as an entry-level underwater archaeological field school. Some of those have pursued careers in the field of underwater and maritime archaeology, while others have stayed in terrestrial archaeology but with an insight into the practical realities and first-hand experience of submerged cultural landscapes.

About 60 individual locations have been surveyed by visual reconnaissance, and this has added roughly 30 new entries into the Danish national finds and monuments database, ranging from a few displaced pieces of worked flint to well-preserved and intact settlement layers.

5.5 Field Results at Falden

The discovery of the Falden site was made in 2010 during a 'Short Term Scientific Mission'—a field course under the SPLASHCOS banner funded as part of the European Cooperation in Science and Technology (COST) Trans-Domain Action 0902. Helnæs Bay was chosen because earlier reconnaissance surveys using a small team and rapid survey methods, as described above, had identified finds worth further evaluation. Also, because the waters in the area are reasonably well sheltered, the risk of having to cancel diving due to bad weather was reduced. The need for potential 'call-off-days' for underwater fieldwork and training missions is an especially important real-world consideration and imposes a need to manage expectations for everyone involved, from students to staff to funding agencies.

During the initial days of the 5-day training course, a number of dive locations along the northern shore of the bay were subjected to the usual visual survey, with the addition that the divers were allowed to hand-fan the surface sediments. During the first 3 days, the limitations of visual survey were apparent and archaeological results were thin. A spot on the Eastern shore had been chosen in advance, but initially nothing but sandy seabed with *Zostera* (sea grass) and boulders was to be seen through non-disturbance methods. At this point, at the end of the survey, one of the most experienced members of the SPLASHCOS survey team (and indeed one of the most experienced underwater archaeologists specialising in prehistoric material), Dr. Ehud Galili, decided to investigate the seabed further. His efforts hand-fanning a small test pit resulted in the recovery of worked flint with sharp edges and unpatinated surfaces, characteristics of a primary, undisturbed deposit. A basic grid was laid on the seabed, with a N–S/E–W cross, measuring 10 m, and more hand-fanned test pits were dug. All of the test pits contained unusually high concentrations of worked flint, even by Danish standards.

5.5.1 Test Excavations

During the relatively few, though often long, dives undertaken in 2010, the minimally-intrusive field work had proved that the site contained intact layers of peat with substantial quantities of worked flint. The site's spatial extent was measured to be at least a 10 × 10 m square. The museum had not investigated a submerged site in Helnæs Bay or its vicinity, though Ertebølle-sites had previously been studied on land on Western Funen (Andersen 1978). The new site had the potential to add new data to the general inventory, with the potential to provide insights into the history of transgression in the region. Also, the fact that the site would not have been discovered but for active investigative methods (hand-fanning and hand-dug test pits) on the seabed gave it a unique status, with the potential to reveal new knowledge about southern Danish submerged sites, their preservation and the possibilities for future significant scientific and archaeological discovery.

In 2011 another field course in the SPLASHCOS-network was organised, with the aim of investigating the Falden site further and training early career researchers. The historic vessel Mjølner once again served as a working platform, and was moored just off the site, allowing divers to enter the water directly from the ship. The basic grid from the previous year was extended (with the intersection between the axes labelled 500/500, to avoid negative coordinates). The x axis was marked with a red plastic baseline, with a tape measure pinned alongside. During the course of a week, five test pits, each 1 m × 1 m, were excavated south of the baseline intersection, and two east of the intersection (Fig. 5.3). In total, the team managed seven test pits in the course of 4 days of diving, which was satisfactory. The last day had to be spent securing the site and backfilling with sandbags and geotextile, since the protective layer of *Zostera* roots and surface sand had been removed.

The 2012 season was a straightforward continuation, with the grid re-established, consistent with the previous year. Further test pits were excavated (Figs. 5.3 and 5.4, bringing the total to 15). The observations previously made were substantiated, namely that the conditions of preservation for flint are good, but only fair regarding organic materials (when compared with the best-preserved submerged sites in the south-west Baltic).

5.5.2 Material Culture, and Faunal Remains and Chronology

The sediments differed considerably between two different test pits. The time needed to excavate the shallow pits amounted to a morning's dive, while the southernmost pit required 2 days. The stratigraphy below the *Zostera* roots on the site was a layer of coarse sand in all pits, which contained the bulk of

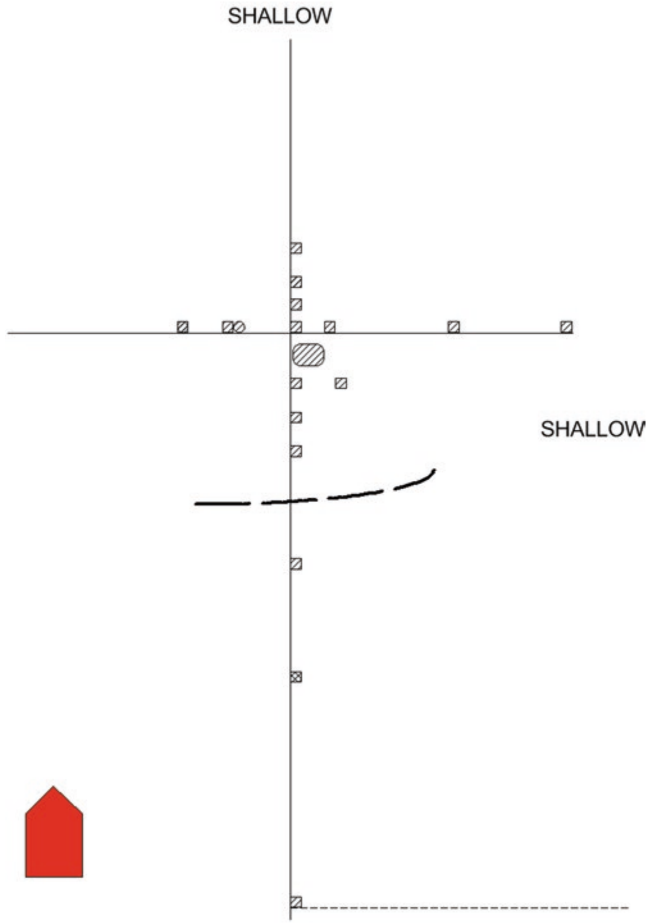

Fig. 5.3 Grid with trenches indicated. The shore is 200 m to the east of the grid centre, towards the north is a now transgressed small spit of land. The *hatched line* shows the approximate location of the prehistoric shoreline (Graphics: Langelands Museum)

the worked flint. Under this, a layer of fibrous peat appeared around y = 490, but not extending to y = 470, and was also seen in patches north of y = 490. At y = 470, the layer of coarse sand was more than 50 cm thick. This could be explained by the presence of the prehistoric shoreline somewhere between these two points. The thick layer of coarse sand containing large amounts of worked flint would thus represent a refuse layer deposited in the shallows just off the beach. The dwelling area would have been to the north, on a small spit of land projecting to the west, still visible today as a shallow mound on the seabed.

The majority of the finds consisted of worked flint. At the time of writing, cataloguing is not complete, but many of the test pits contained several hundred pieces, most of course being flint waste, but including many tools and diagnostic pieces. Notable diagnostic artefacts are the transverse arrowheads, as they date the inventory to the Ertebølle culture, most likely its middle phases (Fig. 5.5). These are made from blades, and of a very uniform markedly splayed type, known as Stationsvej type in Danish archaeology (Vang Petersen 1993). Other evidence of blade production is documented in numerous 'raw' (unretouched) blades, retouched blades in the form of flint knives and scrapers, and cores in their final discarded stage. Larger tools are common in the form of flake axes. They are made from one large flake, often resembling a large transverse arrowhead and ranging in length from 4 cm to the more common 12–15 cm. Many large flakes, presumably blanks intended for being shaped into axes, were also found. No core axes have been found on the site, which is quite unusual and likely to be indicative of its function and character. Scrapers are predominantly circular flake scrapers, made

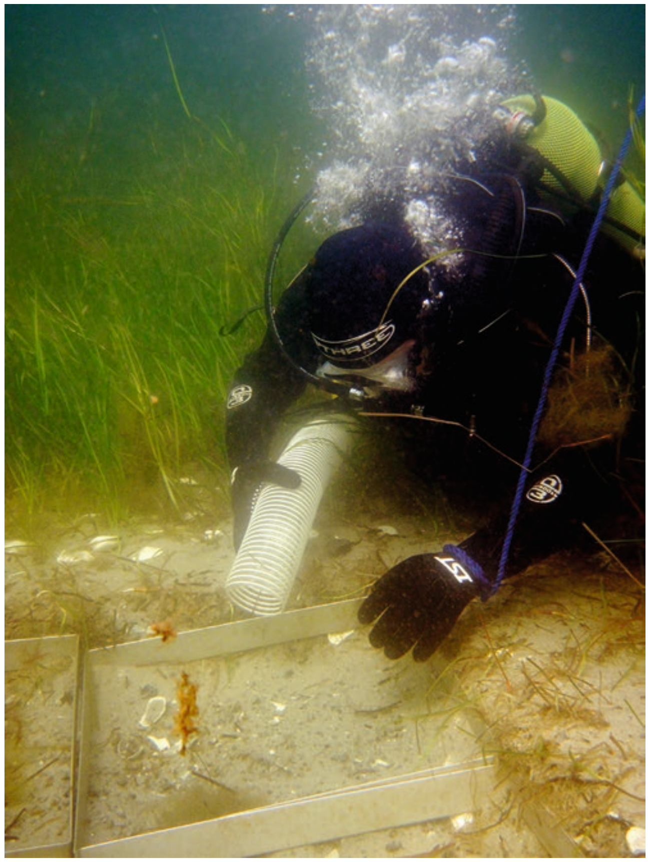

Fig. 5.4 John McCarthy dredging a 1 × 1 m trench marked by stainless 25 × 25 cm frames. *Top layer* was sand, in places covering peat and/or gyttja. The sediment ejects into a bag made of fine-mesh fishing net (Photo: Jonathan Benjamin)

by a direct steep retouch of approximately one third of the circumference from the ventral side. Most of the worked flint is well preserved, with varying degrees of patina (Figs. 5.6 and 5.7). Patinated lithics in the region generally demonstrate whitening when exposed to the seawater, whereas those which are well protected in the anaerobic gyttja are usually dark grey or black in colour. Based on the patina encountered, only very little worked flint had been exposed by erosion. The excavated finds show no mechanical damage, such as rolling or fracturing, as would be expected if they had been transported and redistributed by water action. The site and its material were deemed to have been in situ.

In contrast to the numerous flint artefacts, only a few faunal remains have been recovered so far. During the 2011 campaign, twelve bones were found (Table 5.1). They include a skull fragment and a piece of antler of roe deer, a left humerus and two molars of wild boar and five unidentifiable pieces. Furthermore, two fish bones, from cod and flatfish, are present. The small number of finds limits further statements, but in general roe deer and wild boar are typical prey, and fishing of marine species also is not unusual during this period. The faunal results of the 2012 field season have yet to be fully analysed.

Thus far, two radiocarbon samples have been dated from the Falden site. These are a molar (M3) and a left humerus, both from wild boar (Table 5.2). They come from the same test pit 500/489, but from different strata. The tooth was found on top of the peat or detritus mud just under the coarse sand, the bone roughly 15 cm lower in the same organic sediment. Both samples produced ample collagen yields and the AMS $\delta^{13}C$ values are in the normal range for collagen. Therefore the results are regarded as reliable and because the samples are from terrestrial mammals a marine environmental reservoir correction is not required. The bone from the lower level yielded a date of 4991–4798 cal BC and the tooth from the upper level a date of 4520–4363 cal BC. The dates are significantly different and in the

Fig. 5.5 Typical examples of worked flint from the site. A flake axe at *top left* is slightly damaged, and has a white patina, as has the transverse *arrowhead* at *top right*. Two flakes at *bottom left* are presumably by-products from rough shaping of a flake axe. At *bottom right* is a blade-yielding core (Photo: Langelands Museum)

Fig. 5.6 The amount of worked flint dredged during one single dive in one trench. Blades, flakes and various chips show varying patination (Photo: Langelands Museum)

Fig. 5.7 John McCarthy emptying a net taken off the dredge, and brought topside to be sorted. Sediment is blown through the mesh, and all objects kept inside. Un-worked flint, pebbles and marine life is thrown back in the sea (Photo: Jonathan Benjamin)

Table 5.1 Animal bones from the 2011 survey

Provenance	Number	Quadrat	Depth	
ØHM 15264	X2	499/490	0–10	1 *Capreolus capreolus*; Os frontale with antler tine, left
ØHM 15264	X12	500/489	30–40	1 *Sus scrofa*, Humerus, left
ØHM 15264	X13	500/489	20–30	1 *Sus scrofa*, tooth M3
				1 indet.
ØHM 15264	X14	500/492	0–15	1 indet.
ØHM 15264	X15	500/479	0–40	1 Pleuronectidae (Vertebra caudalis), Flounder?
				1 *Gadus morhua* (Vertebra precaudalis)
ØHM 15264	X16	500/489	0–20	1 *Capreolus capreolus*; Antler
				1 *Sus scrofa*, tooth M2(?)
				3 indet.

Determinations by Dirk Heinrich and Wolfgang Lage, Schleswig-Holstein Archaeological State Museum, Schleswig, Germany

Table 5.2 Radiocarbon results from the 2011 survey, test trench 500/489, calibrated using the IntCal09 calibration (Reimer et al. 2009) and OxCal v4 (Bronk Ramsey 2009)

Inventory number	Layer depth	Laboratory number	Identification	δ13C (‰)[a]	Conventional 14C age (BP)	Calibrated date (95% confidence)
OHM15264-X13	Peat 20–30 cm	KIA-45623	Wild boar (*Sus scrofa*), molar (M3)	−21,34	5620 ± 30 BP	4520–4363 cal BC
OHM15264-X12	Peat 30–40 cm	KIA-45622	Wild boar (*Sus scrofa*), L humerus	−20,27	6005 ± 35 BP	4991–4798 cal BC

[a]Note that the δ13C includes the fractionation occurring in the sample preparation as well as in the AMS measurement and therefore cannot be compared to a mass-spectrometer measurement

right stratigraphic order; however, it remains uncertain if these dates hint at two different occupations or one continuous occupation of the site. More data, including radiometric dates, will be needed to resolve this question.

If the dates are compared with the age of other submerged Ertebølle sites south of Funen, the older Falden date corresponds with Tybrind Vig B, horizon 1, and the younger Falden date with Tybrind Vig B, horizon 2 (Andersen 2013, 51) and with Ronæs Skov (Andersen 2009, 38). Both sites are situated north-west of Falden in the Little Belt while the other well-known sites of Møllegabet I and II are in the south-east off the north-eastern coast of Ærø Island. In this case it seems that Møllegabet II is older than Falden, in contrast to Møllegabet I, which was occupied more recently than the Falden site (Skaarup and Grøn 2004, 103). Further to the south on the German coast of the Western Baltic, sites like Timmendorf-Nordmole II, Rosenfelde, and Rosenhof are more or less contemporaneous with the Falden site (Hartz and Lübke 2006; Hartz et al. 2014).

5.5.3 *Photogrammetry*

The nature of the investigations at Falden as a training exercise allowed scope for experimentation with novel techniques. During the 2012 season, the authors conducted some preliminary trials of underwater photogrammetry on some of the dives using a ruggedized consumer-grade compact Lumix DMC-TS3 without a housing, waterproofed to a depth of 12 m. It was hoped that this would demonstrate methods for achieving a richer and more accurate record of submerged prehistoric sites than had previously been possible. Conditions on the site, such as depth, general light level and visibility were found to be suitable to take photos of sufficient quality. However, the presence of *Zostera* did present a major challenge. Photogrammetric recording requires a largely static subject and the *Zostera* were in constant motion due to the swell and current. After some disappointing results, we concentrated on limited areas which had been manually cleared (for more detail see McCarthy and Benjamin 2014).

We also made successful surveys of individual metre-square trenches using large numbers of oblique images taken in a roughly circular pattern. We also surveyed in a similar manner selected trenches at different stages of excavation (Fig. 5.8) and small individual in-situ archaeological finds including an in-situ flake axe (Fig. 5.9). Trench recording was also possible once *Zostera* was manually removed. Large numbers of images (up to 500 exposures) were captured in several trenches. Despite the large numbers of photographs taken, survey was rapid, in each case taking less than 10 min per dataset. We also found that the use of large numbers of photographs had the effect of filtering out sediment in the water column, making for clearer imagers.

Trench models were output with approximately five million polygons. Processing was undertaken using dedicated geomatics workstations with Agisoft Photoscan software. Small finds were also recorded, including a 15 cm flint flake axe, output as a model of 19.8 million polygons (Fig. 5.9). Although these datasets took over 24 hours of computer time to process, the resulting models of the

Fig. 5.8 Orthographic photogrammetric plan views of Trench 4 before and after removal of archaeological deposits. The trench is one metre square and images are north-orientated (Graphics: John McCarthy)

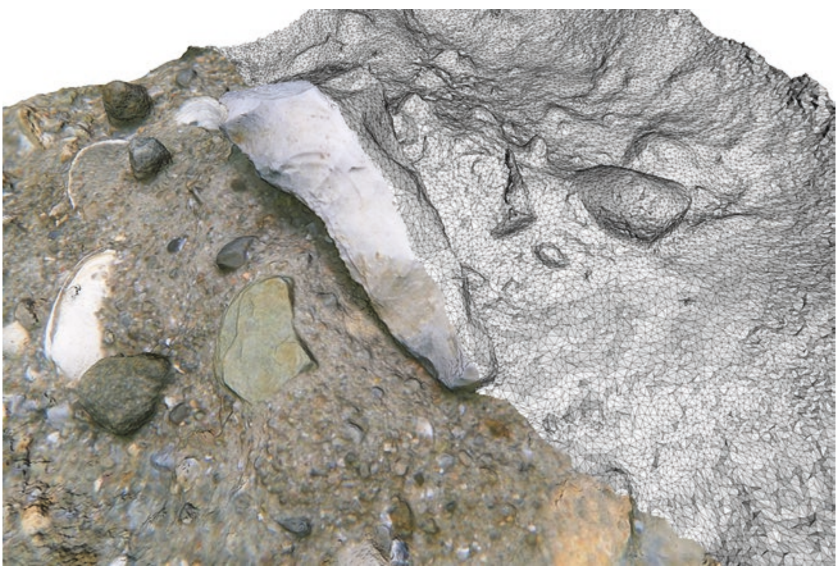

Fig. 5.9 Perspective view of photogrammetric model of an in-situ flake axe on the seabed. The axe is ca. 15 cm from edge to butt (Graphics: John McCarthy)

trenches and the axe proved to be accurate representations of the features encountered and after colour and contrast correction offered a better record than was possible through photography alone, possibly as a result of the filtering described above; for example, compare one of the original photographs (Fig. 5.10) to the photogrammetric trench plans (Fig. 5.8). The 3D trench models also facilitated the creation of virtual reconstructions of the hand dredging excavation, and enabled us to create an animated video showing one of the trenches before and after excavation, and the removal of the overlying

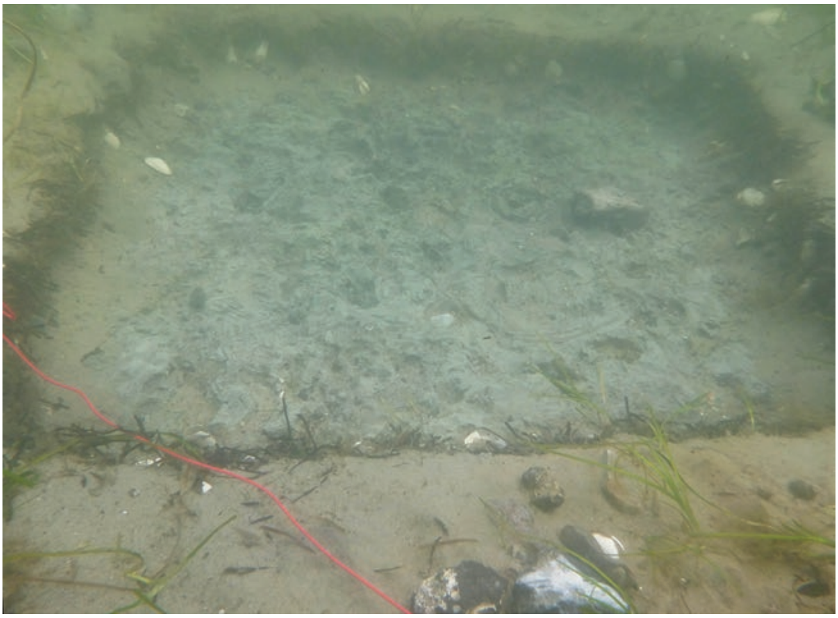

Fig. 5.10 An example of one of the photographs of Trench 4 used in the photogrammetric recording. The trench is 1 m square (Graphics: John McCarthy)

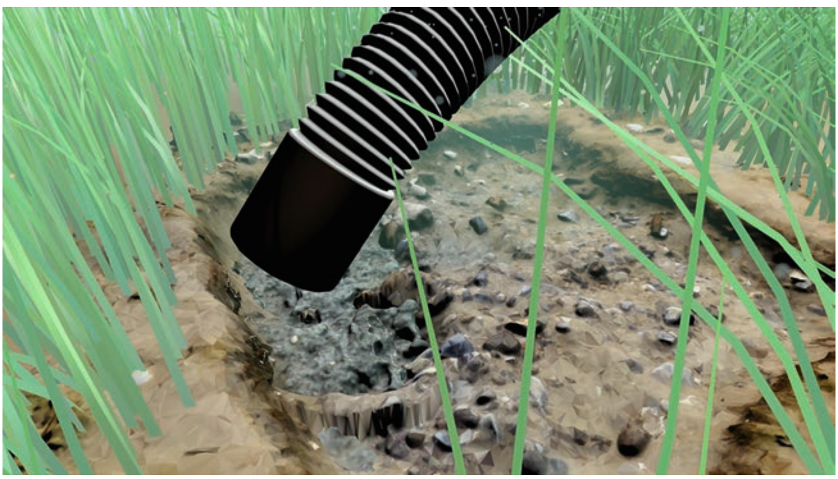

Fig. 5.11 A screen grab from an animated reconstruction of the dredging process (Graphics: John McCarthy)

sediment by a virtual dredger to reveal the underlying surface (Fig. 5.11). This will be used as a teaching tool in future work. The application of these experimental survey techniques proved valuable not only as a record of the site but also in demonstrating the value of interdisciplinary approaches and international collaboration.

5.6 Discussion

5.6.1 Archaeological Significance

Apart from its initial discovery, the Falden site has been investigated by two, 1-week mini-seasons, totalling less than ten full days of work. The results show that much can be gained even by this admittedly limited approach, and certainly much more than by a single-day rapid reconnaissance survey. The ideal would be a comprehensive full season (or multiple seasons) of archaeological excavation. However, given real-world considerations, resources and time, we suggest that the type of activity we conducted at Falden does indeed provide good value for money where full-scale excavation is not justifiable or the resource is simply unavailable. It could be considered on more sites as part of a broader research strategy, and this would both enhance our knowledge of the past and also inform good decision making in the future. It would also facilitate collection of additional absolute dates from the Danish submerged settlement sites, which is necessary if we are to fully incorporate the submerged Mesolithic with what is known generally from terrestrial deposits and with submerged sites further south in the German Baltic (see Goldhammer and Hartz, Chap. 9; Hartz et al. 2014).

The material encountered at Falden may seem a quite unremarkable and typical example of a Late Ertebølle settlement. The work carried out does not proclaim the discovery of the world's (or Europe's) 'oldest evidence'—for example of boating, art, or major cognitive or cultural advancement. However, there is significance in making incremental contributions to the dataset of the past: a record that slowly and steadily fills in the picture of the human experience during prehistoric periods where modern keyhole sampling exercises provide the only information available, information that may be biased because of the limited sample of available data. In the Falden case, the results are of particular interest in referring to peoples who were on the cusp of the transition from foraging to farming. The archaeology of the average site may be just that, but it should not be under-appreciated. Care should be taken to ensure that regional and national inventories are based on methodical data gathering and recording techniques. In this vein, it is important that funding agencies do not expect every archaeological site to produce sensational results. Indeed this will only serve to produce sensationalised reporting or, put differently, unrealistic expectations and interpretations. Substantive archaeological research takes time, and the analysis of the 'mundane' in the Mesolithic may require hundreds of sites before real breakthroughs and interpretive advancements are made. The site at Falden and work carried out there is a good example of a solid contribution to the incremental approach required to build a reliable record of the past and a reliable basis for future interpretation and decision-making.

Because the Falden site was not discovered by visual inspection, but by active search in the form of hand-fanned pits, the result is that a site has been found where almost no erosion had taken place. This was achieved through the use of the fishing-site-location model and the availability of many diving archaeologists at one time. This approach can surely be refined by further experience. It is the first site in Helnæs Bay (a substantial body of water) that shows more than just displaced artefacts in secondary position. Judging from the seabed characteristics, many more sites like this must be present in the Bay and in the waters of the South Funen Archipelago.

5.6.2 Training and Capacity-Building

This site and the archaeological project associated with it also presented an excellent opportunity for capacity-building and training of Early Stage Researchers, many of whom would not have had the opportunity to work, first hand, on such a submerged prehistoric site.

In modern underwater archaeology, SCUBA diving and the ability to breathe and thus work under water are taken for granted. There are, however, numerous considerations which must be acknowledged when working under water:

> It is almost impossible to describe to someone who has never dived what it is like to work underwater; for various technical reasons, even the most realistic of underwater films give a partially false impression. Much of the peculiarity of the experience can be traced to the fact that the diver is effectively weightless under water... (Muckelroy 1978, p. 24).

Coupled with gravity, pressure and mobility issues, limited visibility and communication make underwater archaeology physically different from archaeology on land. In addition to the reality of working underwater, there are numerous basic principles of dive theory which must be considered. It is within this context that we identify a need for training of qualified underwater archaeologists.

Even more specific to this discussion is the opportunity for young practitioners and early career researchers to train on submerged prehistoric sites. Since the vast majority of prehistoric sites are investigated in terrestrial contexts, and most underwater cultural heritage (the broad legal term encompassing archaeological sites of all ages) is concerned with sites of Historic or Classical periods (Bass 1966; Muckelroy 1978; Delgado 1997), there are few opportunities for early stage researchers destined for employment in the heritage profession to gain suitable training and qualifications, and especially to the standard required by competent authorities responsible for the management and, importantly, the authorization of research. Indeed, if such competent authorities are entrusted with checking and weighing the considerations involved (see Maarleveld et al. 2011), it is imperative that they are qualified and experienced beyond mere theoretical familiarity or minimal competence. There is an urgent need for practical training in the applied methodology of this branch of archaeology and heritage management, especially beyond the Danish sphere.

It is also important that when archaeological mitigation is required in a pre-development context, trained professionals are available who are capable of responding to the threats to the cultural heritage of all site-types which may be encountered under water. A lack of training and experience in the discipline of submerged landscape archaeology will limit both the legal framework within which decisions are taken and also the capacity of the profession to respond appropriately to real-world conditions. In the worst-case, with managers and practitioners who lack the necessary knowledge and experience, protection of prehistoric sites may not be considered at all. Also of grave concern under such conditions would be the tendency for heritage authorities to refuse intrusive activity, such as test excavation, even when legitimate reasons of archaeological research and capacity-building justify it. Such a stance would have prohibited the discovery and investigation of the Falden site, and many other sites investigated in the past which we now know to have made both incremental and step-change contributions to our understanding and appreciation of early prehistory. In a world of increased scrutiny and accountability, and with seemingly fewer resources for archaeology, it may perhaps seem safest to do nothing. However, this is a direct threat to scientific progress, to the development of submerged landscape archaeology as an emerging discipline and to archaeology in general.

It is fortunate that presently such a scenario does not exist in Denmark, with the balance of protection and intrusive investigation weighed along with the appropriate needs for scientific and archaeological research as well as an understanding and appreciation of the need for capacity building. However, with an increased focus on in situ preservation and more jurisdiction and responsibility placed on the shoulders of already-stretched heritage managers around the world, the described scenario may not be far-fetched, especially if action is not taken to train future generations in the theoretical and applied aspects of all types of underwater archaeology.

5.6.3 Proposal for an International Centre of Excellence

Through network-building between EU-based participants, the Danish field training undertaken in collaboration with SPLASHCOS participants of various countries and the Langelands Museum can be considered as a highly important first step—a foundation for education and international capacity-building in submerged prehistoric archaeology. Many years of collaborative research with local community members and professional archaeologists in Denmark have provided increased training in the practical aspects of underwater site recording. It is to be hoped that the work undertaken by the SPLASHCOS network will continue; the momentum and good will, as well as awareness in public life, must be harnessed in order to ensure a future in the field of study. Only by continuing research and training—on actual sites, not only theoretical ‘landscapes’—can the next generation of archaeologists and heritage professionals be prepared to encounter real-world scenarios. The Danish Baltic, with its regional experts and practitioners (and international friends) is uniquely positioned to make this globally important contribution to underwater archaeology and cultural heritage management.

The Danish coast and nearshore waters provide an internationally recognized opportunity for a centre for excellence in underwater research, training and capacity building. Building on its history within the field of study, its leadership representation within SPLASHCOS (and other international consortia), Danish marine archaeology has an opportunity to offer a safe, accessible and scientifically significant heritage resource in its shallow coastal waters, a resource that can be considered relatively abundant in its concentration when compared with what is known on a global scale. Denmark has also been at the forefront of developing what is now considered an internationally important field, both in terms of scientific and archaeological contribution as well as heritage management. It now has a unique opportunity to demonstrate its successful development of the field of study since the 1970s. In this vein, but perhaps from a different perspective, it could equally be argued that through the investment in and success of Danish marine archaeology, Danish practitioners have a professional responsibility to share their experience and to assist a growing number of interested members of the professional community of researchers and heritage managers in Europe and worldwide who need training. A recent workshop held near Washington DC, USA, has demonstrated an international demand for such expertise. This should be viewed as an opportunity for Danish practitioners to make a considerable and lasting contribution to World Prehistory.

Without deliberate succession planning for long-term capacity building (following on from SPLASHCOS), a sustained field of research of submerged prehistoric landscape archaeology may not develop to its full potential. A case can be made for the establishment of a training centre, based in Denmark and with international participants, on an annual basis, to ensure the future of suitably trained specialists and practitioners in submerged landscape archaeology worldwide. This would be both a contribution to capacity building and to submerged archaeology and can also be developed to the mutual benefit of all participants and institutions.

5.7 Conclusion

The SPLASHCOS Short Term Scientific Mission in 2010 funded the training of eight international Early Stage Researchers. The Langelands Museum provided training as part of their existing community archaeology programme for the public benefit. This proved to be not only a fruitful exercise, but an example of what is truly necessary to train future generations of researchers and managers both in Denmark and worldwide. The archaeological results presented here are significant in their own right as an original contribution to the European Mesolithic and differ in character from the sites previously known in Helnæs Bay. The Falden site is therefore important in both the incremental sense on the large scale and for its uniqueness at a local scale. It would not have been encountered without some minimally intrusive investigation which was legitimately carried out by trained professionals and inexperienced Early Stage Researchers under appropriate supervision and direction. It is under these conditions that the SPLASHCOS training missions represent an important step forward in capacity building and preparation for the future through appropriate training and real-world experience that involves underwater archaeological survey and excavation of prehistoric sites.

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