Early Holocene sea fishing in Western Scotland

Citation for published version:
Groom, P, Pickard, C & Bonsall, C 2019, 'Early Holocene sea fishing in Western Scotland: An experimental study', *Journal of Island and Coastal Archaeology*, vol. 14, no. 3, pp. 426-450.
https://doi.org/10.1080/15564894.2018.1521481

Digital Object Identifier (DOI):
10.1080/15564894.2018.1521481

Link:
Link to publication record in Edinburgh Research Explorer

Document Version:
Peer reviewed version

Published In:
Journal of Island and Coastal Archaeology

Early Holocene Sea Fishing in Western Scotland: An Experimental Study

Peter Groom[1], Catriona Pickard[2], Clive Bonsall[2]

[1] –Corresponding Author. Mesolithic Resource Group: Stafford, UK. www.mesolithic.org.uk.

Email: peter@mesolithic.org.uk

[2] – Archaeology, University of Edinburgh, School of History, Classics and Archaeology, William Robertson Wing, Old Medical School, Teviot Place, Edinburgh, EH8 9AG, UK.

Early Holocene Sea Fishing in Western Scotland: An Experimental Study

ABSTRACT

Coastal shell middens, a prominent feature of the Mesolithic archaeological record of western Scotland, suggest a maritime economy based on fishing and shellfishing. Despite evidence for the importance of fish to diet, virtually nothing is known of the fishing methods practised, although several 'models' have been proposed. We tested these models by means of a series of field experiments. A range of experimental fishing gear including lines and portable traps and pots were made utilising resources and technologies available during the Mesolithic. Fishing experiments were conducted at, or near to, the Scottish west coast Mesolithic sites of Ulva Cave and Sand (Loch Torridon), and also on the island of Colonsay, South Uist, and the Urr Estuary on the Solway Firth. Results suggested that Mesolithic fishers must have had extensive knowledge of tides as well as species behaviour to successfully exploit coastal environments adjacent to the west coast midden sites. Additionally, capture of the main fish species (i.e., *Pollachius virens*, Labridae and *Pollachius pollachius*) and brachyurans (*Carcinus maenas*, *Liocarcinus depurator* and *Cancer pagurus*) identified in the middens did not require sophisticated fishing gear; simple hand-lines sufficed.

Keywords Experimental archaeology, shell midden, fishing, Mesolithic, Scotland

INTRODUCTION

Shell middens are a prominent feature of the archaeological record of western Scotland, the earliest dating to the later Mesolithic between c. 7500–4000 cal BC. Distributed along the mainland coasts and on several of the Inner Hebridean Islands there are particular concentrations of Mesolithic middens on Oronsay and around Oban Bay (Figure 1). Faunal remains recovered from the shell midden sites point to the exploitation of a diverse range of aquatic resources in the west Scottish Mesolithic including fish, shellfish, sea mammals, echinoderms, brachyurans and seaweeds (Table 1). Shell middens are therefore widely interpreted as the archaeological remains of a maritime adapted culture (Woodman 1989; Bonsall 1996; cf. Wicks et al. 2014).

Biochemical evidence from the Oronsay middens supports this interpretation: dietary reconstruction based on stable isotope analysis of human bone collagen indicates the importance of fish and potentially other marine resources in diet (Richards and Mellars 1998; Charlton 2016). However, little is known of the fishing methods employed by hunter-gatherer groups in western Scotland, owing largely to the lack of definitive fishing gear, such as portable traps or hooks and lines. For example, only one 'fishhook' has been reported from a Scottish Mesolithic site – a small V-shaped bone artefact from a midden on the island of

Risga in Loch Sunart (Morrison 1980, pl. XIV). However, Foxon (1991) re-interpreted this as a reworked barbed bone point, based on the occurrence of barbed points in other Mesolithic shell middens in western Scotland. Thus, there is no certainty that the Risga find was used for fishing – among ethnographically known maritime hunter-gatherers barbed points were also used for the capture of small mammals and birds (Kroeber and Barrett 1962).

By contrast, a wide range of fishing gear has been recovered from Mesolithic sites in continental Europe, with a particular concentration of finds in the circum-Baltic zone where post-glacial environmental conditions have facilitated unparalleled preservation of organic materials. Bone and wooden fishhooks and leisters, fixed and portable traps, nets, floats and sinkers have all been recovered from coastal and inland sites (Pälsi 1920; Andersen 1995; Skaarup 1995; Hansson et al. 2016).

The archaeological record of the Mesolithic in western Scotland is generally more limited than that of southern Scandinavia. Characterized mainly by shell middens and lithic scatter sites (e.g., Bonsall 1996; Mithen 2000) evidence of structures of the scale and duration apparent in eastern Scotland (e.g., Gooder 2007; Robertson et al. 2013) is lacking although putative hut floors have been identified at Camas Daraich, Skye (Hardy & Estevez 2014), Lón Mór, Oban (Bonsall & Robinson 1993) and at Staosnaig, Islay (Mithen 2000). Other recorded features are more ephemeral in nature, and include hearths, pits, stake- and post-holes, and stone settings and paved areas (Bonsall 1996; Wickham-Jones 2004). The acidic peaty soils that dominate western Scotland (Davidson & Carter 1997) hamper organic preservation on terrestrial sites, while coastal conditions are generally unsuitable for the survival of submerged sites. However, preservation conditions are unlikely to be the sole explanation for the lack of finds – the localised alkaline environments created by shell middens have resulted in generally good preservation of bone and fish remains, and so there is no reason why hooks, gorges and other fishing gear made of osseous materials would not also have survived. Paradoxically, bone fish-hooks are common in late Mesolithic shell middens in south-west Norway, which are set within a coastal landscape and environment not dissimilar to that of western Scotland. Interestingly, a study by Bergsvik and David (2015) concluded that the bone technology represented at the Norwegian sites shows distinct ‘eastern’ influences, which are not reflected in the British Isles. Since Britain was separated from the European mainland by 6500 cal BC as a consequence of post-glacial sea-level rise (Shennan et al. 2000; Sturt et al. 2013), it is possible that the absence of bone fish-hooks and gorges from west Scottish shell middens is related to ‘cultural’ factors.

In the absence of unequivocal Mesolithic fishing gear from the west Scottish shell middens, interpretations of capture strategies are necessarily derived from species representation and size distribution of the fish and shellfish remains recovered from the middens. Previous authors have offered varying and sometimes contradictory models of Mesolithic fishing practices in northern Britain. The identification of 'deep-water' species such as *Gadus morhua* (cod) at sites such as Morton B, in Fife, has led several authors to suggest that offshore fishing with boats was practised by maritime hunter-gatherers in Scotland (e.g. Coles 1971; Wickham-Jones 1994; Tolan-Smith 2008). At Sand rockshelter, on the west coast Milner (2007a, b) suggested that fishing baskets and lines may have been used in conjunction with boats, whereas Parks and Barrett (2007) inferred an inshore fishery using stationary traps or nets. In contrast, Pickard and Bonsall (2012) concluded that fishing at Ulva Cave was likely conducted from the shore with little or no specialised equipment.

This paper presents the results of contextual experimental testing of the fishing models described above, assessing the efficacy of different fishing equipment and harvesting strategies in the coastal waters of western Scotland using replica Mesolithic fishing gear.

EXPERIMENTAL STUDIES

Background

Discussing the state of research into Mesolithic hunter-gatherers in Scotland, Baderman and Mithen (2000) commented that experimental studies were lacking. However, a few studies have focused on elucidating the manufacture and uses of specific artefact types. Experiments to determine the purpose of bevel-ended tools, common in western Scottish middens, have produced conflicting interpretations with some researchers (e.g. Griffitts and Bonsall 2001) connecting them with limpet processing and others (e.g. Hardy *et al*. 2009) with hide working. Other experimental studies have included reconstructions of 'Obanian'-style barbed points and antler mattocks (Lord 1998; Baderman and Mithen 2000; Cave-Browne [in Saville 2004]; Mears and Hillman 2008). On Islay, locally acquired flint beach-pebbles were used to knap Mesolithic-type tools (Mithen 2004), while Finlay (2006) explored experimental replication of procedures used in microlith production. Research into food processing and preservation techniques has included hazelnut roasting to replicate activities at Staosnaig Bay (Mithen 2004; Mears and Hillman 2008). However, the value of experimental archaeology as a research tool is still not widely appreciated and, consequently, is under-used in Scottish Mesolithic studies (ScARF 2012).

Often, models of Scottish Mesolithic fishing strategies have been formulated without recourse to empirical analysis. Our research has sought to redress this by testing hypotheses using experimental techniques. While experimentation can enhance knowledge of past lifeways, unless outcomes are quantifiable, and the experiments are undertaken in context (i.e. using Mesolithic technology and appropriate environmental controls), they are of little value. Marsh and Ferguson (2010) noted that few conclusions can be drawn where variables are uncontrolled. However, over reliance on controlled 'laboratory' conditions can invite criticism of limited 'actualism' (cf. Outram 2008). For this study, a combined approach was adopted: 'actualistic' experiments (i.e. using methods and materials that would actually have been available to Mesolithic hunter-gatherers) were conducted and, wherever possible, experimental controls were employed. Two main types of fishing practice were compared: (i) hook and line, and (ii) portable trap/pot. To establish and account for variables potentially affecting the gear (e.g. weather, tides, raw materials and aquatic resources), regulatory checks were developed. Where applicable, controlled experiments tested the technologies/gear throughout manufacture; for example, breaking strains of lines, suitability in a range of conditions, and parallel use of modern and experimental gear. In this way, variables were quantified and, to an extent, constrained.

Manufacture of Experimental Fishing Gear

Given the paucity of British examples on which to base the experimental gear, analogies were drawn from well-documented Mesolithic finds elsewhere in Europe.

The range of Mesolithic fishing gear (including portable equipment as well as large-scale static traps) and inferred fishing strategies evident at Scandinavian sites and throughout the wider Baltic region represent similar deployments of a sophisticated and extensive regional fishing technology often with several different fishing gears in use at any one site – see Andersen (1995, 63). Arguably, however, the rocky shore environments of the Iberian Atlantic coast offer more direct maritime parallels for the Early to Middle Holocene of western Scotland (e.g. Boaventura *et al*. 2002). At Mazaculos, northern Spain, gorge hooks (bi-points) were used to take marine fish (Fano 2007). This technology, known from Upper Palaeolithic times (MacCurdy 1924; Bernal-Casasola 2010), was widely used by prehistoric and historic fishers across both Old and New Worlds. Experimental fishing gear was therefore based on examples from Mesolithic sites not only in the Baltic region but also from Ireland and the Iberian Peninsula (e.g., Andersen 1995, 57; Fano 2007, 140; Schaller Åhrberg 2007, 48; Mossop 2009, 898).

MATERIALS AND METHODS

Replicate fishing gear (i.e. hooks, lines, lures, traps and pots) was manufactured using only technologies known to Mesolithic hunter-gatherers. Ethnohistoric records of fishing gear and gear manufacture in traditional fisheries informed the construction of replicas, where specifics could not be inferred from the archaeological record. For example, details of throated trap manufacture were drawn, in part, from documentary sources that record manufacturing methods for traditional fishing pots (e.g. Hogan 2001). Most of the raw material used in the manufacture of gear was collected from natural sources at the experimental field sites (with the landowner's permission), ensuring that the fishing experiments tested the feasibility of opportunistic construction and use at locales analogous to the midden sites mentioned in the Introduction. Two traps were manufactured from coppice material, which was pre-sourced, dried for several months then rewetted for three days. All experimental fishing gear was constructed by, or under the supervision of, the first-named author (PG).

Materials

Gear was made from a range of plant and animal materials, all of which would have been available to Mesolithic inhabitants of west Scotland. Table S1 lists the plant species that could have been exploited, together with their potential products and uses. The range of animal products that could have been used by Mesolithic hunter-gatherers to manufacture the fishing equipment was informed by Kitchener *et al*.'s (2004) analysis of mammalian species represented in Scottish Mesolithic sites, but taking into account material that may have been washed up on beaches.

Manufacture of fishing lines

Spinning of fibres is the drawing and twisting of material into a continuous length (Leadbeater 1979). As with most natural fibres, plant bast can be spun using a range of distinctive techniques. Wescott (1999) provided a guide to the collection of plant fibres, a process applicable to most tree basts. There are three main hand-spinning methods: rolling fibres along the thigh; using a spinning hook; or twisting fibres by hand. In each process direction of spin determines whether the cord has an ‘S’ or a ‘Z’ twist. Frequently, the direction of spin reflects the handedness of the spinner: left-handed spinners will generally create a Z twist and right-handers an S twist. There is no functional advantage to either direction of twist. Fibres can be further processed by plying, combining two or more spun cords, and by cabling, combining two or more plied cords. Normally, two-ply cord is sufficient for most uses including the manufacture of fishing lines.

Mercer (1978) listed a range of plants suitable for cordage; *Urtica dioica* (common nettle), *Pinus sylvestris* (Scots pine), *Ulmus* sp. (elm) and *Tilia* sp. (lime). However, there is no evidence for the presence of *Tilia* in Mesolithic Scotland (Birks 1989), other plants could have been used for the manufacture of fishing lines (Table S1). In this study, fibres from nine plant species were assessed to determine whether they could be used to produce fishing lines. Difficulties in obtaining sufficiently long pieces of bast for line ‘spinning’ from *Alnus glutinosa* (common alder), *Betula pubescens* (downy birch), *Corylus avellana* (common hazel), *P. sylvestris*, and *Quercus petraea* (sessile oak) meant that these species were discounted. Fibre procurement and line manufacture therefore focused on the other four species investigated, *Salix alba* (white willow), *Salix caprea* (goat willow), *Ulmus glabra* (wych elm) and *U. dioica*.

A standard approach was adopted for the manufacture of all the fishing lines from the fibres of each plant species – individual strands were single-ply S-twisted. When combined these produced an overall Z-twist 2-ply length (see Figure 2; Edholm and Wilder 1999). Breaking strain tests were conducted on samples to assess durability and potential as fishing line.

Manufacture of hooks

No convincing examples of fishhooks have been found in Scottish Mesolithic contexts – experimental hooks were therefore based on archaeological examples from Scandinavia and Iberia as well as on ethnographic examples (e.g. Andersen 1995, 57; Fano 2007, 140;

Schaller Åhrberg 2007, 48). Hooks can be manufactured from a variety of materials, such as bone, shell, stone and wood (Callahan 1999; Mears 2001; Watts 2004, 2010). For our study gorges and 'J'-shaped hooks were manufactured from *Capreolus capreolus* (roe deer) and *Cervus elaphus* (red deer) metapodials as well as wood, using expedient tools, such as unmodified pebbles used as hammerstones to reduce bones to suitable blanks, and unworked sandstone and basalt blocks used for grinding. Thorns of *Crataegus monogyna* (common hawthorn) and *Prunus spinosa* (blackthorn) required little processing to form workable hooks. Replicate lures, feathers and jigs of the types used in traditional and modern sea angling were constructed (Figure 3). Shells of *Cerastoderma edule* (common cockle), *Pecten* sp. (scallop) and *Lutraria lutraria* (common otter shell) (Figure 3d) were perforated using an ad hoc flint point, then attached to a line and a small bead-weight, to form lures. The bead-weights were made from marine clay that was air dried for 60 minutes, fire-hardened for a further 60 minutes and waterproofed by rolling in melted beeswax. Further fishing lures were created from feathers cut with a flint flake into a variety of shapes and were attached to thorn-hooks of *Rosa canina* (dog rose), *C. monogyna* and *P. spinosa*.

A lure based on the popular modern rubber sandeel lure (also known as a redgill), which simulates a small fish, was created using a hollow gull quill as a tube, beeswax and two strands of gull feather, such that the line passes through the tube to the hook. In this instance, a modern monofilament line and a steel hook were used in the field experiment. This ensured that the effectiveness of this type of lure as a sight trigger stimulus to predatory fish was assessed, rather than testing the variables of hook and line strength.

Mastic for securing various elements of composite hooks and lures was made by mixing heated *Pinus* resin with wood ash, producing a hard, black glue when set.

Manufacture of portable traps

Many species of plants can be used for basketry manufacture (Table S2). Mesolithic portable basketry traps of uniform design and structure have been recovered from sites across continental Europe and from Ireland (e.g., Mordant and Mordant 1992; Andersen 1995; Mossop 2009). Trumpet- and throated-traps of this type have been used in non-industrial fisheries into the 20th century AD. Traditionally they were used in tidal creeks and inlets (Smart 2000) or in inland waters such as rivers and lake margins (Mossop 2009) rather than exposed, rocky coasts owing to their light construction. More robust trap types, such as the ‘inkpot’ or Connemara trap, were commonly used in traditional fisheries in exposed coastal waters (Hogan 2001).

Professional basket maker, Rachel Evans, recommended the use of five of the species from those listed in Table S2; *C. avellana*, *Salix* sp. (willow), *Rosa* sp. (rose), *A. glutinosa*, and *Betula* sp. (birch). Eight portable traps were constructed (Figure 4). Four funnel-traps were based on the Clowanstown trap (Mossop 2009) – a Mesolithic trap from County Meath in Ireland, and a style of trap still in use (Hogan 2001). The open end of the original was believed by Mossop (2009) to have held a funnel-shaped ‘restriction’. Dimensions of this internal ‘throat’ were not available, so size was estimated using other archaeological and ethnographic examples. Two traps were based on historic examples: a Connemara-type pot and a tube trap (Hogan 2001; Fenton 2008). Traditionally, Connemara pots had fixed bottoms. For our experiments removable bases were fitted to permit easier access. Two ‘exploratory’ traps, where the natural materials available ultimately dictated the precise shape and form, were also tested – an inverted dome-shaped trap and a tortoise shell-shaped trap.

Two traps were made using processed materials from managed coppice – one of the Clowanstown-type traps and the Connemara pot. To provide a contrast, five traps (two Clowanstown-type, the tube trap and the two exploratory traps) were manufactured from unmanaged (natural growth) woodland. Leaves were left on these traps as gap fillers, reducing the number of rods and weavers required. The final funnel-type trap was made from natural re-growth following a wildfire at Torridon.

Field Experiments

The effectiveness of the experimental gear was tested in a series of controlled field trials over a three-year period (2010 to 2012), and compared to that of modern equipment (rods, reels, lines, hooks, and a Norway lobster creel) to provide controls.

Hooks and traps were baited with a range of fresh shellfish including *Littorina littorea* (edible periwinkle), *Mytilus edulis* (mussel) and *Patella* spp. (limpets), collected from rocky shores, and fish that were caught during the field experiments, including *Clupea harengus* (herring), *G. morhua*, *Labrus bergylta* (ballan wrasse) and *Scomber scombrus* (mackerel). Lures were also tested as part of the line-fishing experiments (see Groom 2014 for details).

The accuracy of our replication studies depended on the identification of suitable biotopes (i.e., fishing grounds similar to those exploited by Mesolithic hunter-gatherers) for the fishing experiments. Fish species have evolved to favour particular biotopes (Williams 1991) and within a single species, biotope preference can vary with age and sex (Kramer *et al*. 2002). Species representation and age/size profiles in fish assemblages can therefore reflect the prevailing biotope(s) exploited by prehistoric fishers. In our study certain assumptions were made: (i) fish behaviour has not changed significantly during the Holocene (see Bell and Walker 1992 for discussion), and (ii) the fish remains recovered from the middens are representative, in terms of relative abundance, of the original catches (see Colley 1990 for discussion).

The preferred biotopes of the fish species identified in the west coast middens were rocky shores, often associated with deep water, characterised by high energy wind and wave action and large tidal ranges. High energy, rocky shores were therefore selected for the fishing experiments including locations near known shell midden sites such as Ulva, Colonsay and Loch Torridon (Sand). Additionally, waters offering distinctive biotopes, on South Uist and in the Solway Firth (Urr Estuary) were also fished to provide control comparisons for fishing gear efficiency (Figure 1). Two different methods of setting the experimental fish traps were explored, based on ethnographic and modern observations of fish trapping (Slack-Smith 2001): (i) the funnel/throated traps were staked out at low tide and fished through high tide; and (ii) the pots were weighted to prevent drifting before lowering into deep water. The funnel/throated traps were set in creeks or rock gullies with natural funnelling features to enhance their effectiveness, while the pots were used in exposed locations and rock pools. Pots were also set against harbour walls that encouraged the movement of fish toward the trap entrance, both in shallow water and in water deeper (>10 m) than was accessible with the handlines used in our experiments. Generally, traps were set adjacent to one another in order to maximise capture efficiency. Traps and handlines were often fished simultaneously in the same locations to establish relative effectiveness.

Descriptions of the locations are as follows:

Ulva

Ulva is a small island c. 8 by 3 km, formed mainly of Tertiary basalt. The Ulva Cave Mesolithic site (56°28′02.91″N, 6°10′20.99″W) in the southwest of the island lies nearly 50 m above sea level and c. 400 m from the present shoreline. In places along the shoreline there are drop-offs into water several metres deep. Fishing experiments were conducted on a range of shoreline types including shallow sandy bays, rocky shores and drop-offs, in both sheltered and exposed locations.

Colonsay

Colonsay is c. 13 km long and up to 4.8 km across, with a varied coastal landscape of sandy beaches and rocky coves; cliffs up to 30 m high occur along the western side of the island. Lying immediately to the south of Colonsay is the smaller island of Oronsay to which it is joined at low tide. Fishing experiments were conducted at Staosnaig Bay (56°03′39.86″N, 6°11′45.38″W) on the more sheltered east coast of the island, near the Mesolithic site excavated by Steven Mithen (2004).

South Uist

The Outer Hebrides, lying 80 km from the Scottish mainland, form a chain of islands, which includes South Uist. While the Inner Hebrides and mainland are rising through isostatic rebound, the outer islands are sinking with the result that much of the evidence of Mesolithic settlement along the west coast of the Outer Hebrides may now be below sea level (Parker Pearson et al. 2004). Fishing experiments were conducted in locations ranging from shallow muddy bays to deeper rocky shores in both sheltered and exposed situations, including Loch Sheileabhaig, (57°20′58.70″N, 7°16′26.61″W) and Loch Carnan (57°22′19.41″N, 7°17′50.18″W).

The Urr Estuary, Solway Firth

The Solway Firth between southwest Scotland and northwest England is a high-energy tidal flat environment. The River Urr enters the Solway Firth from the north and its estuary offers a wide range of shore biotopes in which to test experimental gear, including exposed rocks, salt marsh, mud flats and shingle beaches. Fishing experiments were conducted along the Urr Estuary in shallow muddy or sandy bays in sheltered and more exposed locations, at Port Donnel (54°51′49.94″N, 3°47′46.99″W), Rockcliffe (54°51′56.08″N, 3°48′09.70″W) and Rough Island (54°51′33.53″N, 3°48′03.09″W).

Sand, Applecross Peninsula and Loch Torridon

The Applecross Peninsula between Loch Torridon in the north and Loch Carron to the south is underlain mainly by rocks of the Torridonian Complex. Heavily glaciated with a thin covering of till and moraine in places, there are extensive exposures of sandstone with peat-filled depressions. The Sand Mesolithic rockshelter site lies at c. 28 m a.s.l. overlooking a broad embayment on the west coast of the peninsula, about 500 m from the present shoreline. Since the rocky shoreline below the rockshelter is a restricted area controlled by the UK Ministry of Defence, fishing experiments were conducted at a similar location to the north, Lower Diabaig (57°34′27.74″N, 5°41′09.69″W) on Loch Torridon.

RESULTS AND DISCUSSION

Tests of the breaking strains of fishing lines made from the fibres of five plant species indicated that *S. alba* made consistently high-performing lines (typical breaking strain greater than 12 kg) and that keeping the fibres moist was generally advantageous. These results – presented in Table 2 – confirm that expediently manufactured lines could have been used in the capture of large fish.

A range of species were taken by the fishing gear tested. Table 3 summarises the catches at each site, while Table 4 details raw material needs, and procurement and manufacturing times (for further details, see Groom 2014). In total 78 hand-line attempts captured nine species of fish; *Chelon labrosus* (grey mullet), *G. morhua*, *L. bergylta*, *Lipophrys pholis* (shanny), *Pollachius pollachius* (pollack), *Pollachius virens* (coalfish), *S. scombrus*, *Scyliorhinus canicula* (small spotted catshark) and *Trisopterus luscus* (pouting). Three species of crab were taken as 'bycatch'; *Carcinus maenas* (common shore crab), *Liocarcinus depurator* (harbour crab) and *Necora puber* (velvet swimming crab). All nine species of fish were captured with modern nylon hand-lines, while three species of fish (*L. pholis*, *L. bergylta* and *P. pollachius*) were taken on plant fibre hand-lines. Eight modern rod and line attempts took five fish species (*L. bergylta*, *P. virens*, *S. scombrus*, *P. pollachius* and *L. pholis*).

Replicate hooks and lines fished from the shore proved to be effective at catching a range of species. Size of fish taken in the experiments conducted at Ulva and Oronsay fell between 90–380 mm, with the majority between 140–210 mm. With the exception of one specimen of *P. pollachius* (taken on a line in excess of 10 m in length) all of the fish were taken on short lines ranging from 2–6 m in length. Most of the fish were caught at or around low water, suggesting that using simple short-line technology is influenced by fishing location and state of tide.

No fish were caught in any of the traps: however, 75 specimens of three species of crab (*C. maenas*, *L. depurator* and *N. puber*) were caught in the 33 trap fishing attempts. Of the funnel-traps, trap 1 (Clowanstown type) caught nothing at all; trap 2 (‘Torridon’) caught three *C. maenas*; trap 6 (‘tortoiseshell’) two *C. maenas*; trap 7 (2011 version) six *C. maenas*; trap 8 (2012 version) five *C. maenas*. Trap 5 (dome) caught nine *C. maenas*; trap 4 (tube) eight *C. maenas*; trap 3 (Connemara) thirty *C. maenas*, one *L. depurator* and one *N. puber*. The modern commercial trap, used as a control, caught ten *C. maenas*. Three consecutive days of trap setting on the Urr Estuary with a total fishing time of 24 hours and 20 minutes, took only 24 *C. maenas*. The majority of these crabs were small specimens (13/24, 54.2%) with carapace width of 20-30 mm. Although the number of trap attempts was lower than the number of line fishing attempts, traps were fished for long periods of time, up to 12 hours. Most line attempts were of one to two hours duration.

Ugan *et al.* (2003) observed that many experimental studies have focused on the efficiency of tools or gear without any reference to the effort expended in production. A superior technology may take longer to manufacture (Ugan *et al.* 2003). This ‘cost/benefit’ model was tested by our experimental fishing gear. Manufacture of hand-lines and hooks represented a relatively small investment of time; a significantly greater investment was required to harvest suitable raw materials for, and to construct, the portable traps. However, fishhooks (gorges, composite hooks and thorns with feather lures), arguably a simpler and more cost-effective technology than the fish trap, was in Ugan et al.’s (2003) terminology, superior. Hand-lines were more cost effective still. At Ulva Cave, for example, the three species that dominate the fish remains in the midden (i.e., *L. bergylta*, *G. morhua* and *P. pollachius*) as well as *S. canicula*, were caught directly from the shore in c. 5 m of water using baited hand-lines. Furthermore, the size of the fish taken on experimental hand-lines at both Ulva and Oronsay (ranging from 90–380 mm with the majority between 140–210 mm), is similar to that reported for the majority of the fish (c. 150–500 mm) recovered from the shell midden at Sand (Parks and Barrett 2007). Experimental hand-line fishing from the shore at sites adjacent to, or analogous with, Mesolithic sites produced fish species and fish sizes that closely match those in the west coast shell midden assemblages. Put simply, the same biotope, the same species, the same sizes of fish, equals the same fishing method.

Feather and quill lures based on historically documented examples proved highly successful in the experiments (Table 3). Lures accounted for five species of fish, *P. pollachius*, *P. virens*, *L. bergylta*, *S. scomber* and *C. labrosus* and one species of crab, *C. maenas*.

Although Parks and Barrett (2007) and Milner (2007b) speculated that basketry traps were used at Sand, there is no direct archaeological evidence to support Mesolithic use of traps on the west coast of Scotland. Our findings suggest that traps of the kind used in our experiments are not suited to the local coastal topography or marine biotope. Despite setting nine different traps (eight experimental, one modern) in a range of locations and biotopes, none accounted for fish. On the other hand, fish populations have declined dramatically in British coastal waters over the past 125 years (Odum and Barrett 2005; Thurstan *et al*. 2010). This reduction in fish stocks may have contributed to the lack of fish taken in the experimental traps (cf. Odum and Barrett 2005). However, since the traps were set near to successful hand-line experiments, reduction in fish stocks is unlikely to be the sole explanation for the non-productivity of the traps and highlights the efficacy of line fishing in rocky shoreline environments. Fishing with hand-lines enabled direct visual targeting of prey. This was particularly effective in the capture of crabs. Aggressive competition between crabs for baits tended to result in the capture of larger specimens. Furthermore, once a trap is set it is static until lifted, whereas fishing with hand-lines enables the fisher to move as shoals or crabs move or as the tide changes.

Although fish were the intended target of the trap fishing experiments, crabs were a significant ‘bycatch.’ Traps with deliberately retained foliage, i.e. those constructed from withes from unmanaged woodland, caught crabs – possibly because as the tide falls the darkness of the interior resembles crevices and marine algae under which *C. maenas* hide (Neal and Pizzolla 2008). Warman *et al.* (1993) suggested that on immersion by the incoming tide, small *C. maenas* specimens (< 35 mm carapace) emerge to forage, returning to shelter on the ebb, perhaps accounting for the large proportion of small crabs caught in the traps. Larger, predominantly green crab males migrate up the shore on the flood tide, moving down shore or seeking shelter on the ebb (Warman *et al.* 1993). *C. maenas* were attracted to virtually all baits used even lures and artificial plastic crab, although fish bait (pieces of *C. harengus* and *S. scombrus*) were the most effective in the traps. Traps proved most successful in catching *C. maenas*.

In certain environments neither the hand-lines nor the portable traps were particularly effective, e.g., in the Urr Estuary, where at low tide large areas of sand and mud are exposed with few rock pools and little cover for fish or crabs. For example, three consecutive days of trap fishing on the Urr Estuary comprising a total fishing time of 24 hours and 20 minutes produced a catch of just 24 *C. maenas*, the majority of which were very small specimens with a carapace width of only 20–30 mm (adult *C. maenas* can attain a carapace width of up to 100 mm). This represented a very poor return for the time invested in procurement of materials, manufacture of the trap, transport to and from the fishing location, and baiting and setting the trap. Line fishing in the same location was more successful, resulting in a catch of nine *C. maenas* in a total fishing time of one hour; however, no fish were caught during this experiment.

Experimental gear also had low productivity in a similar environment on South Uist – a shallow sea loch that dried out at low-water, with a flat muddy substrate and areas of marine algae – where 18 hand-line attempts caught 15 *C. maenas* and 15 *L. depurator*, and 19 portable trap attempts caught 18 *C. maenas*.

Although the total number of species taken in the experiments is fewer than those in the shell middens, they are a representative sample of the dominant species in the middens. The difference in numbers of species may reflect the timescales represented by the experiments and the midden assemblages – the former the culmination of months of fishing, the latter the result, in some cases, of repeated exploitation over hundreds or thousands of years.

Lines may have been preferred to traps, not only because of increased effectiveness on rocky shores but also owing to the large quantities of materials required for the manufacture of traps. One branch of *Salix caprea* yields enough bast for several metres of fishing line, but only one rod for a trap that may require 60 or more rods and weavers in total (Table 4). Withes procured from unmanaged woodland for this study were of variable length and diameter and were therefore of poor quality for basket making. High quality Mesolithic basketry traps such as that from Clowanstown were likely made from coppiced stems. Woodland management in the Mesolithic can be inferred from the construction of weirs, or static fish fences set with basket traps, at sites such as Tybrind Vig, Denmark, and Spencer Dock, Dublin (Malm 1995; McQuade and O'Donnell 2009). However, suitable withes can also be obtained from beaver lawns or from re-growth after fire as demonstrated by the construction of the Torridon 're-growth' trap in this study (Trap 2). Notably, all of the experimental basketry traps required regular repairs, involving many days of procurement of materials. Additionally, setting weighted traps into deep waters near to the shell midden sites required the manufacture of strong rope to lower and haul the trap. While Mesolithic groups would have been capable of this, it is an unnecessarily complicated fishing method. Where marine biotopes are suitable for larger scale structures, e.g. static fish traps, such as along shallow estuaries, substantial investment in procurement, manufacture and repair of basketry traps may be worthwhile, but this was not the case at the Scottish west coast shell midden sites. The Mesolithic style funnel-traps, replicates of those used in the tidal creeks and rivers of Scandinavia and Ireland, were not effective along the modern, rocky coasts near Sand, Ulva and Oronsay/Colonsay. In contrast, a combination of simple gorge, composite or thorn hooks and white feather lures together with plant fibre hand-lines captured all the main fish species found in the middens.

Based on procurement, manufacture, experiment and experiential learning, a hypothesis can be proposed that is applicable to the middens at Sand, Ulva, Oronsay and Oban where land and marine biotopes are similar – one where a 'least effort' model (Pickard and Bonsall 2004) for inshore line fishing from rock marks with small groups collecting shellfish in suitable locations nearby. Knowledge of tides, behaviour of target species and seasonality would enable fisher-hunter-gatherers to collect a wide range of shellfish through simple low-water foraging. A combined low-water shellfish collecting/fishing expedition is an efficient use of resources and time. If hand-lines and lures are effective at catching fish, then there is no need to use shellfish as bait; thus, shellfish can be eaten.

The ease with which raw materials could be procured and experimental fishing gear manufactured without the use of any formal tools was unexpected. It was possible to construct hand-lines with gorges, thorn hooks, and thorn and feather lures largely by hand. Throughout the processing, manufacture and use of the fishing gear few tools were used; those that were (with edges suitable for cutting, grinding and boring) were expedient, simple and easily made. Tools were manufactured as and when required and then abandoned, reducing the amount of kit carried. This observation has important implications for identifying tools in the archaeological record, in that most of the tools used in the experiments were unmodified stones that were used for a short period of time, resulting in few macroscopic traces of wear.

This study assessed only two trap-types known to have been used *in the British Isles* – one (funnel/throated) known to have been used during the Mesolithic, the other (pot) used in traditional fisheries of exposed rocky shore environments. Fixed installations (see Cooper et al. 2017 for an extensive review), such as stone or wooden weirs (or 'yairs'), have also been fished successfully in intertidal areas. Remains of stone yairs are not uncommon in our study areas – for example, they occur at Applecross, near Sand, around Ulva and on the shores of Loch na Keal, Mull. Typically, they are crescent shaped, and vary with openings that range from a few metres to more than 300 m across. However, none have been dated accurately and there are no known examples from western Scotland that can be assigned with confidence to the prehistoric period let alone the Mesolithic. Indeed, an unbroken tradition of stone trap construction dating back to the Mesolithic cannot be assumed, against a background of recurring population (hence cultural) replacements since the Mesolithic (Olalde et al. 2018; Brace 2018).

Wattle fish fences and weirs, such as the Tybrind Vig and Spencer Dock examples, have been in use since at least the Late Mesolithic and possibly from the Middle Mesolithic (e.g., at Kalø Vig, Denmark) in northern Europe (Andersen 1995; Fischer 2007; McQuade and O'Donnell 2009). More substantial, fixed fishing installations become more numerous through the Neolithic (e.g., Loader et al. 1997; Fischer 2007). However, these wooden structures were invariably associated with soft substrates and are not so well suited to exposed rocky shores like those around Ulva.

Regardless of whether stone yairs were used by Mesolithic groups in Scotland, further research to test the effectiveness of funnel-traps when used in intertidal fixed structures with leaders in different shore environments is warranted.

CONCLUSIONS

The lack of fishing gear at coastal Mesolithic sites in western Scotland means that fishing strategies have been inferred from the evidence provided by fish bone assemblages recovered from shell midden sites, and regional comparisons most notably with the circum-Baltic region. Such an approach is problematic in several respects: (i) shell midden fish assemblages are palimpsests that likely accumulated during many short-term visits over decades, centuries or, even, millennia; (ii) differential preservation within sites can alter fish assemblage structure; and (iii) regional differences in coastal environments (compounded by cultural differences) means the circum-Baltic region is an inappropriate analogue for western Scotland.

For this study we adopted an actualistic experimental approach to the reconstruction of Mesolithic fishing practices along the Atlantic coast of Scotland. The results of our experiments lead us to four key observations:

1. Handline fishing was far more effective than portable trap fishing in the rocky shore environments near known shell midden locations on Oronsay, Ulva, Oban Bay and Sand.
2. Handline fishing experiments near Ulva Cave captured the same species and size ranges of fish as represented in the Mesolithic shell midden within the cave.
3. Unexpectedly, handline fishing was also very effective for the capture of crabs – whose remains are a common but under-studied component of Mesolithic shell middens in western Scotland (cf. Pickard and Bonsall 2009).
4. Fishing gear (lines, hooks and traps) could be easily and quickly made from locally available plant fibres, thorns, twigs and thin branches, and without the use of formal or specialised tools – materials that are highly perishable and, unlike bone and antler, most unlikely to survive in the Mesolithic archaeological record of western Scotland.

There were a number of variables or factors that could not be controlled in our (admittedly limited set of) experiments. They include: a) changes in the coastal environment at shell midden locations during and since the Mesolithic, b) changes in fish demographics and behaviour over time, and c) the use of funnel traps *in conjunction with* anthropogenic modifications of the shore, i.e. intertidal stone/wood installations. Herein lies considerable scope for further research!

Although, our research to date has been narrowly focused on reconstructing the fishing practices of the Mesolithic populations of central-west Scotland who were dependent on coastal resources, we believe the information gained and the lessons learned are potentially applicable to the study of maritime hunter-gatherers in other parts of the world.

Acknowledgements

Funding for the project was provided by an Arts and Humanities Research Council scholarship (AH/H019146/1) to P. Groom. We are also grateful to The National Trust for Scotland, Torridon Estate, and Jamie and Tessa Howard (Isle of Ulva) for logistical support. Thanks also to S. Hartwell, J. Coates, R. Henshall, L. Crouse, S. Dinning, C. Robertson, F. Fairbairn, A. MacQuarrie, J. Cook, K. Roper, J. Robinson, R. Van Hove, E. Hardwick, N. Thiemann, A. Wood, A. Sikorska-Mazur, A. Nugée, N. Nugée, L. Guillot, K. Yorkston, C. Hall-Eastman, A. Westra, K. O'Donnell, S. Ritchie, U. Brass and S. Brass for their assistance in the experimental research. Finally, we thank the anonymous reviewers for their careful reading of our manuscript and insightful comments and suggestions.

REFERENCES

Andersen, S. H. 1995. Coastal adaptation and marine exploitation in Late Mesolithic Denmark – with special emphasis on the Limfjord region. In *Man and Sea in the Mesolithic* (A. Fischer, ed.):41–66. Oxford: Oxbow.

Baderman, R. and S. Mithen, 2000. The experimental manufacture of an ‘Obanian’ harpoon. In *Hunter-gatherer Landscape Archaeology, the Southern Hebrides Mesolithic Project 1988–98* (S. Mithen, ed.):523–527. Cambridge: McDonald Institute for Archaeological research.

Bernal-Casasola, D. 2010. Fishing tackle in Hispania: reflections, proposals and first results. In *Ancient Nets and Fishing Gear* (T. Bekker-Nielsen, and D. B. Casasola, eds.):83–137. Cádiz: Servicio de Publicaciones de la Universidad de Cádiz.

Birks, H. J. B. 1989. Holocene isochrone maps and patterns of tree-spreading in the British Isles. *Journal of Biogeography* 16:503–540.

Bell, M. and M. J. C. Walker, 1992. *Late Quaternary Environmental Change: Physical and Human Perspectives*. Harlow: Longman.

Bergsvik, K. A. and É. David, 2015. Crafting bone tools in Mesolithic Norway: A regional eastern-related know-how. *European Journal of Archaeology* 18:190–221.

Boaventura, D., P. Ré, L. Cancela da Fonseca, and S. J. Hawkins, 2002. Intertidal rocky shore communities of the continental Portuguese coast: analysis of distribution patterns. *Marine Ecology* 23:69–90.

Bonsall, C. 1996. The Obanian problem, coastal adaptation in the Mesolithic of Western Scotland. In *The Early Prehistory of Scotland* (T. Pollard, and A. Morrison, eds.):183–197. Edinburgh: Edinburgh University Press.

Bonsall, C., M. R. Robinson, R. Payton, and M. G. Macklin, 1993. Lón Mór. *Discovery and Excavation in Scotland* 1993, 76.

Brayshay, B. and K. Edwards, 1996. Late-Glacial and Holocene vegetational history of South Uist and Barra. In *The Outer Hebrides: The Last 14,000 Years* (D. Gilbertson, M. Kent, and J. Gratton, eds.):13–26. Sheffield: Sheffield Academic Press.

Brace, S. et al. 2018. Population replacement in Early Neolithic Britain. bioRxiv preprint first posted online Feb. 18, 2018; doi: http://dx.doi.org/10.1101/267443.

Callahan, E. 1999. More bone fish hooks. In *Primitive Technology a Book of Earth Skills* (D. Wescott, ed.):66. Utah: Gibbs Smith.

Charlton, S., M. Alexander, M. Collins, N. Milner, P. Mellars, T. C. O'Connell, R. E. Stevens, and O. E. Craig, 2016. Finding Britain's last hunter-gatherers: A new biomolecular approach to ‘unidentifiable’ bone fragments utilising bone collagen. *Journal of Archaeological Science* 73:55–61.

Coles, J. M. 1971. The early settlement of Scotland: Excavations at Morton, Fife. *Proceedings of the Prehistoric Society* 37:284–366.

Colley, S. 1990. The Analysis and Interpretation of Archaeological Fish Remains. *Archaeological Method and Theory* 2:207–253.

Cooper, J. P. 2017. A Saxon fish weir and undated fish trap frames near Ashlett Creek, Hampshire, UK: Static structures on a dynamic foreshore. *Journal of Maritime Archaeology* 12:33–69.

Davidson, D. A. and S. P. Carter, 2003. Soils and their evolution. In *Scotland: Environment and Archaeology 8000 BC–AD 1000* (Edwards, K. J. and I. B. M. Ralston, eds):45–62. Chichester: Wiley.

Edholm, S. and T. Wilder, 1999. Cordage. In *Primitive Technology: A Book of Earth Skills* (D. Wescott, ed.):149–150. Utah: Gibbs Smith.

Edwards, K. J. and H. Sugden, 2003. Palynological visibility and the Mesolithic colonisation of the Hebrides, Scotland. In *Mesolithic on the Move* (L. Larsson, H. Kindgren, K. Knutsson, D. Loeffler, and A. Åkerlund, eds.):11–17. Oxford: Oxbow.

Fano, M. Á. 2007. The use of marine resources by the Mesolithic and Early Neolithic societies of Cantabrian Spain: the current evidence. In *Shell Middens in Atlantic Europe* (N. Milner, O. E. Craig, and G. N. Bailey, eds.):136–149. Oxford: Oxbow.

Fenton, A. 2008. Fish traps, spears and poaching. In *Scottish Life and Society* (J. R. Coull, A. Fenton, K. Veitch, eds.):124–132. Edinburgh: John Donald.

Finlay, N. 2006. Manifesting microliths: insights and strategies from experimental replication. In *Skilled Production and Social Reproduction* (J. Apel, and K. Knutsson, eds.):299–314. Uppsala: Societas Archaeologica Upsaliensis and The Department of Archaeology and Ancient History.

Fischer, A. 2007. Coastal fishing in Stone Age Denmark – evidence from below and above the present sea level and from human bones. In *Shell Middens and Coastal Resources along the Atlantic Façade* (N. Milner, G. Bailey, and O. Craig, eds.):54–69. Oxford: Oxbow.

Foxon, A. D. 1991. Bone, antler, tooth and horn technology and utilisation in prehistoric Scotland. PhD dissertation. University of Glasgow.

Gooder, J. 2007. Excavation of a Mesolithic house at East Barns, East Lothian, Scotland: an interim view. In *Mesolithic Studies in the North Sea Basin and Beyond* (C. Waddington, and K. Pedersen, eds.):49–59. Oxford: Oxbow.

Griffitts, J. and C. Bonsall, 2001. Experimental determination of the function of antler and bone 'bevel-ended tools' from prehistoric shell middens in western Scotland. In *Crafting Bone: Skeletal Technologies Through Time and Space* (A. M. Choyke, and L. Bartosiewicz, eds.):207–220. Oxford: BAR International Series 937.

Groom, P. 2014. *An Experimental Study of Mesolithic Coastal Fishing Practices and Shellfish Procurement in Western Scotland*. PhD dissertation, University of Edinburgh.

Hamilton-Dyer, S. 2006. Faunal remains. In *Excavations at Northton, Isle of Harris* (D. D. A. Simpson, E. M. Murphy, and R. A. Gregory):33–35. BAR 408. Oxford: Archaeopress.

Hansson, A., B. Nilsson, A. Sjöström, S. Björck, S. Holmgren, H. Linderson, O. Magnell, M. Rundgren, and D. Hammarlund, 2016. A submerged Mesolithic lagoonal landscape in the Baltic Sea, south-eastern Sweden – Early Holocene environmental reconstruction and shore-level displacement based on a multiproxy approach. *Quaternary International* 463:110–123.

Hardy, K., S. Birch, and R. Shiel, 2009. Tools and colour in Mesolithic Scotland. In *Mesolithic Horizons* (S. McCartan, R. Schulting, G. Warren, and P. Woodman, eds.):766–771. Oxford: Oxbow.

Hardy, K. and J. Estevez, 2014. *Early Prehistory of Skye and Adjacent Areas 2011–2012*. Data Structure Report. Barcelona: Department of Prehistory.

Hogan, J. 2001. *Basketmaking in Ireland*. Dublin: Wordwell.

Kitchener, A. C., C. Bonsall, and L. Bartosiewicz, 2004. Missing mammals from Mesolithic middens: a comparison of the fossil and archaeological records from Scotland. In *Mesolithic Scotland and its Neighbours* (A. Saville, ed.):73–82. Edinburgh: Society of Antiquaries of Scotland.

Kramer, D. L., R. W. Rangeley, and L. J. Chapman, 2002. Habitat selection: patterns of spatial distribution from behavioural decisions. In *Behavioural Ecology of Teleost Fishes* (J.-G. Godin, ed.):37–80. Oxford: Oxford University Press.

Kroeber, A. L. and S. A. Barrett, 1962. *Fishing Among the Indians of Northwestern California.* Anthropological Records 21:1–210. Berkley: University of California.

Leadbeater, E. 1979. *Spinning and Spinning Wheels*. Aylesbury: Shire Publications.

Loader, R., I. Westmore, and D. Tomalin, 1997. *Time and Tide: An Archaeological Survey of the Wootton-Quarr Coast.* Isle of Wight: Isle of Wight Council.

Louwe Kooijmans, L. P. 1987. Neolithic settlement and subsistence in the wetlands of the Rhine/Meuse delta of The Netherlands. In *European Wetlands in Prehistory* (J. M. Coles, and A. J. Lawson, eds.):227–251. Oxford, Oxford University Press.

Lord, J. 1998. The methods used to produce a complete harpoon. In *Stone Age Archaeology, Essays in Honour of John Wymer* (N. Ashton, F. Healy, and P. Pettit, eds.):193–195. Oxford: Oxbow.

MacCurdy, G. G. 1923. Certain specimens from the Rivière Collection. *American Anthropologist* 25:72–89.

Malm, T. 1995. Excavating submerged Stone Age sites in Denmark – the Tybrind Vig example. In *Man and Sea in the Mesolithic* (A. Fischer, ed.):385–396. Oxford: Oxbow.

Marsh, E. J. and J. R. Ferguson, 2010. Introduction. In *Designing Experimental Research in Archaeology* (J. R. Ferguson, ed.):4–7. Colorado: University Press of Colorado.

McQuade, M. and L. O'Donnell, 2009. The excavation of Late Mesolithic fish trap remains from the Liffey estuary, Dublin, Ireland. In *Mesolithic Horizons* (S. McCartan, R. Schulting, G. Warren, and P. Woodman, eds.):889–894. Oxford: Oxbow.

Mears, R. 2001. *Outdoor Survival Handbook*. London: Ebury.

Mears, R. and G. Hillman, 2008. *Wild Food*. London: Hodder and Stoughton.

Mellars, P. 1987. *Excavations on Oronsay: Prehistoric Human Ecology on a Small Island.* Edinburgh: Edinburgh University Press.

Mercer, J. 1978. *The Spinner's Workshop*. Dorset: Prism Press.

Milner, J. E. 1992. *The Tree Book. The Indispensable Guide to Tree Facts, Crafts and Lore*. London: Collins and Brown.

Milner, N. 2007a. Mesolithic middens and marine molluscs: procurement and consumption of shellfish at the site of Sand. In *Mesolithic and Later Sites around the Inner Sound* (K. Hardy, and C. R. Wickham-Jones, eds.). Society of Antiquaries of Scotland. Scottish Archaeological Internet Reports. https://doi.org/10.5284/1017938

Milner, N. 2007b. Consumption of crabs in the Mesolithic: side stepping the evidence? In *Mesolithic and Later Sites around the Inner Sound* (K. Hardy, and C. R. Wickham-Jones, eds.). Society of Antiquaries of Scotland. Scottish Archaeological Internet Reports. https://doi.org/10.5284/1017938

Mithen, S. J. 2000. *Hunter-Gatherer Landscape Archaeology. The Southern Hebrides Mesolithic Project 1988–98*. Cambridge: McDonald Institute for Archaeological Research.

Mithen, S. J. 2004. The Mesolithic experience in Scotland. In *Mesolithic Scotland and its Neighbours* (A. Saville, ed.):243–260. Edinburgh: Society of Antiquaries of Scotland.

Mordant, D. and C. Mordant, 1992. Noyen-sur-Seine: A Mesolithic waterside settlement. In *The Wetland Revolution in Prehistory* (B. Coles, ed.):55–64. Exeter: Short Run Press Ltd.

Morrison, A. 1980. *Early Man in Britain and Ireland*. London: Croom Helm.

Mossop, M. 2009. Lakeside developments in County Meath, Ireland: A Late Mesolithic fishing platform and possible mooring at Clowanstown 1. In *Mesolithic Horizons* (S. McCartan, R. Schulting, G. Warren, and P. Woodman, eds.):895–899. Oxford: Oxbow.

Neal, K. and P. Pizzolla. 2008. *Carcinus maenas.* Common shore crab. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [online]. Plymouth: Marine Biological Association of the United Kingdom.

Odum, E. P. and G. W. Barrett, 2005. *Fundamentals of Ecology*. Belmont: Thomson Brooks/Cole.

Olalde, I. et al. 2018. The Beaker phenomenon and the genomic transformation of Northwest Europe. *Nature* 555:190–196.

Outram, A. K. 2008. Introduction to experimental archaeology. *World Archaeology* 40:1–6.

Pälsi, S. 1920. Ein steinzeitlicher Moorfund bei Korpilahti im Kirchspiel Antrea. Lan Viborg. *Suomen muinaismuistoyhdistyksen aikakauskirja* 28:1–19.

Parks, R. L. and J. H. Barrett. 2007. The zooarchaeology of Sand. In *Mesolithic and Later Sites around the Inner Sound* (K. Hardy, and C. R. Wickham-Jones, eds.). Society of Antiquaries of Scotland. Scottish Archaeological Internet Reports. https://doi.org/10.5284/1017938

Parks, R. L. 2012. *Seal, Seabirds and Saithe: Assessing Intensification of Marine Resource Exploitation through the Mesolithic of Scotland*. PhD dissertation, University of York.

Parker Pearson, M., N. Sharples, and J. Symonds, 2004. *South Uist: Archaeology and History of a Hebridean Island*. Stroud: Tempus.

Pickard, C. and C. Bonsall, 2004. Deep sea fishing in the Mesolithic: fact or fantasy? *Journal of European Archaeology* 7:273–290.

Pickard, C. and C. Bonsall, 2009. Some observations on the Mesolithic crustacean assemblage from Ulva Cave, Inner Hebrides, Scotland. In *Understanding the Past* (J. M. Burdukiewicz, K. Cyrek, P. Dyczek, and K. Szymczak, eds.):305–314. Warsaw: Warszawa University Press.

Pickard, C. and C. Bonsall, 2012. A different kettle of fish: food diversity in the Scottish Mesolithic. In *Food and Drink in Archaeology 3* (D. Collard, J. Morris, and E. Perego, eds.):76–88. Totnes: Prospect Books.

Richards, M. P. and P. A. Mellars, 1998. Stable isotopes and the seasonality of the Oronsay middens. *Antiquity* 72:178–184.

Robertson, A., J. Lochrie, S. Timpany, L. Bailey, A. Mynett, and L.-M. Shillito, 2013. Built to last: Mesolithic and Neolithic settlement at two sites beside the Forth estuary, Scotland. *Proceedings of the Society of Antiquaries of Scotland* 143:73–136.

Saville, A. 2004. The material culture of Mesolithic Scotland. In *Mesolithic Scotland and its Neighbours* (A. Saville, ed.):185–220. Edinburgh: Society of Antiquaries of Scotland.

ScARF 2012. Experimental archaeology. In *Palaeolithic and Mesolithic Panel Report* (A. Saville, and C. R. Wickham-Jones, eds). Scottish Archaeological Research Framework: Society of Antiquaries of Scotland. http://tinyurl.com/d86dgfq

Schaller Åhrberg, E. 2007. Fishing for storage: Mesolithic short term fishing for long term consumption. In *Shell Middens in Atlantic Europe* (N. Milner, O. E. Craig, and G. N. Bailey, eds.):46–53. Oxford: Oxbow.

Shennan, I., K. Lambeck, F. Flather, B. Horton, J. McArthur, J. Innes, J. Lloyd, M. Rutherford, and R. Wingfield. 2000. Modelling western North Sea palaeogeographies and tidal changes during the Holocene. In *Holocene Land–Ocean Interaction and Environmental Change around the North Sea* (I. Shennan, and J. Andrews, eds.):299–239. London: Geological Society.

Skaarup, J. 1995. Hunting the hunters and fishers of the Mesolithic – twenty years of research on the sea floor of Funen, Denmark. In *Man and Sea in the Mesolithic* (A. Fischer, ed.):397–401. Oxford: Oxbow.

Slack-Smith, J. 2001. *Fishing with Traps and Pots.* FAO Training Series. Rome: Food and Agriculture Organization of the United Nations.

Smart, D. 2000. Design and function in fishing gear: shell mounds, bait and fishing practices. In *Mesolithic Lifeways: Current Research from Britain and Ireland* (R. Young, ed.):15–22. Leicester: Archaeology Monographs 7, University of Leicester.

Sturt, F., D. Garrow, and S. Bradley. 2013. New models of North West European Holocene palaeogeography and inundation. *Journal of Archaeological Science* 40:3963–3976.

Thurstan, R. H., S. Brockington and C. M. Roberts. 2010. The effects of 118 years of industrial fishing on UK bottom trawl fisheries. *Nature Communications* 1:15. doi: 10.1038/ncomms

Tolan-Smith, C. 2008. Mesolithic Britain. In *Mesolithic Europe* (P. Spikins and G. N. Bailey, eds.):132–157. Cambridge: Cambridge University Press.

Ugan, A., J. Bright, and A. Rogers, 2003. When is technology worth the trouble? *Journal of Archaeological Science* 30:1315–1329.

Warman, C. G., D. G. Reid, and E. Naylor, 1993. Variation in the tidal migratory behaviour and rhythmic light-responsiveness in the shore crab, *Carcinus maenas*. *Journal of the Marine Biology Association* 73:355–364.

Watts, S. M. 2004. Some primitive fish hooks. *Practicing Primitive. A handbook of Aboriginal Skills.* Salt Lake City: Gibbs Smith.

Watts, S. M. 2010. From flint to fish: A Stone Age challenge. *Bulletin of Primitive Technology* 39:66–70.

Wescott, D. 1999. Gathering and preparing plant fibres. In *Primitive Technology: A Book of Earth skills* (D. Wescott, ed.):140–143. Utah: Gibbs Smith.

Wickham-Jones, C. R. 1994. *Scotland's First Settlers*. Bath: The Bath Press.

Wickham-Jones, C. R. 2004. Structural evidence in the Scottish Mesolithic. In *Mesolithic Scotland and Its Neighbours* (A. Saville, ed.):229–242. Edinburgh: Society of Antiquaries of Scotland.

Wicks, K., A. Pirie, and S. Mithen, 2014. Settlement patterns in the Late Mesolithic of western Scotland: the implications of Bayesian analysis of radiocarbon dates and inter-site technological comparisons. *Journal of Archaeological Science* 41:406–422.

Williams, G. 1991. *Techniques and Fieldwork in Ecology*. London: Harper Collins.

Woodman, P. 1989. A review of the Scottish Mesolithic: a plea for normality! *Proceedings of the Society of Antiquaries of Scotland* 119:1–32.

Figure Legends

Figure 1. Locations of key Mesolithic sites (red dots) and experiment locations (black circles with upper case text).

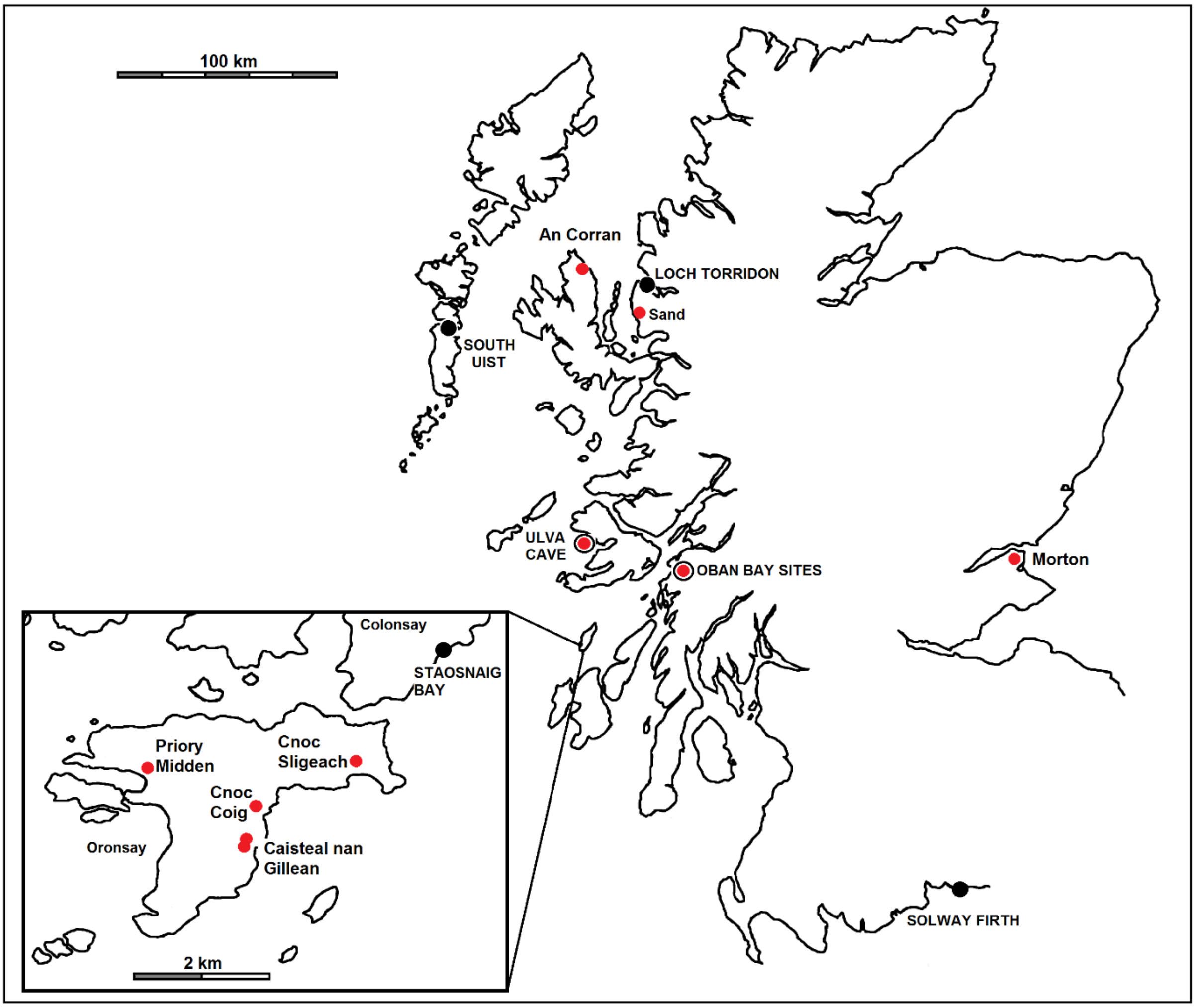

Figure 2. a) line of *U. glabra* bast made by PG, fresh fibre, spun using an S-twist on each strand to produce a combined 2-ply Z-twist (photograph S. Hartwell): b) 140 mm leader of *S. alba*, 1–2 mm diameter 2-ply Z-twist, the cord was so fine it could be threaded through the eye of a modern fishing hook (photographs P. Groom).

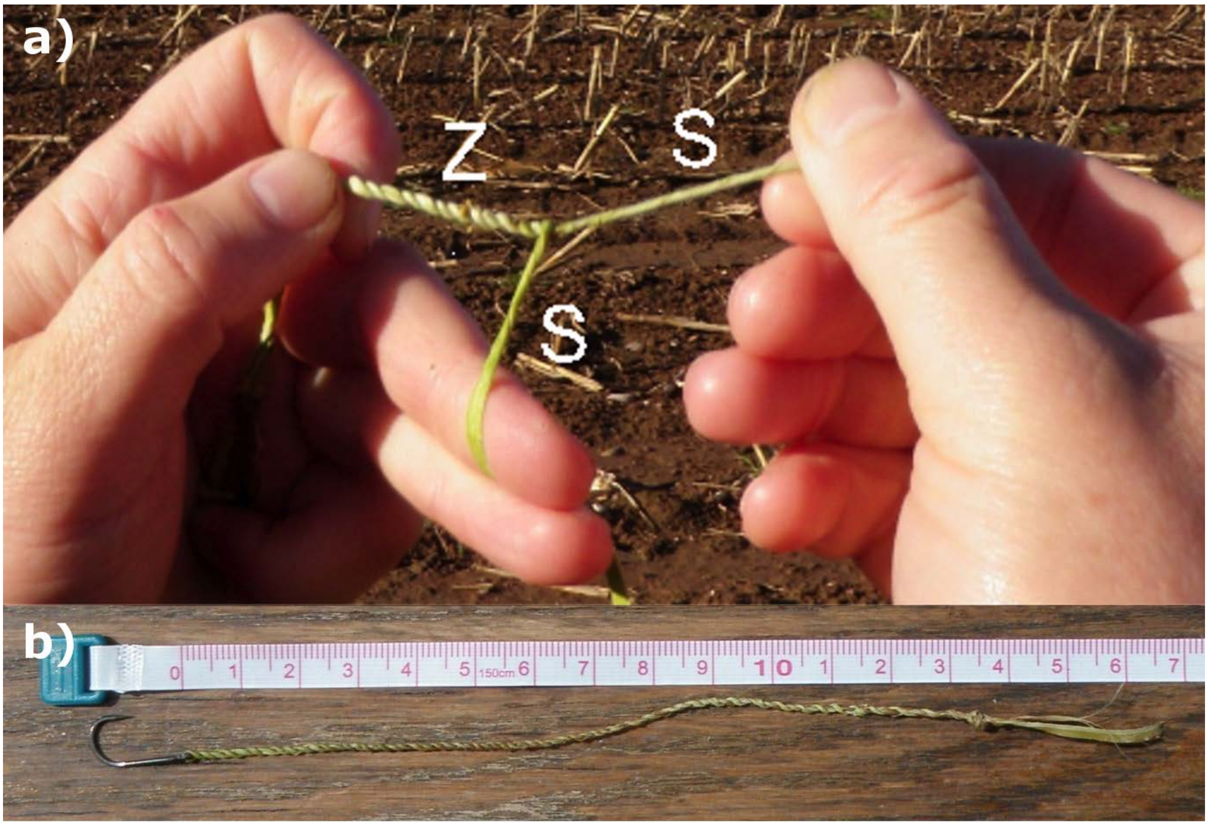

Figure 3. Hooks, gorges and lures used for the fishing experiments: a) *Capreolus capreolus* bone gorges, attached to a *Salix caprea* 2-ply line; b) *Crataegus monogyna* thorn hook with *Salix caprea* 2-ply Z-twist cord, and a lure made from a c. 20 mm section of hollow gull quill; c) 'J'- shaped bone hook and bone fragment; d) *Lutraria lutraria* shell lures with marine clay bead weights; e) *Rosa canina* thorn hooks on *Salix alba* 2-ply cord – the top two examples have white down feather lures while the example at the bottom has a grey down feather; and f) *Crataegus monogyna* hook on *Ulmus glabra*-bast fishing line attached through a double looping method. (Photographs P. Groom).

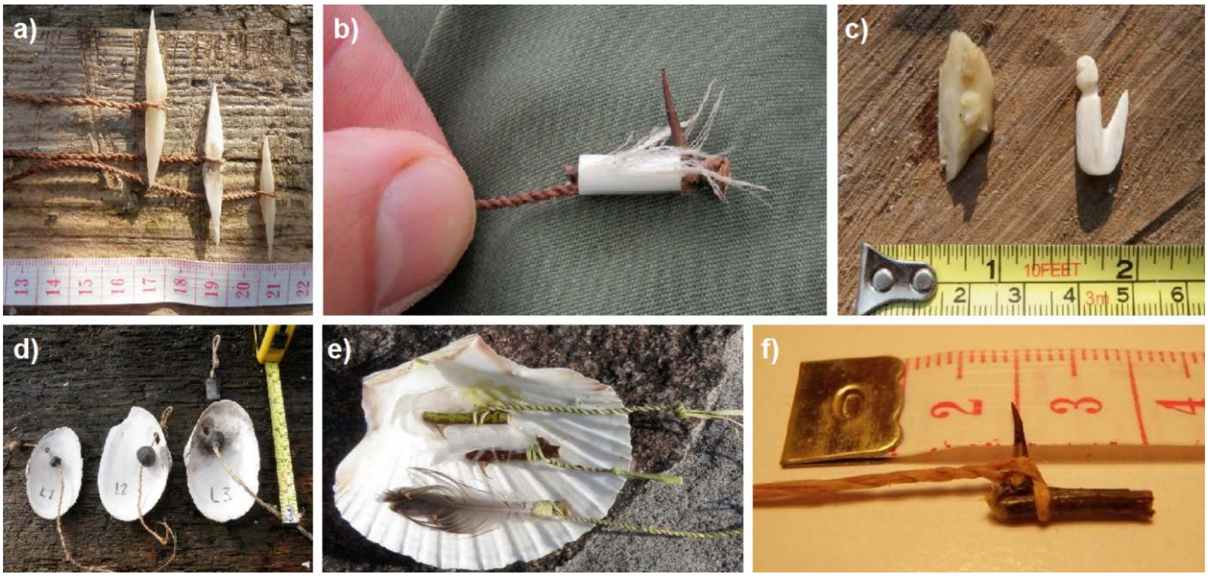

Figure 4. Experimental traps: a) Clowanstown-type trap (T1) – length 1.12 m, mouth Ø 400 mm, internal cone (not shown) has an eye of Ø 90 mm; b) 'Torridon re-growth' trap (T2) – length 1.04 m, mouth Ø 350 mm, internal cone eye Ø 80 mm; c) Connemara-type traps (T3) – the example to the front of the image is incomplete; d) Tube trap (4) during construction. Photographs P. Groom.

Table 1. Fish and crab taxa present at selected west coast Mesolithic shell midden sites. Presence is indicated by ✓, NISP is given where available (from Wilkinson [1981], Hamilton-Dyer [2006], Parks and Barrett [2007], Parks [2012], and Pickard and Bonsall [2012]). A species list for the Cnoc Sligeach midden was collated by Wilkinson (1981)* and the fish assemblage was later re-evaluated by Parks (2012)** – both data sets are given below.

Species	Sites												
	Caisteal nan Gillean I	Caisteal nan Gillean II	Cnoc Coig	Cnoc Sligeach*	Cnoc Sligeach**	Priory Midden	Carding Mill Bay I	Carding Mill Bay II	MacArthur Cave	Northton	Risga	Sand	Ulva
Pollachius virens	✓	✓	✓	✓	3079	✓			✓			509	✓
Pollachius pollachius			✓	✓	120	✓						144	✓
Pollachius pollachius?					1								
P. pollachius/P. virens					789							2323	
Gadus morhua					1					✓		136	✓

G. morhua/P. pollachius/P. virens					21							1786	
Gadidae					95							1911	✓
Labrus bergylta	✓	✓	✓	✓	2	✓						405	✓
Labrus mixtus	✓				1							18	✓
L. bergylta/L. mixtus												1798	
Labridae									✓			5231	
Symphodus melops					1					✓		85	
Ctenolabrus rupestris												2	
S. melops/C. rupestris												78	
Scomber scombrus										✓		199	✓
Scyliorhinus canicula				✓									
Squalus acanthias	✓			✓							✓		
Scyliorhinidae/Squalidae												13	
Anguilla anguilla	✓	✓	✓	✓	2	✓						14	
Conger conger	✓	✓	✓	✓	1						✓	1	
Salmo spp.			✓	✓									
Salmonidae												4	
Gaidropsarus vulgaris										✓			

Gaidropsarus spp.												3	
Clupea harengus										✓		199	
Galeorhinus galeus				✓							✓	1	
Perciformes					1							1	
Platichthys cf. *flesus*	✓			✓									
Pleuronectes platessa												1	
Pleuronectidae					1							6	
Pleuronectiformes												1	
Melanogrammus aeglefinus											✓	8	
Merlangius merlangus										✓		8	
Trisopterus esmarkii					1								
Trisopterus minutus												3	
Trisopterus spp.												8	
Merluccius merluccius			✓										
Molva molva			✓	?									✓
Triglidae					1							2	
Taurulus bubalis			✓			✓							
Scorpaenidae					2							3	
Trachurus trachurus												17	

Pholis gunnellus					1							18	
Belonidae					2								
Ammodytidae					1							5	
Dentex dentex													✓
Pagellus bogaraveo	✓			✓	1							1	
Spondyliosoma cantharus				✓							✓		
Sparidae					1							1	
Dipturus batis	✓										✓		
Raja clavata		✓	✓	✓									
Rajidae	✓	✓	✓	✓		✓						6	
Elasmobranch	✓	✓	✓	✓		✓						2	
Squatina squatina	✓			✓							✓		
Trisopterus luscus													
Lipophrys pholis	✓	✓	✓	✓		✓							
Zoarces viviparus	✓		✓	✓		✓						1	
Chelon ramada	✓										✓		
Liocarcinus depurator												✓	✓
Cancer pagurus												✓	✓
Carcinus maenas												✓	✓

Necora puber													✓

* evaluation of the fish remains from Ulva Cave is ongoing.

Table 2. Breaking strains of the fresh, tree-bast and nettle fibre fishing lines with different manufacture processes (fibres were non-retted or soaked in fresh or salt water). All of the lines were 2-ply cord with a Z-twist. Lines were tested with up to 12 kg strain.

Species	Process	Sample	Spun fibre diameter	Breaking Strain
S. caprea	No pre-treatment	S	3-5 mm	> 12.0 kg
S. caprea	Air dried for 12 hours	D1	3-5 mm	4.1 kg
S. caprea	Air dried for 24 hours	D2	3-5 mm	4.6 kg
S. caprea	Air dried for 36 hours	D3	3-5 mm	2.8 kg
S. caprea	Air dried for 48 hours	D4	3-5 mm	1.8 kg
S. caprea	Soaked in freshwater for 12 hours	S1	3-5 mm	> 12.0 kg
S. caprea	Soaked in freshwater for 24 hours	S2	3-5 mm	> 12.0 kg
S. caprea	Soaked in freshwater for 36 hours	S3	3-5 mm	> 12.0 kg
S. caprea	Soaked in freshwater for 48 hours	S4	3-5 mm	> 12.0 kg
S. caprea	Soaked in seawater for 12 hours	A1	3-5 mm	11.0 kg
S. caprea	Soaked in seawater for 24 hours	A2	3-5 mm	> 12.0 kg
S. caprea	Soaked in seawater for 36 hours	A3	3-5 mm	> 12.0 kg
S. caprea	Soaked in seawater for 48 hours	A4	3-5 mm	> 12.0 kg

U. glabra	No pre-treatment	F	3-5 mm	> 12.0 kg
U. glabra	Air dried for 12 hours	G1	3-5 mm	> 12.0 kg
U. glabra	Air dried for 24 hours	G2	3-5 mm	4.5 kg
U. glabra	Air dried for 36 hours	G3	3-5 mm	5.4 kg
U. glabra	Air dried for 48 hours	G4	3-5 mm	4.0 kg
U. glabra	Soaked in freshwater for 12 hours	F1	3-5 mm	11.0 kg
U. glabra	Soaked in freshwater for 24 hours	F2	3-5 mm	11.0 kg
U. glabra	Soaked in freshwater for 36 hours	F3	3-5 mm	9.0 kg
U. glabra	Soaked in freshwater for 48 hours	F4	3-5 mm	9.5 kg
U. glabra	Soaked in seawater for 12 hours	H1	3-5 mm	> 12.0 kg
U. glabra	Soaked in seawater for 24 hours	H2	3-5 mm	> 12.0 kg
U. glabra	Soaked in seawater for 36 hours	H3	3-5 mm	11.0 kg
U. glabra	Soaked in seawater for 48 hours	H4	3-5 mm	11.0 kg
S. alba	No pre-treatment	Z	3-5 mm	> 12.0 kg
S. alba	Air dried for 12 hours	X1	3-5 mm	> 12.0 kg
S. alba	Air dried for 24 hours	X2	3-5 mm	> 12.0 kg

S. alba	Air dried for 36 hours	X3	3-5 mm	> 12.0 kg
S. alba	Air dried for 48 hours	X4	3-5 mm	> 12.0 kg
S. alba	Air dried for 60 hours	X5	3-5 mm	> 12.0 kg
S. alba	Air dried for 72 hours	X6	3-5 mm	> 12.0 kg
S. alba	Air dried for 84 hours	X7	3-5 mm	10.4 kg
S. alba	Soaked in freshwater for 12 hours	Z1	3-5 mm	11.0 kg
S. alba	Soaked in freshwater for 24 hours	Z2	3-5 mm	> 12.0 kg
S. alba	Soaked in freshwater for 36 hours	Z3	3-5 mm	> 12.0 kg
S. alba	Soaked in freshwater for 48 hours	Z4	3-5 mm	> 12.0 kg
S. alba	Soaked in freshwater for 60 hours	Z5	3-5 mm	> 12.0 kg
S. alba	Soaked in freshwater for 72 hours	Z6	3-5 mm	> 12.0 kg
S. alba	Soaked in freshwater for 84 hours	Z7	3-5 mm	> 12.0 kg
S. alba	Soaked in seawater for 12 hours	Y1	3-5 mm	> 12.0 kg
S. alba	Soaked in seawater for 24 hours	Y2	3-5 mm	> 12.0 kg
S. alba	Soaked in seawater for 36 hours	Y3	3-5 mm	> 12.0 kg
S. alba	Soaked in seawater for 48 hours	Y4	3-5 mm	> 12.0 kg

S. alba	Soaked in seawater for 60 hours	Y5	3-5 mm	> 12.0 kg
S. alba	Soaked in seawater for 72 hours	Y6	3-5 mm	> 12.0 kg
S. alba	Soaked in seawater for 84 hours	Y7	3-5 mm	> 12.0 kg
Q. petrea	No pre-treatment	Q	3-5 mm	10.0 kg
Q. petrea	Air dried for 12 hours	P1	3-5 mm	10.0 kg
Q. petrea	Air dried for 24 hours	P2	3-5 mm	10.0 kg
Q. petrea	Air dried for 36 hours	P3	3-5 mm	10.0 kg
Q. petrea	Air dried for 48 hours	P4	3-5 mm	10.0 kg
Q. petrea	Soaked in freshwater for 60 hours	Q5	3-5 mm	3.5 kg
Q. petrea	Soaked in freshwater for 72 hours	Q6	3-5 mm	9.0 kg
Q. petrea	Air dried for 60 hours	P5	3-5 mm	10.0 kg
Q. petrea	Soaked in freshwater for 12 hours	Q1	3-5 mm	7.2 kg
Q. petrea	Soaked in freshwater for 24 hours	Q2	3-5 mm	5.9 kg
Q. petrea	Soaked in freshwater for 36 hours	Q3	3-5 mm	5.4 kg
Q. petrea	Soaked in freshwater for 48 hours	Q4	3-5 mm	4.5 kg
Q. petrea	Soaked in freshwater for 60 hours	Q5	3-5 mm	3.5 kg

Q. petrea	Soaked in freshwater for 72 hours	Q6	3-5 mm	3.0 kg
Q. petrea	Soaked in seawater for 12 hours	R1	3-5 mm	7.2 kg
Q. petrea	Soaked in seawater for 24 hours	R2	3-5 mm	6.3 kg
Q. petrea	Soaked in seawater for 36 hours	R3	3-5 mm	4.5 kg
Q. petrea	Soaked in seawater for 48 hours	R4	3-5 mm	> 12.0 kg
Q. petrea	Soaked in seawater for 60 hours	R5	3-5 mm	> 12.0 kg
Q. petrea	Soaked in seawater for 72 hours	R6	3-5 mm	> 12.0 kg
Q. petrea	Soaked in seawater for 84 hours	R7	3-5 mm	> 12.0 kg
U. dioica	Air dried	N1	2-3 mm	9.0 kg
U. dioica	Air dried	N2	1-2 mm	5.0 kg

Table 3. Fish and crab species caught using experimental methods. Experimental gears were fished for at least one hour for each attempt.

				Species								
Site	**Fishing method**	**Attempts**	**Bait**	*Pollachius pollachius*	*Gadus morhua*	*Pollachius virens*	*Labrus bergylta*	*Scyliorhinus canicula*	*Trisopterus/Gaidropsarus*	*Lipophrys pholis*	*Scomber scombrus*	*Chelon labrosus*
Solway	Hook & line	7	Mussel									
	Trap	7	Mussel, mackerel									
	Foraged by hand	1										
Torridon	Hook & line	2										
	Trap	1	Limpet									
	Foraged by hand	1										
Oban	Foraged by hand	1										

Ulva	Hook & line	50	Lure, limpet, mussel, mackerel	3	2	6	7	1	3	23	1
	Trap	6	Mackerel, herring								
	Foraged by hand	5								3	
Colonsay	Hook & line	1	Lure			5					
	Foraged by hand	1								2	
S. Uist	Hook & line	18	Limpet, cockle, mackerel								
	Trap	1	Mackerel. cockle								
	Foraged by hand	19								1	

Table 4. Comparison of raw material requirements, and procurement and manufacture times of experimental gear and species caught with gear.

Gear	No. of people	Procurement time (min.)	Manufacture time (min.)	Total time (min.)	Rods & weavers	Catch
Clowanstown type trap, T1	1	N/A	360	360+	R=110 W=115	No catch
Torridon re-growth trap, T2	1	60	270	330	R=87 W=20	*C. maenas*
Connemara trap, T3	1	N/A	300	300+	R=14 W=200-300	*C. maenas, L. depurator, N. puber*
Tube trap, T4	1	50	360	410	R=48 W=70	*C. maenas*
Dome-shaped trap, T5	2	130	300	410	R=7 W=70	*C. maenas*
Tortoise-shell shaped trap, T6	4	170	360	530	R=20 W=108	*C. maenas*
Funnel trap, T7	4	130	330	460	R=38 W=110	*C. maenas*
Funnel trap, T8	4	170	360	530	R=48 W=80	*C. maenas*
2.7 m *S. alba* hand-line	Individual 1	15	140	155		*C. maenas*
2.4 m *S. cinerea* hand-line	Individual 1	15	140	155		*C. maenas. L.pholis*
3.0 m *S. cinerea* hand-line	Individual 1	20	150	170		*L. bergylta, P. virens, L. pholis, C*
S. cinerea leader	Individual 1	N/A	N/A	N/A	N/A	*N. puber*
S. cinerea leader	Individual 1	N/A	N/A	N/A	N/A	*L. bergylta*
3.0 m S. cinerea hand-line, plus 5.0 m U. dioica hand-line	Individual 2	30	260	290		*C. maenas, L. pholis*
2.8 m *S. cinerea* hand-line	Individual 3	10	180	190		*C. maenas*
2.0 m *S. cinerea* hand-line	Individual 4	15	180	195		*C. maenas, L. depurator*
2.0 m *S. cinerea* hand-line	Individual 5	15	180	195		*C. maenas, L. depurator*
2.0 m *S. cinerea* hand-line	Individual 6	15	180	195		*C. maenas, L. depurator*
2.0 m *S. cinerea* hand-line	Individual 7	15	180	195		*C. maenas, L. depurator*
2.2 m *U. dioica hand-line*	1	20	190	210		*C. maenas*

Table S1. Plant species present, and potential products and uses, in the Scottish Mesolithic (compiled from Schauenberg and Paris 1977; Milner 1992; Brayshay and Edwards 1996; Edwards and Sugden 2003; Mears and Hillman 2008).

Scientific name	**Common name**	**Products**	**Uses**
Alnus glutinosa	Alder	Bast fibre	Fish smoking, friction fire, basketry, dye, medicinal
Betula spp.	Birch	Bast fibre and flour, root, bark, sap	Shelters, canoes, containers, basketry, cord, friction fire, glue, tar, food, medicinal
Calluna vulgaris	Heather	Fibres, leaves	Shelters, rope, basketry
Corylus avellana	Hazel	Bast fibre?, nuts	Food, shelters, basketry, hurdles, arrows, coracles, friction fire, medicinal
Crataegus spp.	Hawthorn	Fruit, leaves, thorns	Food, fishhooks, boats, arrows, bows, kindling/firewood
Fraxinus excelsior	Ash	Bast fibre and edible mast	Food, spears, shelters, arrows, coracles, basketry, bows, friction fire, medicinal
Juniperus communis	Juniper	Bast flour, resin, fruit	Bows, friction fire, tinder, food
Malus sp.	Crab apple	Fruit	High quality timber, bows, food
Pinus sylvestris	Scots pine	Bast fibre and flour, resin, root, needles	Cord, boats, basketry, fire making, flavouring, food, medicinal
Populus tremula	Aspen		Light timber, basketry, friction fire, medicinal
*Prunus avium**	Wild cherry	Fruit, bast fibre	Food, cord

Prunus spinosa	Blackthorn	Fruit, leaves, flowers, thorn	Food, fishhooks, leister points, bows, medicinal
Quercus sp.*	Oak	Bast fibre, acorns	Boats, tanning, food smoking, food
Rosa spp.	Wild rose	Thorns, edible parts	Hooks, arrows, friction fire, food
Rubus spp.	Bramble/ raspberry	Bast fibre, fruit, leaves	Cord, fishhooks, friction fire, food
Salix sp.	Willow	Bast fibre	Basketry, shelters, coracles, friction fire, medicinal
Sambucus nigra	Elder	Flowers, fruit, timber	Bows, friction fire, food, medicinal
Sorbus aucuparia	Rowan	Fruit, timber	Bows, food
Ulmus sp.	Wych elm	Bast fibre, edible mast	Bows, boats, basketry, food
*Alisma plantago-aquatica***	Water plantain	Rhizomes	Food
Atriplex sp.	Orache	Leaves	Food
Chenopodium sp.	Goosefoot	Leaves, seeds	Food
Empetrum nigrum	Crowberry	Fruit	Food
Fragaria vesca	Wild strawberry	Fruit, leaves	Food
Galeopsis tetrahit	Hemp-nettle	Leaves	Food
Galium aparine	Cleavers	Leaves	Food
Hedera helix	Ivy	Leaves, fibres	Binding, friction fire, bows
Hyacinthoides non-scripta	Bluebell	Sap	Glue

Lonicera periclymenum	Honeysuckle		Cord, basketry
Menyanthes trifoliata	Bog bean	Rhizomes	Food
Nuphar lutea	Yellow water lily	Seeds	Food
Nymphaea alba	White water lily	Rhizomes, seeds, buds	Food
Phragmites australis	Common reed	Rhizomes, stems	Food, thatch, rafts
Plantago lanceolata	Ribwort plantain	Leaves, seeds	Food
Poaceae	Grasses	Seeds, stems	Food, cord, basketry
Polygonum bistorta	Bistort	Leaves, roots	Food
Polygonum sp.	Knotgrass	Seeds	Food
Potentilla anserine	Silverweed	Roots	Food
Ranunculus ficaria	Lesser celandine	Roots	Food, medicinal
Rumex crispus	Dock	Leaves	Food, medicinal
Sparganium erectum	Branched bur-reed	Roots, stems	Food, medicinal
Stachys spp.	Woundwort	Roots	Wound dressing
Stellaria media	Chickweed	Leaves	Soap, medicinal
Taraxacum officinale	Dandelion	Roots, leaves, flowers, salt	Food
Typha latifolia	Reedmace	Roots, stems, leaves	Food, fire making, cord, baskets
Urtica dioica	Common nettle	Leaves, fibre	Food, cord, dye

Vaccinium sp.	Bilberry	Fruit	Food, dye
Vicia sp.**	Vetch	Seeds	Food

*- status uncertain in the Outer Hebrides. **- absent from the Outer Hebrides.

Table S2. Materials suitable for basketry (after Bichard 2008).

Material type	**Scientific Name**	**Common Name**
Split thin flat strips of wood	*Quercus* spp.	Oak
	Corylus avellana	Hazel
	Pinus sylvestris	Scot's pine
	Populus tremula	Aspen
	Fraxinus excelsior	Ash
Roots	*Pinus sylvestris*	Scot’s pine
Branches and roots	*J. communis*	Juniper
Stems	*Salix* spp.	Willow
	Ulmus spp.	Elm
	Betula spp.	Birch
	Prunus padus	Bird cherry
	Cornus sanguinea	Dogwood
	Frangula alnus	Alder buckthorn
	Myrica gale	Bog myrtle
	Clematis spp.	Clematis
	Lonicera spp.	Honeysuckle
	Rubus fruticosus	Bramble/Raspberry
	Ammopila arenaaria	Marram
	Agrostis spp.	Bents
	Molinia caerulea	Purple moor grass
	Juncus spp.	Rushes
	Phragmites australis	Common reed
	Typha latifolia	Reed mace

	Typha augustifolia	Lesser reed mace
	Scirpus lacustris	Common chub-rush
	Rumex acetosa	Docks
	Calluna vulgaris	Heather