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Technical Report: The fish remains from the Holm of Papa Westray North, a Neolithic chambered tomb

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Summary

This report presents an analysis of the fish remains from the Holm of Papa Westray North, a Neolithic chambered tomb in Orkney. Fish remains were found in and around the tomb and were recovered by hand collection, coarse sieving and wet sieving. Two discrete types of deposits were found, one derived from deliberate, anthropogenic fishing and other from otter spraint; both were found throughout the tomb with little evidence of spatial or temporal patterning. People were fishing for cod family fish, including large cod and ling, as well as inshore, coastal species like wrasse, and comparisons with other contemporary assemblages suggests this was typical of the period. The presence of large ling suggests deep water fishing from boats at some distance from the shore. Small quantities of pierced vertebrae from ling and cod family fish were found throughout the tomb, and may have been worn as beads; parallels from other Neolithic Orcadian sites are discussed, as are their potential symbolic meanings. A single cod vertebra was butchered with a stone tool and likely represents the earliest evidence for fish butchery and processing in the Neolithic. The fish remains may have been introduced to the tomb as grave goods, as feasting while interring or visiting the dead, or they may represent food consumed while building the tomb. The presence of otter spraint throughout this and other tombs suggests that otters were contemporary with the use of these tombs, and were likely accepted, or at least not discouraged, by humans.

KEYWORDS: FISH BONES, ORKNEY, NEOLITHIC, OTTER, FISH BONE BEADS, ZOOARCHAEOLOGY

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Fish Report: Holm of Papa Westray North

Introduction

This report details the analysis of 4738 identified fish bones from hand collected, coarse sieved and sieved features excavated at the Holm of Papa Westray North, a Neolithic chambered cairn located in Orkney. Although disturbed by antiquarian digging, the recent excavations by Anna Ritchie revealed extensive undisturbed deposits in and around the tomb; even the disturbed areas appeared to contain remains of appropriate Neolithic date.

The fish remains fall into three categories, as described below. Firstly, there are those remains that are most likely the result of deliberate, anthropogenic fishing for marine species, including some that could only have been caught using deep water fishing methods. Secondly, there are very numerous remains of very small fish, many of which were crushed and, given the species ranges found, it is most likely these represent otter spraint. Finally, a number of 'pierced' vertebrae were discovered, and parallels are discussed from other sites in Neolithic Orkney.

Methods

Analysis was conducted using the extensive reference collection available in the *fishlab*, Centre for Human Palaeoecology, University of York. Specimens recovered by hand collection and coarse sieving were fully recorded using the York system recording methods, as detailed in Harland *et al.* (2003). Briefly, this entails the detailed recording of 18 commonly occurring and easily identified elements, termed quantification code (QC) 1. For each of these, the element, species, approximate size, side, fragmentation, texture, weight, applicable measurements and any modifications are recorded in detail. Fish vertebrae (QC2) are recorded in more limited fashion, with counts, element and species recorded. Some elements are unusual and particularly diagnostic, like otoliths, and are fully recorded (QC4). The final category of material (QC0), includes elements not routinely identified as well as unidentifiable material. Elements that are from very unusual species, or that are butchered or otherwise modified, are recorded in detail even if not from the QC1 category.

Due to time constraints full recording of the very extensive 1.5mm wet sieved material was not possible. Upon initial examination it was noted that this material contained numerous very small specimens, including many from species that are notoriously difficult to identify beyond family level. Prior to analysis, the wet sieved material was randomly subsampled using a sample splitter, and one quarter of each sample was then sieved to 2mm and analysed. For very small samples of fewer than 50 bones the whole bag was recorded. The remaining three quarters of these samples was quickly scanned to ensure that no unusual remains were neglected. A similar method was successfully applied to a discrete, dense deposit of very tiny fish bones at Bu Broch (Colley 1987), where it was possible to successfully ascertain the nature of the deposit without spending undue amounts of time identifying myriad tiny remains. A bulk sample from compartment 4 NE, context 3, was dry sieved by the authors to 2mm, sorted and analysed as per the wet sieved material. Sieving to 2mm is standard practice when identifying fish remains (Harland *et al.*2003), and throughout the sieving process, the small 1.5-2mm fraction was routinely scanned. This predominantly contained small, unidentifiable fragments.

To maximise the information collected from this sieved material from the Holm, a summarized version of the York system was applied. The routinely identified cranial and appendicular elements (QC1) were identified as usual. The vertebrae (QC2 elements) were recorded to family level but were not split into anterior or posterior vertebral groups. Two additional taxonomic categories were applied to this material: 'tiny perciformes' and ‘rocklings’. The former includes a variety of species that are very difficult to distinguish when small, including blennies, gobies, eelpouts, dragonet and butterfish, while the latter includes a number of morphologically very similar species. In both cases, our reference collection did not include all possible fish species that could have been found in the Orcadian Neolithic, making it necessary to generalise. That said, in the few cases where secure identification could be made, particularly for QC1 elements, species level recording was applied.

The complete archive has been submitted to the excavator as both an Access file and as simple text files containing the same data. These are also kept on file in the *fishlab* at the University of York.

Recovery

A total of 12,505 bones were recovered from all areas of the site, 4738 of which were identified to either species or family. Three methods of recovery were used, as summarised in Table 1, showing the quantities of bone analysed by area, recovery method and quantification code. Coarse and detailed 2mm sieving focused on samples taken from Trench I and the entrance passage (EP), while hand collection was undertaken throughout the site. The 2mm sieving produced the largest quantity of material, particularly from compartment 4 and cell 5 within the tomb. Hand collected recovery of fish bone has a known bias towards large, distinctive elements from larger fish, while material from sieved bulk samples is generally considered to provide a more representative sample of fish bones (Wheeler and Jones 1989; Colley 1990, 208-209). However, smaller bones were present in the hand collected material suggesting that collection during excavation was very thorough. Samples taken and coarsely sieved to 4mm (referred to throughout as ‘coarse sieved’) present similar problems as the hand collected material, with much of the smaller bones and smaller fish likely not recovered from this fraction. Samples for wet sieving were taken from inside the tomb and were sieved to 1mm during processing, and later sieved to 2mm for analysis. It became apparent during analysis that the sampled material contained very few of the larger elements and species. As the entirety of the tomb’s interior had been sampled, it is likely that hand collected bone was first removed during excavation, and then the remaining sediment was either coarse or fine sieved.

Preservation

Preservation was assessed on two criteria: surface texture and percent element completeness of QC1 elements, as defined in Harland *et al.* (2003). Table 2 and Table 3 detail preservation by context and recovery method. Across all contexts and recovery methods surface texture was typically good to fair with few elements of poor texture recorded. Element completeness was variable but most were greater than 20% complete. No particular patterns were noted, aside from those caused by differing recovery methods.

Modifications

Very little burning was found. Three specimens were noted: context 4 of the entrance passage, context 3 of compartment 3, and from context 2 of compartment 4. Specimens with evidence of carnivore gnawing were restricted to cell 5, contexts 2 and 3 and trench V, context 2 (Table 4 and Table 5). A typical example of carnivore gnawing is illustrated in Figure 4, showing a wrasse articular with a typical ‘puncture’. Bones with signs of acid etching, typically an indication of digestion, were recovered from cell 4, cell 5 and trench V.

Crushing was the predominant form of modification, with 153 crushed specimens from the hand collected and coarse material (Table 4) and 1377 from the >2mm material (Table 5). A high proportion of the crushed bones were vertebrae, and this pattern is indicative of otter spraint and is returned to in more detail below.

Results

Taxonomic abundance and element representation
With the exception of material recorded as >2mm, as outlined above, specimens were identified to species wherever possible, or family level when morphology or preservation did not allow a more detailed identification.

To summarise the overall assemblage, species from the wrasse family and cod family were most abundant in the hand collected and coarse sieved material (Table 6 and Table 7). Cod family fish (Gadidae) included cod, ling, saithe, haddock, pollack and specimens identified to either saithe or pollack (see Table 16 for Latin nomenclature). Within the wrasse family (Labridae), both ballan and cuckoo wrasse were recorded. While the vertebrae are very difficult to identify to species, most are likely to have been ballan wrasse, on the basis of QC1 identifications. A small number of corkwing wrasse was also recorded. From the hand collected and coarse sieved material some specimens of eel, megrim, horse mackerel, herring, conger eel, sea scorpion family fish, butterfish and species belonging to the ray family and dogfish family were also recorded.

In stark contrast to the hand collected and coarse sieved material, rocklings account for most of the gadids in the >2mm sieved fraction (Table 8). Ling and haddock disappear and cod, saithe and pollack are only present in small numbers. Wrasse become less common, eels increase in significance and there is a dramatic increase in the number of ‘tiny perciformes’ and sea-scorpion family fish. Although it is possible these small fish were stomach contents of the larger ones, this is unlikely given the overwhelming quantities of the small fish compared to the larger.

Table 6, Table 7 and Table 8 give a summary of the numbers of QC1 and QC2 elements by method of recovery. Detailed element representation is given for the wrasse and cod family fish in Table 9, Table 10 and Table 11, and a full breakdown of elements from all species is provided in the site archive. There is no obvious skeletal element patterning in any area of the site, suggesting that all parts of the fish were found and none was removed from the site. There is no evidence that might be indicative of a particular processing method, but a single cut mark on a cod caudal vertebra may represent an attempt to divide the tail into sections (discussed in more detail below). The higher number of vertebrae (QC2 elements) from all species is to be expected given the high frequency of these elements in the skeleton. For example, saithe typically have 53-56 vertebrae, ling 63-65, ballan wrasse 35-40 and conger eel 148-153 vertebrae (Hureau 1996). Turning to the two most common families from the site, wrasse appendicular and cranial elements (QC1) do appear to be more abundant than those from the cod family, but it is likely that the number of wrasse elements has been inflated as they are more robust and distinct than the cod family and thus survive very well in the archaeological record.

The element representation of the >2mm material does differ from that of the hand collected and coarse sieved material. Even when the high frequency of vertebrae in the skeleton is taken into account there seem to be fewer QC1 elements. This could be the result of taphonomic patterning, and could likely result from much of this small material being otter spraint, rather than the remains of anthropogenic fishing. Otter spraints typically include high numbers of vertebrae and jaw bones, while other elements tend to be much less easily identifiable (Nicholson 2000).

Detailed intra-site comparison is difficult given the different recovery methods and disturbed fillings found in much of the tomb. This was compounded by the fact larger bones were probably removed during hand collection from sediments that were later sampled – leading to a discrepancy between recovery methods that is difficult to reconcile. However, it is possible to discuss the variation found within the entrance passage, as well as within compartment 4. In the upper layer of the entrance passage (context 2) the fish bone is in a fill rich in limpet shells while the lower fill (contexts 3 and 4) has a near lack of shells. While more fish bone was noted in the upper layer, there is no discernable difference between fish species present between the lower and upper fill of the entrance passage. Given that these layers represent the infilling of the entrance passage, it is conceivable that both represent re-deposition of midden material from the same source.

Compartment 4 is of special interest due to context 4NE3, which was described during excavation as a large deposit of fish within a stone setting. The material, which also included small stones, was recovered in bulk and weighed a total of 9kg. In addition, it was noted during analysis that many small mammals and amphibians were also present. The majority of identified specimens are from the >2mm fraction and species present include those from the flatfish order, the tiny perciformes group, sea scorpion family and rocklings. However, fish bones from 4NE3 show no real difference from the other sieved deposits from the NE corner of compartment 4. Fish bone evidence, therefore, suggests that the fish in 4NE3 is consistent with otter spraint, as discussed below. Repeated use over time may have led to stony material becoming incorporated into the build up of spraint material.

Otter spraint

Otter spraints are the excreted remains of food, mixed with glandular secretions, and they are deliberately placed in prominent locations for reasons of territoriality and communication, including near or at the entrances to 'holts' – the tunnel-like systems that are created or reused by otters for shelter and for raising their young (Kruuk *et al.* 1998, 124). Otters will also spraint within their holts, particularly where young are being fed (Nicholson 2000, 56), and over time these can develop into large accumulations of food remains (Kruuk 2006, 78-82). Otters will often re-use man made structures for their holts – like tombs – and they will readily live near to human activities (Kruuk *et al.* 1998, 124).

The diet of otters varies with location and no detailed study of spraints from Orkney is available. Studies from similar island coastal environments, however, do give some insight into the types of fish targeted by otters. Analysis by Kingston *et al.* (1999) of modern spraints from the Aran Islands off the west coast of Ireland revealed rocklings and wrasse were the main species groups eaten, with each representing about one third of the diet (by weight). Other species groups each represented less than 10%, including eel, cottids and blennies, while sticklebacks, butterfish and conger eel were also noted (Kingston *et al.* 1999). The faster-moving fish like saithe, pollack and whiting were less frequently caught by otters, even if they inhabited the same coastal environments as their preferred prey; however, in Shetland, otters were observed eating saithe and pollack in winter, when they could be found among dense seaweed and therefore were easier for otters to catch (Kingston *et al.* 1999, 178). Other modern studies of otters have included eelpout, salmonids and small perciformes (blennies, gobies, butterfish etc.) in the diet, and at one study in mainland Scotland, eelpout was the most commonly eaten species (Kruuk *et al.* 1998, 121; McMahon and McCafferty 2006, 32). Flatfishes were occasionally observed as prey, but it appeared otters inhabit the rocky shorelines that flatfishes naturally avoid (Kingston *et al.* 1999, 179). Although it was difficult to positively identify the rocklings and wrasses to species in the modern samples, the five-bearded rockling, ballan and corkwing wrasses were likely the most commonly eaten species in both the Irish and Shetlandic studies (Kruuk *et al.* 1998, 121; Kingston *et al.* 1999, 180).

The marine fish eaten by otters all tend to be very small, at less than 50g per specimen, often represented by fish of less than 30cm total length, and these fish are found in inshore, shallow coastal waters usually within 100m of the shore at depths of no greater than 10m (Kruuk *et al.*

1998, 122; Nicholson 2000, 56). However, otters will sometimes scavenge larger species, including those caught by humans (O'Sullivan *et al*. 1992).

Some of the contexts from the Holm were identified as otter spraint during excavation (including EP2, EP5 and Trench I, 4SE6), and otter remains were themselves found in most contexts, making it likely that otter spraint would be found. The two entrance passage contexts were only recovered by hand collection or coarse sieving, which would have discarded most of the small bones associated with otter spraint – as confirmed by the overall large size of these fish (see Table 12). However, the deposit in 4SE6 *was* sieved to 2mm, and can therefore be examined for evidence of sprainting activity. The fish sizes in this context were all small, at less than 30cm total length – but so were most of the fish from the >2mm sieved contexts in Trench I. This therefore opens the suggestion that other sieved material was in fact otter spraint, but not identified as such during excavation. The most common species observed in 4SE6 were, in order, cod family, rocklings, tiny perciformes, saithe, eel and sea scorpion family. However, these were among the most common species recovered from all of the >2mm sieved material, including the one sample from EP4, the only sample taken from outside of Trench I. In fact, there is very little variation between the order of commonly occurring species throughout all the >2mm sieved samples – even those with very small sample sizes. All species commonly found are those that are favoured by otters and almost all are within the small size ranges that otters prefer.

This hypothesis can be further examined by considering the taphonomic evidence for otter spraint. Much of the >2mm material contained bones that had been crushed when fresh, with vertebrae in particular showing a high degree of crushing (Table 5). In Nicholson's (2000) study of modern and archaeological otter spraint, in addition to species presence and fish size, spraint was identified using three criteria. The first was element representation, with most of the elements tending to be vertebrae and jaw bones, which are naturally more robust. The second was distinctive gnaw marks: "chewed or crushed bones were more often vertebrae than head bones, and the vertebrae tended to be crushed in the medio-lateral plane" (Nicholson 2000, 59-60). The large numbers of crushed vertebrae, summarised in Table 5, were almost entirely crushed in a manner consistent with otter spraint. These crushed vertebrae and other elements also showed a lack of acid etching, which is again a distinctive trait of otter spraint (Nicholson 2000, 61). Finally, concretions of fish bones were sometimes noted in modern spraints, but were not common (Nicholson 2000, 61). Few concretions were noted from the Holm material but it was present on material from 4NE3. It therefore does seems likely that all of the sieved material was in fact otter spraint. The disturbed nature of the fills caused by otters and sheep in the Neolithic fills, and more recently following the antiquarian explorations, means that the fish remains likely represent both deliberately caught fish as well as otter spraint, combined together.

Fish sizes

Fish sizes were estimated for the suite of routinely identified cranial elements (QC1 and QC4), based on comparisons with modern reference material of known size. Some measurements were recorded, but were insufficient in quantity to use for comparative purposes and are included in the site archive. Sizes are summarised in Table 12, grouping together the individual contexts within each cell or compartment, while details for the most commonly occurring species from Trench I are provided in Table 13, allowing greater exploration of the context-level variations within each cell and compartment.

A wide variety of fish sizes were recorded, from fish of less than 15cm total length, to those of over a metre – indicating varied fisheries exploiting a wide range of habitats, a conclusion supported by the wide species diversity observed throughout the site (see above). The hand collected material is biased towards the larger fish species and individuals, while the sieved material is predominantly very small fish, as is to be expected given the recovery methods.

However, the presence of smaller individuals in the hand collected material is further proof that this was undertaken with a high degree of thoroughness.

Considerable size variation was noted in the gadids, the cod family fish. Those that could only be identified to broad family level (because of high fragmentation or poor preservation) were generally less than 30cm total length in the sieved material, as expected given the small nature of the remains in this fraction. These were likely small, inshore cod family fish like rocklings or saithe. A wider range of sizes was observed for the other fractions, from 15cm to over 100cm in length. Fish identified as cod were found throughout much of the site, and again they ranged in size from 15cm to over 100cm total length. Some spatial differences can be seen in the hand collected assemblage. Some of the cod family fish from trench I, cell 5 tend to be slightly bigger than those from the other cells in the tomb interior. The cod tended to be between 50 and 100cm in cell 5, with one individual of over 100cm in length. In the other compartments, the cod tended to be slightly smaller, with no emphasis on any particular size range; this cannot be explained by taphonomic patterning as preservation and texture was broadly similar between all cells and compartments within the tomb. The ling found in cell 5 also tended to be larger, from at least 80cm total length to well over 1m, while in the other cells and compartments, a greater size range was found. Within cell 5, this pattern is particularly notable in context 1, and, to a lesser degree, context 3.

A range of saithe sizes were noted in the hand collected material, while they tended to be less than 30cm total length in the sieved material, and 15 to 50cm total length in the coarse sieved material – again a reflection of sieving methods. There was no particular focus on the smaller sized, young saithe that are very commonly found in the coastal waters around Orkney today (e.g. Fenton 1978, 527-540; Nicholson 2005). The few haddock, pollack and saithe/pollack identifications again represented a variety of sizes, from less than 15cm in the sieved material to over a metre in the hand collected. The rocklings, small, mostly inshore fish which tend not to get very large, were generally less than 30cm total length.

The wrasse family fishes were predominantly in the 30 to 50cm length category, with a few smaller ones found in the sieved material and a few larger, predominantly ballan wrasse, found in the hand collected fraction. An abundance of 15-30cm ballan wrasse in the hand collected material from cell 5 may suggest a deliberate fishery for this size of fish. When examined at the context level, this was particularly apparent in context 2; corresponding sieved and coarse material showed no such focus on this fish, however.

The flatfishes were again represented by a variety of sizes, from less than 15cm to 50-80cm total length. Almost all of the conger eels recorded were substantial, at over a metre in length. The few identified common eels that could be sized were typically much smaller, at 15-50cm in length. Herring and salmon and trout family were both small, at 15-30cm total length. The one tentative angler identification was very large, at over 100cm total length, while species and families like the small perciformes, the sea scorpions, bull-rout, perches, eelpout, scaldfish and butterfish all tended to be very small at 30cm or less in length.

Aside from a *slight* tendency for Trench I, Cell 5 to contain larger cod and ling (contexts 1 and 3), and to contain an abundance of 15-30cm ballan wrasse (context 2), there were few general trends through space or time. The recovery methods were the greatest divider of sizes, with the sieved material containing much smaller fish than the hand collected material. The lack of any larger fish in the sieved material suggests that they had previously been removed during hand collection, as this was particularly apparent in cases where both hand collected and sieved material were available from the same area.

The fish species and sizes represent a variety of habitats, from coastal inshore waters that would have been relatively easy to exploit, to deeper, offshore habitats that would have required considerable effort to fish. Most of the ling found at the Holm are sizable, and thus represent mature adults – who prefer to live at depths of 100 to 400m (Froese and Pauly 2007). Even without taking into account the slightly lower sea levels in the Neolithic, the inhabitants would have had to travel considerable distances to reach waters of this depth, as discussed below.

Butchered and pierced vertebrae

A total of eleven pierced vertebrae were discovered during analysis of the fish bone assemblage (summarised in Table 14 and illustrated in Figure 1, Figure 2 and Figure 3), and one further vertebra showed evidence of butchery, most probably using a stone tool. All of these modified vertebrae were from the cod family fish, and all were from large or very large fish. Other pierced vertebrae are known from Neolithic Orcadian contexts, as will be discussed below, but this is believed to be the first evidence of butchery.

The one butchered cod vertebrae was from Trench V, Sample 1 (illustrated in Figure 5). This was from a fish of about 80-100cm total length, and was from the caudal or tail region. A single cut was made in the transverse plane, and as it had a broad 'v' shaped profile that was wider than is usually made with metal tools, this was most likely to have been made with a stone tool (Mark Edmonds, pers. comm.). This butchery mark was shallow, but immediately adjacent to it, the vertebral body may have been chopped; the poor condition of the bone makes this difficult to distinguish. The profile of the butchery mark is consistent with that of the decorated stone knife from Skara Brae (Saville 1994). If the vertebra had indeed been chopped, the single cut could represent an abortive attempt at dividing the vertebral column, with a later, successful cut or chop made immediately adjacent. This action would have divided the tail into sections, perhaps for ease of cooking or for preserving. No other butchery marks were noted in the assemblage.

Of the eleven pierced vertebrae, nine show definite evidence of having been selected and pierced with a small, round object, while the remaining two have only been tentatively attributed to anthropogenic action, given poor condition or recent fragmentation. Nine of the vertebrae, including the two tentative identifications, were made from very large ling of over a metre in length, some of which may have been from fish as large as 1.5m in length. One smaller cod of about 80cm total length contributed another vertebra, and one final vertebrae was in poor condition and thus difficult to identify, but was most likely cod or saithe. Again, this was from a fish of 80-100cm in length. Almost all vertebrae were from the anterior part of the vertebral column. The large size of these fish, plus the apparent choice of anterior positioning, would indicate deliberate selection. All of these vertebrae were missing their neural and haemal spines, perhaps because they had been deliberately removed – although these are naturally fragile and are frequently broken off through natural taphonomic attrition, even on the larger fish vertebrae.

The pierced vertebrae were found throughout the assemblage, both inside and outside of the tomb. Seven were found in trench I, in cells 1, 2, 4 and 5. Four were found in trench V, context 1, although as two of these were tentative identifications, this concentration is perhaps not as great as it seems. There was no particular species, size or element patterning associated with an area, but the four found in Trench V were in poorer condition (despite the overall similar taphonomic patterning in all areas; see above). Both whole and partial vertebrae were found in both areas. One ling vertebrae from trench V had a broken dorsal surface that may have been caused by the piercing device slipping upwards (Figure 1). This same vertebrae has a series of small, overlapping holes that could have been made by a device that was approximately circular and about 1.5mm in diameter – as could have been fashioned by a sturdy mammal bone point like those found in quantity at Skara Brae (Childe 1931b).

While anthropogenic action is the most likely source of these pierced vertebrae, a few other alternatives must be discussed. Firstly, root etching was apparent on some of the larger fish bones analysed, particularly those from hand collection or coarse sieving (Table 4) – the recovery method for all found here. Roots were sometimes apparent in the pierced holes, making it possible that they had, over millennia, enlarged the naturally-occurring small openings in the centre of these vertebrae. However, had this been the case, not only would this have been expected on other of the very large vertebrae, but other naturally occurring holes should have also been enlarged. None were observed.

Carnivore gnawing is another alternative explanation. Much of the assemblage had indeed been gnawed or crushed during the process of chewing. Carnivore teeth puncture and crush bones in a distinctive manner, creating triangular-shaped holes or linear depressions, as shown in Figure 4. The 'holes' in these vertebrae were rather more rounded, making it likely that they were deliberately cut or bored. It is also worth noting that had the vertebrae been chewed, holes and crushing marks would have been present on all surfaces, not just the centres. Inevitably, some ambiguity remains; a few 'pierced' trout vertebrae recovered at Skara Brae were recently interpreted as evidence of chewing and digestion (Jones 1993), which is possible given their relatively small size. However, the very large size of the ling and cod from the Holm make it very unlikely that they had passed through the digestive system of any omnivore or carnivore in the Orcadian Neolithic. Together with the presence of pierced fish vertebrae at other Neolithic sites, and their absence from sites of other dates in the Northern Isles (e.g. Harland 2006), these are most likely to have been deliberate, anthropogenic, creations.

None of the pierced vertebrae show any sign of wear or polish, either on the outside or in the immediate area of the piercing. However, if they had been worn on a fibre or sinew thread, the small opening in the vertebrae may have ensured a snug fit, without any movement and thus without any polish or wear.

Discussion

Fishing in the Neolithic

Several sites of Neolithic date have been excavated in Orkney, but few have large fish bone assemblages like that from the Holm of Papa Westray North. That said, the results presented here are very similar to those from other Neolithic sites, as there is surprisingly little variation throughout the Orcadian Neolithic. This is partly a reflection of the small number of sites available for comparison, once recovery biases, taphonomic patterning – including otter spraint – and quantification methods are all considered. The hand collected and coarse sieved remains from the Holm of Papa Westray North are very similar to those found at most other sites (see Table 15 for a summary of comparative sites), both in terms of species composition and fish sizes.

Skara Brae stands out among the comparative material, as the recent excavations produced a fish assemblage that was over 50% salmon and trout family (Jones 1993, 14). Although bones from this family are difficult to distinguish, analysis of the cranial bones showed that of those that could be identified to species, all were trout (Jones 1993, 14). Eels were also relatively more common at Skara Brae than at other sites, suggesting that freshwater fishing was of primary importance, perhaps even a "highly targeted fishing activity" (Jones 1993, 18). Skara Brae is located close to the freshwater lochs of Mainland, which could easily have supplied these species, while the inhabitants of sites on the smaller north isles, like Westray, would not have had access to such large freshwater resources.

Leaving aside the otter spraint, which is discussed separately below, it is clear that (anthropogenic) fishing is represented in the assemblages from Neolithic Orkney, and that at least some of the fish remains recovered from tombs would have been directly placed there by humans. Was this a deliberate act, or were these remains discarded with no formality in the vicinity following meals? There are several different options to consider, not all of which are mutually exclusive. Hedges attached such an importance to what he saw as the 'totemic' qualities of certain species, that he named an entire book after the eagles found at Isbister. For him, the inclusion of other animal remains was "...part of a larger ritual wastage of economic resources (with possibly some element of ceremonial consumption)" (1983, 269). Hedges articulated a distinction between 'totemic' animals and others, which became incorporated as a result of funerary consumption, or direct interment as food for the dead. His choice of the eagle is, perhaps, easy for us to understand, but in the past, concepts of totemism might be equally valid for explaining deposits of more 'mundane' animals, among them, for example, the dogs from Cuween Hill. More importantly, it may well be that those species that were subjects of consumption were themselves of some symbolic or metaphoric importance, because of their character, their origins or simply their inclusion in certain events. We cannot dismiss the fish remains, or the remains of the domestic mammals, as simple foodstuffs without other meanings.

Certainly, there is evidence to suggest that food was being prepared for consumption, by the living or by the dead. At Isbister for example, the domestic mammal remains had been prepared and jointed prior to inclusion in the tomb. While there is only one butchered cod from the Holm of Papa Westray North, this may suggest that prepared food on these occasions extended to fish. However, we should also allow that some of the larger, deliberately caught fish might be present in the tomb as a consequence of animal (including otter) scavenging of food remains left behind after acts of consumption outside (Nicholson and Jones 1992, 5; O'Sullivan *et al.* 1992). How we interpret these deposits is a matter for conjecture. Chesterman thought the animal remains found in association with the human remains from Quanterness were the result of "jollification" during the internment and ceremonial processes (1979, 107), which is certainly a possibility.

Other deposits hint at the complexity of the processes that we are dealing with and thus the difficulties involved in interpreting them. For example, some of the fish from the Holm were found in the sealing deposits of the entrance passage and cell 5. It might be tempting to attach some importance to their presence here. However, it is rather more likely that they became incorporated as part of a matrix of midden material deliberately introduced as blocking in this area. This effectively sealed the tomb and may thus have been a significant act, but it is doubtful whether or not the presence of fish remains in the matrix was explicitly regarded as important at that moment.

Davidson and Henshall describe an apparent dichotomy between the animals deliberately placed in the tombs, like eagles, red deer and dogs, and those that may have been found within 'midden' and thus with little deliberate or explicit symbolism read into their presence – including the fish and other bird remains (1989, 84). We could argue that this secondary category definitely includes animals that were not merely food remains. The presence of fish bone beads at several sites indicates that fish had metaphoric or symbolic potential. Indeed, the apparent choices made relating to species used for necklaces may indicate some aspect of territoriality. At Skara Brae, freshwater trout were the preferred species, whereas on the Holm of Papa Westray and on Sanday, deep water ling were seen as more desirable; Wickham-Jones believed that animal remains can be "interpreted as indicative of totemic spirits that were attached to the different communities" (Wickham-Jones 2006, 39). These two species groups appear to have been deliberately chosen from a wide range of species that could have been made into beads. Various social identities may have been articulated through the wearing of these beads made from specific species. This may have been important during social gatherings when people from different areas or islands met. These beads were probably deliberate inclusions in the tombs, perhaps as grave goods, perhaps to signify the connections between respective species and territories, or perhaps left as gifts by visitors to the dead. The discovery of the discrete, separate caches of beads at Skara Brae would further this interpretation, that beads were an important and specially curated aspect of the Neolithic life and death. The sample size of pierced fish vertebrae is very small to make such generalisations, but they must be considered, particularly in the light of other beads made from mammals. The use of whale teeth as beads from Point of Cott may be a means of referring to and conveying the 'fearsome nature' of killer whales, as suggested by Jones and Richards (2003, 47). It is possible that the wearing of fishbone beads suggests some form of 'ownership' or control over the waters they were fishing (following Clarke *et al.* 1985, 58), or even signified some form of respect for the skills involved in fishing.

Fishing methods
Although difficult to ascertain the boat technology used, the Neolithic inhabitants of the Northern Isles must have had boats of sufficient strength and size to transport livestock and people across some very treacherous waters. Knowledge of tides, currents and winds would have been considerable in order to travel from island to island, and must not be underestimated (Noble 2006, 109). Even if fish were not consumed with sufficient regularity to produce elevated marine isotopic signatures (Schulting *et al.* 2004), it is clear the sea was routinely interacted with – as can be demonstrated by the frequent orientation of monuments towards the sea or sea-views (Phillips 2003), and the importance of the conjunction of a marine and freshwater loch at the heart of Neolithic Orkney (Sturt 2005).

The large ling found at the Holm and other sites, including the Knap of Howar and Skara Brae, are indicative of deep water fishing, probably undertaken with hook and line or long lining. Modern sources vary in their descriptions of ling habitats, but there is a consensus that larger mature ling live in waters of 300 to 400m depth – with occasionally a few of these large specimens straying into shallower waters (Wheeler 1969, 175-76). Depths of about 100m could be reached by travelling from the Holm of Papa Westray approximately 37km in a north west by west direction, past the north end of Westray. Other waters of comparable depth could be reached by travelling about 63km in a north-easterly direction, towards Shetland. Reaching depths of 300m or more would have required a trip of over 100km in a north-westerly direction (Anon. 2008). All of these options would have been risky, given the powerful currents that operate in this region of the North Atlantic. Perhaps the more likely fishing grounds would have been the stretch of deep water of over 100m between Shetland and Orkney, as this area is immediately to the west of Fair Isle and, on a clear day, it would have been possible to reach without losing site of land (Hunter 1996, 1). Neolithic settlers to Shetland would have certainly passed close to this region of deep water, as it is thought likely that Fair Isle was a staging post on the route from Orkney (Hunter 1996, 4). If this area was being exploited for the larger cod, saithe and flatfishes, then perhaps an occasional large ling may have strayed from deeper waters into this region and been caught. However, fish that are now considered deep water may have been found closer to shore in the past, before large-scale commercialised fishing began to alter habitats and ecosystems. We must therefore bear in mind that the larger gadids may therefore have been slightly easier to catch in the Neolithic (Jones 1993, 18; Nicholson 2007a, 214).

The large numbers of limpet shells found throughout the entrance passage could have been used as bait on a hook and line for catching small, inshore gadid species (Fenton 1978, 535). Colley and Wheeler have both suggested that the small, inshore fish from Isbister and the Knap of Howar could have been caught using spears, sticks, hook and line, baited drop nets or could have been scooped out of rock pools (Colley 1983, 153; Wheeler 1983, 104) – although at these site these fish may also represent otter spraint. Wrasse are generally shallow water fish that could also be caught inshore, using traps or nets (Treasurer 1996). An experimental study of Neolithic Swedish fishhooks suggested that bone hooks were sufficient for hooking even large cod of up to 13kg (Olson *et al.* 2008), well within the size range of the larger gadids found in the Orcadian Neolithic. The authors hypothesised that these hooks would have been attached to hand lines and would have been hung off the side of a boat, while the smaller cod found in the Swedish Neolithic could have been caught with the nets or leisters (pronged spears) found at the site (Olson *et al.* 2008). A direct parallel can be seen in the possible fishing artefact found at the Knap of Howar, which could be a composite barbed spear or double-ended gorge, possibly suitable for fishing from boats (Ritchie 1983, 55; Wheeler 1983, 104).

Fishing in deeper water was obviously a high risk activity, but one undertaken relatively often during the Neolithic. At a time before overfishing, depleted fish stocks and altered ecosystems, when a wealth of coastal resources would have been available to the inhabitants of the Northern Isles, one does wonder why deeper waters were occasionally fished and why fish bones representing these deep waters were chosen for decorative purposes. At Tofts Ness, the presence of the deeper water fish led to much speculation: "Why such risks should have been taken, when a rich and plentiful source of fish must have been available close to the shore, is worthy of debate. Burial monuments testify to community organisation in the Neolithic and Bronze Age, and a stratified social structure demanding risk-taking above the level required for simple subsistence could fit the fish-bone evidence from these periods at Tofts Ness" (Nicholson 2007a, 215). The status and prestige associated with bringing home a large fish may have been sufficient reward, or deep water fishing may have been seen as an important rite of passage, signifying mastery of the sea and its strengths.

Otter spraint in Neolithic tombs and settlements

Comparative sites to the Holm are summarised in Table 15, showing the likely taphonomic history of each site, particularly whether or not the analysts identified the fish bone material as deriving from otter spraint, anthropogenic activity, or both. Otters and other animals have been responsible for a large quantity of the fish bones found in Neolithic tombs, and it is therefore crucial to be able to separate the two types of material in order to understand human fishing and fish consumption.

Otter spraints have long been identified in archaeological assemblages from the Northern Isles, including some of Neolithic date. Wheeler suggested that animals may have been responsible for the accumulation of remains in the Quanterness chambered tomb, mentioning that "[s]hore dwelling otters...would be capable of catching most of the species of fish" found in the tomb (Wheeler 1979, 147). However, he doubted that otters would actually spraint in their holts, and together with the undigested nature of the fish remains, he concluded that they were the result of anthropogenic fishing activities (Wheeler 1979, 148). We now know that not only will otters readily spraint within their holts, but also that fish found in spraints characteristically do not appear acid etched following digestion (Nicholson 2000, 55, 61). The Quanterness material has therefore been reassessed as otter spraint in the literature (i.e. Nicholson and Jones 1992). A few years after Wheeler's publication, Colley examined the fish remains from Isbister chambered tomb, and found quantities of tiny and very small fish in the sieved material. As these included many fish of less than 300g (including small gadids, wrasses and flatfishes), as well as some tiny ones of less than 100g, she concluded that the assemblage was likely the result of both anthropogenic activity and natural accumulation (Colley 1983, 152-53). Otter spraints have since been identified from a variety of other settlement and cairn sites (see Table 15). As we will demonstrate, the identification of otter spraint is of importance to understanding site use and history – particularly when otter spraint is found to be contemporary with the use of a cairn.

As well as being found throughout the Holm of Papa Westray North, otter spraint has been identified at the following cairns: Isbister (Colley 1983), Point of Cott (Coy and Hamilton-Dyer 1997), Quanterness (Wheeler 1979) and Links of Noltland (Nicholson and Jones 1992). Otter spraint was also identified in an abandoned building of Late Bronze Age or early Iron Age at the Tofts Ness settlement (Nicholson 2007a), and some otter activity was likely represented in the fish assemblage from Skara Brae (Jones 1993) and in some of the small samples from the Brough of Birsay area of Neolithic and Bronze Age date (Nicholson 1989; Rackham 1989). At each of these sites, otters were either contemporary with the human settlement or use, as at Isbister (Barker 1983, 134), or immediately followed it, as at Point of Cott (Barber 1997, 59). There is no suggestion that the otters represented recent disruptions to the archaeology. Indeed, both direct dating and secure stratigraphic sequencing involving infilling and sealing events suggests that otters were active in the Neolithic, using cairns as holts. The analysis of the human remains from the tombs suggests repeated visits, internments, and perhaps removal of the bones; “all tombs seem to have been designed to be entered repeatedly” (Wickham-Jones 2006, 39). Not only would this allow animals like sheep and otters to make use of the tomb, but it would also provide occasions for food to be brought into the tombs, as sustenance for the people visiting and/or as offerings.

At the Holm of Papa Westray North, the presence of large quantities of neonatal and fetal lambs has suggested the tomb was open over a long period of time, allowing naturally occurring deaths to accumulate within the tomb (Balasse *et al.* 2008, 171). These were contemporary with the tomb’s use, and were thus likely contemporary with the otter activity as well. These pre-date the sealing events that filled in the tomb, implying that live animals were not discouraged from using the tomb even when it was being used for recently deceased people. Davidson and Henshall have speculated that the tombs were temporarily sealed between use events, even with masonry blocking (1989, 59), but the ubiquity of contemporary animal usage would suggest otherwise.

As it appears otters were not discouraged from living in the tombs, even when they were in active use (Ritchie 2004, 102), it must be assumed that the Neolithic human inhabitants of the islands did not mind the occasional disruptions to the dead. It may be possible that otters were seen as an intrinsic part of the life of the tombs, or, alternatively, the tombs may have provided a useful means for capturing otters; their fur provided a fine, waterproof skin (Fenton 1978, 526).

Comparative bone and shell ‘beads’

Comparable examples of fish bone beads are known from a variety of other Neolithic Orcadian sites, including Skara Brae, Quanterness and Tofts Ness, Sanday. Beads made of mammal bone and shells were also very common on Neolithic sites.

Fish bone beads were noted in early excavations at Skara Brae in conjunction with beads made from mammalian bone, though not discussed in any detail (Childe 1931b, 96, 145). Several thousand beads were identified from the antiquarian excavations at Skara Brae, most of which were made from domestic mammal long bones, or teeth from domestic mammals or whales (Petrie 1866-68, 212; Traill 1866-68, 436; Stewart and Dawkins 1913-14, 352; Callander 1930-31, 109; Childe 1931b, 144, 145, 149). At least one discrete deposit contained about 3000 beads and amulets, suggesting some sort of curation while another deposit of a few hundred beads in a doorway was interpreted as evidence of a hasty retreat from the settlement (Childe 1931a, 49, 56). The analysis of fish bones from the more recent excavations at Skara Brae included several trout vertebrae that were pierced in antiquity, and although interpreted as evidence of chewing and digestion (Jones 1993), the presence of previously identified anthropogenically modified fish bones from so many comparative sites makes this an unlikely explanation. At Skara Brae, these trout vertebrae were very small, with a centrum width of approximately 4 to 5mm (interpolated from photographs in Jones 1993); the pierced holes would therefore have been slightly smaller than those from the Holm.

A single fish vertebra bead was found at Quanterness and described as “an unusual item”, comparable to those from Skara Brae (Henshall 1979, 80-89). Although no description was provided, the illustration shows a moderately large elasmobranch vertebra with an enlarged vertebral centrum.

A number of beads were found at Tofts Ness, Sanday, including some made from fish vertebrae, as well as antler and mammal long bones. These included two pierced ling vertebrae from Phase 1 and one of unknown species from Phase 4. Those from Phase 1 were made by piercing small holes through the middle of large vertebrae, creating a hole of about

1.5mm in diameter; the fish sizes are not given, but from the dimensions provided, it is clear these were large ling of over 100cm total length. The spines had been removed, although as with the beads from the Holm, it is not clear whether this was by natural taphonomic attrition or deliberate action.

Beads were noted from Isbister, but not of fish bone; instead, some were made of mammal bone and were noted as similar to those from Skara Brae, and additionally, some were made from pierced limpet shells (Henshall 1983, 45). Marine mammal teeth were used to make beads at both Skara Brae (Traill 1866-68, 436; Stewart and Dawkins 1913-14, 352) and Point of Cott on Westray, where 16 modified and, in some cases, pierced, whale teeth were found. These included killer whale, pilot whale and sperm whale teeth (MacSween and Finlay 1997). Dog teeth may have been used in necklaces at Burray or Cuween Hill, where dog remains were found in close conjunction with human remains (Jones and Richards 2003, 47), perhaps suggesting some specialised importance of dog remains at this tomb compared to others.

In summary, it appears animal remains were often used as ornaments in the Neolithic, and a wide variety of bones, shells and teeth were utilised for this purpose. The overlaps between different site types and areas – such as the whale teeth used at both the Skara Brae settlement and the Point of Cott tomb – suggest some uniformity in this practice across the Neolithic period in Orkney. However, at the same time, there does appear to be some species that are site-specific. For example, Skara Brae appears to focus on pierced trout vertebrae, while the inhabitants of the Holm preferred deep sea ling and other large gadids. This trend towards site-specific specialisation is particular apparent within the pierced fish vertebrae, although this could simply be a product of the small numbers of sites with sieved fish remains available for study. If viewed as part of the larger picture of animal usage, it could be interpreted as evidence of totemism, with specific animals identified with in certain regions of the Northern Isles. It might be no coincidence that the Westray island group is associated with deep sea fish, as they are on the edges of the Orkney island archipelago and thus may have had a greater knowledge of the sea than the inhabitants of Mainland.

Conclusions

The large assemblage of fish remains found at the Holm of Papa Westray North represents both deliberate fishing and the remains of otter spraint, indicating otters were living in the tomb even while it was in contemporary use. Cod family and wrasse family fish were the most commonly exploited taxa, though a wide variety of fish taxa were found indicating broad exploitation of the coastal and deeper marine waters surrounding the islands. Little spatial or temporal patterning was found within or around the tomb. Some of the fish, including large ling, would have been caught in deep waters at some distance from Orkney, suggesting detailed knowledge of the sea and its inherent risks. These larger, deep water fish may have been caught with hooks and lines. Smaller fish like the wrasses and some smaller cod family fish, including cod and saithe, may have been caught from inshore waters using hook and line, nets or traps, based on ethnographic parallels. The deliberately caught fish may have been placed in the tomb as grave goods, or they might represent food eaten while visiting the dead. The fish found in the infilling deposits might have inadvertently been incorporated in the tomb, and it is possible that otters living in the tomb scavenged the remains of human meals and thus introduced fish into the tomb. The presence of several fish bone ‘beads’ at the Holm and a number of other Neolithic Orcadian sites may indicate that fish had a meaning beyond simply that of food.

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Tables and Figures

Table 1: Summary of trench and cell/compartment bone quantities analysed

Trench	Cell/ Compartment	Hand collection			Coarse sieving			>2mm			Grand total
		Id'd	Unid'd	Total	Id'd	Unid'd	Total	Id'd	Unid'd	Total	
EP		207	251	458	120	291	411	94	62	156	1025
I	1	195	349	544	43	58	101	61	181	242	887
	2	96	148	244	39	124	163	304	818	1122	1529
	3	35	60	95	1	2	3	106	124	230	328
	4	108	254	362	128	1007	1135	1367	2671	4038	5535
	5	384	317	701	7	8	15	1263	671	1934	2650
II		3	10	13							13
III		39	49	88							88
IV		5	3	8							8
V		127	304	431							431
VI		3	4	7							7
VI/central cairn		3	1	4							4
Grand total		1205	1750	2955	338	1490	1828	3195	4527	7722	12505

Table 2: Surface texture of QC1 elements

Trench	Cell/ Comp.	Context	Hand collected: Excellent	Good	Fair	Poor	Total	Coarse: Excellent	Good	Fair	Total	>2mm: Excellent	Good	Fair	Poor	Total	Grand Total
EP			10	28	9	2	49	16	26	10	52		4	2		6	107
I	1		21	30	11	4	66	3	7	2	12	1	5			6	84
	2		7	26	10	2	45	1	8	4	13	1	22	5		28	86
	3			15	5	1	21			1	1		7	2		9	31
	4		2	21	20		43	2	24	8	34	5	143	63	4	215	292
	4	1	1	18	17		36		12	5	17						53
		2	1	1	3		5	2	8		10						15
		3		1			1						38	26	2	66	67
		4							2		2		21	12		33	35
		5							2	3	5		10	4		14	19
		6		1			1					5	53	13	1	72	73
		7											12	5	1	18	18
		8											9	3		12	12
	5		8	87	39	1	135	2	1	1	4		73	24		97	236
II			1	1			2										2
III			2	7	2	1	12										12
IV				1		1	2										2
V			2	29	9	1	41										41
VI				1		1	2										2
VI/central cairn				1			1										1
Grand Total			53	247	105	14	419	24	66	26	116	7	254	96	4	361	896

Table 3: Completeness of QC1 elements

Trench	Cell/ Comp.	Context	Hand collected 0-20%	Hand collected 21-40%	Hand collected 41-60%	Hand collected 61-80%	Hand collected 81-100%	Hand collected Total	Coarse 21-40%	Coarse 41-60%	Coarse 61-80%	Coarse 81-100%	Coarse Total	>2mm 0-20%	>2mm 21-40%	>2mm 41-60%	>2mm 61-80%	>2mm 81-100%	>2mm Total	Grand Total
EP			1	6	8	5	29	49	12	8	18	14	52	1		2	2	1	6	107
I	1		3	8	9	17	29	66		3	3	6	12		1	2	1	2	6	84
	2		1	10	4	9	21	45		5	4	4	13		5	8	12	3	28	86
	3		1	2	4	4	9	20				1	1		1	4	2	2	9	30
	4			5	10	8	20	43	6	5	8	15	34	2	27	46	75	65	215	292
		1		5	9	7	15	36	1	3	4	9	17							53
		2				1	4	5	3	1	2	4	10							15
		3					1	1							11	10	18	27	66	67
		4							1		1		2	1	2	5	18	7	33	35
		5							1	1	1	2	5	1	1	2	4	6	14	19
		6			1			1							12	20	22	18	72	73
		7													1	5	6	6	18	18
		8														4	7	1	12	12
	5		8	31	21	31	44	135				4	4	1	17	25	29	25	97	236
II							2	2												2
III					2	4	6	12												12
IV					2			2												2
V				6	8	6	21	41												41
VI						1	1	2												2
VI/central cairn						1		1												1
Grand Total			14	68	68	86	182	418	18	21	33	44	116	4	51	87	121	98	361	895

Table 4: Bone modifications (hand collected and coarse sieved)

Recovery		Coarse				Hand collected											Total
Trench		EP		I		EP	I								V		
Cell/ compartment				2	4		1	2	3	4	5						
Context		2	4	2	2	2	3	2	1	1	1	2	3	4	1	2	
QC	Modification																
0	Carnivore gnawing											1					1
	Crushed					9	2	1		1						9	22
1	Acid etched															2	2
	Carnivore gnawing											5	2			2	9
	Crushed									1		1	1	1			4
	Root etching										7		2			1	10
2	Carnivore gnawing				1										1		2
	Crushed	1	1		1	26	8	2	1	1	1	22	59	1	1	2	127
Total		1	1	1	1	35	10	3	1	3	8	29	64	2	2	16	177

Table 5: Bone modifications (>2mm sieved fraction)

Trench		EP	I													Total
Cell/ compartment			1	2			3	4						5		
Context		4	4	3	4	5	3	3	4	5	6	7	8	2	3	
QC	Modifications															
0	Acid etched							1								1
	Crushed		2			2		41			1					46
1	Acid etched							2				3			1	6
	Crushed							2		1	3			1	2	9
2	Acid etched	1							3		1				1	6
	Carnivore gnawing														1	1
	Crushed	57	7	101	7	7	49	107	117	39	80	66	29	165	491	1322
Total		58	9	101	7	9	49	153	120	40	85	69	29	166	496	1391

Table 6: Number of identified specimens (hand collected)

Trench		EP					I																		II		III			IV		V			VI		Total
Cell/ compartment							1		2				3			4						5															
Context		1	2	3	4	5	1	3	1	2	3	4	1	2	3	1	2	3	4	6	7	1	2	3	4	1	2	1	2	3	1	2	1	2	3	1	2	
Taxa	QC																																					
Dogfish Families	2		2				1	1			1		1			1																		6				13
Ray Family	2																					4		9						1				1				15
	4							4					1			4																						9
Eel	1							2																														2
	2		4					7			1	1												1										5				19
Conger Eel	1		3		3	3	2		2	1					1	1	1					1	1	5		1				1				2				28
	2		2				3						1									1		5	1	1		2				2	2	8		1		29
Atlantic Herring	1																					1																1
	2		3				3	2	3	3						14						1						1										30
	4															3																						3
Cod	1		1				6	1		3	2		5		1	3						9	1	13				2			2		5	10	1		1	66
	2	1	1				1	7	1	2					1	2	1		1				1	5				5			1		6	6			1	43
Cod/ Saithe/ Pollack	1						1						1																									2
	2				1																			1										1				3
Five-bearded/ Northern Rockling	1																							1														1
Haddock	1	1			1			3	4																			2										11
	2						2	2		1	1		1															2										9
Ling	1	1	1				4	1	1	1			2		1	8		1				5		2				2					4	5		1	1	41
	2		3				2	3	1	2			5		1	4	1		1			7	2	3				5					6	4	2			52
Pollack	1						1	2	1		1						1					2		1	1			1						1	1			13
	2				1		2			1	2	1										3	1					1					1	3	1			17
Rockling	1												1											4														5
	2		14				1	23							1	7							11	25										4				86
Saithe	1						8	2	6	3	3		1			7						2		1				1						2				36
	2		1				4	11	1	5					1	2	1					1	4	3				3					1	8				46
Saithe/ Pollack	1				1		3		4		1					1																		1				11
	2						1	2	1							1						1	1	1				1						3				12
Cod Family	1						2	1	2	2			2			5						1	1	1		1		1						3				22
	2		19				1	5	1	3	1					9							13	11				1						10	1	1		76
Gurnard Family	2																						1															1

Bull-rout	1		1													1								2									2					6
	2		6					1								1							3															11
Sea Scorpion	1																																	1				1
Sea Scorpion Family	1															1																						1
	2							3																3														6
Scorpaeniformes	2							1								5					1		7															14
Atlantic Horse-mackerel/ Scad	2																											1					1					2
Ballan Wrasse	1		17		1		3	10	4				2			2	2			1			38	16										1				97
	2		4																															1				5
Ballan/Cuckoo wrasse	1		2																																			2
	2		74				3	20	2	10						10							75	20	1			2						1				218
Corkwing	1		4					2					1										9															16
	2		1					1								1							2															5
Corkwing wrasse/Goldsinny	2		2																																			2
Cuckoo Wrasse	1		2					3																														5
Wrasse Family	1		3					2															5	5	1													16
	2		14					2							1													1					1	1				20
Butterfish	2																							2														2
Blenny Family	2																							1														1
Megrim	1		3		1		1	1			2				2		1						1	2				2						1				17
	2									3																												3
Megrim?	1									1																							1					2
Turbot Family	1									1												1																2
	2		1				2	3		2				1		2						2	4	2										2				21
Halibut Family	1																							1														1
	2		4					8		1													2	6					1									22
	4						1	1																1														3
Flatfish Order	2																						1															1
Total identified		3	192		9	3	58	137	34	45	15	2	24	1	10	95	8	1	2	1	1	42	184	153	4	3		36	1	2	3	2	30	91	6	3	3	1204
Total fish		6	230	2	6	3	98	249	51	73	23	1	41	6	11	211	24	3	7	1	7	48	54	175	7	1	9	41	6	2	3		30	259	15	1	4	1708

Table 7: Number of identified specimens (coarse sieved)

Trench		EP				I											Total
Cell/ compartment						1	2			3	4				5		
Context		2	3	4	5	3	2	3	5	3	1	2	4	5	3	4	
Taxa	QC																
Dogfish Family	2					1								1			2
Dogfish Families	2			1		1							1				3
Ray Family	4												1				1
Eel	1											3					3
	2			4		1	2				1	2	2				12
Conger Eel	1			2	3	1					1						7
	2		2	2	1										1		6
Atlantic Herring	2					2	1					1					4
Cod	1			1			2				1						4
	2			2	3												5
Cod Family	1					2	2						1	2			7
	2		1	2	1	5			5	1	8	9	4	4		1	41
Cod/ Saithe/ Pollack	2						1										1
Five-bearded/ Northern Rockling	1											1					1
Four Bearded Rockling	2			2													2
Haddock	1						1										1
	2			1					1								2
Ling	1				1	1	1										3
	2	1				1	1						1				4
Pollack	1			2				1			1						4
	2		1	1			1										3
Rockling	1		1														1
	2	1										10	5				16
Saithe	1		1		1		1				2	2			1		8
	2			1		3	7				2	4	7				24
Saithe/ Pollack	1										1						1
	2					1						1					2
Scorpion-fish Family	2											1					1
Bull-rout	1											2					2
Sea Scorpion Family	1											1					1
	2			1							2						3
Atlantic Horse-mackerel/ Scad	2						1										1
Ballan Wrasse	1	1	3	7	14	3	2			1	9	1	1	1			43
	2			2		5					13	1			1		22
Ballan/Cuckoo wrasse	1				2	1	1				1			1			6
	2	9		10						5	2						26
Corkwing	1		2	1						1						1	5
Wrasse Family	1	1	2		3	1	1				1	1		1			11
	2		5	3	7	1	4							1			21
Butterfish	2											2					2
Megrim	1			4		2	1									2	9
Turbot Family	1				1												1
	2			1	1	4	1										7
Halibut Family	2			1			1				3	2	2				9
Identified fish		13	18	51	38	36	32	1	6	8	48	44	25	11	3	4	338
Total fish		3	58	95	114	57	111	1	13	2	217	474	242	74	3	5	1489

Table 8: Number of identified specimens (>2 sieved fraction)

Trench		EP	I													Total
Cell/ compartment			1	2			3	4						5		
Context		4	4	3	4	5	3	3	4	5	6	7	8	2	3	
Taxa	QC															
Dogfish Families	2			1			1		2		1		2		2	9
Eel	1			2			2		2			1	1		5	13
	2	23	14	31	8	10	20	15	7	2	21	10	12	42	72	287
Conger Eel	1	1						1								2
Atlantic Herring	2			2						1					1	4
Salmon & Trout Family	2							1								1
Cod Family	1		1	4	1	1		12	1	4	16	4	2	6	14	66
	2	25	12	89	9	10	34	44	57	36	40	46	25	136	222	785
Cod/ Saithe/ Pollack	2							2								2
Cod	1										1					1
	2						1									1
Saithe/ Pollack	1							1								1
	2							4								4
	4											1				1
Saithe	1	1		2				3			7				2	15
	2		9	2		3		9	2		18		1	2	8	54
Rockling	1	3		5			3	12	11	3	15	7	5	4	28	96
	2	17	1	30	5	7	16	158	54	9	66	18	7	67	223	678
Five-bearded/ Northern Rockling	1							1	2		2					5
Stickleback Family	2					1										1
Three-spined Stickleback	2											1				1
Bull-rout	1				1			4			1					6
Sea Scorpion Family	1		1	4	1		2	20	6	3	11	2	3	8	12	73
	2	13	3	19	7		8	71	35	14	26	17	8	40	87	348
Scorpaeniformes	1			1				2			1					4
	2					3		2								5
Dragonet	1											1				1
	2					1										1
Wrasse Family	1	1	2		1	1					4					9
	2		2				3	3	13		1			6	13	41
Corkwing wrasse/Goldsinny	1								2	1				1	4	8
	2		1								5					6
Goldsinny	1										1					1
	2					1										1
Ballan/Cuckoo wrasse	1		1											2		3
	2							2	1	1						4
Ballan Wrasse	1		1					2	2		1					6
Corkwing	2		1		1			5			2					9
Butterfish	1										6					6
Eelpout Family	1										1					1
	2										1					1
Viviparus Eelpout	1										1					1
Blenny Family	1										1	1				2
Perch Family	1				1						1					2
Perciformes order	1										1					1
'Tiny' perciformes	1			2			2	7	5	2	1	1		3	4	27
	2	7	12	19	3	6	9	138	19	8	52	14	1	58	159	505
Megrim	1												1			1
Scaldfish	1										1					1
Turbot Family	1			1					1							2
	2						1									1
Halibut Family	1								1	1					2	4
	2					1		5			1					7
Flatfish Order	1							1							2	3
	2	3		6			4	11	10	1	4	6	1	6	21	73
Identified fish		94	61	220	38	45	106	536	233	86	311	130	69	381	881	3191
Total fish		39	177	531	125	137	106	732	369	149	835	290	129	120	395	4134

Table 9: Cod family and wasse family element representation (hand collected)

Trench			EP			I																			II	III	IV	V			VI		
Cell/ compartment						1		2				3		4					5														Total
Context			1	2	4	1	3	1	2	3	4	1	3	1	2	3	4	6	1	2	3	4	1	1	1	1	2	3	1	2	
Taxa	QC	Element																													
Cod	1	Articular				1															2										3
		Basioccipital							1																	1	1	1			4
		Ceratohyal				1															1					1	1				4
		Cleithrum																	1												1
		Dentary				1			1			1		1					1		1			1		1	2				10
		Hyomandibular																			1			1							2
		Infrapharyngeal										1															1				2
		Maxilla																			1				2		2				5
		Opercular												1							1										2
		Palatine																		1							1				2
		Parasphenoid				1	1					1							3												6
		Posttemporal								1				1							3										5
		Premaxilla							1			2							1							1				1	6
		Quadrate				2																									2
		Supracleithrum											1								2					1	2				6
		Vomer		1						1									3		1										6
	2	Abdominal vertebra 1	1			1	2														3					3					10
		Abdominal vertebra 2					1	1	2					1	1						1			3			2			1	13
		Abdominal vertebra 3		1			4							1										1		1	4				12
		Caudal vertebra																		1											1
		Caudal vertebra 1											1				1				1				1	1					5
		First vertebra																						1		1					2
Cod family	1	Articular					1																								1
		Basioccipital																			1										1
		Ceratohyal				1						1		1																	3
		Dentary												1																	1
		Maxilla																					1								1
		Parasphenoid				1			1			1																			3
		Preopercular							1																						1
		Posttemporal						1											1												2
		Premaxilla												1						1							1				3
		Quadrate						1						1										1							3
		Supracleithrum												1													2				3
	2	Abdominal vertebra		4		1	1	1	3					4										1			1		1		17
		Abdominal vertebra 1																			2										2
		Abdominal vertebra 2																			1										1
		Abdominal vertebra 3					1																								1
		Caudal vertebra		14			2							5						6							3				30
		Caudal vertebra 1																		5	5						6				16
		Caudal vertebra 2					1			1											2										4
		Ultimate vertebra		1																2	1										4
		Vertebra																										1			1
Cod/ saithe/ pollack	1	Basioccipital										1																			1
		Posttemporal				1																									1
	2	Abdominal vertebra 3																			1										1
		Caudal vertebra			1																										1
		Caudal vertebra 2																									1				1
Five-bearded/ Northern Rockling	1	Parasphenoid																			1										1
Haddock	1	Cleithrum					1																								1
		Hyomandibular						2																							2
		Palatine			1																										1
		Preopercular						2																							2
		Posttemporal	1																												1
		Quadrate					1																	2							3
		Supracleithrum					1																								1
	2	Abdominal vertebra 1								1		1																			2
		Abdominal vertebra 2				1																		1							2
		Abdominal vertebra 3					1		1															1							3
		Caudal vertebra					1																								1
		Caudal vertebra 2				1																									1
Ling	1	Articular																	1		1			1		1					4
		Basioccipital																								1					1
		Cleithrum																											1		1
		Dentary	1			1								2		1			1		1						3				10
		Hyomandibular																												1	1
		Maxilla																	1												1
		Parasphenoid				1						1							1							1					4
		Preopercular												1																	1
		Posttemporal				1								1																	2
		Premaxilla												2												1	1				4
		Quadrate		1				1	1					1																	4
		Supracleithrum					1																	1			1				3
		Vomer				1						1	1	1					1												5
	2	Abdominal vertebra 1						1				1									1			1			1				5
		Abdominal vertebra 2							2				1	1	1				4	1				1		2					13
		Abdominal vertebra 3		1		2	1					2		3			1		3		2			1		3					19
		Caudal vertebra		1			1																	1							3
		Caudal vertebra 1		1			1					2								1							3	2			10
		First vertebra																						1							1
		Vertebra																								1					1
Pollack	1	Articular																						1							1
		Basioccipital																	1												1
		Cleithrum																			1										1
		Dentary						1																			1				2
		Parasphenoid																										1			1
		Preopercular				1																									1
		Posttemporal																				1									1
		Premaxilla					1			1					1																3
		Quadrate																	1												1
		Supracleithrum					1																								1
	2	Abdominal vertebra 1																		1							1				2
		Abdominal vertebra 2																								1					1
		Abdominal vertebra 3			1	1			1	1	1								2								1	1			9
		Caudal vertebra 1																	1					1			1				3

		Caudal vertebra 2								1																					1
		First vertebra				1																									1
Rockling	1	Articular																			1										1
		Basioccipital																			1										1
		Cleithrum										1									2										3
	2	Abdominal vertebra		4		1	3							3						2											13
		Abdominal vertebra 2																			5										5
		Abdominal vertebra 3																			5										5
		Caudal vertebra		10			19						1														4				34
		Caudal vertebra 1					1							3						7	6										17
		Caudal vertebra 2												1						2	9										12
Saithe	1	Articular				1			2	1									1					1							6
		Basioccipital				1																									1
		Ceratohyal				1		2						1																	4
		Cleithrum						1																							1
		Dentary				1		2	1												1						1				6
		Maxilla				1	1	1																							3
		Opercular				1																									1
		Palatine					1							1																	2
		Parasphenoid				1								3																	4
		Preopercular				1																									1
		Premaxilla								2		1							1								1				5
		Supracleithrum												1																	1
		Vomer												1																	1
	2	Abdominal vertebra 1				4	1						1																		6
		Abdominal vertebra 3					3		2					1					1					1			1				9
		Caudal vertebra		1																											1
		Caudal vertebra 1					6		3						1					3	3			1		1	5				23
		Caudal vertebra 2					1	1						1										1			2				6
		First vertebra																		1											1
Saithe/ pollack	1	Basioccipital				1																									1
		Dentary						1																			1				2
		Hyomandibular				1																									1
		Parasphenoid			1			3																							4
		Preopercular				1																									1
		Premaxilla								1																					1
		Vomer												1																	1
	2	Abdominal vertebra 1				1														1											2
		Abdominal vertebra 2																									1				1
		Abdominal vertebra 3						1						1										1			1				4
		Caudal vertebra					2												1												3
		Caudal vertebra 1																			1										1
		Caudal vertebra 2																									1				1
Cod family total			3	40	4	39	63	23	23	11	1	18	6	49	4	1	2		31	35	72	1	1	27	3	23	61	6	2	3	552
Ballan wrasse	1	Articular		1																3											4
		Ceratohyal					1													1											2
		Dentary		3		1	2													15	2										23
		Hyomandibular																		1											1
		Infrapharyngeal		5	1			1							1					4	2										14
		Maxilla		1			1					1		1						2	3										9
		Opercular																			2						1				3
		Palatine					1					1								2											4
		Parasphenoid																		2											2
		Preopercular						1																							1
		Posttemporal					2													2	3										7
		Premaxilla		2				2							1			1		3	3										12
		Quadrate		4		1	2													1	1										9
		Supracleithrum		1		1								1																	3
		Scapula					1													2											3
	2	Abdominal vertebra		3																											3
		Caudal vertebra		1																											1
		First vertebra																									1				1
Ballan/Cuckoo wrasse	1	Infrapharyngeal		1																											1
		Premaxilla		1																											1
	2	Abdominal vertebra		28		1	7	1	4					3						31	8						1				84
		Caudal vertebra		42		2	11	1	5					5						36	11	1									114
		First vertebra		4			2		1					2						8	1			1							19
		Penultimate vertebra																						1							1
Corkwing	1	Dentary					1													1											2
		Infrapharyngeal		3			1					1								7											12
		Opercular																		1											1
		Premaxilla		1																											1
	2	Caudal vertebra		1			1							1						2											5
Corkwing wrasse/Goldsinny	2	Caudal vertebra		2																											2
Cuckoo wrasse	1	Infrapharyngeal		2			3																								5
Wrasse family	1	Articular																			1										1
		Dentary		1			2														1										4
		Infrapharyngeal		2																4											6
		Opercular																				1									1
		Premaxilla																		1	1										2
		Supracleithrum																			1										1
		Scapula																			1										1
	2	Abdominal vertebra		7																											7
		Caudal vertebra		6			2						1											1			1				11
		First vertebra		1																						1					2
Wrasse family total				123	1	6	40	6	10			3	1	13	2			1		129	41	2		3		1	4				386

Table 10: Cod family and wrasse family element representation (coarse sieved)

Trench			EP				I											Total
Cell/ compartment							1	2			3	4				5		
Context			2	3	4	5	3	2	3	5	3	1	2	4	5	3	4	
Taxa	QC	Element																
Cod	1	Basioccipital						1										1
		Ceratohyal			1													1
		Opercular						1										1
		Premaxilla										1						1
	2	Abdominal vertebra 1				1												1
		Abdominal vertebra 2			1	1												2
		Abdominal vertebra 3			1	1												2
Cod Family	1	Ceratohyal													1			1
		Dentary												1				1
		Maxilla					1											1
		Posttemporal						2										2
		Vomer					1								1			2
	2	Abdominal vertebra			1		2			1		3	1	2			1	11
		Caudal vertebra			1	1	3			4	1	5	8	2	4			29
		First vertebra		1														1
Cod/ Saithe/ Pollack	2	Caudal vertebra						1										1
Five-bearded/ Northern Rockling	1	Premaxilla											1					1
Four Bearded Rockling	2	Abdominal vertebra			1													1
		Caudal vertebra			1													1
Haddock	1	Quadrate						1										1
	2	Abdominal vertebra 3			1													1
		First vertebra								1								1
Ling	1	Dentary						1										1
		Posttemporal				1												1
		Quadrate					1											1
	2	Abdominal vertebra 2					1											1
		Caudal vertebra												1				1
		Caudal vertebra 1	1					1										2
Pollack	1	Articular										1						1
		Basioccipital			1													1
		Hyomandibular			1													1
		Opercular							1									1
	2	Abdominal vertebra 2		1														1
		Abdominal vertebra 3			1			1										2
Rockling	1	Premaxilla		1														1
	2	Abdominal vertebra	1										3	2				6
		Caudal vertebra											7					7
		Caudal vertebra 1												2				2
		Caudal vertebra 2												1				1
Saithe	1	Basioccipital						1										1
		Ceratohyal										1						1
		Maxilla										1						1
		Parasphenoid				1												1
		Premaxilla		1									1			1		3
		Vomer											1					1
	2	Abdominal vertebra 1					1							1				2
		Abdominal vertebra 2												1				1
		Abdominal vertebra 3					1	3										4
		Caudal vertebra 1			1		1	3					4	4				13
		Caudal vertebra 2										2		1				3
		First vertebra						1										1
Saithe/ Pollack	1	Supracleithrum										1						1
	2	Caudal vertebra 1					1						1					2
Cod family total			2	4	12	6	13	17	1	6	1	15	27	18	6	1	1	130
Ballan Wrasse	1	Articular	1			1		1				1		1				5
		Dentary			1	1		1										3
		Hyomandibular			1	1												2
		Infrapharyngeal			4	5	1				1							11
		Maxilla				1	1					2						4
		Posttemporal					1					1						2
		Premaxilla				2												2
		Quadrate		1								2			1			4
		Supracleithrum		2	1							1						4
		Scapula				2						2	1					5
		Vomer				1												1

	2	Abdominal vertebra					4					9						13
		Caudal vertebra			1		1					4	1					7
		First vertebra			1											1		2
Ballan/Cuckoo wrasse	1	Infrapharyngeal						1				1						2
		Maxilla				1									1			2
		Posttemporal				1												1
		Supracleithrum					1											1
	2	Abdominal vertebra	3		5						4	1						13
		Caudal vertebra	5		5						1							11
		First vertebra	1									1						2
Corkwing	1	Infrapharyngeal		2	1						1						1	5
Wrasse Family	1	Infrapharyngeal	1	2		2	1					1			1			8
		Maxilla						1										1
		Premaxilla											1					1
		Supracleithrum				1												1
	2	Abdominal vertebra		4	1	2		1										8
		Abdominal vertebra 1						1										1
		Caudal vertebra		1	2	4		2							1			10
		Caudal vertebra 1					1											1
		First vertebra				1												1
Wrasse family total			11	12	23	26	11	8			7	26	3	1	4	1	1	134

Table 11: Cod family and wrasse family element representation (>2mm sieved fraction)

Trench			EP	I													Total
Cell/ compartment				1	2			3	4						5		
Context			4	4	3	4	5	3	3	4	5	6	7	8	2	3	
Taxa	QC	Element															
Cod	1	Articular										1					1
	2	Vertebra						1									1
Cod Family	1	Articular		1	1				4			9			2		17
		Basioccipital							1		1		1			2	5
		Ceratohyal							1			1	1			1	4
		Cleithrum							1			1				2	4
		Dentary			1				2			2			1		6
		Hyomandibular							1		2	2		1	1	1	8
		Infrapharyngeal			1					1			1				3
		Maxilla									1					3	4
		Opercular												1		2	3
		Palatine														1	1
		Parasphenoid					1										1
		Preopercular				1											1
		Premaxilla										1	1		2	2	6
		Quadrate							1								1
		Supracleithrum			1												1
		Vomer							1								1
	2	Abdominal vertebra		2					1			2					5
		Caudal vertebra		6					1			11					18
		First vertebra			1			2									3
		Ultimate vertebra							1	1							2
		Vertebra	25	4	88	9	10	32	41	56	36	27	46	25	136	222	757
Cod/ Saithe/ Pollack	2	Vertebra							2								2
Five-bearded/ Northern Rockling	1	Dentary							1			2					3
		Hyomandibular								1							1
		Vomer								1							1
Rockling	1	Articular							3	4	2	2	1	1	1	1	15
		Basioccipital						1	1	1					2		5
		Ceratohyal											2	1	1	5	9
		Cleithrum	1		1			1	1			1				3	8
		Dentary			1					1		3	2			6	13
		Hyomandibular	1		2				1	1	1	6	1	1		1	15
		Maxilla	1		1				2				1			5	10
		Opercular								1							1
		Premaxilla						1	4	2		2		2		6	17
		Quadrate								1		1				1	3
	2	Abdominal vertebra		1			1		2			8					12
		Caudal vertebra										5					5
		Vertebra	17		30	5	6	16	156	54	9	53	18	7	67	223	661

Saithe	1	Articular										2					2
		Dentary	1														1
		Hyomandibular			1												1
		Palatine										1					1
		Parasphenoid										1				1	2
		Preopercular										1					1
		Posttemporal							1								1
		Premaxilla							2			1					3
		Quadrate										1					1
		Vomer			1											1	2
	2	Abdominal vertebra					3					2					5
		Abdominal vertebra 2													1		1
		Abdominal vertebra 3							1								1
		Caudal vertebra		7					3			6					16
		Caudal vertebra 1		2					1								3
		Vertebra			2				4	2		10		1	1	8	28
Saithe/ Pollack	1	Cleithrum							1								1
	2	Caudal vertebra							1								1
		Caudal vertebra 1							1								1
		Caudal vertebra 2							1								1
		Vertebra							1								1
	4	Otolith											1				1
Cod family total			46	23	132	15	21	54	246	127	52	165	76	40	215	497	1709
Ballan Wrasse	1	Dentary							1								1
		Hyomandibular										1					1
		Premaxilla							1	1							2
		Quadrate								1							1
		Supracleithrum		1													1
Ballan/Cuckoo wrasse	1	Maxilla		1													1
		Premaxilla													2		2
	2	Abdominal vertebra							1								1
		Caudal vertebra							1								1
		Vertebra								1	1						2
Corkwing	2	Abdominal vertebra		1								1					2
		Caudal vertebra							2			1					3
		First vertebra				1											1
		Vertebra							3								3
Corkwing wrasse/Goldsinny	1	Dentary								1							1
		Infrapharyngeal														1	1
		Opercular														1	1
		Preopercular									1				1		2
		Premaxilla														2	2
		Quadrate								1							1
	2	Vertebra		1								5					6
Goldsinny	1	Preopercular										1					1
	2	Caudal vertebra					1										1
Wrasse Family	1	Articular				1											1
		Infrapharyngeal										1					1
		Opercular										1					1
		Palatine										1					1
		Posttemporal	1														1
		Premaxilla		1													1
		Quadrate		1													1
		Scapula					1					1					2
	2	Caudal vertebra		1								1					2
		First vertebra		1													1
		Vertebra						3	3	13					6	13	38
Wrasse family total			1	8		2	2	3	12	18	2	14			9	17	88

Table 12: Fish sizes, summary

Recovery		Hand collected													Coarse sieved							>2mm							Grand Total
Trench		EP	I					II	III	IV	V	VI	VI/ central cairn	Total	EP	I					Total	EP	I					Total	
Cell/ compartment			1	2	3	4	5									1	2	3	4	5			1	2	3	4	5		
Common name	Total length																												
Eel	15-30cm		2											2										3	1	4	1	9	11
	30-50cm																		3		3			2	1	1	4	8	11
Conger Eel	30-50cm																					1						1	1
	50-80cm														1						1								1
	80-100cm			1				1						2															2
	>100cm	9	2	2	1	2	7		1		2			26	4	1			1		6					1		1	33
Atlantic Herring	15-30cm					3	1							4															4
Salmon & Trout Family	15-30cm																									1		1	1
Cod Family	<15cm																						1	5		16	5	27	27
	15-30cm			1			3				1			5		1			1		2		2	1		26	15	44	51
	30-50cm		1	2	1	1		1			1			7		1	1				2								9
	50-80cm		1			2			1					4			1		1		2								6
	80-100cm					2	1							3															3
	>100cm		1											1															1
Cod/ Saithe/ Pollack	15-30cm		1											1															1
	50-80cm				1									1															1
Cod	15-30cm			1	2		1				1			5												1		1	6
	30-50cm		1	2			4				3			10					1		1								11
	50-80cm	1	4	1	2	2	10		2		9	1		32	1		2				3				1			1	36
	80-100cm		2	1	2	1	9				4			19															19
	>100cm						1			2				3															3
Haddock	15-30cm		1	1										2															2
	30-50cm			3										3			1				1								4
	50-80cm	2	2											4															4
	80-100cm								2					2															2
Saithe/ Pollack	<15cm																									2		2	2
	15-30cm		3	1										4															4
	30-50cm			3										3															3
	50-80cm	1				1								2					1		1								3
	80-100cm			1							1			2															2
Pollack	30-50cm			1										1					1		1								2
	50-80cm		3	1			3				1			8	2						2								10
	80-100cm					1	1		1		1			4			1				1								5
Saithe	<15cm																									6	2	8	8
	15-30cm		6	4		1								11	1		1		4	1	7	1		2		5	1	9	27
	30-50cm		2	5		5	2							14	1						1								15
	50-80cm		2	1		1	1		1		2			8															8
	80-100cm						1							1															1
	>100cm			2	1									3															3
Rockling	<15cm																					2		3		28	20	53	53
	15-30cm				1		3							4	1						1	1		2	3	30	12	48	53
	30-50cm						1							1															1
Five-bearded/	15-30cm																		1		1					5		5	6
Northern Rockling	30-50cm						1							1															1
Ling	15-30cm																1				1								1
	30-50cm					1								1															1
	50-80cm		1			4					5			10	1	1					2								12

	80-100cm		1		1		1		1					4															4
	>100cm	2	3	2	2	9	8		1		5	1	1	34		1					1								35
Angler?	>100cm						1							1															1
Sea Scorpion Family	<15cm																						1	3		33	15	52	52
	15-30cm		1			1								2					1		1			2	1	12	5	20	23
Bull-rout	<15cm																		1		1					2		2	3
	15-30cm	1				1	2				2			6					1		1			1		3		4	11
Sea Scorpion	15-30cm										1			1															1
Perch Family	<15cm																							1		1		2	2
Wrasse Family	<15cm																		1		1		1	2		3		6	7
	15-30cm	3	3				5							11	4	1	1		2		8	1	1			1		3	22
	30-50cm						6							6	1						1								7
Ballan/Cuckoo wrasse	15-30cm	2	3				15							20	2	1	1		2		6		1				1	2	28
	30-50cm																									2	1	3	3
Ballan Wrasse	<15cm																									1		1	1
	15-30cm	12	12	3		1	38							66	15	3			3		21		1			2		3	90
	30-50cm	6	1		2	2	12				1			24	7	1	1		9		18					2		2	44
	50-80cm			1		2	4							7	2		1				3								10
Cuckoo Wrasse	15-30cm	2	3											5															5
Corkwing wrasse/ Goldsinny	<15cm																									3	1	4	4
	15-30cm																										4	4	4
Corkwing	<15cm						1							1															1
	15-30cm	4	2		1		8							15	2			1		1	4								19
	30-50cm														1						1								1
Goldsinny	<15cm																									1		1	1
Eelpout Family	<15cm																									1		1	1
Viviparus Eelpout	<15cm																									1		1	1
Butterfish	<15cm																									3		3	3
	15-30cm																									3		3	3
Blenny Family	<15cm																									2		2	2
Dragonet	15-30cm																									1		1	1
Turbot Family	<15cm																							1				1	1
	15-30cm						1							1												1		1	2
	30-50cm			1			1							2	1						1				1			1	4
	50-80cm			1										1															1
Megrim	30-50cm	4	2		2	1	3				1			13	3		1				4					1		1	18
	50-80cm			3					2		1			6	1	2				2	5								11
Scaldfish	<15cm																									1		1	1
Halibut Family	<15cm																										1	1	1
	15-30cm		1											1												1	1	2	3
	30-50cm		1				2							3												1		1	4
Flatfish Order	<15cm																									1	2	3	3
	15-30cm						1							1															1
Perciformes order	15-30cm																									1		1	1
Scorpaeniformes	<15cm																									3		3	3
	15-30cm																							1				1	1
Tiny perciformes	<15cm																						1	2	2	17	3	25	25
	15-30cm																									2	4	6	6
Totals		49	68	45	19	44	159	2	12	2	42	2	1	445	51	13	13	1	34	4	116	6	9	31	10	232	98	386	947

Table 13: Fish sizes, detail

Recovery		Hand collected , Trench I																							
Cell/ compartment		1			2						3			4								5				Total
Context		1			1		2		3		1	3		1			2		3	4	6	1	2	3	4	
Sub-sections			E	W	E	W	E	W	E	W	W	E	W	NE	SE	W	SE	W	NE	NW	NE					
Common name	Total length																									
Cod Family	15-30cm							1															2	1		4
	30-50cm			1	1			1			1					1										5
	50-80cm	1													1	1										3
	80-100cm															2						1				3
	>100cm		1																							1
Cod/ Saithe/ Pollack	15-30cm			1																						1
	50-80cm										1															1
Cod	15-30cm									1	2												1			4
	30-50cm		1				1	1																4		7
	50-80cm		3	1				1			2			1		1						5		5		19
	80-100cm		1	1						1	1	1				1						3		6		15
	>100cm																					1				1
Haddock	15-30cm			1	1																					2
	30-50cm				3																					3
	50-80cm		2																							2
Saithe/ Pollack	15-30cm		2	1	1																					4
	30-50cm				1	2																				3
	50-80cm													1												1
	80-100cm								1																	1
Pollack	30-50cm				1																					1
	50-80cm	1		2						1												1		1	1	7
	80-100cm																	1				1				2
Saithe	15-30cm		2	4	2			2								1										11
	30-50cm		1	1	2	2	1									5						1		1		14
	50-80cm		1	1						1						1						1				5
	80-100cm																							1		1
	>100cm								2		1															3
Rockling	15-30cm										1													3		4
	30-50cm																							1		1
Five-bearded/ Northern Rockling	30-50cm																							1		1
Ling	30-50cm															1										1
	50-80cm			1										2		1			1							5
	80-100cm			1							1													1		3
	>100cm	1	1	1	1			1			1		1			8				1		7		1		24
Wrasse Family	15-30cm		2	1																			4	1		8
	30-50cm																						1	4	1	6
Ballan/Cuckoo wrasse	15-30cm		1	2																			15			18
Ballan Wrasse	15-30cm			12		3										1							31	7		54
	30-50cm			1							2							1			1		4	8		17
	50-80cm				1										1		1						3	1		7

Cuckoo Wrasse	15-30cm		3																					3
Corkwing	<15cm																					1			1
	15-30cm			2							1											8			11
Totals		3	21	35	14	7	2	7	3	4	14	1	1	4	2	24	1	2	1	1	1	21	70	47	2	288

Recovery		Coarse Trench I													>2mm sieved Trench I																		
Cell/ compartment		1			2		3	4				5			1	2				3		4									5		
Context		1		3	2	3	3	1	2	4	5	3	4	Total	4	3		4	5	3		3	4		5	6		7	8		2	3	Total
Sub-sections		E	W	W	E	W	E	SE	SW	NE					W	E	W		W	E	W	NE	NE	NW	NE	NE	SE	NE	NE	NW			
Common name	Total length																																
Cod Family	<15cm														1	3		1	1			8			2	4		1		1	3	2	27
	15-30cm	1								1				2	2		1					4	1		2	2	13	3		1	3	12	44
	30-50cm	1			1									2																			
	50-80cm				1						1			2																			
Cod	15-30cm																									1							1
	30-50cm							1						1																			
	50-80cm				2									2							1												1
Haddock	30-50cm				1									1																			
Saithe/ Pollack	<15cm																					1						1					2
	50-80cm							1						1																			
Pollack	30-50cm							1						1																			
	80-100cm					1								1																			
Saithe	<15cm																					4				2						2	8
	15-30cm				1			2	2			1		6		1	1									2	3				1		8
Rockling	<15cm															2	1					10		2	3	7	1	2	2	1	2	18	51
	15-30cm															2				2	1	2	8	1		3	9	5		2	2	10	47
Five-bearded/ Northern Rockling	15-30cm								1					1								1	2				2						5
Ling	15-30cm				1									1																			
	50-80cm		1											1																			
	>100cm	1												1																			
Wrasse Family	<15cm								1					1	1			1	1							2	1						6
	15-30cm		1		1			1			1			4	1											1							2
Ballan/Cuckoo wrasse	15-30cm	1			1			1			1			4	1																1		2
	30-50cm																								1					1	1		3
Ballan Wrasse	<15cm																					1											1
	15-30cm	2		1				3						6	1							1					1						3
	30-50cm	1			1			6	1	1	1			11									1	1									2
	50-80cm				1									1																			
Corkwing wrasse/Goldsinny	<15cm																						2		1							1	4
	15-30cm																														1	3	4
Corkwing	15-30cm						1						1	2																			
Goldsinny	<15cm																									1							1
Total		7	2	1	11	1	1	16	5	2	4	1	1	52	7	8	3	2	2	2	2	32	14	4	9	25	30	12	2	6	14	48	222

Table 14: Pierced fish vertebrae

Trench	Cell/ Comp.	Context (Co-ords)	Species	Fish size (TL)	Element	Description	Size and shape of anterior hole (width x height)	Size and shape of posterior hole (width x height)
I	1	3 (W)	Ling	>100cm	Abdominal vertebra group 3	Anterior, ventral part of vertebral body, missing spines; id 10719	5.1 x 4.3mm; comma shape with two overlapping circles	
I	1	1 (W)	Cod	c. 80cm	Abdominal vertebra group 1	Whole vertebral body, missing spines; possibly pierced from posterior to anterior when still fairly fresh; id 399	3.7 x 2.8mm; three overlapping circular holes visible	1.7 x 2.0mm; circular hole
I	2	2 (W)	Ling	>100cm	Abdominal vertebra group 2	Whole vertebral body, missing spines; also chewed on dorsal surface; id 493	2.4 x 2.9mm; rough ellipse shape	3.9 x 3.5mm; very rough circular shape
I	4	1 (W)	Ling	>100cm	Abdominal vertebra group 3	Whole vertebral body, missing spines, in very poor condition; id 200	3.0 x 2.5mm; roughly circular	3.3 x 2.4mm; roughly oval
I	4	4 (NW)	Ling	>100cm	Abdominal vertebra group 3	Dorsal vertebral body, missing spines; id 240	2.0mm wide; approximately circular	3.1 x 3.0mm; comma shape
I	5	1	Ling	>100cm	Abdominal vertebra group 3	Whole vertebral body, missing spines; id 10135	2.2 x 2.0mm; slight comma shape	1.7 x 1.9mm; circular
I	5	1	Ling	>100cm	Abdominal vertebra group 2	Ventral part of vertebral body, missing spines; id 10134	Estimated hole c. 8 or 9mm diameter	
V		1	Cod/ Saithe	80-100cm	Abdominal vertebra group 1	Whole vertebral body, missing spines; chewed and in poor condition; id 731	2.1 x 1.7mm; circular	2.9 x 3.1mm; recessed smaller hole in larger opening
V		1	Ling	>100cm	Abdominal vertebra group 3	Whole vertebral body, missing spines; dorsal surface broken, possibly caused by piercing device slipping; id 708	3.3 x 4.1mm; larger hole in centre, with two smaller holes overlapping indicating a device of about 1.5mm diameter	2.8 x 3.1mm; oval shape
V		1	Ling	>100cm	Caudal vertebra group 1	Ventral, posterior vertebral body, missing spines; fragmentation makes this a tentative piercing; id 715		1.7 x 1.9mm; circular
V		1	Ling	>100cm	Abdominal vertebra	Small fragment of articular surface; has some recent fragmentation so tentative piercing identification; id 710	4.2 x 5.3mm; circular	

Table 15: Summary of comparative Neolithic fish assemblages

Site	Site type	Recovery	Otter remains	Otter spraint	Anthropogenic origin	References
Isbister	Cairn	Special deposit sieved to 5mm, also hand collection	Yes	Sieved deposit likely otter spraint	Larger hand collected bones were probably anthropogenic	Barker 1983; Colley 1983
Point of Cott	Cairn	Hand collection and sieving, but the sieved material wasn't identified	Yes, they were likely living between the revetting walls, using them as holts	All deposits likely otter or bird activity	A few of the larger conger and cod might have been caught by humans, but as they were chewed and crushed, they may have been caught or at least scavenged by otters	Coy and Hamilton-Dyer 1997; Halpin 1997
Skara Brae	Settlement	Hand collection and sieving, including some 5mm	?	Some bones were crushed and chewed, particularly the vertebrae; some otter and other animal activity therefore suggested	Yes, most of the remains were likely anthropogenic	Jones 1993
Tofts Ness	Settlement	Mostly hand collection, some sieving to 3mm and 0.5mm	Yes	Yes, from a floor context of Late Bronze Age/early Iron Age, likely an abandoned building used as a holt	Yes, including deep water fishing from boats	Nicholson 2007a; Nicholson and Davies 2007
Quanterness	Cairn	?some sieving to 2mm	Yes, but not in the main chamber	Yes, most of the remains were probably caught by animals, including birds (large quantity of owl pellets)	Possibly, as some of the larger fish like ling prefer deeper water so might have been fished from boats	Clutton-Brock 1979; Wheeler 1979
Knap of Howar	Settlement	Mostly hand collected, with some sieved material presented separately	Yes, but only found in the topsoil		Definitely some deeper water fishing from boats; one possible fishing spear or gorge found	Noddle 1983; Ritchie 1983; Wheeler 1983
Pool	Settlement	Hand collection and 3mm sieving			Very small collection of poorly preserved Neolithic bones so difficult to interpret	Nicholson 2007b
Pierowall Quarry	Cairn		Yes		No Neolithic fish remains	MacCormick 1984; Swinney 1984
Howe	Cairn	Very little sieving	No		No fish recovered from Neolithic layers	Locker 1994; Smith 1994
Links of Noltland	Cairn and ?Settlement	Sieving and hand collection	Not specified if otter remains were found; coprolites were found containing fish bones, likely from scavengers larger than otters, possibly dogs or humans	Yes	Larger hand collected fish were possibly remains of human consumption; a few bones were burnt, even from deposits positively identified as otter spraint, indicating some anthropogenic influence and possible scavenging from human meal remains	Nicholson and Jones 1992
Cliff sample 1979, Brough of Birsay (Late Neolithic/early Bronze Age)	Midden	Sieving to 1mm	No	Discussed as likely	Only two bones from large fish, so unlikely but possible	Nicholson 1989
Area 6, Brough of	Midden	Sieving to ?2mm	No	Most likely explanation for almost all of	A few larger bones could represent human	Rackham 1989

Birsay (early Bronze Age)				the fish	activity	
Cuttings 5 and 6, Brough of Birsay (Middle Bronze Age)	Midden	Sieving	No	No	Some of the larger fish, including large gadids, might have been caught by people off shore; presence of butchered seal and domestic mammals indicates anthropogenic assemblage	Rackham *et al.* 1989

Table 16: Latin and common names for species referred to in the text

Common name	Latin name
Dogfish Families	Scyliorhinidae/Squalidae
Dogfish Family	Scyliorhinidae
Ray Family	Rajidae
Eel	*Anguilla anguilla*
Conger Eel	*Conger conger*
Atlantic Herring	*Clupea harengus*
Salmon & Trout Family	Salmonidae
Cod	*Gadus morhua*
Cod Family	Gadidae
Cod/ Saithe/ Pollack	Gadus/Pollachius
Five-bearded/ Northern Rockling	Ciliata
Four Bearded Rockling	*Rhinonemus cimbrius*
Haddock	*Melanogrammus aeglefinus*
Ling	*Molva molva*
Pollack	*Pollachius pollachius*
Rockling	Ciliata/Gaidropsarus
Saithe	*Pollachius virens*
Saithe/ Pollack	Pollachius
Angler?	*Lophius piscatorius?*
Stickleback Family	Gasterosteidae
Three-spined Stickleback	*Gasterosteus aculeatus*
Scorpaeniformes	Scorpaeniformes
Scorpion-fish Family	Scorpaenidae
Gurnard Family	Triglidae
Bull-rout	*Myoxocephalus scorpius*
Sea Scorpion	*Taurulus bubalis*
Sea Scorpion Family	Cottidae
Perch Family	Percidae
Atlantic Horse-mackerel/ Scad	*Trachurus trachurus*
Ballan Wrasse	*Labrus bergylta*
Ballan/Cuckoo wrasse	*Labrus bergylta/Labrus bimaculatus*
Corkwing	*Symphodus (Crenilabrus) melops*
Corkwing wrasse/Goldsinny	*Symphodus (Crenilabrus) melops/Ctenolabrus rupestris*
Cuckoo Wrasse	*Labrus bimaculatus*
Goldsinny	*Ctenolabrus rupestris*
Wrasse Family	Labridae
Eelpout Family	Zoarcidae
Viviparus Eelpout	*Zoarces viviparus*
Butterfish	*Pholis gunnellus*
Blenny Family	Blenniidae
Dragonet	Callionymus
Tiny perciformes	Tiny perciformes
Megrim	*Lepidorhombus whiffiagonis*
Megrim?	*Lepidorhombus whiffiagonis?*
Scaldfish	*Arnoglossus laterna*
Turbot Family	Bothidae
Turbot Family	Scophthalmidae
Halibut Family	Pleuronectidae
Flatfish Order	Heterosomata (Pleuronectiformes)
Perciformes order	Perciformes

Figure 1: Pierced ling abdominal vertebrae, from Trench V, Context 1 (id 708). Dorsal surface broken, possibly caused by piercing device slipping and breaking the vertebral body. Note the series of small overlapping holes, apparently made with an approximately circular device of about 1.5mm diameter. Scale 1cm.

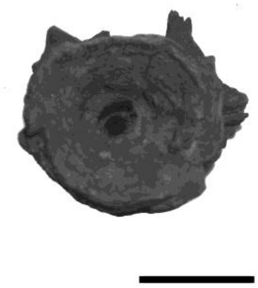

Figure 2: Pierced cod/saithe abdominal vertebra from Trench V, Context 1 (id 731). Scale 1cm.

Figure 3: Pierced ling abdominal vertebra from Trench I, Cell/Compartment 4, Context 4NW (id 240). Scale 1cm.

Figure 4: Example of carnivore gnawing on a ballan wrasse articular, from Trench I, Cell 5, Context 3 (id 10067). Scale 1cm.

Figure 5: Butchered cod caudal vertebra, from Trench V, Context 1 (id 725). Scale 1cm.