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A TAPHONOMIC APPROACH TO RECONSTRUCTING UPPER PALAEOLITHIC HUNTER-GATHERER FISHING STRATEGIES

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A TAPHONOMIC APPROACH TO RECONSTRUCTING UPPER PALAEOLITHIC HUNTER-GATHERER FISHING STRATEGIES

A load of old trout!

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Key words: Fish, Palaeolithic, cave, Italy, Spain, hunter-gatherer, taphonomy, salmon, trout.

In many cases in the past fish bones recovered during archaeological excavations at Upper Palaeolithic sites were often assumed to result from human activity without any consideration for alternate accumulation processes. Many of these assemblages had not been analysed in a scientifically rigorous manner, with some receiving no consideration at all.

A review of current evidence and results of new analyses indicate that salmonids (salmon and trout) are the most frequently recorded fish at the European Palaeolithic cave sites. Two potential accumulation agents for fish remains were explored: brown bears (*Ursus arctos*) and eagle owls (*Bubo bubo*). Controlled feeding experiments integrated with ecological studies indicate that salmonid remains survive the digestive systems of both species and result in distinctive patterning in assemblage characteristics. Post-depositional taphonomic processes, such as trampling, also produce distinct taphonomic signatures and are an agent of differential inter-species preservation. A thorough consideration of depositional and post-depositional processes of archaeological assemblages in central Italy (Grotta di Pozzo, Maritza, La Punta and Ortucchio) and Spain (El Juyo, Altamira, Salitre, Castillo and Rascaño) shows that the fish remains from these sites result from human activity. The over-representation of cranial elements at the Italian sites suggest that fish were processed by removing the head to perhaps smoke or dry before transportation to other locations for consumption.

This research lead to improved methods of analysis, and thus enhanced understanding of the role of fishing and fish consumption in Upper Palaeolithic hunter-gatherer societies.

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Dedication

To Steve Thornton, my A Level Archaeology teacher:
his enthusiasm and knowledge inspired the archaeologist in me and many others.

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Chapter 1: Introduction

1.1 Introduction

Fish remains have been recovered from many European Palaeolithic sites, almost exclusively from cave deposits. These remains offer the opportunity to improve our understanding of fishing and fish consumption by hunter-gatherers during this period. However, there are many challenges that must be overcome so that these remains can be accurately interpreted. Whilst frequently recovered, a full detailed analysis of fish bone assemblages is not often undertaken. For individual sites it is common to see only 'fish' in a list of faunal remains, or a list of fish species present. In both cases number of individual specimen (NISP) values and minimum number of individuals (MNI) are not stated. Discussion of the role of fishing is often considered on a region scale, and is usually limited to a list of sites with 'fish' (e.g. Clark 1983; Straus 1983b; Bietti 1990; Straus *et al.* 2002). Again basic data on species or quantification, site location, dating, spatial distribution, and element representation is omitted – all these factors are needed to fully understand the role of fishing in Palaeolithic subsistence strategies. Chapter 2 of this thesis reviews the published fish remains from over 160 sites in Western Europe, including those in Spain, France, Italy, United Kingdom, Belgium and Switzerland. For two regions; the Fucino Basin, central Italy and Cantabria, northern Spain, access was granted for analysis of fish bone assemblages that had previously not been studied in any detail, see Chapters 6 and 7. This allows patterns in fish exploitation to be identified, questioning regional variation and changes through time in terms of the importance of fish as a dietary resource and the types of fish exploited. Studies of recent hunter-gatherers (see Chapter 3) suggest that where fish are exploited it is the anadromous (migrating between the sea and freshwater for spawning) salmonids (salmon and trout species) that were most valued. This is a result of the reliable spawning time for salmon and trout species. This event provides excellent opportunity for the exploitation of large fish (up to 1.5 m (Robins & Ray 1986)), which at certain points during the migration (when many fish ascend rivers at one time) can be taken from the water by hand. Fish carcasses can also be collected from river edges after spawning. However, while many Pacific forms of salmon (*Oncorhynchus* sp.) are semelparous (Quinn 2005: 6), meaning they only spawn once in a lifetime, Atlantic salmon (*Salmo salar*, see Figure 1.1) are able to spawn several times (Rochard & Elie 1994), suggesting that, while collection of salmon carcasses in Pacific regions might provide a good source of fish, in Atlantic regions these specimens are likely to be old, in less than prime condition, and much fewer in quantity. For Atlantic salmon, potentially a critical species in Palaeolithic fish exploitation, after hatching the young (fry and later, parr) remain in freshwater for between one and six years, this time spent in freshwater before migration out to sea correlates with river temperature (Rochard & Elie 1994). The migration of young salmon (smolts) to the sea also presents an opportunity for exploitation, however, the fish are small (11-16 cm TL) at this time. During the marine phase the fish mature, becoming very large, returning to spawning grounds after one to four years at sea (Rochard & Elie 1994). Today Atlantic salmon are usually found in rivers where temperature rises above 10° C for about 3 months a year, but where temperatures do not exceed 20° C for more than a month during the summer (Kottelat & Freyhof 2007). Sea trout (*Salmo trutta trutta*) have a similar life cycle to the Atlantic salmon, migrating between freshwater and marine environments to spawn, although the timing differs slightly with sea trout spending one to five years in fresh water and 6 months to 5 years in the marine environment (Rochard & Elie 1994). Similarly, brown trout (*Salmo trutta fario*) also migrate up river to spawn, but this species does not routinely enter a marine environment at any point during its life cycle, except for on rare occasion when they may enter brackish waters in search of food (Adamson 1955). Given their reliable spawning behaviour and the preferential exploitation of salmonids over other fish species in recent hunter-gatherer populations, this pattern might also be expected during the Palaeolithic period.

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Figure 1.1: The life cycle of the Atlantic salmon (*Salmo salar*) and sea trout (*Salmo trutta trutta*). Source: North Atlantic Salmon Conservation Organization NASCO: http://www.nasco.int/atlanticsalmon.html

In the past fish remains have often been attributed to human activity based on their association with artefacts and other faunal remains that can be more readily attributed to human agency through the identification of cut-marks and other cultural modifications. While some studies have gone to great lengths to rule out the possibility of non-human deposition (Van Neer & Morales 1992; Van Neer *et al.* 2007; Le Gall 2008; Rambaud & Laroulandie 2009), many have given little consideration for alternate processes which may lead to the accumulation of fish remains, especially in cave deposits. While alternate accumulation agents are now being proposed (e.g. Erlandson 2001; Erlandson & Moss 2001; Moss & Erlandson 2002; Van Neer *et al.* 2007; Adán *et al.* 2009) the fish remains themselves are also being considered in more detail (e.g. Butler 1987; Stewart 1989; Butler 1993; Stewart 1994; Van Neer 1997; Van Neer *et al.* 2007; Le Gall 2008; Russ *et al.* 2008; Russ & Jones 2009). These detailed studies conclude that it is often difficult to attribute fish remains to human activity, suggesting that the assumptions made regarding agency for fish bone deposition were made too hastily. Ethnographic and ethnohistoric data is often used in the interpretation of fish bone assemblages, but could this data also be used to produce criteria for the recognition of human accumulations of fish remains from those deposited by animals or fluvial processes? Chapter 3 reviews the fishing behaviour of recent hunter-gatherer populations in North America, Canada and northern Europe in an attempt to recognise patterns in species exploitation, fishing methods, fish processing and disposal of fish waste that can be used to construct a theoretical taphonomic signature for human agency in fish deposits.

Several authors have specifically addressed the problem of distinguishing fish remains that have been deposited by humans from those deposited by natural processes (e.g. Butler 1987; 1990; Stewart 1991; Butler 1993; Stewart 1994; Stewart & Gifford-Gonzalez 1994; Erlandson 2001). These studies have provided some criteria for attempting to recognise natural accumulations for the geographic areas and periods on which they focus. However, while these studies offer valuable contributions to the field, they do not adequately cover the variety of site formation and post-depositional processes that can impact upon fish remains prior to or post-deposition, see Chapter 4. One area which requires further research is in the understanding of the impacts of piscivorous and fish eating faunas on archaeological sites. Erlandson and Moss (Erlandson 2001; Erlandson & Moss 2001; Moss & Erlandson 2002) consider non-human faunas and the effects these animals have on formation processes on coastal sites in the United States of America. To date they have offered a list of species that can be identified as potential accumulation agents at coastal sites based on documentary records. While they identify several species that are also potential accumulators for fish bone assemblages from European Late Pleistocene caves, there are many more that need to be recognised for this period, geographical location and site type. It is now necessary to move beyond a list of potential accumulators and begin to understand the characteristics or 'taphonomic signature' of fish bone assemblages produced by these animals and investigate the extent to which specific accumulation agents can be identified in the archaeological record. Without such research we are limited to presenting a host of possibilities for the presence of fish remains and unable to advance our understanding of human fish consumption during the Upper Palaeolithic. This thesis considers two potential non-human fish accumulation agents; bears (*Ursus* spp.) and the Eurasian eagle owl (*Bubo bubo*) in order to close some of the gaps in actualistic research considering fish remains, improving methods for identifying accumulation agents.

Where fish remains have been studied in detail it is common for the skeletal part representation to be taken into consideration. Most frequently this is used to suggest fish processing activities (Stewart & Gifford-Gonzalez 1994; Van Neer & Pieters 1997; Zohar *et al.* 2001; Russ *et al.* 2008; Russ & Jones 2009), for example where cranial elements are abundant and vertebrae are rare, it could be suggested that this is the result of people removing the heads of the fish and leaving them at the site while the flesh, containing the vertebrae, is transported away from the site for consumption elsewhere. This interpretation implies that some method of preservation; drying or smoking, was used because fresh fish spoils very quickly if not preserved in some way. Likewise, the absence of cranial elements might be interpreted as the use of pre-preserved fish brought from another location. But potentially these patterns may not result from the actions of humans, but through natural depositional and post-depositional processes that variably affect the different skeletal elements of fish. Similarly, these processes may affect the bones of different species in different ways, potentially leading to biases in preservation and therefore species representivity at archaeological sites. Discussion of the variation in fish bone physical and chemical properties and taphonomic processes (Chapter 4) and experimental investigation of trampling; a poorly understood but critically important post-depositional taphonomic process (Chapter 5), investigate whether patterns in species and skeletal part representation observed in archaeological assemblages does in fact result from human prey choices and fish processing, or if taphonomic factors are responsible.

The Upper Palaeolithic appears to be period when a diversification in the exploitation of dietary resources occurs; this is referred to as the broad spectrum revolution (BSR)

(Stiner *et al.* 1999; Stiner *et al.* 2000; Stiner 2001; Weiss *et al.* 2004). The BSR sees a shift away from specialised exploitation of large and medium sized mammals to a focus on smaller prey beginning in the Middle Palaeolithic in the Mediterranean Basin progressing through Europe through the Upper Palaeolithic (Stiner 2001). The broad spectrum diet included hares (*Lepus* sp.), rabbits (*Oryctolagus cuniculus*), Alpine marmot (*Marmota marmota*), birds (Aves, including their eggs), reptiles (Reptilia, including tortoise), terrestrial and marine molluscs (e.g. Stiner 2001: 6994). This shift to a broad spectrum diet is thought to result from either population pressure, or changes in climatic and environmental conditions, or a combination of these (Stiner *et al.* 1999). However, the impact of these factors on the role of fish during this period, and therefore in the broad spectrum diet has yet to be understood. Fish may have been a reliable nutritious resource (see Table 1.1) which could be easily procured with minimal technology. The spawning period for anadromous salmonids sees great numbers ascending rivers and streams from the sea or from lake environments. The absence of fish in BSR discussions likely results from limited documentation and understanding of fish remains (reviewed previously in this chapter) that have been recovered from archaeological deposits of this date.

	Calories (kcal)	Fat	Sodium	Protein	Vitamins (% daily value)
Salmon (wild - raw)	142	6 g	44 mg	20 g	Vitamin A 1% Calcium 1% Iron 4%
Flatfish (raw)	91	1 g	81 mg	19 g	Vitamin A 1% Calcium 2% Iron 2% Vitamin C 3%
Deer (raw)	120	2 g	51 mg	23 g	Calcium 1% Iron 19%
Terrestrial mollusc (raw)	90	1 g	70 mg	16 g	Vitamin A 2% Calcium 1% Iron 19%
Rabbit (wild – raw)	114	2 g	50 mg	22 g	Calcium 1% Iron 18%
Limpets (raw)	85	0 g	660 mg	17 g	-
Horse (raw)	133	5 g	53 mg	21 g	Calcium 1% Vitamin C 2% Iron 21%
Bison (raw)	223	16 g	66 mg	19 g	Calcium 1% Iron 19%
Boar (wild – raw)	122	3 g	0 mg	22 g	Calcium 1%

Table 1.1: Nutritional values for selected foods exploited during the Upper Palaeolithic. All values per 100 g. Source: www.nutritiondata.self.com.

1.2 Hypotheses

Based on current understanding of fish bone accumulations and hunter-gatherer subsistence strategies during the Palaeolithic, especially the Upper Palaeolithic, several hypotheses regarding the role of fish during this period can be proposed:

Hypothesis 1

'Some fish bone assemblages currently interpreted as human accumulations were deposited by non-human agents'.

Hypothesis 2

‘Element representation patterns that could be used to identify fish processing sites can be explained by natural taphonomic processes’

Hypothesis 3

‘Ethnographic and ethnohistorical accounts of recent hunter-gatherers can be used to construct a taphonomic signature for identifying human agency for fish remains’.

Hypothesis 4

‘Salmonid exploitation coincided with a broadening of diet (BSR) *seen during the Upper Palaeolithic in Europe; it had a direct impact on hunter-gatherer subsistence and mobility strategies’.*

1.3 Objectives

In order to test the proposed hypotheses several objectives were identified. Each chapter of this thesis addresses one of the objectives stated below.

- To review the current data for fish remains from Palaeolithic sites in Western Europe.
- Considering the value of ethnographic and enthnohistoric data in identification of human agency and the interpretation of Prehistoric fish bone assemblages.
- Understanding taphonomic processes applicable to fish bones.
- Providing new data for the recognition of fish bones deposited by non-human faunas through controlled feeding experiments with potential accumulation species; bears (*Ursus* spp.) and the Eurasian eagle owl (*Bubo bubo*).

- Assessing the impact of post-depositional processes, such as trampling though experimentation.
- Increasing the number of sites with detailed site reports through analysis and re-analysis of Upper Palaeolithic fish bone assemblage from two regions within the overall study area; the Fucino Basin, central Italy and Cantabria, northern Spain.
- Integration of fish bone data for Palaeolithic Western Europe with climate proxies, including ice core, sea level and glacier activity data, to explain factors effecting variation in fishing activity.

Each hypothesis is discussed in Chapter 8 citing evidence presented in earlier chapters. Conclusions regarding the role of fishing in Palaeolithic hunter-gatherer subsistence strategies in western Europe are presented in Section 8.2; based on the data presented in this thesis further hypotheses are proposed.

Chapter 2. Fishing and subsistence in the Palaeolithic: an overview

To assess the visibility of fish in the archaeological record a review of sites with fish remains dating to the Palaeolithic period (c.2.5 million years ago to c. 10,000 years ago) have been considered. To do this the sites have been divided into Lower, Middle and Upper Palaeolithic periods and discussed in chronological order.

2.1 Lower Palaeolithic fish remains

Several Lower Palaeolithic sites (between c. 2.5 million years ago to c. 300,000 years ago) in Africa have yielded fish remains. They include Lokalalei, Senga, Kanjera, nine locations in East Turkana and eleven locations at Olduvai Gorge. The fish remains from sites at Olduvai Gorge (FLKNN level 3, FLK-*Zinj* and BK) have been suggested to represent remains deposited by early hominins based on seven characteristics:

1) Riverine or delta locations
2) Low taxonomic diversity
3) Selective exploitation of seasonally spawning taxa
4) Taxa that can be easily procured with little or no technology
5) Skewed skeletal element representation
6) Repeated occupation of site
7) Bone modification

(Stewart 1994: 243)

These criteria were based on analysis of fish remains from Late Pleistocene sites in Africa which could be more reliably attributed to human activity, including Gogo Falls, White Paintings, Ishango, Kom Ombo, Khor Musa, Wadi Kubbaniya and Isna (Stewart 1989; 1994). They are based largely on distinguishing fluvial deposits of fish remains from anthropogenic deposits but non-hominin fish bone accumulators, which can produce assemblages which fulfil these criteria, were not considered.

Sites in the UK dating to the Lower Palaeolithic have also yielded fish remains; including West Runton (Stuart & Lister 2001), Boxgrove (Pitts & Roberts 1998; Roberts & Parfitt 1999), Stanton Harcourt (Buckingham *et al.* 1996), Hoxne (Stuart *et al.* 1993) and Southfleet Road (Wenban-Smith *et al.* 2006). Also in Germany at Bilzingsleben a site dating to the Lower Palaeolithic with freshwater fish remains dominated by cyprinids (carp family), specifically *Tinca tinca* (tench) (Böhme 1998). These assemblages are considered to represent natural deposits because many of the sites were once river or coastal beds. There has not been any detailed consideration for possible hominin accumulation of fish bones in these cases, except for in the case of Boxgrove where Erlandson (2001) discusses a positive correlation between the spatial distribution of fish and artefactual remains. No further investigation of this observation has yet been carried out.

2.2 Middle Palaeolithic fish remains

Sites dating to the Middle Palaeolithic (c. 300,000 to c. 30,000 years ago) with fish remains remain rare. They fall into two categories, 1) cave sites with Middle Palaeolithic deposits containing tools of the Mousterian tool type and also fish remains, and 2) open air sites that once were the location of a body of water, but are now above the water table where archaeological evidence and fish remains are present. For (1) the consensus is that although the fish remains come from deposits that also contain evidence for archaic human activity in the form of stone tools, and often other faunal remains, it is currently not possible to ascertain human agency. For (2), the assumption is that the fish remains in these sites result from the natural deposition of fish which occurred when the sites transformed from an aqueous environment (lake or river bed) to dry land.

In total, a review of Middle Palaeolithic sites yielded 24 sites with fish remains across Western Europe, the majority of which were located in Spain and France. These sites date to the end of the Middle Palaeolithic, from c. 40,000 – 35,000 cal BP and are all associated with Neanderthal occupation layers.

In Spain, fish remains were recovered from Mousterian deposits at Cueva Millán, Tito Bustillo, Cueva del Castillo, Arbreda Cave, Cueva de Amalda and Cova dels Ermitons. There are also two Mousterian sites, Gorham's Cave and Vanguard Cave, with fish remains on Gibraltar. With 289 fish bone and fish bone fragments from Mousterian levels, Cueva Millán has the largest fish bone assemblage for this period (Morales-Muñiz 1984; Rosello-Izquierdo & Morales-Muñiz 2005). Species diversity is low, with only trout (*Salmo trutta*), Iberian nase (*Chondrostoma polylepis*) and European eel (*Anguilla anguilla*) being recorded. The assemblage is dominated by trout with high representation of vertebrae and very few cranial elements for all three species. Tito Bustillo is also dominated by trout remains, and again vertebrae presence is high. In total 125 fish remains were recovered from the Mousterian deposits, 123 of which represented trout with only single bones identified as Atlantic salmon (*Salmo salar*) and flatfish, (Pleuronectidae) (Morales-Muñiz 1984; Adán *et al.* 2009). Mousterian deposits at Cueva del Castillo yielded at least 24 fish remains (see Chapter 7). All the remains are vertebrae and the assemblage is dominated by *Salmo* sp. ranging from very small to around 85cm in total length. Arbreda Cave has a long sequence of deposits from the Mousterian to the end of the Upper Palaeolithic, yielding a total of 504 fish bone and fish bone fragments. However only 16 of these come from

Mousterian deposits, they include remains of *Salmo* sp. (including *Salmo trutta fario* – brown trout), European eel, barbel (*Barbus* sp.) and European chub (*Squalius cephalus*), with European eel dominating (Muñoz & Casadevall 1997; Rosello-Izquierdo & Morales-Muñiz 2005). Excavations at Cova Amalda yielded just three fragments of fish bone from Mousterian deposits, all of these were identified as *Salmo* sp., therefore representing either salmon or trout (Rosello-Izquierdo & Morales-Muñiz 2005). At Cova dels Ermitons a single fish bone was recovered from Mousterian deposits, if has been identified as brown trout (Rosello-Izquierdo & Morales-Muñiz 2005).

Mousterian deposits at Gorham's Cave, Gibraltar, yielded two fragments of fish bone (Stringer *et al.* 2008). Fish remains are also recorded in Mousterian deposits at Vanguard Cave, Gibraltar, with at least one fragment of a sea bream species (*Diplodus sargus/vulgaris*) present (Stringer *et al.* 2008: 14322-14323).

Two cave sites in Belgium; Caverne Marie-Jeanne (Gautier & Heinzelin 1980; Van Neer 1997) and Grotte Walou (Van Neer & Wouters 2007; Le Gall 2008) have yielded fish remains in association with Mousterian tool forms; again due to small sample size there is little discussion of the implications of their presence in terms of hominin subsistence.

Twelve Middle Palaeolithic sites with fish remains are known in France; Baume de Gigny, Grotte de la Carrière, Grotte de la Cure, Erguillère-Pont-Racine, Les Fieux, Grotte Mandrin, Grotte du Noisetier, Abri Olha, Pair-Non-Pair, Grotte du Salpêtre, Abri Vaufrey and an unnamed site in the Savoie region. The fish remains from many of the sites have been studied by Olivier Le Gall. Some of the sites yield a wide range of freshwater species, for example at Abri Vaufrey where nine species are recorded;

salmon, trout, European eel, grayling, pike, perch, European chub, dace and roach (Le Gall 1988a; b; 1992b; 1994).

In Germany fish remains were recovered from Middle Palaeolithic deposits at Kogelstein. All fish remains represented freshwater species and were dominated by grayling (Böttcher *et al.* 2000), like at other Middle Palaeolithic sites these are thought to have resulted from natural processes.

At Pin Hole Cave at Creswell Crags fish remains have been recovered from deposits containing Mousterian stone tools. Armstrong (1928) comments that:

> "*the frequency of remains of pike and roach in the Mousterian 2 and 3 zones points to the occupation having been resumed whilst lake conditions still prevailed in the gorge*" (Armstrong 1928: 333).

However, later analysis of the Pin Hole fish bone assemblage does not recognise any roach (*Rutilus rutilus*) remains at the site in deposits of any age (Jenkinson 1984: 122). The lower levels of Pin Hole Cave according to analysis by Jenkinson (1984) are dominated by pike (*Esox lucius*) and grayling (*Thymallus thymallus*) remains, the only other species represented is one cyprinid. Minimum number of individuals (MNI) for the Mousterian deposits is 25; no number of individual specimen (NISP) values are presented.

Because the assemblages dating to the Middle Palaeolithic are so small (even the NISP of 289 at Cueva Millán, Spain gives an MNI of only 28) an interpretation of their role in Neanderthal subsistence in Western Europe remains difficult.

2.3 Upper Palaeolithic fish remains

Fish remains become more frequent in European sites around the onset of the Upper Palaeolithic, c. 40,000 BP. This review focuses on sites in Western Europe, including Spain, France, United Kingdom, Belgium, Germany, Switzerland and Italy. A detailed account of the fish remains from each of the sites identified in these countries can be found in Appendix I, a further list of sites that have fish remains that have been attributed to species can be found in Appendix II. The sites will be discussed first in terms of geographic region and by date from the earliest (Early Upper Palaeolithic or Châtelperronian) to latest (Late Upper Palaeolithic or Azillian). Where every attempt has been made to use radiocarbon or other radiometric dates for sites included in this review it has not been possible for every site. For sites where radiocarbon dates are not available sites were assigned a cultural period based on stone tool typologies. Table 2.1 outlines the cultural periods and ages used in this review. While it is acknowledged that the use of these terms is not precise for age determinations, in the absence of absolute dates, they at least allow broad comparisons across Western Europe. For each region discussed a detailed literature search for sites with fish bones from Upper Palaeolithic deposits was undertaken, however, it is likely that some sites have been missed. In some cases this is due to absence of reporting on fish remains, and others are through the volume of published excavation records for these regions that it would be near impossible to find them all. To date, this thesis presents the only collation of information regarding fish remains from Upper Palaeolithic sites covering the Western Europe region.

<table>
<tr><th>Date</th><th>Time Period</th><th>Italy</th><th>France and Spain</th></tr>
<tr><td>300,000 – 30,000 BP</td><td>Middle Palaeolithic</td><td colspan="2">Mousterian</td></tr>
<tr><td>35,000 – 29,000 BP</td><td rowspan="6">Upper Palaeolithic</td><td>Uluzzian</td><td>Châtelperronian</td></tr>
<tr><td>32,000 – 26,000 BP</td><td colspan="2">Aurignacian</td></tr>
<tr><td>28,000 – 22,000 BP</td><td colspan="2">Gravettian</td></tr>
<tr><td>21,000 – 17,000 BP</td><td rowspan="2">Epigravettian</td><td>Solutrean</td></tr>
<tr><td>18,000 – 10,000 BP</td><td>Magdalenian</td></tr>
<tr><td>c. 10,000 BP</td><td>Epi-Palaeolithic</td><td>Azilian</td></tr>
</table>

Table 2.1: Summary of cultural periods for Western Europe.

Fish taxonomy is a complex matter, and some changes in accepted scientific names have occurred which makes comparing previously published assemblages difficult. One of the main changes for species recorded at Upper Palaeolithic sites is for European chub which previously was called *Leuciscus cephalus,* but is now regarded as *Squalius cephalus*. This presents a problem as many cyprinid remains can only be identified at genus level; previous studies have often grouped remains into a '*Leuciscus* sp.' category which included European chub (then *Leuciscus cephalus*), orfe/ide *(Leuciscus idus)* and common dace (*Leuciscus leuciscus*). For purposes of this research the *Leuciscus* sp. category will be referred to as *Leuciscus/Squalius* sp. and include the three species as listed above.

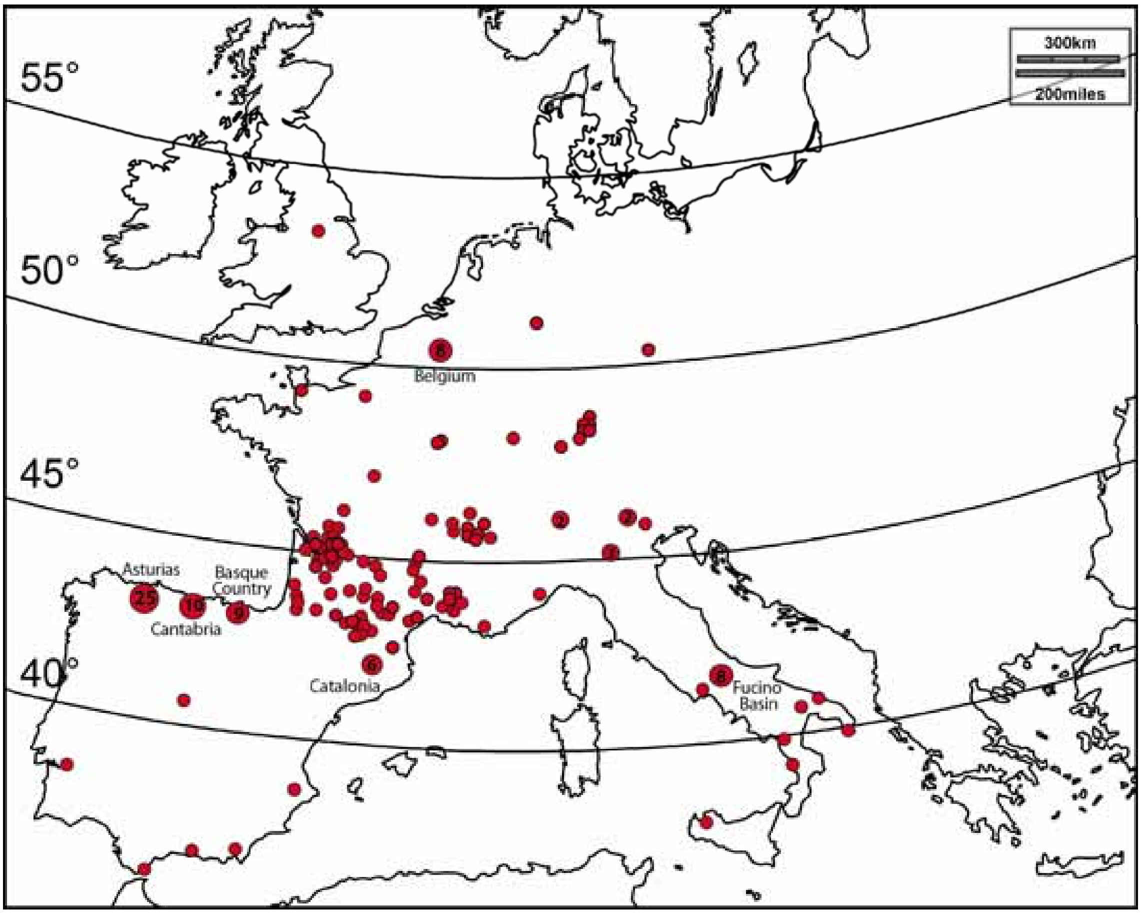

Figure 2.1: Location of Upper Palaeolithic sites in Portugal, Spain, Gibraltar, France, United Kingdom, Belgium, Switzerland, Germany, Italy and Sicily, with identified fish remains with latitude. Base map source: d-maps.com: http://d-maps.com/carte.php?lib=western_and_central_europe_map&num_car=2249&lang=en

Methods applied during the excavation of archaeological sites have improved greatly in the past few decades. While this is good news for site excavated in recent times, many of the sites discussed in this thesis were excavated between 1900 and 1970. During these years it was not common for sediments to be sieved, or for samples to be taken. Therefore, many fish bones (and other smaller archaeological remains) are likely to have been missed, or a biased created towards larger fish species. It is difficult to account for this problem which affects all countries studied here.

2.3.1 The Iberian Peninsula (Spain, Portugal and Gibraltar)

A total of 58 sites in Spain, one in Portugal and one in Gibraltar have fish remains from Upper Palaeolithic deposits. However, for the 60 sites identified only 22 (including Picareiro Cave in Portugal) have any published information about the species present. While the remains from an additional six sites (Aitzbitarte, El Buxu, Las Caldas, Mazaculos, Santa Catalina and Santimamiñe) are currently under analysis by Arturo Morales Muñiz (Universidad Autónoma de Madrid)**,** and remains from a further five sites are presented in this thesis (Chapter 7), there still remain a large proportion (44%) of Spanish Palaeolithic fish bone assemblages that have not been studied, or are as yet unpublished. This review concentrates on the 22 Spanish sites where either basic or detailed analysis of the fish remains has been undertaken (i.e. at least a species list is given). Cueva de Nerja is discussed separately due to the variation observed at this site in comparison with all the other Upper Palaeolithic Spanish sites.

Because detailed information regarding number of individual specimens (NISP) minimum number of individuals (MNI), size estimation and taphonomic data is unavailable, even for the 22 sites where species have been identified, the best way to consider the occurrence of different fish is to record their presence and absence at sites. Figure 2.2 shows that when fish groups are considered in terms of how frequently they are recorded, *Salmo* sp. are by far the most common taxon in Spanish Upper Palaeolithic assemblages. Cyprinids, which here include European chub (*Squalius cephalus*), roach (*Rutilus rutilus*), carp (*Cyprinus carpio*) and barbel (*Barbus* sp.), and Pleuronectiforms, which include sole (*Solea* sp.) and other unidentified flatfish feature in only six assemblages each.

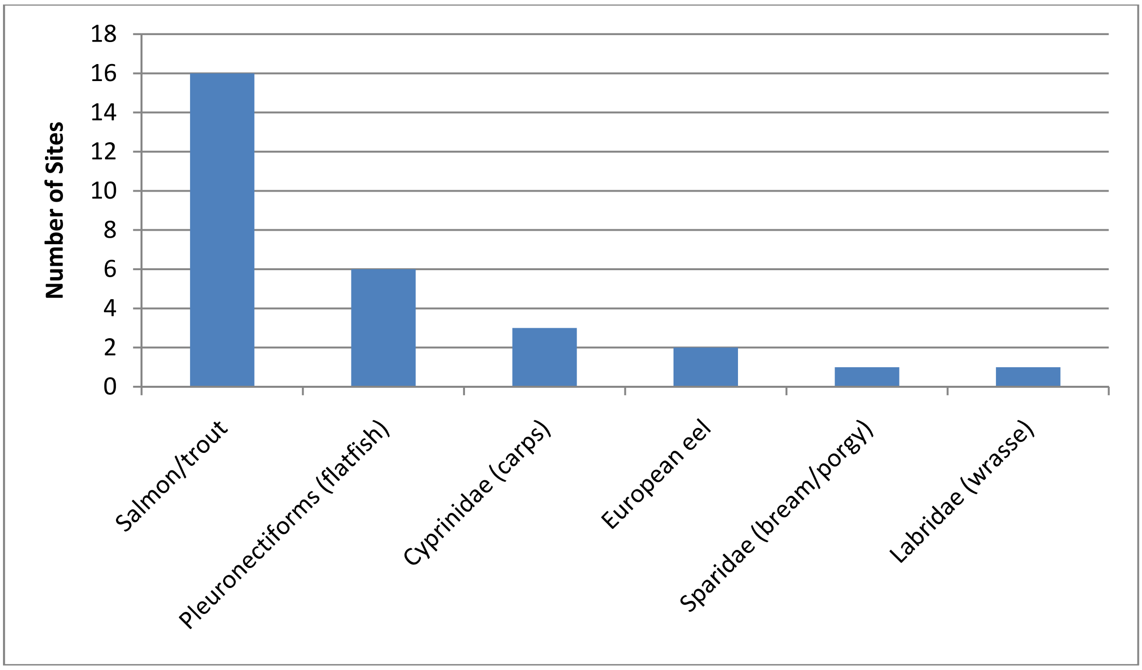

Figure 2.2: Summary of fish types recorded at Spanish Upper Palaeolithic cave sites.

The species diversity for the Spanish assemblages is low, especially if the fact that sea bream/porgy (Sparidae) and wrasse (Labridae) were each only recovered at one site (other than at Cueva de Nerja). These represent the only true marine species and were recovered from the Late Upper Palaeolithic deposits at La Riera (sea bream/porgy) (Straus *et al.* 1981; González Morales 1982; Clark 1983; Straus 1983a; b; Straus & Clark 1986; Pokines & Krupa 1997; Straus 2005; Adán *et al.* 2009) and Mazaculos (wrasse) (González Morales 1982; Adán *et al.* 2009).

The Spanish assemblages most frequently contain remains of *Salmo* sp., which in this case refer to Atlantic salmon (*Salmo salar*) and trout; both sea trout (*Salmo trutta trutta*) and brown trout (*Salmo trutta fario*). Of the 16 sites recording the presence of salmonids, 9 specifically identify the remains of Atlantic salmon and 8 have trout. Differentiation between these species is difficult in skeletal remains; the reliability of these identifications may be questioned. However, despite this fact the data still indicates that salmon and trout were the most frequently recorded species.

Cueva de Nerja stands out from the other Spanish sites for several reasons. The number of taxa for fish from the Upper Palaeolithic deposits (Epipalaeolithic dating to 13,780 – 12,695 cal BP and Upper Palaeolithic dating to 18,900 – 16,700 cal BP) at the site is very high, with 18 species representing 11 families being recorded, this differs from other Spanish site of this date which at most feature fish from 3 families. Unlike the other Spanish sites the fish species at Cueva de Nerja are exclusively marine (Morales-Muñiz *et al.* 1994; Morales-Muñiz & Roselló-Izquierdo 2004; 2008), the only anadromous (i.e. entering freshwater to spawn) species being Atlantic/European sturgeon (*Acipenser sturio*). Fish of the family Sparidae (sea breams and porgies) dominate the assemblage; this is thought to have resulted from a particular abundance of the common pandora (*Pagellus erythrinus*) at this time. The cave is located only 1km from the current coastline, which may explain the dominance of marine species in the Cueva de Nerja assemblage. However, other cave sites included in this review are also close to the coast and do not yield marine species. Neither can the difference result from sampling or recovery strategies as those employed at Cueva de Nerja are comparable with those used at some of the other sites. The remains from this site indicate different fish exploitation strategy was being employed.

2.3.2 France

In France 91 Upper Palaeolithic sites with fish remains have been identified. They are concentrated in the south-west region. Details of the fish remains from 22 of the French sites do not include a species list. Like in the Spanish sites, *Salmo* sp. are the most frequently recorded fish group, Figure 2.3. However, a more diverse range of freshwater fish species are recorded. Cyprinids in general (which for the French sites include those as listed for the Spanish sites with the additional of common dace (*Leuciscus leuciscus*) and shad (*Alosa* sp.) are more frequently recorded in France than in Spain. Additional species seen in France which are not recorded in any Upper Palaeolithic site in Spain include pike (*Esox lucius*), grayling (*Thymallus thymallus*), burbot (*Lota lota*), European perch (*Perca fluviatilis*) and whitefish (*Coregonus* sp.). At two late Upper Palaeolithic sites (La Crouzade and Abri-sous-roche de Pointe du Rozel) there is evidence for marine exploitation on a small scale by the presence of sparidae and labridae species.

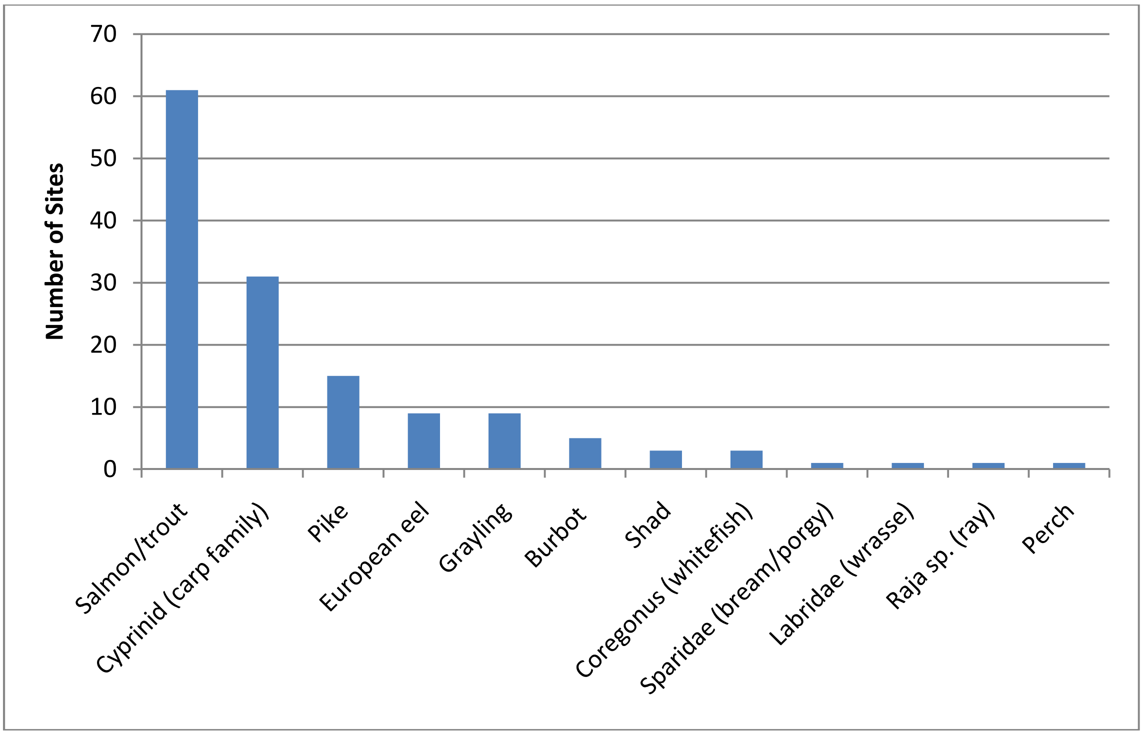

Figure 2.3: Summary of fish types recorded at French Upper Palaeolithic cave sites.

At the majority of sites marine species are not recorded at any of the French Upper Palaeolithic sites considered in this research. Shad (*Alosa* sp.) are a marine species, however, adults enter rivers to spawn, with the young remaining in the freshwater environment for several years after hatching. Eels also spend some time in a marine environment, where they spawn after spending several years in freshwater or estuarine environments. All the species recorded at Upper Palaeolithic French sites could have been procured from freshwater. The absence of any true marine species, the inland locations of many of the French sites and the increase in number of species suggests that sea fishing did not form part of subsistence strategies.

2.3.3 United Kingdom

Very few sites in the UK that have yielded Upper Palaeolithic archaeological remains have also yielded fish bone assemblages, this is probably linked to the fact that there are generally fewer Upper Palaeolithic cave sites in the UK. The only site with Upper Palaeolithic deposits with fish remains is Pin Hole Cave at Creswell Crags. As previously mentioned, Mousterian deposits in Pin Hole Cave yielded pike (*Esox lucius*), grayling (*Thymallus thymallus*) and cyprinid remains (Jenkinson 1984). Upper Palaeolithic deposits at the site also yielded pike, grayling and cyprinid remains, but also perch (*Perca* sp.), European chub (*Squalius cephalus*), salmon or trout (*Salmo* sp.) and flounder (*Platichthys flesus*). Only MNI values are presented, these indicate that in total 16 fish are represented in the Upper Palaeolithic deposits. These assemblages are dominated by pike and grayling.

2.3.4 Belgium

Seven Upper Palaeolithic cave sites in Belgium with fish remains have undergone detailed identification and analysis (Giltay 1931; Van Neer 1997; Van Neer & Wouters 2007; Van Neer *et al.* 2007; Le Gall 2008). Figure 2.4 summarises the fish remains recovered from Upper Palaeolithic deposits at the seven Belgian sites. As in the French sites, marine species are absent from the Belgian deposits. However, in contrast with the French and Spanish data there is not an overall dominance of *Salmo* sp. In Belgium it seems that other freshwater species, notably grayling (*Thymallus thymallus*) and burbot (*Lota lota*) have been identified at the same number of sites as *Salmo* sp. Belgium has the only Upper Palaeolithic site, Néviau, where catfish (*Silurus glanis*) remains have been recovered (Giltay 1931; Van Neer 1997), however, Van Neer and Ervynck question its attribution to this period (Van Neer & Ervynck 2009).

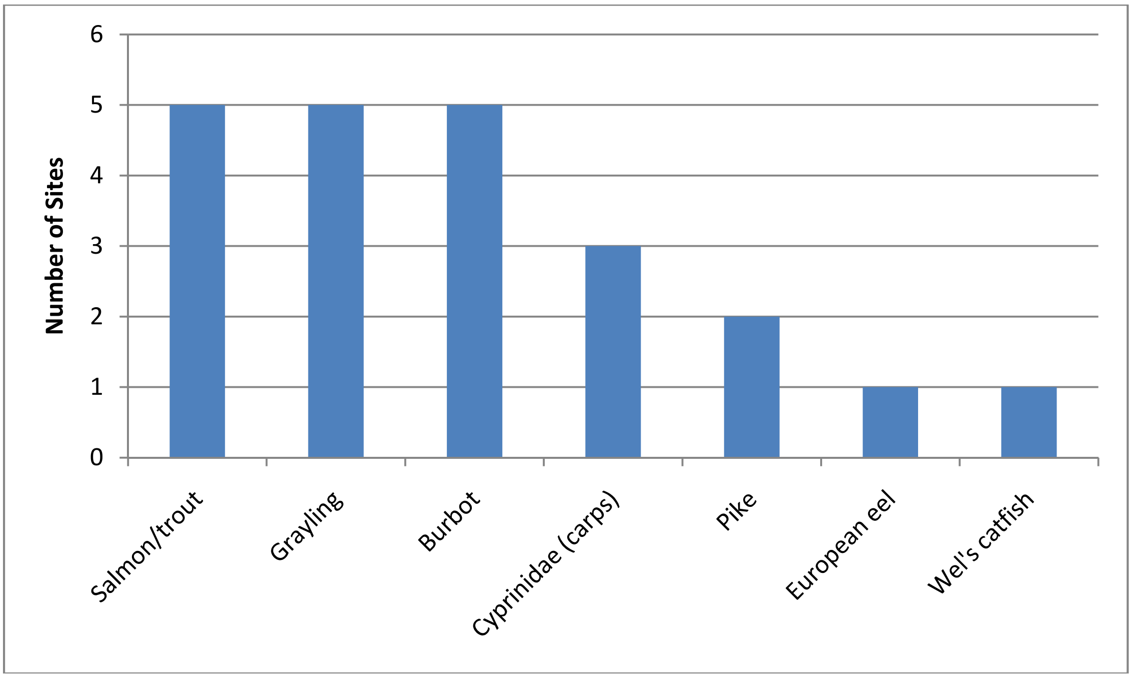

Figure 2.4: Summary of fish types recorded at Belgian Upper Palaeolithic cave sites.

2.3.5 Switzerland

Just two sites in Switzerland could be included in this review; unlike elsewhere the two Swiss sites are open air. They are located near the edge of Lake Neuchâtel, the preservation of the sites results from an increased lake level soon after the areas had been occupied. Fish remains from both sites were studied by Werner Müller (2008). Remains of burbot (*Lota lota*) dominate at Champréveyres, however, while present at Monruz, the four species recorded at this site (burbot, grayling (*Thymallus thymallus*), Arctic char (*Salvelinus alpinus*) and Salmonidae (which at this site may include trout, grayling and Arctic char) are more equally represented. The scales of grayling were recovered from both sites, but are much more abundant at Monruz (765 scales at Monruz, 2 scales at Champréveyres). Although based on only two sites the species represented are more comparable with those usually recovered from Belgian Upper Palaeolithic sites, than those in France and Spain. The main difference is the frequent occurrence of burbot and grayling at Swiss and Belgian sites, species which are absent in the Spanish sites and rare in the French sites.

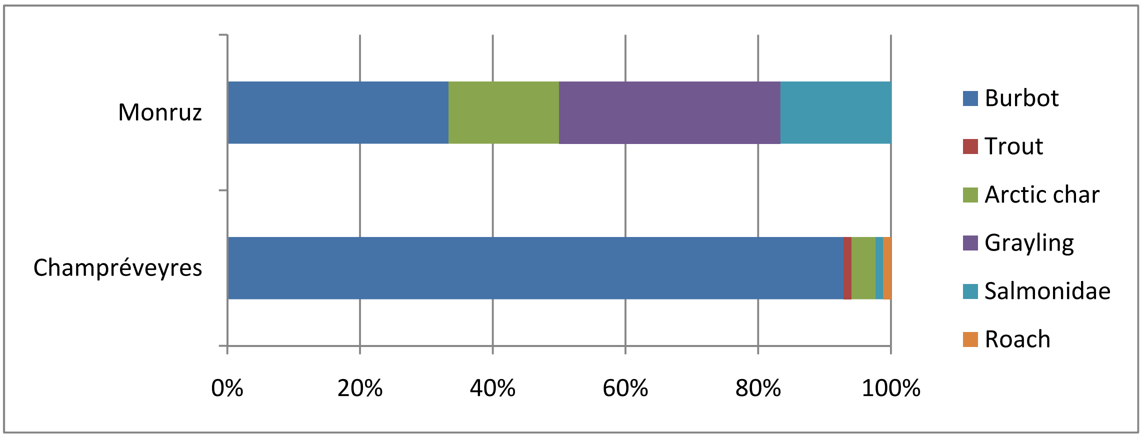

Figure 2.5: Fish remains from the Swiss Upper Palaeolithic sites of Champréveyres and Monruz. Data from Müller (2008: 306).

2.3.6 Italy and Sicily

In total 21 Upper Palaeolithic sites have yielded fish bone assemblages in Italy, and 1 site in Sicily. Twelve sites do not have any detailed information regarding fish species present. All the sites with a detailed analysis of the fish remains have trout, except Riparo Cogola, which is thought to be accumulated by carnivores or owls (Albertini & Tagliacozzo 2004b). The pattern in Italy more closely resembles that seen in France and Spain with *Salmo* sp. by far the most frequently recorded species. Although no pike remains have been reported from Spanish Upper Palaeolithic sites, the rest of the Italian species match well with those observed in French and Spanish deposits.

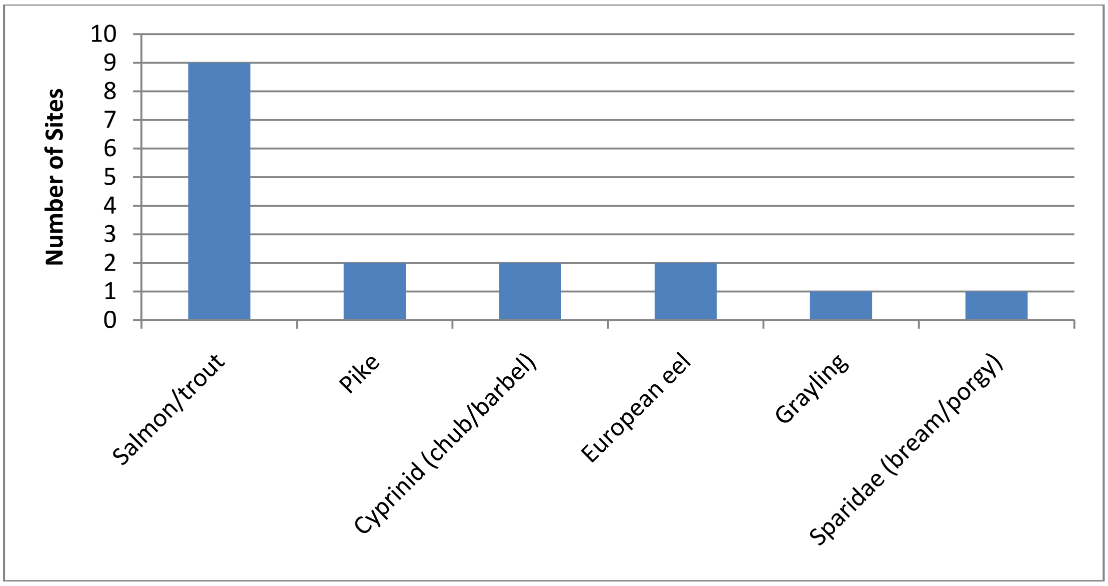

Figure 2.6: Summary of fish types recorded at Italian Upper Palaeolithic cave sites.

2.3.7 Germany

Upper Palaeolithic freshwater fish remains from German sites have mostly been studied by Wolfgang Torke (Torke 1981; 1998). Early Upper Palaeolithic remains were recovered from Aurignacian contexts at Geissenklösterle (GH 11-19 (not 17)) (Torke 1981; Hahn 1988; Torke 1998; Münzel 2001; Münzel & Conard 2004), a site where fish remains are present throughout the Upper Palaeolithic period from the Aurignacian to the Magdalenian (Torke 1998). Freshwater fish have been recorded in Gravettian contexts at Brillenhöhle (V-VII), Höhle Fels (AH IIb-d and AH III) and Geissenklösterle (GH5-9) (Torke 1981; 1998; Hahn 2000; Hockett & Haws 2005; Smith 2007). Fish remains were also found in Magdalenien contexts at Geissenklösterle, Malerfels (GH GK), Felsställe (IIIb), Spitzbubenhöhle (8/9), Höhle Fels (AH I), Buttentalhöhle and Zigeunerfels (H), and in final Magdalenian contexts at Burghöhle (455-300), Zigeunerfels (D-G) and Brillenhöhle (IV) (Torke 1998: 241). The overall species represented are similar to those seen in Belgium and Switzerland during the Upper Palaeolithic (Figure 2.7), with high representation of grayling and burbot and presence of charr. While cyprinids (European chub and nase) and trout are present they are not dominant as seen in France, Spain and Italy.

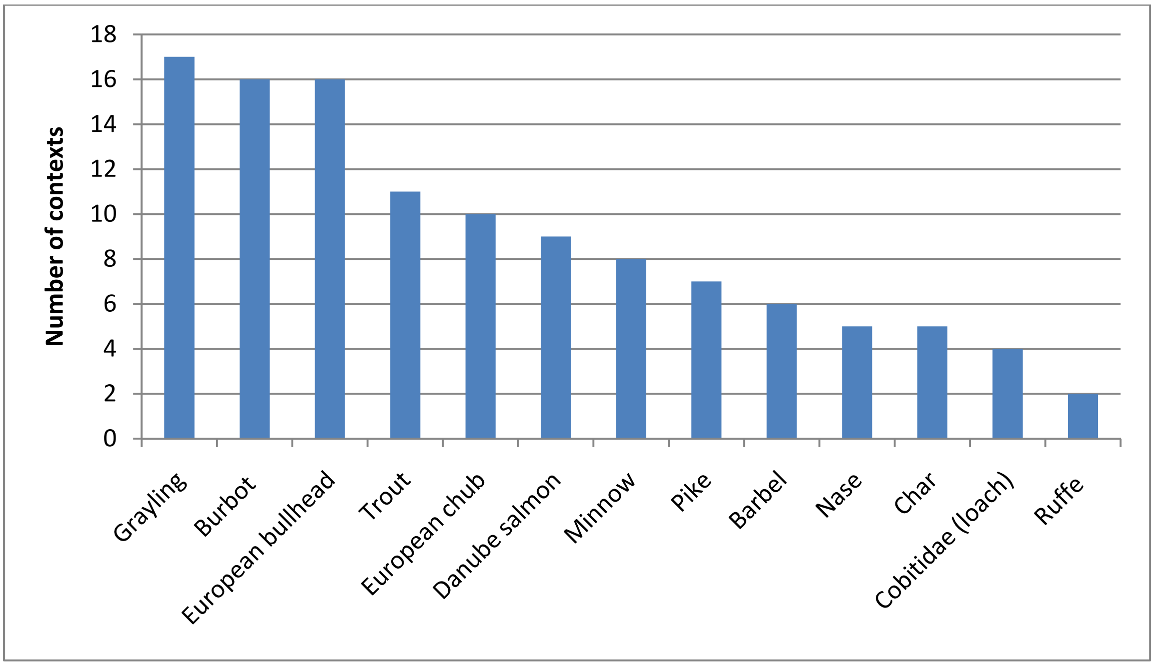

Figure 2.7: Summary of fish types recorded at German Upper Palaeolithic cave sites.

2.3.8 Variation in Upper Palaeolithic fish assemblages by region

Except for the site Cueva de Nerja in Spain, Upper Palaeolithic sites in Western Europe have low species diversity, representing only a fraction of the fish species available at this time. Exploitation of marine fish does not appear to have formed part of subsistence until the Epipalaeolithic/Azillian periods; even then true marine species (ones that live their whole lives at sea) are rare. Figure 2.8 summarises the occurrence of fish species, genera and families in the Upper Palaeolithic across Western Europe. In this case the UK has not been included as there is only one site. It is clear that in Spain, France and Italy species of the genus *Salmo* are the most commonly recorded fish at Upper Palaeolithic sites. The absence of marine species suggests that whether the *Salmo* remains represent Atlantic salmon, sea trout or brown trout they were most likely caught in freshwater environments. Exploitation is likely to be linked to seasonal migration events that see Atlantic salmon and sea trout ascending rivers and streams from the sea to spawn. In the case of brown trout, which essentially could be procured from freshwater environments all year round, migration usually sees large groups of fish to move up stream from larger rivers and lakes to spawn. At spawning time *Salmo* sp. species are abundant in shallow waters making them an easily exploited resource.

German, Belgian and Swiss sites seem to display different species occurrences to those recorded in Spain, France and Italy. While *Salmo* sp. are still present, they are not as frequently recovered from Upper Palaeolithic deposits, and for the most part *Salmo* sp. remains are seen to represent trout, rather than salmon. Instead a wider range of species are represented, including burbot and grayling. These two species are rarely recorded at Spanish, French or Italian sites. The similarity in the assemblages recovered in Germany, Belgium and Switzerland may result from the distance to the coast during the Upper Palaeolithic period. This would suggest that there was minimal access to anadromous salmonids in Belgium and Switzerland, therefore reducing the opportunity for these species to be exploited during their spawning seasons. In comparison Western France, Spain and Italy had extensive coastlines during this period, permitting access to inland areas by anadromous salmonids.

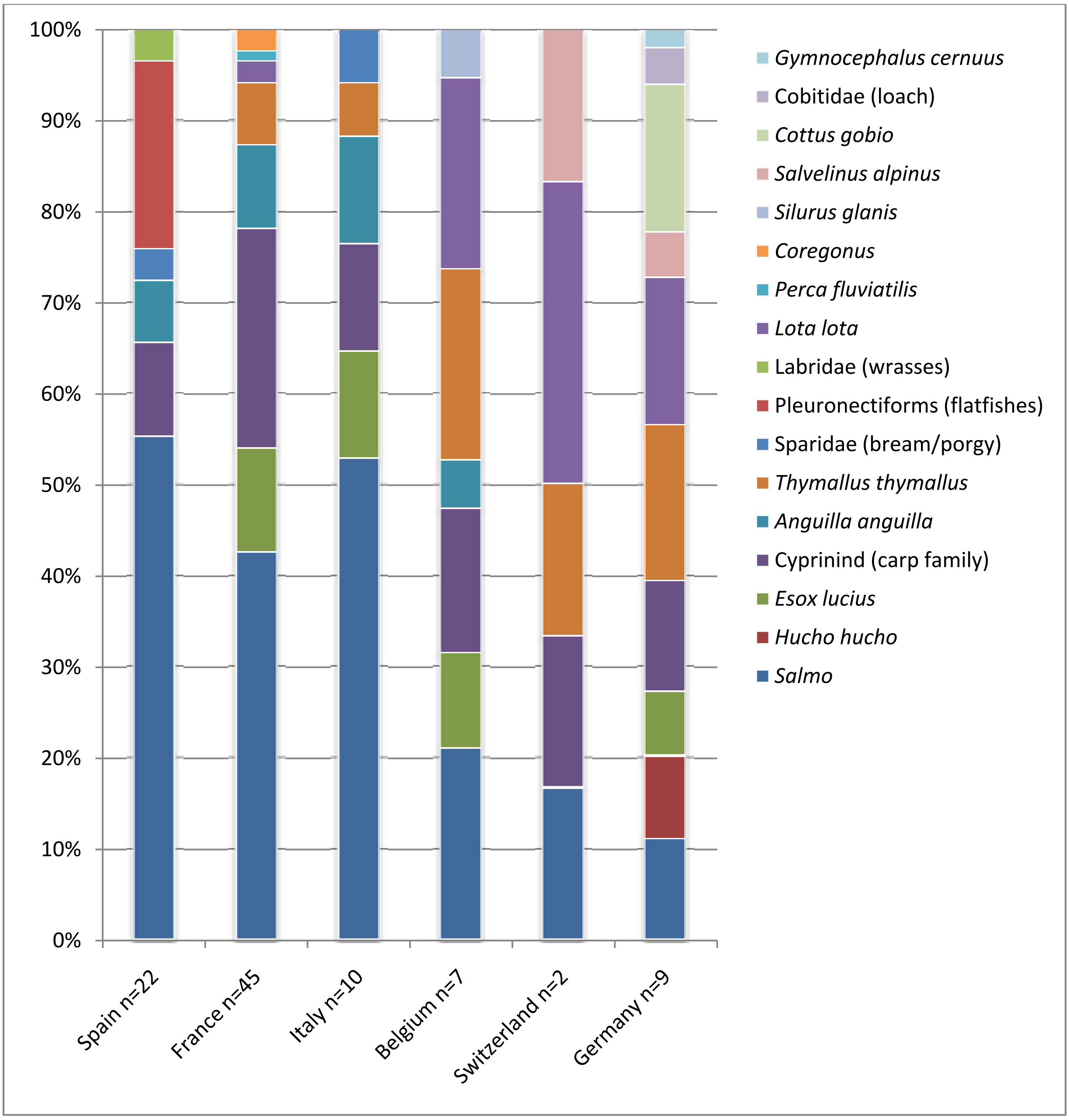

Figure 2.8: Fish species recorded at Upper Palaeolithic cave sites across south-west Europe. See Appendix I for data and sources.

2.4 Changes in fish assemblages over time

While comparisons of fish species at Upper Palaeolithic sites in general may improve understanding of the role of fish in subsistence during this time, in order to assess the importance of fish and fishing and the overall role in subsistence and impacts on mobility, changes in the frequency of fish exploitation and target prey need to be understood. This section will consider changes in fish bone assemblages over time for

Spain, France, Italy and Belgium, see Figures 2.9 and 2.10. Switzerland and the UK have not been considered because they have produced so little data.

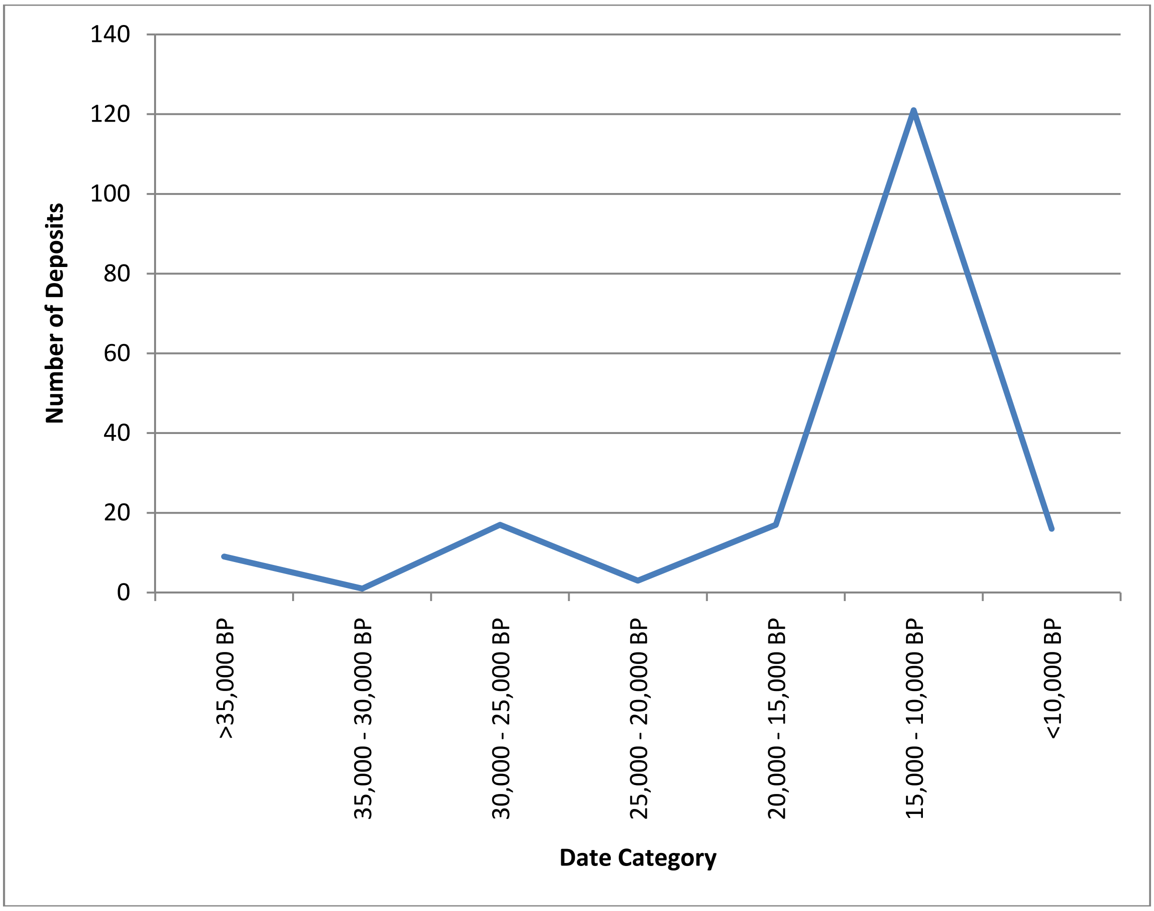

Figure 2.9: Number of Western European deposits yielding fish remains by date category.

Figure 2.9 clearly demonstrates a great deal of variability in the visibility and/or density of fish remains over the last c. 35,000 years. Few deposits yield fish remains in some periods. In particular, just one site (Cueva del Castillo, Spain) yielded fish remains between 35,000 and 30,000 cal BP. Following a small increase between 30,000 and 25,000 BP, especially in France, there appear to be no fish bone assemblage recorded for the period 25,000 – 20,000 BP in any country. After c. 20,000 BP there is a marked increase in the number of sites yielding fish remains which then peaks between 15,000 and 10,000 BP, see Figure 2.9. This peak in fish presence in cave deposits can also be observed in each country, see Figure 2.10, suggesting that increased exploitation of fish was not a local trend in any particular region but a large scale change in subsistence which occurred over a large area of Europe.

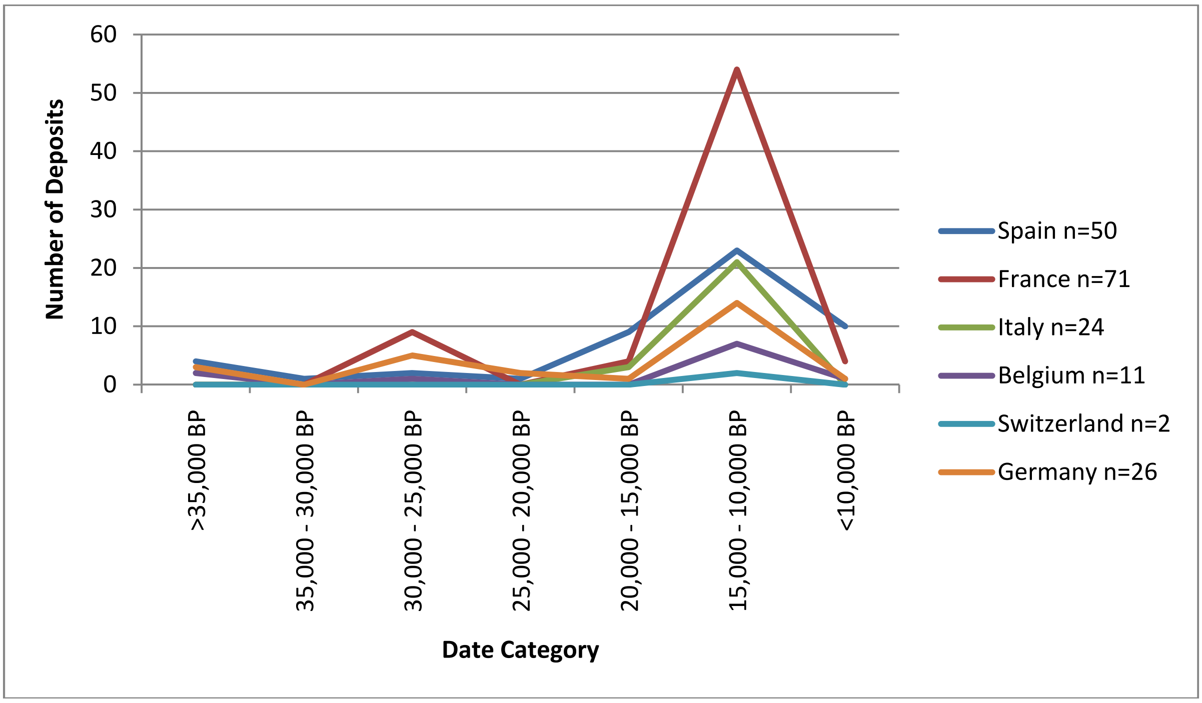

Figure 2.10: Number of deposits yielding fish remains by country and date category.

2.5 Identifying fishing in the Upper Palaeolithic without fish bones

In addition to considering the skeletal remains of fish other lines of evidence can offer useful insights into fishing activities in the past.

2.5.1 Fishing gear

After fish remains, one of the most important sources of evidence in recognising and understanding fishing in the past are artefacts that can be directly associated with fishing. Most early evidence for fishing based on fishing gear comes from waterlogged Mesolithic sites and include nets, fish traps, weirs, harpoons, boats, gorges, hooks and net weights. Many of these objects are made from perishable materials, but are occasionally preserved by anaerobic conditions within the burial environment. Unfortunately very few Palaeolithic sites with waterlogged deposits have been excavated, so the archaeological record for perishable materials, which potentially were used in fishing gear production during this period, is very sparse.

Although the earliest documented nets in Europe only date back to the Mesolithic period (7,200 bc) (Gramsch 1992), the potential to make nets can be traced back further to Ohalo II, Israel where twisted fibres dating to 19,300 BP have been recovered from the site which also yielded substantial fish remains (Nadel *et al.* 1994). Also at Lascaux Cave in France a cast of string/rope was recovered dated to the Early Magdalenian period (White 1986: 49), Figure 2.11. However, there is no evidence to suggest that these fragments could be made into nets during this period. Furthermore, if nets could be made, it is not possible to say that these nets were used for fishing as other animals can be hunted using nets, as seen with the Mbuti, and many other hunter-gatherer groups in central Africa (Turnbull 1961; Lupo & Schmitt 2002). Nets can also be used simply to transport objects from place to place, or store materials.

Other artefacts often referred to as ‘net weights’ may also be associated with fish exploitation, these are often stones, or shells, with holes through to attach them to a net. A role of birch bark filled with clay and gravel at Henauhof Nord II, dating to the Late Mesolithic has also been suggested to represent a net weight (Jochim 1998: 98). Similarly at the Mesolithic site of Star Carr Clark (Rabeder 1999) suggests the use of birch bark rolls as net weights, despite the lack of fish remains at this site (Wheeler 1978). Perhaps perishable materials were used to make these items in earlier periods. Net weights are not known from any Upper Palaeolithic sites in Europe, and even when recovered from later sites their link with fishing is only suggested, not confirmed, with many also being identified as possible spindle whorls. The lack of evidence for nets and net weights especially suggests that netting was not a frequently used method in the exploitation of fish during the Palaeolithic period.

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Figure 2.11: Clay cast of three-strand braided rope made from plant fibres from Lascaux Cave, France (White 1986: 49).

Fishhooks are also absent from most Palaeolithic sites. Two bone gorges, still used in fishing by recent hunter-gatherer populations today, have been recovered from Upper Palaeolithic contexts, Figure 2.12. One at La Ferrassie, in France, (Johnstone 1980: 4) and one at Laugerie-Basse, Les Eyzies, France (Sauvage 1875; Crawford-Burkitt 1925) have both yielded Late Upper Palaeolithic dates. Laugerie-Basse also yielded abundant fish remains from these deposits (Cleyet-Merle 1990). One issue could be that some bone artefacts that could potentially be gorges have not been recognised as such. For example at Grotta-riparo Maritza in central Italy several bone items fitting the gorge description were recovered (Radmilli 1997), but were not seen to represent fishing gear, leading to the assumption that no fishing gear has been recovered from this site (see Wilkens 1994). This site also yielded over 50,000 fish bone and fish bone fragments (see Chapter 6). Despite occasional finds of fish gorges, fish gorges and later fish hooks are not frequently recovered until the Mesolithic period.

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***Figure 2.12*:** Bone gorge, c. 12,500 BP. Trustees of the British Museum.

Harpoons made from animal bone, often bird (see Figure 2.12), are frequently found on sites dating to the Upper Palaeolithic in France (Cleyet-Merle 1990) and Spain (Pokines & Krupa 1997) and are often associated with abundant fish remains, leading to the interpretation that they were used in fishing activities (Julien 1982). However, harpoons are also suitable for hunting mammals, the fine nature of the example from Rocher de la Peine, France (Figure 2.13) suggests that they were for fishing, because they would not survive the force required to allow them to penetrate bird or mammal skins.

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Figure 2.13: Harpoons recovered from Rocher de la Peine, France (White 1986: 50).

2.5.2 Art and adornment

There are many instances where fish have featured in Palaeolithic art, especially in the Upper Palaeolithic (MacCurdy 1923; 1924; Cleyet-Merle 1990; Le Gall 2001). These range from carvings of fish on bone and antler to carvings and paintings on cave and rock-shelter walls. There are also images that are thought to represent fishing gear such as nets and weights represented in some cases. A number of portable and non-portable pieces of art dating to the Upper Palaeolithic period are also found at sites across Europe, for example the fish shaped bone spatula recovered from Upper Palaeolithic deposits at El Pendo, Spain, Figure 2.14. Although they do not directly imply fishing, they nevertheless suggest an importance for fish in that they were recognised as either food or symbolic objects, or both. A famous engraving of a fish identified as salmon is located on a rock shelter ceiling at Abri de Poisson (Fish Shelter), Dordogne, France, see Figure 2.15.

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Figure 2.14: Bone artefact from El Pendo, Cantabria. After Sieveking (1991: 46).

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Figure 2.15: Engraving of a fish at Abri de Poisson, France (White 1986: 110).

Rock carvings of a salmonid fish are found at Niaux, Ariege, France, see Figure 2.16 and El Pindal, Figure 2.17. These engravings are associated with the late Upper Palaeolithic period. Although artwork depicting fish is rare, it is dominated by salmonid type fish (trout and salmon) (Cleyet-Merle 1990: 173; Crémades 1998; Le Gall 2001), with some pike and eels and a number of images unidentifiable as any particular species (Cornwall 1968; Cleyet-Merle 1990; Crémades 1998; Le Gall 2001). The fact that species can be identified by archaeologists from these objects, demonstrates that their makers were very familiar with different fish species.

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Figure 2.16: Engraving of a fish at Niaux, Ariege, France. Source: Cornwall (1968: 108).

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Figure 2.17: Fish carving at El Pindal, Spain. Source: Adan *et al*. (2009: 898).

Fish bones, exclusively vertebrae, in the form of personal adornment, have been recovered from burials at several Upper Palaeolithic sites. Twenty-four salmon vertebrae, thought to represent a necklace, were recovered in association with human remains from one of the Mentone Caves. At Barma Grande Cave (Balzi Rossi, Grimaldi di Ventimiglia, 500 km from the French border), Italy, fish vertebrae, deer teeth and shells of marine gastropods accompanied a human skeleton, and are again interpreted as representing a necklace (MacCurdy 1923; 1924: 78-79), see Figure 2.18. Perforated fish vertebrae were also recovered from Upper Palaeolithic deposits at Cave Rey, France (MacCurdy 1924: 79). At La Madeleine in France a single cyprinid vertebra was recovered from the Upper Palaeolithic grave of child. This was associated with many perforated shells and beads made from Dentaliidae and is assumed to represent a bead (Vanhaeren & d'Errico 2001). Dyed and perforated fish bones have been recovered in Aurignacian contexts at Geissenklösterle in association with other ornamental objects made from antler and ivory (Hahn 1988; Münzel 2001; Münzel & Conard 2004).

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Figure 2.18: Fish bone necklace and 'beads' from Upper Palaeolithic burial at Barma Grande, Italy. Source: Paolo Botton.

2.5.3 Isotopic analysis

Stable isotope analysis on collagen samples taken from human bone can provide information on the diet of that individual (e.g. Burleigh & Brothwell 1978; Lee-Thorpe *et al.* 1989; Lillie & Richards 1999; Emery *et al.* 2000; Richards *et al.* 2000; Van der Merwe *et al.* 2000; Richards *et al.* 2001; Schulting & Richards 2002; Richards *et al.* 2003b; Sponheimer *et al.* 2003; Richards *et al.* 2005; Lillie & Jacobs 2006; Richards *et al.* 2006; Richards & Trinkaus 2009). Results reflect protein intake for approximately the last ten years before death (Schwarcz & Schoeninger 1991; Ambrose 1993). It can be used to identify inclusion of marine foods, including fish in the diet, because marine and terrestrial proteins give different δ^{13}C and δ^{15}N values. Research has shown that protein from non-marine aquatic resources can also have more negative δ^{13}C values than protein from terrestrial and marine systems, this is because carbon in freshwater systems can also come from geological sources. Inclusion of freshwater resources in the diet would show high δ^{15}N values combined with low δ^{13}C values (Fry & Sherr 1984).

Isotope analysis on human remains dating from the Upper Palaeolithic is limited due to the relatively small number of human skeletons recovered from this period that were sufficiently well preserved. Analysis of specimens from Gough's Cave and Sun Hole Cave in Somerset, U.K. indicated a diet high in terrestrial proteins with δ^{13}C ranging from 18.5 to 19.8 and δ^{15}N values ranging from 5.4 to 7.2 (Richards *et al.* 2000). Isotope analysis on human bone from three individuals from Kendrick's Cave, North Wales, showed higher δ^{15}N values still, which the authors interpreted as possibly including marine mammal, rather than fish (Richards *et al.* 2005). In all cases however, since marine diets should yield a combination of values more enriched in both δ^{13}C and δ^{15}N, the human collagen values observed do not present a strong case for the inclusion of marine foods. Identification of the presence of freshwater foods such as fish in the diet by these means is more problematic since δ^{13}C values of freshwater fish can vary enormously (Dufour *et al.* 1999).

Researchers that have studied isotope values for European human remains dating to the Upper Palaeolithic period suggest that the values indicate some inclusion of aquatic resources in the diet during this period (Richards *et al.* 2001). However, there was extensive debate between Richards' and Drucker and Bocherens' research groups, over the interpretation of the data. Drucker and Bocherens (Drucker & Bocherens

2004; Bocherens & Drucker 2006) believed that the isotopic values could be explained by terrestrial herbivore inclusion in the diet and does not “necessarily require the addition of significant amounts of freshwater fish” (Drucker & Bocherens 2004: 172) (see Richards *et al.* 2001; Drucker & Bocherens 2004; Richards *et al.* 2005; Bocherens & Drucker 2006; Richards *et al.* 2006). Hayden *et al.* (1987) studied a total of twelve individuals from Duruthy, Cap Blanc, St. Germaine, La Riviere, La Madelaine, Abri Pataud and Cro-Magnon. The skeletons date between 30,000 – 11,150 cal BP. Hayden *et al*. (1987) agree that fish could have only represented a small part of the diet based on stable isotope values. However, only three of the sites studied also yielded fish bones (Straus 1983b: 101; Cleyet-Merle 1990: 28-29).

Some problems emerge in a review of studies that rely on stable isotope analysis of human bone collagen to deduce the presence of fish in the diets of Upper Palaeolithic individuals. For one, the isotopic signatures of freshwater resources in most catchments are extremely poorly understood (Dufour *et al.* 1999). Furthermore, authors frequently refer back to sources that they *claim* indicate fish consumption during the Upper Palaeolithic. For example in Richards *et al*. (2005, 391), references used to support the inclusion of fish in the diet during this period are Richards *et al.* (2001), Stiner (2001) and Pettitt *et al*. (2003), however, none of these references specifically or independently support this claim. Richards *et al*. (2001) used isotopic ratios to suggest the inclusion of freshwater resources in the diet. This claim is challenged by Drucker and Bocherens (Drucker & Bocherens 2004; Bocherens & Drucker 2006). Stiner (2001) only mentions fish once, in a summary of resources that were exploited during the BSR, but she does not cite references for the inclusion of fish in this list. Pettitt *et al.* (2003) only discusses the diet including c. 25% marine protein based on $\delta^{13}C$ and $\delta^{15}N$ values for the individual in the Gravettian burial at Arene Candide 1 (28,630 – 27,835 cal BP) (which is in any case debatable), and not the inclusion of any freshwater resources.

More recently the study of sulphur isotopes **(**$\delta^{34}S$) in human bone collagen has been used to distinguish freshwater from terrestrial diets in past populations (Richards *et al.* 2003a; Privat *et al.* 2007; Nehlich *et al.* 2010). Sulphur isotope values also vary between marine and freshwater resources so have great potential for furthering knowledge of human exploitation of fish in the Palaeolithic period. To date this type of analysis has not yet been applied to Palaeolithic remains, for which access to for destructive analysis is difficult.

2.5.4 Stone tools, microwear and residue analysis

Previous studies on the microscopic wear patterns on stone tools have focussed on the identification of tools used on plants, hide and meat (e.g. Del Bene 1979; Hardy & Garufi 1998; Evans & Donahue 2005). Very few studies have considered the use of tools in processing fish, or the recognition of such implements. The site of Loma Lasca, located at the mouth of the Santa Valley in Peru yielded abundant fish remains (bones and scales) from midden deposits (Donnan & Moseley 1968). The only stone tool types recovered were 3 bifacial chopping tools and 88 large primary basalt flakes, none with retouch, but with 35 displaying evidence for use (secondary chipping). Despite being much later in date (930-1476 AD) than the sites studied in the research the association of stone tools of a particular type with abundant fish remains and little evidence for any other resource or activity suggests that these flakes were produced and used for fish processing. The recognition of stone tools used for fish processing in Palaeolithic sites has not yet been considered. This could be due to the absence of sites where a single activity, as there appears to be at Loma Lasca, has taken place. Microwear analysis on stone tools might allow fish processing activities to be identified, however no large scale experimental study of the impacts of fish processing on stone tools has been undertaken. Smaller scale studies have not yet proved whether microwear analysis can be used to identify stone tool use on fish (Van Gijn 1986; Lemorini 2000: 67).

Analysis of residues found on artefacts such as stone tools, bone artefacts, ceramics and those recovered from archaeological contexts can indicate use in association with fish. The most common applications have involved the use of Gas Chromatography (GC) or liquid chromatography mass spectroscopy , can detect degradation products in fish residues, which may survive within the fabrics of cooking pots (Malainey *et al.* 1999). However, hunter-gatherers in the Palaeolithic did not make or use ceramic vessels. The only forms of residue analysis applicable for this period are those associated with stone tools. Existing research on stone tool residues, however, has focused on the identification of plant, hide and meat residues. Experimental studies have shown that fish lipids can be distinguished from those from terrestrial animals but are difficult to distinguish from plants (Brown & Heron 2005; Olsson & Isaksson 2008). Because the surface of material used to make stone tools (usually flint or chert, but various others are used depending on availability) is non porous it is less likely that enough residue will survive for analysis. This problem is heightened by the fact that identification of fish lipid residues requires a larger yield of residue than those needed to identify other materials.

One area that has not received any attention in archaeological research is the potential for bone implements, especially in the case of identifying fishing, harpoons, to provide residues for the identification of past use(s). This may be because bone is highly porous and that any residue that might have originally been present may have leached out of the bone during burial, and that contaminant residues may also leach in during this period.

2.6 Conclusions

A review of Palaeolithic sites across Western Europe shows an increase in visibility of fish at archaeological sites from the Lower to Upper Palaeolithic, with a peak in fish presence seen c. 20,000 – 12,000 BP. At present, despite being poorly studied in many cases, the fish remains themselves present the strongest evidence for changes in the importance of fishing and fishing strategies. Other sources of evidence, including fishing gear, fish in art, isotopic, microwear and residue analyses, have not yet been developed sufficiently and/or suffer from interpretational problems.

Chapter 3: Fishing in recent hunter-gatherer populations

3.1 Introduction

Many historically documented and contemporary hunter-gatherer groups exploit fish as a dietary resource. In some cases fish and fish remains surpass their dietary role and are incorporated into technology (e.g. Allen 1973; Choyke & Bartosiewicz 1994: 63). Understanding the ways in which hunter-gatherers catch, process, preserve, cook, eat, and dispose of fish may aid the interpretation of fish remains recovered from archaeological sites by providing criteria for recognising assemblages deposited by people from those deposited by animals.

This chapter focuses on hunter-gatherer groups in northern North America and Canada, areas with environmental and climatic conditions comparable to those reconstructed for Late Pleistocene Europe. Fishing behaviours of recent European hunter-gatherers, the Saami are also considered. Ethnographic and ethnohistoric records of North American and Canadian hunter-gatherer groups have frequently been used to develop models for the understanding of Late Pleistocene and Early Holocene hunter-gatherers in Europe, especially in understanding land-use and settlement systems (e.g. Newell & Constandse-Westermann 1996; Lovis *et al.* 2005; Donahue & Lovis 2006). Figure 3.1 shows the approximate locations of North American and Canadian hunter-gatherer groups considered in this research. Some groups occupy much larger areas than others, for example, the Copper Inuit and other Inuit groups occupy large areas of the Nunavut Territory of northern Canada, whereas the Aleut are restricted to a few of the small Aleutian Islands. The groups were selected based on their extensive ethnographic documentation and to cover a range of different environmental conditions.

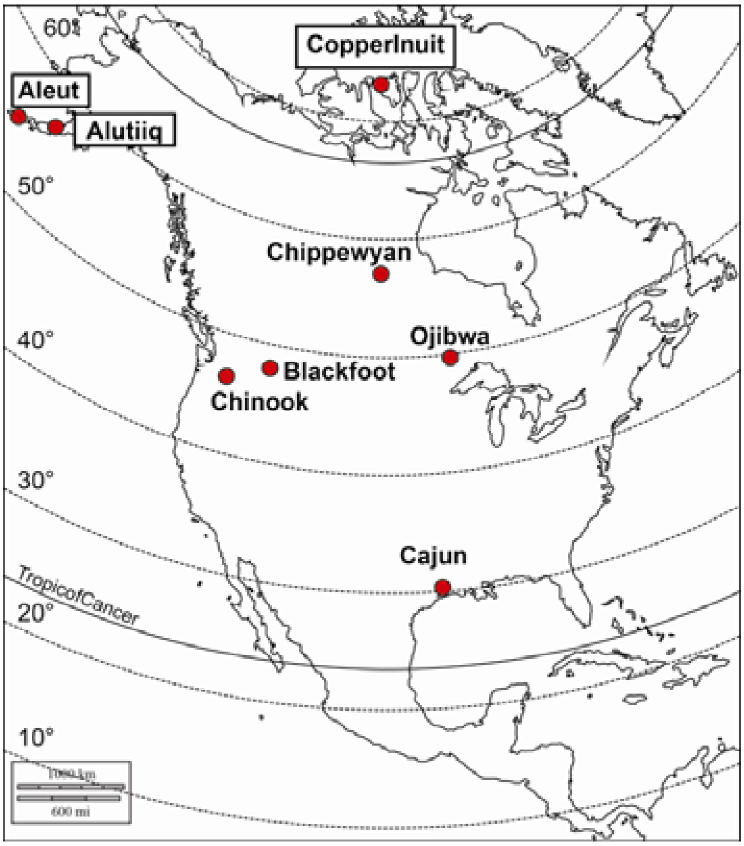

Figure 3.1: Geographical location of North American and Canadian hunter-gatherer groups considered in this research. Base image source: d-maps.com http://d-maps.com/carte.php?lib=north_america_map&num_car=1399&lang=en

3.2 How can ethnographic accounts of hunter-gatherers help interpret archaeological fish remains?

There are two main areas where knowledge of ethnographically and ethnohistorically documented hunter-gatherers can aid interpretation of archaeological remains accumulated by Late Pleistocene hunter-gatherers. Firstly, information on species and size of fish caught, seasonal activities, processing methods, taboos, cooking methods and disposal can be used to build a model for interpretation of fish bone assemblages from archaeological sites. Secondly, it provides an idea of the fishing technology that is used where only naturally occurring materials are available. This is important because as observed in Chapter 2 unequivocal fishing gear is absent from many Late Pleistocene sites in Europe, especially those dating to before 14,000 BP. The absence of fishing gear may have resulted from the destruction of plant materials and animal fibres that may have been used in the production of fishing gear such as nets, baskets, traps, weirs, floats, and lines which are used in fishing by hunter-gatherers in the ethnographic record. Observing the ways in which recent hunter-gatherers process fish for consumption allows taphonomic signatures to be built for identifying specific fish processing by Palaeolithic hunter-gatherers. Observation of recent groups can identify which parts of the fish would be deposited at a processing site, which parts are consumed, so might only be expected to be found with evidence for digestion, which skeletal parts are likely to be burned. For each group considered the documented fishing methods and choices will be used to predict fish bone assemblage characteristics.

Many of the ethnographic records do not include specific species names for the fish exploited by recent hunter-gatherers. The scientific names listed in this chapter have been established by using the common names given in ethnographic texts and species range as provided by FishBase (www.fishbase.org). In some cases it was only possible to state genus or family name; this is because quite often the same common name is used to refer to several species of fish that are common in the given geographic range. All common and scientific names given in this chapter are consistent with those provided by FishBase in July 2010.

3.2.1 Aleut

(Unalaska, Aleutian Islands) (Table 3.1)

The Aleut occupy the more distant of the Aleutian Island, off the west coast of Alaska (Figure 3.1). The marine mammals of the Aleutians are of major economic importance to the native inhabitants; sea lion, seal, whale, dolphin, porpoise, and formerly the sea otter supplied the Aleuts with the raw materials for food, clothing, light, heat, transportation, and shelter (Shade 1949: 1-2). In terms of fish they mainly exploit halibut (Atlantic halibut, *Hippoglossus hippoglossus*, or Pacific halibut, *Hippoglossus stenolepis*) and various species of salmon (*Oncorhynchus* sp.); occasionally cod (Atlantic cod, *Gadus morhua* or Pacific cod *Gadus macrocephalus*) (Cook 1785: 515; von Langsdorff 1817: 333). Five types of salmon were recognised: pink (*Oncorhynchus gorbuscha*), silver (*O. kisutch*), chinook (*O. tshawytscha*), dog (*O. keta*) and red (*O. nerka*). Of these red salmon were caught in the greatest numbers (Shade 1949: 1-2). On a smaller scale they also fish for and eat bass (*Micropterus or Morone* sp.), ling (*Molva* sp.), loach (unknown species), capelin (*Mallotus villosus*), herring (probably Pacific herring, *Clupea pallasii pallasii*), sand lance/eel (*Ammodytes* sp.), mackerel (Atlantic, *Scomber scrombrus* or chub, *Scomber japonicus*), sculpin (cf. *Myoxocephalus* sp.), liparids (cf. snailfish, *Careproctus* sp.) rockfish (*Sebastes* sp.), and in the streams, several varieties of trout (*Salvelinus* sp.) (Sarychev 1806: 70; Innokentii 1840: 229; Shade 1949: 1-2).

The Aleut use skin-boats or small wooden boats made of planks from which they fish near the shore (Jochelson 1933: 57). Weirs, fish-spears, nets with sinkers and bone hooks and lines are used for fishing (Hrdicka 1945: 139; Berreman 1954: 102). For spears a bone point was attached directly to a wooden shaft. A piece was cut from the lower end. A piece was also cut off the shaft to receive the point. The joint was lashed by a sinew cord and strips of whalebone. These were used to spear fish near the dam or weir (Jochelson 1925: 85) For catching small fish in shallow water, there were simple bone hooks (Jochelson 1925: 87). Hooks were only usually used in sea fishing, or fishing from the shore, not in the rivers and lakes (Pallas & Masterson 1948: 91).

In the summer (May to September) the various species of salmon come to the rivers and lakes to spawn, these are caught and many are dried for the winter months (Jochelson 1925; Pallas & Masterson 1948: 91; Berreman 1954: 104). In autumn and winter, when the anadromous salmon are absent, they catch cod and halibut in the sea (Innokentii 1840: 202-204; Pallas & Masterson 1948: 88). Fresh foods of all kinds were usually eaten raw (Coxe 1804: 228; Sarychev 1806: 70; Collins 1945: 26). The Aleuts had no cooking pots, therefore boiling was not practiced until iron and copper pots were introduced by the Russians. When cooked, meat was placed on flat stone ‘frying pans,’ or roasted between two hollow stones cemented with clay (Coxe 1804: 228-229; Collins 1945: 26; Pallas & Masterson 1948: 45). Meat and fish could be boiled in water that gushed from hot springs on Kanaga Island in the Andrean (Elliott 1886: 153; Collins 1945: 26). Many fish were sun-dried after gutting and removal of the head and stored for future use (Coxe 1804: 228-229; von Langsdorff 1817: 343; Collins 1945: 26). Cod was often preserved for winter use (Cook 1785: 515). Capelin, small fishes reaching a maximum length of about 10 inches, can be easily caught during summer spawning. Capelin are dried in great numbers, only the heads are removed, they do not require cleaning (Clark 1945: 57).

Boys were restricted from eating the tails of fish, which were thought to cause trembling like the tail of a fish in motion (Laughlin 1980: 30). The warmed fats of fish are often kept and consumed to cleanse and heal (Innokentii 1840: 261).

Species	**Freshwater/Anadromous**	**Marine/Estuarine**
	Salmon (pink, silver, chinook, dog and red)	Pacific/Atlantic halibut
	Trout (unknown varieties)	Pacific/Atlantic cod
		Bass (various possible species)
		Ling
		Loach
		Capelin
		Pacific herring
		Sand lance/eel
		Atlantic/chub mackerel
		Sculpin
		Liparids
		Rockfish
Size	All	
Catching methods	Net, spear, bone hook & line, weir	
Season	Summer – anadromous Autumn and winter - sea	
Cooking methods	Often eaten raw Between two clay sealed stones On a flat stone over a fire In hot spring water	
Preservation	Dried (sun-dried)	
Cut-marks	? From head removal	
Digestion	Unknown	
Customs	• Boys cannot eat fish tails • Warm fish fat used as a healing medicine	
Animal interaction?	Unknown	

Table 3.1: Fishing behaviour by Aleut groups. Shading indicates important species. For references see text.

3.2.2 Alutiiq

(Aleutian Islands) (Table 3.2)

Alutiiq subsistence was also based on sea mammals and fish, and similar in many ways to the Aleut. The area is well situated for taking whales, seals, fur seals, sea lions, and porpoises, but, unlike the Aleut there is no evidence that sea otters were ever hunted. Sea fish include halibut (Atlantic, *Hippoglossus hippoglossus* or Pacific, *Hippoglossus stenolepis*), cod (Atlantic, *Gadus morhua* or Pacific, *Gadus macrocephalus*), herring (probably Pacific herring, *Clupea pallasii pallasii*), eulachon (*Thaleichthys pacificus*), sculpin (*Myoxocephalus* sp.) and dogfish (*Squalus acanthias*) (Birket-Smith 1953: 18; Woodforde 1974: 15; Holmberg *et al.* 1985: 46-47). Various salmon species are exploited during the spawning season including pink (*Oncorhynchus gorbuscha*), chinook (*O. tshawytscha*), dog (*O. keta*) and red (*O. nerka*) from June and silver salmon (*O. kisutch*) in the autumn (Birket-Smith 1953: 18; Woodforde 1974: 15).

Fishing occurred by spear, net, weir and snare. Of these, spears were the most frequently used method (Holmberg *et al.* 1985: 46-47). A fish snare could be made from spruce roots and fastened to the end of a stick. The length of the snare varied according to the depth of the stream (Birket-Smith 1953: 42). Wooden leisters and rakes were used to snare herring (Birket-Smith 1953: 41).

The summer is an important time for fishing, with the spawning of salmon in the rivers; generally the different species spawn at slightly different times (Woodforde 1974: 15). First, the largest salmon species, chinook salmon appears, sometimes as early as early May and stays until the mid June. The red salmon arrives next, when it disappears in the beginning of July, the pink and dog salmon appear. These are followed by the silver salmon in the beginning of August. From the middle of September the salmon season is over (Birket-Smith 1953: 18; Holmberg *et al.* 1985: 46-47). Fish were eaten fresh, but were also preserved by drying (Birket-Smith 1953: 8; Harumi 1970: 29). Fresh fish were generally roasted, with sticks positioned to spread it, then placed over an open fire (Birket-Smith 1953: 43). Fish for the winter were dried on racks which were hung over the fire place. The dried fish were then stored in the roof of sleeping areas (Birket-Smith 1953: 54).

Fish eggs were sometimes used to treat animal skins (Holmberg *et al.* 1985: 39). Like the Aleut, the Alutiiq also have customs relating to the preservation of fish populations. The Alutiiq believe that fish intestines should be thrown back into the water so that they can turn into new fish. If they drift ashore, the soul of the fish, which remains in the guts, will die and the fish will not come to life again. Furthermore, the first salmon caught each year must be eaten entirely except for the gall and the gills. If anything of the fish is wasted, it will never come back (Birket-Smith 1953: 42).

Species	**Freshwater/Anadromous**	**Marine/Estuarine**
	Salmon (various species)	Halibut
		Cod
		Pacific herring
		Olachen
		Sculpin
		Dogfish
Size	Unknown	
Catching methods	Spear, net, weir, rake, leister, snare	
Season	Summer – anadromous Autumn and winter - sea	
Cooking methods	Roasted	
Preservation	Drying	
Cut-marks	Unknown	
Digestion	Unknown	
Customs	• Intestines thrown into the water • Fist salmon of the season must be consumed in full	
Animal interaction?	Unknown	

Table 3.2: Fishing behaviour by Alutiiq groups. Shading indicates most important species. For references see text.

3.2.3 Blackfoot

(Northern Montana, (U.S.) and Southern Alberta and Saskatchewan (Canada)) (Table 3.3)

In this area antelope, deer, elk, bighorn, bear (black and grizzly), beaver, otter, mink, muskrat, wolves, foxes, badgers, weasels, and rabbits offered a variety of animal foods and materials for use in Indian handicrafts (Ewers 1955: 121). Buffalo and deer were hunted for meat, hides, and other parts. Fur-bearing animals were hunted and trapped with snares and deadfalls for their skins, which were used for clothing and sacred articles (Hungry Wolf 1977: 191). Edible plant foods of primary importance to the Indians were the spring roots of the prairie turnip, bitterroot and camass, and the fall berries of the chokecherry (Ewers 1955: 121; Grinnell 1962: 207). Although fish were abundant in the streams and lakes, they were rarely eaten by the Blackfoot. Animals that spent most or all of their time in water were almost never eaten. Spiritually, they were thought to belong to '*SoyeTuppi'*, the Underwater People (Hungry Wolf 1977: 191; Kehoe 1995: 113), monsters of human form who inhabit the rivers and lakes and at every opportunity seize unwary swimmers and draw them down to their underwater homes, there to kill them (Schultz 1962: 29).

Species	**Freshwater/Anadromous**	**Marine/Estuarine**
	None	None
Size	N/A	
Catching methods	N/A	
Season	N/A	
Cooking methods	N/A	
Preservation	N/A	
Cut-marks	N/A	
Digestion	N/A	
Customs	Fish not eaten due to belief that the fish belong to the Underwater People.	
Animal interaction?	N/A	

Table 3.3: Fishing behaviour by Blackfoot groups. For references see text.

3.2.4 Chinook

(Southern Washington and Northern Oregon (U. S.)) (Table 3.4)

Fishing was the principal economic pursuit of the Chinook, providing a plentiful supply of food for both consumption and trade. Salmon was by far the most important fish but other species figured very prominently. White sturgeon (*Acipenser transmontanus*), was important due to the amount of food that was provided by a single catch. The rainbow trout (*Oncorhynchus mykiss*) was taken in large numbers. The eulachon (*Thaleichthys pacificus*) and longfin smelt *(Spirinchus thaleichthys)* were in great demand for the oil they produced. The Pacific herring (*Clupea pallasii pallasii*) and the South American pilchard (*Sardinops sagax*), were very abundant and were taken in large quantities with a herring rake. Five species of salmon (*Oncorhynchus* sp.) enter the Columbia River for spawning. The Columbia River has produced more salmon than any other river in the world (Ray 1938: 46). The different species spawn between January and November, although the best fish generally enter the river between May and July (Ray 1938: 107-108).

The most productive method of salmon fishing used by the Chinook was that using the sieve net. These seines were straight webs using stick type floats of cedar and round stone weights. The nets were sometimes very large. A small seine could be used by three men. A good haul in a small seine brought in about a hundred fish; an average was around forty. The larger seines required more than three men to handle them (Ray 1938: 107-108). Dams, weirs, hook and line, dip-nets and spears were also used, often spearing was done in conjunction with a weir (Ray 1938: 108). Flatfish were sometimes caught by wading barefoot into the water and feeling them out with the feet. As soon as the fish was felt it was stepped on, then grasped and thrown on shore. Fish caught in this manner sometimes weighed as much as twenty pounds (Ray 1938: 110). Despite an abundance of fresh fish, dead fish that washed up on the beach were also gathered and used (Ray 1938: 110).

Cooking methods include boiling, broiling, roasting, and steaming. Vessels used were dugout wooden and bark containers, and baskets. The fish were split dorsally, opened out and held in this position by thin cedar skewers. A cedar stick is used as a spit, it is pointed at one end and split at the other. The extended fish is inserted in the split portion with tail end opposite the point. The fish was then tied together, with the pointed end forced into the ground near the fire so that the top inclined toward it (Ray 1938: 129). Fish were also dried; Ray (1938) describes the drying process for salmon:

> *"in preparing salmon for drying the fish was split down the back so that the head, backbone, and tail were separated from the rest of the body. The head and tail were cut from the backbone and strung together for drying. The flesh of the backbone was eaten immediately. The ventral portion was laid open with cedar skewers and slashed evenly so that as great an area would be exposed as possible. Thus prepared the* fish *was hung from poles near the ceiling of the house or upon specially constructed scaffolding"* (Ray 1938: 130)

For the 5th to 10th day after the delivery of a baby the mother remained secluded and ate nothing but fish soup, this was thought to ensure that she would produce a good supply of milk (Ray 1938: 69). Similarly to the Alutiiq, the Chinook regard the first salmon of the season as a special fish:

> *"If it were to be boiled it was broken into pieces with the hands; a knife was never used. The head and tail were broken from the body, then the body was broken open so that the heart might be removed. This was thrown immediately into the fire. The eyes were removed and swallowed whole, "to avoid bad luck in the future." The same was done with the point of the nose. The intestines were not removed, but all parts were now placed in an oblong container of alder and boiled. If the salmon were roasted it was cut lengthwise down the back with a mussel shell knife. The backbone and intestines were removed, together with the heart, and carefully placed in the fire. The head and tail remained attached to the*

> *body. The fish was then roasted in the usual manner, except that only alder wood was used for the fire. When cooked the fish was broken apart and a portion given to all present, including the children and the fisherman. Girls near puberty were not allowed to partake, but neither were they permitted to attend the ceremony. Every morsel of the fish was eaten. Care was taken that the head be eaten from the nose toward the back, never in the opposite direction. Also, no part was allowed to remain uneaten after sunset. Even though many fish were caught during the day, all were consumed before sundown. If any vestige of the bones remained in the fire they were carefully buried*" (Ray 1938: 129).

Species	**Freshwater/Anadromous**	**Marine/Estuarine**
	Salmon (various species)	South American pilchard
	White sturgeon	Pacific herring
	Rainbow trout	
	Eulachon	
	Longfin smelt	
Size	Unknown	
Catching methods	Nets, dams, weirs, hook and line, dip-nets, spears	
Season	January – November but mainly May-July	
Cooking methods	Boiling, broiling, roasting, steaming	
Preservation	Drying	
Cut-marks	Where head/vertebrae are removed	
Digestion	Bones are eaten in some cases	
Customs	• After delivery new mothers eat fish soup • First salmon is cooked and eaten in a specific way	
Animal interaction?	Unknown	

Table 3.4: Fishing behaviour by Chinook groups. Shading indicates most important species. For references see text.

3.2.5 Chipewyan

(Northwest Territories and Nunavut, Canada) (Table 3.5)

The Chipewyan are a nomadic group of northern North America and Canada. Caribou was the main food resource for the Chipewyan, it also provided clothing and shelter, they used other game, waterfowl and fish to supplement their caribou diet (Birket-Smith 1930; Smith 1976: 13; Gordon 1977: 72-73; Smith 1981). The species of fish generally caught in the nets are pike (*Esox lucius*), whitefish (*Coregonus clupeaformis)* and barbel (unknown species)*;* species caught using hooks are trout (*Salvelinus* sp.), pike and burbot (*Lota lota*) (Hearne 1958: 44). Perch (American yellow perch, *Perca flavescens)*, Arctic char (*Salvelinus alpinus*) and fish referred to as methy (unknown species) are also caught (Hearne 1958: 168; Smith 1981: 272). A large range of methods are used by Chipewyan groups in catching fish, these include nets (Hearne 1958: 253; Irimoto 1981: 42-43; Brumbach & Robert Buell 1982), hook and line (Birket-Smith 1930: 80), spears (Birket-Smith 1930: 26) and bow and arrow (Birket-Smith 1930: 19). Spearing was done from canoes, or near weirs where fish were grouped. Rackets and clubs (Figure 3.2) were also often used near to weirs, the racket used to scoop fish from the water then the club used to kill the fish (Birket-Smith 1930: 26-27). Both nets and hook and line were used to fish though the ice in the winter (Hearne 1958: 11).

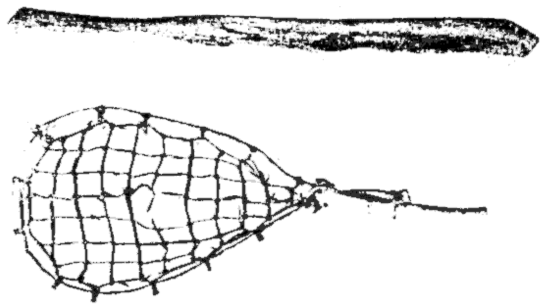

Figure 3.2: Top: Fish club. Bottom: Fish racket. Both used to aid weir fishing (Birket-Smith 1930: 27).

Fishing occurred in all seasons, although was more frequently done during the summer months (Irimoto 1981: 88). In all cases it appears that fish were only exploited substantially when caribou were in short supply. The salmon season, which generally began at the end of June, and finished in August (Hearne 1958: 253). In spring, white sucker run up the small streams, these are followed by the predatory northern pike. The Chipewyan know of this migration and often place their camps to allow exploitation of pike at this time. In autumn whitefish and trout move to the shallower water ready to spawn and may be exploited at this time (Irimoto 1981: 40). Nets are used more in summer as they can be dried easily, but are also occasionally used in winter, set under the ice (Birket-Smith 1930: 27). More frequently than nets, hooks and lines are used for fishing under the ice (Birket-Smith 1930: 28).

All fish are often eaten raw (Birket-Smith 1930: 31), but are also boiled (Jarvenpa 1980: 116) or made into soup (Birket-Smith 1930: 32). Fish is also split down the middle to be smoked and dried for future use as well as being consumed fresh (Birket-Smith 1930: 31; Irimoto 1981: 148). Fish also provided an important source of food for the sled dogs that were employed for winter transportation (Brumbach & Robert Buell 1982:

30). Braumbach & Robert Buell (1982) noted that fish bones were not recovered from site previously used by the Chipewyan during the fishing season, this is a result of the method of discard for such remains, which were usually disposed of in lakes or rivers to reduce odour and keep scavengers away (Brumbach & Robert Buell 1982: 30). Some fish bone were kept and used as needles (Birket-Smith 1930: 64).

Like several of the northern North American groups the Chipewyan treat the first salmon of the season in a specific manner. If caught in a net it must be fried whole over the fire, the flesh must be removed without breaking a joint and then the bones burnt up. This also applied also to the first fish taken on a new hook (Birket-Smith 1930: 80).

Species	**Freshwater/Anadromous**	**Marine/Estuarine**
	Whitefish	
	Trout	
	Pike	
	Barbel	
	Burbot	
	Whitefish	
	Perch	
	Char	
	Methy	
Size	All	
Catching methods	Net, hook and line, spear, bow and arrow, racket and club, weir, canoe	
Season	All but focussed on the summer	
Cooking methods	None (Raw), boiling, soup	
Preservation	Smoke, dry	
Cut-marks	Unknown	
Digestion	By dogs	
Customs/Other	• Bones thrown into river or lake • Fish spines used as needles • First salmon is regarded as special, as is the first fish caught on a new hook	
Animal interaction?	Dogs	

Table 3.5: Fishing behaviour by Chippewyan groups. For references see text.

3.2.6 Copper Inuit

(Victoria Island and Coronation Gulf, Canada) (Table 3.6)

The Copper Inuit occupied the coastal and adjoining inland regions of much of Victoria Island and the opposite shores of the Canadian Arctic mainland. The most important fish species to the Copper Inuit were Arctic char (*Salvelinus alpinus alpines)* and lake trout (*Salvelinus namaycush)*, which could be found in the many lakes of the region. Char was the most important of these and formed a major part of the diet during summer and early winter (Condon 1983: 24; 1987: 24). Ocean fish in the area included cod (Atlantic cod, *Gadus morhua*, or Pacific cod, *Gadus macrocephalus*), sculpin (*Myoxocephalus* sp.), and flounder (unknown species), but none of these were actively fished (Condon 1983: 24).

Char and trout are fished during spring, summer and autumn using nets and hooks (Condon 1987: 24-25). Weirs and traps were also used and larger fish could be speared (Richardson 1851: 345; Jenness 1922). Gaff hooks and three–pronged spear hooks are also used in river fishing, fish caught in this manner are killed by clubbing (Cadzow 1920: 11-12). Large char and trout were caught using weirs on their way up river to spawn, small trout and char swimming down-stream to the sea were caught using traps (Jenness 1922). During spring and early summer fish were caught through the ice of lakes, which remained frozen until May (Merwin 1915; Damas 1984; De Coccola 1986; Collignon 1993). Fishing continues throughout the year by those unable to participate in caribou hunting (Merwin 1915).

Fish were often eaten raw, while the bones of large fish were not consumed, small fish were frequently eaten whole (Jenness 1922: 99). Some fish were dried for later consumption, this was done by women who cut the fish in strips, dried them on low racks, and then stored them in caches for winter use (Cadzow 1920: 11). Other times fish were dried whole, but with the bones removed; the heads of the fish were cut off, the backbones and fins were removed and given to the dogs, the fish were then laid out on rocks or on poles to dry in the sun. The removed heads were boiled and entirely consumed (Jenness 1959: 130).

Species	**Freshwater/Anadromous**	**Marine/Estuarine**
	Arctic char	
	Lake trout	
Size	All	
Catching methods	Net, hook and line, weir, trap, gaff hook, 3-pronged hook, club	
Season	All but mainly focussed in the summer	
Cooking methods	Often none (raw) Boiled fish heads	
Preservation	Drying in sun	
Cut-marks	From head removal	
Digestion	For bones of small fish Bone from boiled fish heads are gnawed by people By dogs	
Customs	• Animism including fish	
Animal interaction?	Dogs	

Table 3.6: Fishing behaviour by Copper Inuit groups. Shading indicates most important species. For references see text.

3.2.7 Ojibwa

(South-eastern Canada and North-eastern North America) (Table 3.7)

Ojibwa communities range from southern and north-western Ontario, northern Michigan and Wisconsin, and Minnesota, to North Dakota and southern and central Manitoba and Saskatchewan. Fish-catching is not the principal means of existence among the Ojibbeways, they depend mainly on hunting (Kohl 1860: 327), however, fish are of importance in the Ojibwa diet. Pike (*Esox lucius*) and whitefish (*Coregonus clupeaformis)* were most highly prized, but lake trout (*Salvelinus namaycush)*, perch (American yellow perch, *Perca flavescens)*, lake cisco (*Coregonus artedi*), white sucker

(*Catostomus commersonii)* and walleye (*Sander vitreus*) are frequently exploited (Kohl 1860: 325; Grant 1890: 310; Hilger 1951: 129; Dunning 1959: 23; Bishop 1974: 23; Holzkamm *et al.* 1988: 196; Hodgins & Benidickson 1989: 40; Hallowell & Brown 1991: 16), with moriah (unknown species) being caught for the dogs (Dunning 1959: 23). During the spawning period white sturgeon (*Acipenser transmontanus*) could be captured most effectively using traditional Ojibwa fishing methods (Grant 1890: 310; Dunning 1959: 23; Holzkamm et al. 1988: 196).

The Ojibwa used a wide range of fishing techniques, most frequently used were nets (Hilger 1951: 127; Bishop 1974: 39-40; Dunk 1987: 11), which could be left in the water overnight to catch lake trout (Hilger 1951: 127) or set under the ice during the winter to catch trout and whitefish (Doherty 1990: 24). Nets were always carefully dried after use (Hilger 1951: 127). Scoop nets, spears, hooks, traps and birch bark jacklights were also used, although to a lesser extent (Kohl 1860: 326; Hilger 1951: 127; Doherty 1990: 24). Fishhooks were made of bone or wood and could measure up to two inches in length (Hilger 1951: 127). At night fish were attracted by burning roots of Norway pine on canoes, attracted by the light, the fish were both hooked or speared. Fish caught by all methods were often killed on landing by being clubbed (Hilger 1951: 127).

Fish were available to the Ojibwa during all seasons (Kohl 1860: 326; Jenness 1935: 10), however most fishing occurred during the summer months, from June onwards (Bishop 1974: 39-40). In winter they speared trout and sturgeon through the ice (Hilger 1951: 127; Doherty 1990: 24). Sturgeon like deep water and were caught with spears that could be 12m in length (Doherty 1990: 24). Trout and whitefish were exploited during migration for spawning, trout in early October and whitefish later in the month, this could continue until the ice formed in early December (Hodgins & Benidickson 1989: 41).

At least one meal almost every day in the summer includes fish (Bishop 1974: 39-40). Pike is only fit to eat roasted, but the head, when boiled, is considered a delicacy (Grant 1890: 310-311). Whitefish are also roasted (broiled) over small fires, one end of a stick would be thrust under the lower jaw of the fish; the other was planted in the ground in a slanting position. Heads, scales and entrails were often not removed from fish eaten fresh (Hilger 1951: 128). Fish were also occasionally boiled (Kohl 1860: 326). There is a certain amount of preservation of fish by smoke drying, which is mainly done in the summer (Dunning 1959: 33). For several weeks at a time the focus of the summer camp would be netting fish and preserving them in large quantities (Dunning 1959: 34). For drying, fish were skinned, slit down the back, the vertebrae and guts removed then hung on poles in the smoke of smouldering fires for around 2 days (Hilger 1951: 128). The parts of the fish that cannot be eaten are used as food for their dogs (Kohl 1860: 327).

The Ojibwa had few customs relating to fish, one stated that trout should not be eaten during the October trout fishing season as this would lead to poor catches (Jenness 1935: 21). Pregnant women were discouraged from eating fish entrails, the belief being that this would cause the umbilical cord to wind about the child's neck, shoulders or body, making birthing extremely difficult (Hilger 1951: 7).

Species	**Freshwater/Anadromous**	**Marine/Estuarine**
	Pike	
	Whitefish	
	Lake trout	
	White sturgeon	
	Perch (American yellow)	
	Lake cisco	
	Walleye	
	White sucker	
Size	Unknown	
Catching methods	Nets, scoop nets, spears, hooks, traps, birch bark jacklights	
Season	All, but focus in summer and October	
Cooking methods	Broil (roast), boil (especially heads)	
Preservation	Drying, smoking	
Cut-marks	From removing vertebrae for smoking	
Digestion	By dogs	
Customs	Animism including fish Not to eat fish during October Pregnant women to eat fish entrails	
Animal interaction?	Dogs	

Table 3.7: Fishing behaviour by Ojibwa groups. Shading indicates most important species. For references see text.

3.2.8 Saami

(Northern Europe & Russia) (Table 3.8)

Saami (also known as Sámi, Sapmi (formerly Fenni) or Lapp) are seasonally nomadic hunter-gatherer groups living in Finland, Russia, Sweden and Norway (Scheffer 1704; Collinder 1949; Vorren & Ernst McFarlane 1962). The Saami were primarily reindeer herders, but often fish was a substantial part of dietary intake. Freshwater fishing focuses on Atlantic salmon (*Salmo salar*), Arctic char (*Salvelinus alpines*) lake trout (*Salmo trutta lacrustris/Salmo trutta)*, grayling (*Thymallus thymallus*), pike (*Esox lucius*), European perch (*Perca fluviatilis*) and whitefish (unknown species)*,* which are the most highly prized (Scheffer 1704: 348; Itkonen & Minn 1948: 428; Pelto 1962: 24; Ingold 1976: 92; Anderson 1978: 816-817). Seasonal marine and fjord fishing allowed exploitation of Atlantic cod (*Gadus morhua*), Atlantic halibut (*Hippoglossus*

hippoglossus), rockfish (unknown species*),* saithe/pollack (*Pollachius virens/pollachius)*, and sole species (Soleidae) (e.g. Anderson 1978: 114; 455).

The Saami use three main fishing techniques: 1) nets, including seine and purse-seine nets (Anderson 1978: 113-114), 2) weir, and 3) rod (Dikkanen 1965: 25). Of these, nets were the more frequently used fishing gear (Vorren & Ernst McFarlane 1962: 86-87). Fishing even occurs during the winter through the ice of lakes and rivers using nets and lines (Itkonen & Minn 1948: 480; Paine 1957: 21; Ingold 1976: 72; Anderson 1978: 851), see Figure 3.3. When the ice was thin and clear on the lakes fish were easily caught in the shallow bays where they could be seen under the ice. The fishermen would strike the ice with an axe; this stunned the fish and they floated to the top, belly up, a hole was then made in the ice to fish them out (Vorren & Ernst McFarlane 1962: 86-87).

Fish caught with the help of weirs is considered the best in quality, followed by fish caught with fishing rods, seines, and nets (Itkonen & Minn 1948: 480). The weir is particularly good for catching many small fish (Dikkanen 1965: 26).

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Figure 3.3: Saami ice fishing (Ingold 1976: 92).

In most places some fishing was carried out all year round (Pelto 1962: 27), although most fishing was done between late spring and autumn according to spawning seasons (Anderson 1978: 174) and to fit in with the availability of reindeer which are lean and too dispersed for hunting during the summer months (Pelto 1962: 27; Anderson 1978: 455). Saami in Norway, however, fished mostly during the spring, because the summer fish could not be dried in time before autumn conditions set in (Gjessing 1954: 35). Summer catches mostly consisted of perch, pike and grayling, while in the autumn it was mainly whitefish and trout. However, summer catches can be poor, the fish can be lethargic and able to see the nets in the sunlight. In addition, dead fish putrefy quickly in warm water so nets have to be checked regularly during this season. A fresh catch must be salted or cooked and eaten immediately (Ingold 1976: 92).

The fish are gutted on the shore before being taken back to camp; small fish are not always gutted. Often the fish are not rinsed so that the flavour is not be lost; the scales are left untouched (Itkonen & Minn 1948: 482). When eaten fresh most fish are boiled, fried, broiled (roasted) (Itkonen & Minn 1948: 38; Collinder 1949: 81; Anderson 1978: 113-114), sometimes a soup or broth is made or a paste made by mixing with boiled cloudberries (Collinder 1949: 77-78). They also prepare “sour whitefish,” where the fish is salted slightly and put into a keg and left for months, until it becomes gelatinous and emits a characteristic smell (Collinder 1949: 81). Occasionally sausages were made by stuffing the intestines of pike and cod with fat and liver (Itkonen & Minn 1948: 482).

Some fish, most frequently whitefish, salmon, grayling and pike, are preserved by salting (Itkonen & Minn 1948: 480; Collinder 1949: 80; Whitaker 1955: 72), smoking

(Anderson 1978: 856), drying (Itkonen & Minn 1948: 38; Collinder 1949: 77-78; Pelto 1962: 27) and freezing (Itkonen & Minn 1948: 485). In drying sometimes the fish were first boiled, then left to dry in the air and sun (Collinder 1949: 77-78). If the fish were small only the viscera are removed; they are then placed on twigs to dry under a shelter. Large fish are cut in two and hung on sticks by their tails, their heads are removed. The largest fish, such as pike, trout, and grayling, are opened at the stomach and impaled on sticks through the lower fins. The big fish are opened along their backs and impaled on sticks by their tails, see Figure 3.4. Perch are cut in half through the stomach and threaded on sticks through the gills, see Figure 3.4. Perch and other small fish are not sprinkled with salt, only big pike and whitefish. Sometimes the fish are soaked in salt water before drying (Itkonen & Minn 1948: 482-483). When salmon is dried, usually occurring in early summer, the head is removed, the vertebrae pulled out, and slits cut in the flesh. These are dried on rocks or under a shelter, without adding any salt (Itkonen & Minn 1948: 485-486). Drying takes from two to three weeks, after drying the fish are kept in shelters or storehouses. To consume the dried fish it was usually soaked in salt water then roasted on a stick. Dried fish is mostly eaten in the autumn and early spring (Itkonen & Minn 1948: 483). The importance of the custom of drying fish is demonstrated by the fact that summer camps were often chosen for the presence of suitable rocks on which to dry the fish (Itkonen & Minn 1948: 482-483).

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Figure 3.4: Size dependent methods of drying fish used by the Saami (Itkonen & Minn 1948: 482).

Fish, especially whitefish, is also frozen in the winter. Frozen fish is preserved as such until spring; only the intestines and the liver are removed (Itkonen & Minn 1948: 485).

The Saami have several customs relating to the procurement and consumption of fish. These activities would not leave an archaeological trace, but are mentioned here to illustrate how hunter-gatherer attitudes to fish can be very diverse.

The phases of the moon are thought to impact upon the catches of both freshwater and marine fish, with fishing avoided during new moon phases (Anderson 1978: 267). Fish bones are often thrown into the water after the eating; this is done on the basis that it will ensure large fish populations in lakes and rivers are maintained for future years. The head bones of large fish, especially trout, are used for predicting future happenings. They are first scorched and then thrown in different directions (Itkonen & Minn 1948: 482).

Dogs are often kept by Saami groups and are fed on waste foods including fish heads and guts. Sometimes gruel was made for the dogs which included the innards of freshwater fish, spoiled blood, or leftover crusts and broth, which is then thickened with whole wheat flour (Anderson 1978: 297).

Species	**Freshwater/Anadromous**	**Marine/Estuarine**
	European whitefish	Atlantic cod
	Atlantic salmon	Atlantic halibut
	Trout	Rockfish
	Arctic char	Saithe/pollack
	Grayling	Sole species
	Pike	
	European perch	
Size	All	
Catching methods	Nets, rod, weir	
Season	Year round	
Cooking methods	Boil, broil (roasted), fry, make sausages	
Preservation	Salt, dry, smoke, freeze	
Cut-marks	Potentially where head and tail are removed for preservation.	
Digestion	Bones removed before consumption	
Customs	• Fishing not done during new moon. • Fish bones thrown into the water to ensure future fish populations. • Head bones of large fish, especially of a trout, are used for predicting future happenings: they are scorched, thrown in different directions.	
Animal interaction?	Unknown	

Table 3.8: Fishing behaviour by Saami groups. Shading indicates most important species. For references see text.

3.3 Conclusions

This chapter reviews the fishing behaviour of eight hunter-gatherer groups based in a range of different environments with different resource availability. Although there are some similarities between the fishing strategies and behaviours of the groups discussed here, such as a focus on exploitation of anadromous forms during migration seasons, the variation in the importance of fish in the diet as well as species exploited, fishing, cooking, preservation, disposal and customs related to fish is great between the different groups. This is also documented by Cordain *et al*. (2000) in a review of 229 hunter-gatherer populations worldwide. They see dependence on fish as a dietary resource vary from 0-85% (Cordain *et al.* 2000: 684). It is therefore not possible to construct an expected taphonomic signature for assemblages produced by human groups based on ethnographic accounts of hunter-gatherer groups.

Cordain *et al.*'s (2000) study also indicates that the exploitation of fish in hunter-gatherer groups is correlated with latitude, with fishing being more frequently included in subsistence strategies of recent hunter-gatherer populations as latitude increases. This is an important model which may aid the understanding of the role of fishing in Palaeolithic hunter-gatherer groups.

If an archaeological assemblage can be attributed to human activity by other means (see Chapters 4 and 5) then the data presented in this chapter become useful in the interpretation of Upper Palaeolithic hunter-gatherer fishing strategies. Ritual and taboo plays an important part in the formation of fish bone deposits for many recent and historical hunter-gatherer groups, these can rarely be recognised in the archaeological record, but must be considered in the interpretation of archaeological fish deposits. This conclusion is supported by a study by Van Neer and Morales (1992), where they analysed fish remains in 5 river-side middens in Dakar-Bango, Senegal. The middens were known to result from human activity, yet the absence of other cultural artefacts would prevent them being attributed as such, should they have been recovered during an archaeological excavation (Van Neer & Morales 1992: 683). If all of the possible natural accumulation processes applicable for the area could have been ruled out (such as fluvial processes and piscivorous animals), then one would have had to come to the conclusion that the accumulation resulted from human activity. The assemblage could then have provided a useful insight into recent fishing practices by assessment the species present, size of fish, season of capture and spatial distribution.

Chapter 4. Taphonomic processes and fish bones

4.1 Why is taphonomy important?

Fish bones recovered from archaeological sites have survived the effects of a range of taphonomic processes. Biotic, thanatic, perthotaxic, taphic, anataxic, sullegic and trophic processes lead to destruction, modification and preservation of fish remains. It is important that these processes can be identified and considered in the interpretation of fish remains. Failure to identify these assemblage-altering processes can potentially lead to incorrect assumptions about agency and patterns in the collection and processing of fish remains. At present, however, the effects of taphonomic processes on fish remains have been poorly studied.

To understand taphonomic processes further the chemical and physical characteristics of fish bone must be considered as these influence all taphonomic processes, and potentially can be used to predict the preferential preservation of fish remains.

4.2 Chemical composition and physical characteristics of fish bone

Physical properties and the chemical composition of fish bones have a direct impact on the preservation of fish remains on archaeological sites in terms of:

1) Variable preservation between fish, mammal, bird, reptile and amphibian remains
2) Variable preservation between different fish species
3) Variable preservation between different skeletal elements in a single fish (e.g. cranial vs. non-cranial)

Fish remains tend to be smaller and less robust than those of many mammal species (Lyman 1984; Nicholson 1992a; Butler & Chatters 1994). Although little research has been conducted on the comparative survivability of mammal, bird, amphibian and reptile versus fish bones, bone density is known to have a significant impact on preservation (Lyman 1984; Nicholson 1992a; Butler & Chatters 1994; Erlandson 2001). Many fish bones, notably cranial elements, are extremely fine, sometimes paper-like. Vertebrae, while often being more resistant to post depositional taphonomic processes (Butler & Chatters 1994; Nicholson 1996a; b), are often extremely porous, creating a high surface area to volume ratio, increasing chemical degradation rates (Erlandson 2001).

Few studies have considered the impacts of variation in the chemical and physical properties of fish bones on preservation at archaeological sites. Preferential destruction of skeletal remains of certain species and elements caused by these factors can produce element representation patterns that can be misleading. For example, in North America low frequencies of cranial elements compared with vertebrae were used to suggest the cultural use of stored fish. This was based on ethnographic and ethnohistoric accounts of fish processing in the area (Butler & Chatters 1994). However, other taphonomic processes may produce similar signatures, leading to incorrect interpretation of material from archaeological sites. Data derived from bone density studies (e.g. Lyman 1984; Nicholson 1992a; Butler & Chatters 1994) have been applied to archaeological assemblages to aid identification of accumulation agents and identify processing techniques (Butler & Chatters 1994; Whitridge 2001; Zohar *et al.*

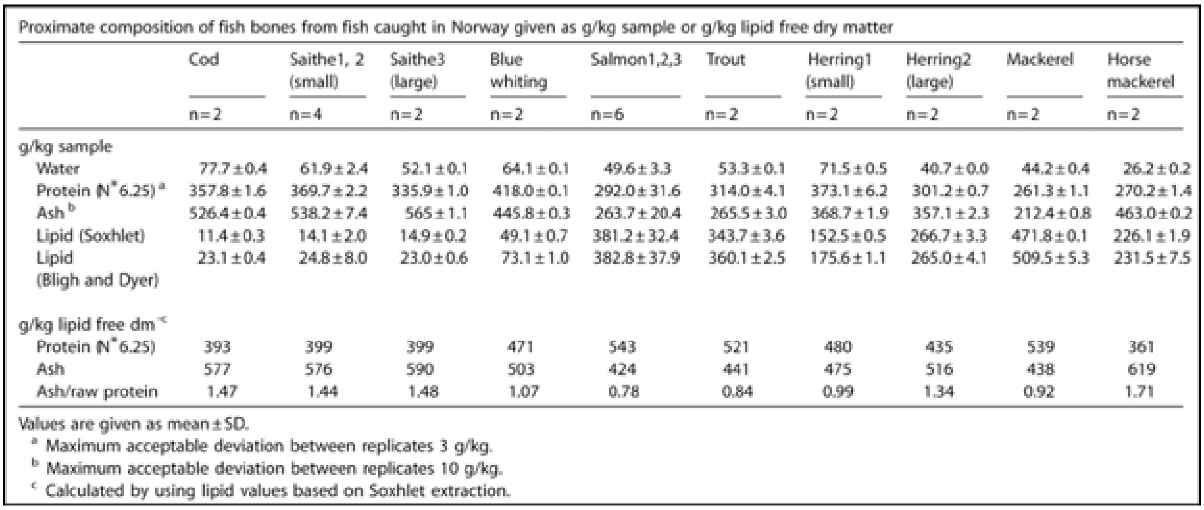
2001). Research on chemical composition of fish bones remains limited, with studies mainly focussing on the nutritional value of fish bone for addition to animal feeds and human diet (Shimosaka *et al.* 1996; Toppe *et al.* 2007), rather than the implications for the study of fish remains from archaeological sites.

4.2.1 Chemical composition

The chemical composition of fish bone differs from that of skeletal material of mammals, reptiles, birds and amphibians (Biltz & Pellegrino 1969). Although previous studies have provided some idea of the difference between other vertebrate, especially mammal, and fish bone, a general observation is that fish bone is less mineralised. Fish remains have lower proportions of biological apatite and hence calcium and phosphate, than mammalian bone. An indication of mineralisation is also provided by the density.

Chemical composition of bone also varies between different fish species (Table 1, Toppe *et al.* 2007). It is also suggested to vary by age and sex within a single species (Jowsey 1968). The chemical properties of fish bone directly impact on the preservation of remains within the archaeological record and may lead to under- and over-representation of particular animal groups, and different fish species. This may be a problem in terms of species diversity, which is used in establishing agent(s) of accumulation for fish bone assemblages from archaeological sites and in the interpretation of human fishing strategies.

The full chemical properties of fish bones are not well known. Little research has focussed on the implications of varying fish bone chemical composition in the study of fish remains in archaeology. More frequently investigated are the implications of chemical composition for fish bone inclusion in animal feeds (e.g. Toppe *et al*. 2007) and human diet (Shimosaka *et al.* 1996). Results of such studies can be used to investigate the potential for variation in chemical composition to cause differential preservation between mammals, reptiles, amphibians, birds and fish, and differential preservation between fish species. Recent research (Toppe *et al*. 2007) has considered 8 fish species; it showed that fish bone lipid content varies considerably between species, from 23g/kg in Atlantic cod (*Gadus morhua*) to 509g/kg in Atlantic mackerel (*Scomber scombrus*), Table 4.1. Variation in protein and ash content were also observed, but were not as pronounced as variation in lipids, Table 4.1 (Toppe *et al.* 2007). Mineral proportions remained similar for the 8 species considered, Table 4.2. Amino acid profiles for 8 fish species showed some minor variations, Table 4.3 (Toppe *et al.* 2007).



Proximate composition of fish bones from fish caught in Norway given as g/kg sample or g/kg lipid free dry matter

	Cod	Saithe1, 2 (small)	Saithe3 (large)	Blue whiting	Salmon1,2,3	Trout	Herring1 (small)	Herring2 (large)	Mackerel	Horse mackerel
	n=2	n=4	n=2	n=2	n=6	n=2	n=2	n=2	n=2	n=2
g/kg sample										
Water	77.7±0.4	61.9±2.4	52.1±0.1	64.1±0.1	49.6±3.3	53.3±0.1	71.5±0.5	40.7±0.0	44.2±0.4	26.2±0.2
Protein (N*6.25)[a]	357.8±1.6	369.7±2.2	335.9±1.0	418.0±0.1	292.0±31.6	314.0±4.1	373.1±6.2	301.2±0.7	261.3±1.1	270.2±1.4
Ash[b]	526.4±0.4	538.2±7.4	565±1.1	445.8±0.3	263.7±20.4	265.5±3.0	368.7±1.9	357.1±2.3	212.4±0.8	463.0±0.2
Lipid (Soxhlet)	11.4±0.3	14.1±2.0	14.9±0.2	49.1±0.7	381.2±32.4	343.7±3.6	152.5±0.5	266.7±3.3	471.8±0.1	226.1±1.9
Lipid (Bligh and Dyer)	23.1±0.4	24.8±8.0	23.0±0.6	73.1±1.0	382.8±37.9	360.1±2.5	175.6±1.1	265.0±4.1	509.5±5.3	231.5±7.5
g/kg lipid free dm[c]										
Protein (N*6.25)	393	399	399	471	543	521	480	435	539	361
Ash	577	576	590	503	424	441	475	516	438	619
Ash/raw protein	1.47	1.44	1.48	1.07	0.78	0.84	0.99	1.34	0.92	1.71

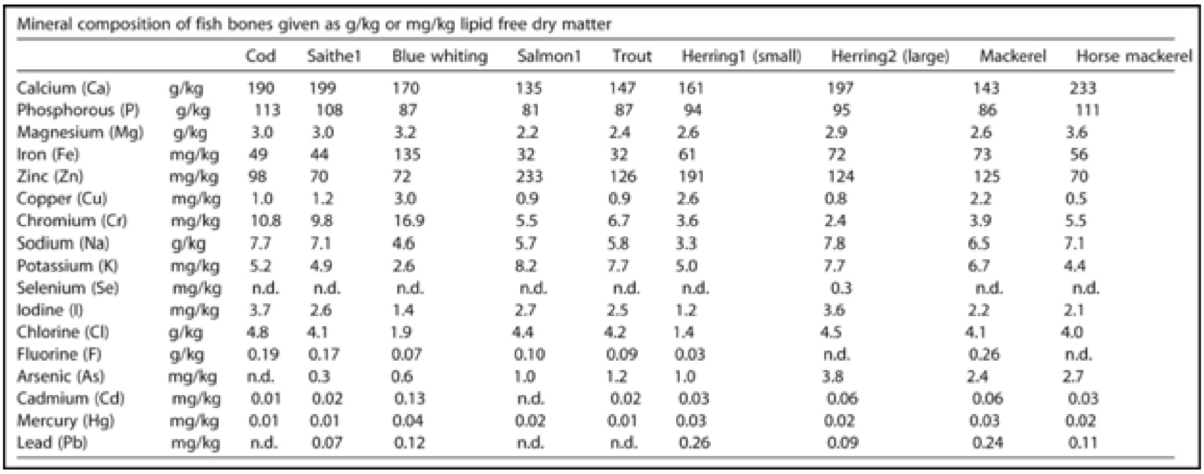
Values are given as mean±SD.

[a] Maximum acceptable deviation between replicates 3 g/kg.

[b] Maximum acceptable deviation between replicates 10 g/kg.

[c] Calculated by using lipid values based on Soxhlet extraction.

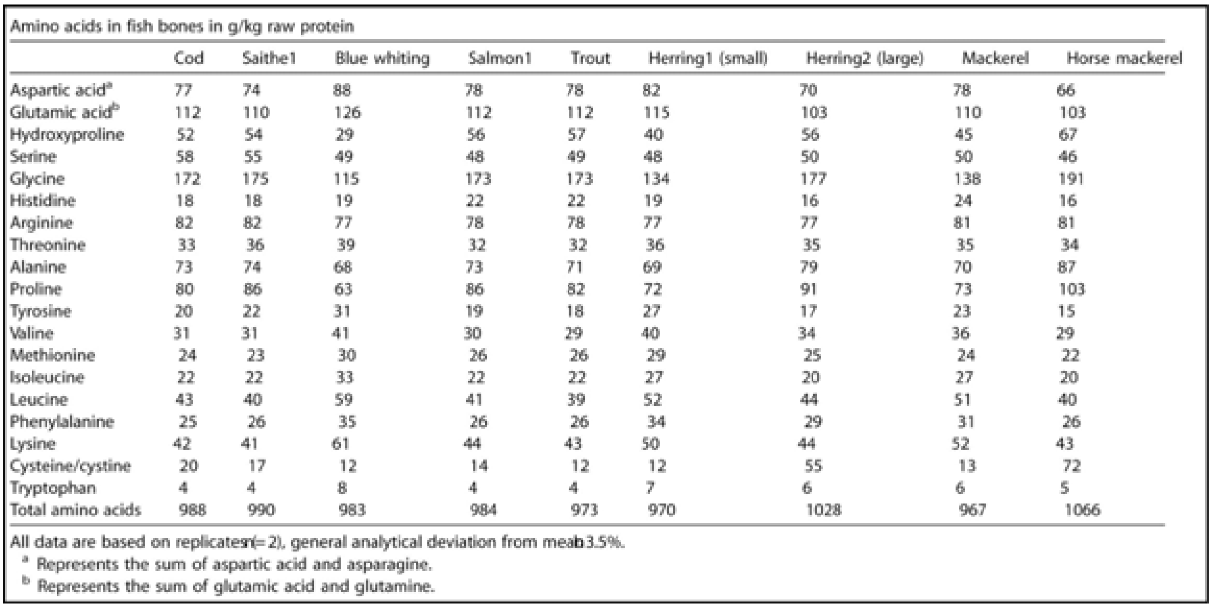
Table 4.1: Proximate composition of fish bones from fish caught in Norway given as g/kg sample or g/kg lipid free dry matter (Toppe *et al.* 2007: 397).



Mineral composition of fish bones given as g/kg or mg/kg lipid free dry matter

		Cod	Saithe1	Blue whiting	Salmon1	Trout	Herring1 (small)	Herring2 (large)	Mackerel	Horse mackerel
Calcium (Ca)	g/kg	190	199	170	135	147	161	197	143	233
Phosphorous (P)	g/kg	113	108	87	81	87	94	95	86	111
Magnesium (Mg)	g/kg	3.0	3.0	3.2	2.2	2.4	2.6	2.9	2.6	3.6
Iron (Fe)	mg/kg	49	44	135	32	32	61	72	73	56
Zinc (Zn)	mg/kg	98	70	72	233	126	191	124	125	70
Copper (Cu)	mg/kg	1.0	1.2	3.0	0.9	0.9	2.6	0.8	2.2	0.5
Chromium (Cr)	mg/kg	10.8	9.8	16.9	5.5	6.7	3.6	2.4	3.9	5.5
Sodium (Na)	g/kg	7.7	7.1	4.6	5.7	5.8	3.3	7.8	6.5	7.1
Potassium (K)	mg/kg	5.2	4.9	2.6	8.2	7.7	5.0	7.7	6.7	4.4
Selenium (Se)	mg/kg	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.3	n.d.	n.d.
Iodine (I)	mg/kg	3.7	2.6	1.4	2.7	2.5	1.2	3.6	2.2	2.1
Chlorine (Cl)	g/kg	4.8	4.1	1.9	4.4	4.2	1.4	4.5	4.1	4.0
Fluorine (F)	g/kg	0.19	0.17	0.07	0.10	0.09	0.03	n.d.	0.26	n.d.
Arsenic (As)	mg/kg	n.d.	0.3	0.6	1.0	1.2	1.0	3.8	2.4	2.7
Cadmium (Cd)	mg/kg	0.01	0.02	0.13	n.d.	0.02	0.03	0.06	0.06	0.03
Mercury (Hg)	mg/kg	0.01	0.01	0.04	0.02	0.01	0.03	0.02	0.03	0.02
Lead (Pb)	mg/kg	n.d.	0.07	0.12	n.d.	n.d.	0.26	0.09	0.24	0.11

Table 4.2: Mineral composition of fish bones (Toppe *et al.* 2007: 398).



Amino acids in fish bones in g/kg raw protein

	Cod	Saithe1	Blue whiting	Salmon1	Trout	Herring1 (small)	Herring2 (large)	Mackerel	Horse mackerel
Aspartic acid[a]	77	74	88	78	78	82	70	78	66
Glutamic acid[b]	112	110	126	112	112	115	103	110	103
Hydroxyproline	52	54	29	56	57	40	56	45	67
Serine	58	55	49	48	49	48	50	50	46
Glycine	172	175	115	173	173	134	177	138	191
Histidine	18	18	19	22	22	19	16	24	16
Arginine	82	82	77	78	78	77	77	81	81
Threonine	33	36	39	32	32	36	35	35	34
Alanine	73	74	68	73	71	69	79	70	87
Proline	80	86	63	86	82	72	91	73	103
Tyrosine	20	22	31	19	18	27	17	23	15
Valine	31	31	41	30	29	40	34	36	29
Methionine	24	23	30	26	26	29	25	24	22
Isoleucine	22	22	33	22	22	27	20	27	20
Leucine	43	40	59	41	39	52	44	51	40
Phenylalanine	25	26	35	26	26	34	29	31	26
Lysine	42	41	61	44	43	50	44	52	43
Cysteine/cystine	20	17	12	14	12	12	55	13	72
Tryptophan	4	4	8	4	4	7	6	6	5
Total amino acids	988	990	983	984	973	970	1028	967	1066

All data are based on replicates ($n = 2$), general analytical deviation from mean 3.5%.

[a] Represents the sum of aspartic acid and asparagine.

[b] Represents the sum of glutamic acid and glutamine.

Table 4.3: Amino acids present in fish bones (Toppe *et al.* 2007: 398).

4.2.2 Physical characteristics of fish bone

The physical characteristics of fish bone also vary from those of mammals, birds, amphibians and reptiles, and also between fish species (Chasler 1972).

Bone density

It has long been suggested that bone density is an overriding factor in the survival of animal bones. High bone density leads to increased preservation of bones over those with low density values. Several methods have been applied in establishing bone density values for animal bones (Brain 1976; Binford & Bertram 1977; Lyman 1984; Nicholson 1992a), although each method has associated problems which have resulted from the difficulty in establishing density values (Nicholson 1992a). Results suggest that fish bone density is not the dominant mediator of bone survival as previously suggested (Nicholson 1992a). A low-density measurement for a bone indicates a high volume: weight ratio - a porous, less mineralised bone with a large surface area. Bones with a large surface area are likely to be more vulnerable to attack by micro-organisms. Porous bones absorb more water more quickly leading to accelerated protein decay and leaching (Nicholson 1992a).

Structural and mechanical properties

Little is known about the mechanical properties of fish bones (Currey 2006: 25). The main difference between fish bone and the bones of most other animals; is that in many teleosts there are no bone cells (i.e. bone is acellular) (Moss 1961). Moss (1961) found that out of 136 teleost species (representing 71 families) studied, only 26 had cellular bones and only one (*Albula vulpes*) had both cellular and acellular bones. Cellular bone was present only in lower order teleosts while acellular bone was present in the higher orders (Moss 1962). Teleost bone has both lamellar and woven bone forming both compact and cancellous structures. The organic matrix of fish bones (cellular and acellular) is composed of two types of collagen; calcified matrix fibres and uncalcified fibre bundles (Moss 1961: 353). In fish there is also no bone re-modelling, instead bone growth spreads from centres of ossification in straight lines (Currey 2006: 26). To date, no studies have considered fully the implications of variation between fish bone structural and mechanical properties and those for other vertebrates for preservation in the archaeological record.

Chasler (1972) considered mechanical variation in rib bones of Atlantic herring (*Clupea harengus*), Atlantic mackerel (*Scomber scombrus*), European chub (*Squalius cephalus*) and Atlantic cod (*Gadus morhua*). Results of this study suggest that, in the case of ribs at least, fish remains more susceptible to bending forces than mammal bone. Further experiments by Jones comparing an Atlantic cod parasphenoid, a robust bone in comparison to many other fish bones, with a metacarpal of sheep (*Ovis aries*) also indicate the lower resistance of fish bones to mechanical damage (Wheeler & Jones 1989: 63).

4.3 Pre-depositional and depositional taphonomic processes

Fish harvesting methods

The use of different fishing gear and strategies can create assemblages that do not reflect the taxonomic diversity of a given aquatic environment. The selectivity of different fishing methods has been used to determine how fish were caught in the past (Goodwin 1946; Leach 1979; e.g. Colley 1987; Owen & Merrick 1994). For example, if a weir is used in a stream or river during salmonid spawning, it will catch only salmon and trout that are moving up-water, despite there being other residential species inhabiting the water system. Another example is that of poison fishing, used by hunter-gatherer groups in historic and recent times (e.g. Quigley 1956). This process leads to the death of species which inhabit specific areas. Some poisons affect only bottom-dwelling species, while others affect surface living. Within these areas the poisons affect all fish, both small and large. It has been suggested that the use of piscicides can be identified in the archaeological record at 141B-T3 of Salango, Equador, South America which dates between 900 and 350BC (Béarez 1998). The species and size of fish and mortality profiles can be used to identify several fish harvesting methods, but should be applied only with an understanding of fish behaviour and population structure as well as taphonomy and environmental conditions (Greenspan 1998).

Butchery

Little research has considered the effects of fish preparation – including skinning, gutting and various methods of portioning – on skeletal remains and the potential for recognising these in the archaeological record. In a recent study by Willis *et al.* (2008) 37 fish were butchered using stone tools. Results suggested that cut-marks could be underrepresented in archaeological material because they are often sustained on elements that cannot be identified to a low taxonomic level (genus or species) and therefore are not considered closely by the identifier (Willis *et al.* 2008). This pattern was also observed in experimental work carried out by the Hunter-Gatherer Research Laboratory at the University of Bradford (unpublished). This research looked to build on this by looking at cut-marks on fish bones using scanning electron microscopy (SEM) to establish criteria that can be used along with distribution of cut marks to further understand fish processing in the past. It is important to establish the characteristics of this type of modification for comparison with that caused by other taphonomic processes, such as trowel marks and tooth marks.

Cooking and burnt fish remains

Burnt remains in fish bone assemblages are often used as an indication of human activity (Nicholson 1993b; Stewart & Gifford-Gonzalez 1994; Zohar *et al.* 2001). However, this criterion should be applied with caution. Naturally deposited fish bone fragments may become burnt through natural or cultural means. This would happen, for example, if a fire is built over an area where bones have previously been deposited, or if a natural fire occurs. Many fish bone assemblages are recovered from cave sites. It is known that lightning is drawn to cave mouths (Choppy 1994; Gookin 2003) and therefore natural cave fires are common. Fire built on top of previously deposited (natural or cultural) fish bones could cause heating of sediments and non-cultural, *in situ* “cooking”. The ethnographic record indicates that human populations would have most likely cooked fish before consumption, although consumption of raw fish was common in some groups. Identification of ‘cooked’ fish remains in the archaeological record has been investigated in the past by comparing collagen fibrils extracted from archaeological material to those from experimentally produced material. Bone exposed to indirect heating (for example, cooking) does not display macroscopic evidence of this process. Initial experimental data (Ritcher 1986) indicated that an increase in temperature caused morphological changes in collagen fibrils that could be observed using transmission electron microscopy (TEM). It was suggested that the method employed could be applied to the recognition of ‘cooked’ fish bone at archaeological sites (Ritcher 1986). Koon *et al*. (2003; 2010) showed that within the same burial environment ‘heated’ could be separated from ‘non-heated’ bone (mammal). However, problems were recognised when trying to compare material originating from different burial environments. It was also observed that low pH produced similar characteristics in collagen fibrils to low temperature heating (Koon *et al.* 2003). Nevertheless, this suggests that if a site has fairly homogeneous sediments 'cooked' bone can be separated from 'un-cooked' bone.

Digestion (Human)

Jones (Jones 1984; 1986) undertook experiments into the effect of the human digestive system on fish remains in the mid-eighties. In an initial experiment a whole herring (*Clupea harengus* L.) was consumed by Jones and faeces collected for one day. Only vertebrae were recovered from this experiment, many of which were fragmentary (Jones 1984). Jones felt that some bones might have been lost as a result of only one day of faecal collection, so the experiment was later repeated. In later experiments the author (Jones) consumed a whole grilled herring (Jones 1986). This was followed by seven days of faecal collection. Study of the surviving remains indicated that less than 10% of ingested bone survived human mastication and digestive processes. Vertebrae appeared compressed and fragmentary, and were comparable to vertebrae from archaeological sites (Jones 1986). However, many post-depositional processes cause similar fragmentation. Despite the loss of over 90% of remains, some elements displayed no distinctive signs of passing through the digestive system (Jones 1986).

Smith (1985) proposed criteria for the recognition of fish remains that had passed through the human digestive system based on archaeological fish remains from Hidden Cave, Nevada. He proposed that material that had passed through the gut would display dark staining, acid etching, have adhering organic rich particles and be small in size. These criteria were later shown to be inaccurate through the study of known human coprolites (Butler 1996; Butler & Schroeder 1998).

Research by Nicholson (Nicholson 1993a) confirmed a >90% loss of fish remains after passing through the human gut. The aims were to produce criteria for recognising remains that had passed through the human digestive system, to replicate earlier experiments by Jones (1984; 1986) and to consider additional species – sardine (*Sardina pilchardus*) and sprat (*Sprattus sprattus*). Fish were lightly cooked, either by grilling or frying before consumption. Faecal samples were diluted and sieved as by Jones (1986). Results indicated that vertebrae were the most likely element to survive human mastication and digestive processes. Most bones were damaged beyond species identification, with no bones from smaller species surviving. Several vertebrae were stained dark brown to black and displayed evidence of extreme acid dissolution; these vertebrae were recovered from samples also yielding unstained, un-eroded vertebrae.

Experiments on human consumption of tui chub (*Gila bicolour*) (Butler & Schroeder 1998) questioned previous claims (Jones 1984; Smith 1985; Jones 1986; Nicholson 1993a) that fish remains that had passed through the gut would display characteristic staining, pitting, rounding and deformation. Results showed that skeletal elements with relatively flat surfaces often had small pits and cavities with many elements displaying broken edges or worn surfaces. Vertebrae were often compressed and fragmentary, confirming the earlier results achieved by Jones (1984; 1986) and Nicholson (1993a). The conclusion of this research was that some previously established criteria for the identification of material that had passed through the gut were incorrect and misleading. The study also showed only a 74% loss of skeletal material, lower than the >90% previously suggested by Jones (1984; 1986) and Nicholson (1993a). Butler and Schroeder suggest that this is because tui chub are smaller than the species used by Jones (1984; 1986) and Nicholson (1993a), and so less porous, preventing digestive juices penetrating the external surface. In addition smaller fish require less processing and mastication (Butler & Schroeder 1998).

Although the composition and density of fish bone varies from those of small mammals, results of investigations into the effects of human mastication and digestion processes on small mammal remains by Crandall & Stahl (1995) may prove useful in recognising fish bones that have passed through the human gut. This study includes the use of scanning electron microscopy (SEM) to show in detail the effects of digestive juices on small bones and teeth (Crandall & Stahl 1995).

Digestion (by animals)

Feeding experiments with non-hominin faunas are limited to dogs (*Canis* sp.), domestic pig (*Sus domesticus*), otter (*Lutra lutra*) and rats (*Rattus* sp.). Experimental feeding of species of the genus *Canis* were carried out by Jones (1984; 1986). A domestic dog (*Canis lupis familiaris*) was fed lightly cooked skin and bones of two red snappers (*Lutianus* sp.). The dog rejected some bones and these were collected and labelled 'rejected'; some of these were chewed but none were swallowed. Another group of bones were regurgitated; these were labelled 'vomited'. Faecal material was collected for the following seven days. Many elements were destroyed during digestive processes; remaining elements displayed varying fragmentation, compression and dissolution by stomach acids. Over 80% of identifiable bones were lost through digestion (Jones 1984). In a second experiment Jones (1986) fed a gutted herring (*Clupea harengus* L.) and a small haddock (*Melanogrammus aeglefinus*) to a domestic dog. Again some bones were regurgitated by the dog and collected separately from faecal material. Results were comparable with those for human consumption presented in same paper, with >90% loss of swallowed skeletal material.

Research into the diet of the coyote (*Canis latrans*) has involved collection of scat samples. However, the digestive processes of this species are such that bones of mammals survive only as small splinters and it is unlikely that fish remains will be recovered (Álvarez-Castaňeda & González-Quintero 2005; Broughton *et al.* 2006).

Only one experimental study considering suids has been undertaken. Jones (1986) fed fresh, gutted mackerel (*Scomber scombrus*) and herring (*Clupea harengus*) to a domestic pig (*Sus domesticus*) and collected faecal matter for the subsequent seven days. As a result of mastication and digestive processes >90% of skeletal elements were lost. The presence of pigs on archaeological sites in the past may lead to loss of fish remains, although additional research in this area is required in order to assess the full impact of this species (Jones 1986).

Otters (*Lutra lutra*) have been identified as potential agents of accumulation of fish remains on archaeological sites (Nicholson 2000). Criteria have been developed for recognising fish remains from otter spraints using modern reference material collected from the northern coast of Scotland. Species and element representation patterns and element damage were used to assess three assemblages of small fish bones from prehistoric sites on the Orkney Isles. It is concluded that they were produced by otters (Nicholson 2000). Additional information on the analysis of otter faecal material is abundant in the field of dietary studies on otters; however, these do not consider the taphonomic effects the digestive system has on fish remains (Webb 1980; Weber 1989; Carss & Elston 1996; Conroy *et al.* 2005; Clavero *et al.* 2006; Blanco-Garrido *et al.* 2008).

In another experiment three rats (*Rattus* sp.), separately caged, were fed whole young plaice (*Pleuronectes platessa*) and young herring (*Clupea harengus* L.)(maximum length 13cm) and later the head and backbone of a medium size herring (27cm in length). All bones were consumed with no identifiable remains recovered from faecal material. This indicates that rats, and one could assume other rodent species, should be regarded as agents with the potential to remove evidence for human consumption and use of fish on archaeological sites (Wheeler & Jones 1989: 69-70).

Additional information related to digestion comes from research regarding recognition of tooth marks on bone (Binford 1978; Bonnichsen 1979; Haynes 1980; Binford 1981; Brain 1981; Haynes 1983; Blumenschine & Selvaggio 1988; Johnson 1989; Bonnichsen & Will 1990; Capaldo & Blumenschine 1994; Fisher Jr. 1995; Pickering & Wallis 1997; Njau & Blumenschine 2006; Landt 2007). While such studies have focussed on bones of large mammals, the theory has recently been applied to small mammal (leporid) remains (Lloveras 2009) where tooth marks could be identified in experimentally produced material. However, cooked fish can easily be removed from the bone with the fingers and contains no marrow; it does not require the ‘gnawing’ as rabbit and other small mammal bones may require in order to remove the flesh, or crack open the bone to remove the marrow. Fish bones are more porous and present fewer cortical bone surfaces for tooth marks to be left than mammal bones. They are also generally smaller and so it is more difficult to recognise characteristics associated with tooth marks. These are predictions and have not yet been tested either ethnographically or experimentally. To date, no instances where tooth marks, human or large mammal, have been documented on fish remains.

Scavengers

Scavengers lead to the loss and modification of fish remains deposited by people and other animals, but they may also create fish bones assemblages in caves, either though bringing scavenged food back to a den or through defecation. Scavengers cause dispersal of skeletal remains, potentially masking patterns in spatial density and distribution that are used to identify accumulation agents. The effect of scavengers on fish remains is limited to the digestion studies discussed previously in this chapter using rat and pig. Spatial modification is discussed by Bullock and Jones (1998); they observed extensive loss at spatial distribution of remains during an experiment where Atlantic herring (*Clupea harengus*) and Atlantic mackerel (*Scomber scombrus*) were laid out for 5 weeks. However, while they identify dog (*Canis lupus familiaris*) mink (*Mustella vison*) and rat (*Rattus norvegicus*) as likely mechanisms, they were unable to reliably identify specific agents. They noted that although exposure to the elements and animal populations had a severe impact on the minimum number of individuals (MNI) (from 20 to 5 for herring and 5 to 1 for mackerel), the overall percentage representation remained constant (Bullock & Jones 1998).

Weathering

The effects of weathering vary according to the time period for which bones are exposed to the element prior to burial (Hesse & Wapnish 1985). The effects of this process have been described in five successive stages (Behrensmeyer 1978):

1) Exterior surface shows some degree of superficial longitudinal cracking.

2) The cracks become more pronounced and flakes of bone begin to lift from the surface.

3) The smooth exterior begins to take on a fibrous quality.

4) The cracks grow deeper and flaking becomes extensive.

5) Bone begins to fall apart.

The extent to which weathering has modified an assemblage can greatly affect the amount of material that can be identified. Weathering can however be useful in some cases in the reconstruction of environmental conditions at the time of burial, for example strong sunlight causes bleaching (Cutler *et al.* 1999). At present there are no criteria to describe weathering in fish remains.

Fluvial Processes

Transportation of remains prior to burial can be caused by fluvial (water) and aeolian (air) processes. Attempts to recreate processes of sediment and water movement in the archaeological record have been carried out by Coard (1999). Despite causing spatial variation experimental studies have shown that little or no physical damage occurs as a result of these processes (Bonnichsen 1979).

4.4 Post-depositional taphonomic processes

Root etching

Plant and tree roots secrete digestive enzymes in order to dissolve nutrients in the surrounding soil for absorption into their systems. These enzymes are often acidic. When roots come into contact with skeletal material root enzymes cause the surface to degrade (Hesse & Wapnish 1985: 85). This creates a 'crazed' pattern on larger bone surfaces, but can destroy the porous structure of small bones such as fish vertebrae. The action of roots within the burial environment can also cause substantial movement of objects as well as fragmentation due to growth.

Soil conditions - pH, temperature, aeration and moisture content

Acidic sediments (low pH) can lead to total loss of skeletal material (Van Wijngaarden-Bakker 2000). In alkaline soils fish bone preservation is often very good, especially otoliths. For this reason fish remains are frequently recovered from caves and rock shelters. The geology of these features is often calcium carbonate based, e.g. limestone; fluvial and aeolian processes lead to the formation of the bone preserving alkaline soils. Other soil conditions such as aeration, temperature and water content affect the species and abundance of bacteria that are able to survive. Bacteria may cause both chemical and physical changes in skeletal material. Freeze-thaw cycles can even cause spatial distribution. Sediments contract and expand during each cycle, which over an extended period of time can cause extensive movement within the burial environment (Capaldo & Peters 1995). When investigated experimentally pH was found to have varying impacts on different fish skeletal elements, with acidic conditions leading to loss of cranial elements more quickly than vertebrae loss (Lubinski 1996).

Bioturbation

Bioturbation has been studied in both on-site and in actualistic studies. Small and large burrowing animals, insects and megadriles cause movement of sediment and objects. This creates a skewed picture of past events and conditions. Ecological and experimental studies have shown the extent to which bioturbation can affect stratigraphic sequences in some cases, however, many Palaeolithic fish remains are recovered from cave environments and no research on this issue has yet been published. An example of how bioturbation can affect archaeological remains at cave sites is Tsodilo Hills White Painting Rock Shelter in Botswana (Robbins *et al.* 2000). Here re-fitting pottery sherds and fragments of ostrich eggshell at the site were found with up to 30cm vertical distance between. Movement on this scale is likely to have major impact on the interpretation of cultural and natural sequences at the site. At nearby open-air excavation a 1-year-old coin was found at a 10-15cm depth, indicating the potential for quite large objects to move within the burial environment (Robbins *et al.* 2000). Most troglobites and troglophiles are small animals that may have some impact upon archaeological and paleontological assemblages, but they are unlikely to bring fish remains from outside of the cave environment. However, the actions of some cave dwelling animals have been recognised as having effects on cave deposits that may distribute fish remains. The action of earthworms, once overlooked by archaeologists, has been shown to move objects (Armour-Chelu & Andrews 1994), and also ‘sort’ them and even create false layers in stratigraphic sequences (Canti 2003).

Abrasion

Abrasion is caused by sediment movement (Behrensmeyer 1978: 307; Wood & Johnson 1978). This can cause bones to become polished in fine sediments (Shipman *et al.* 1984). Coarse sediments can cause abrasion to fish remains, removing the lamellar surface, or parts of it (Smith *et al.* 1988). This can remove evidence of butchery and gnawing, and may prevent seasonal analysis, which requires the very external annulations of vertebrae and other elements. Extreme abrasion can cause loss of smaller and less dense elements.

Trampling

Trampling of sediments by either animals or humans can cause fragmentation and surface modification of bones that may become confused with carnivore, scavenger or human activity during analysis (Olsen & Shipman 1988). An experiment by Jones (1999) investigated the impacts of walking on the skeletal elements of *Gadus morhua* (Atlantic cod). Results suggested that some cranial elements (notably parasphenoid, dentary, maxilla and premaxilla) were resilient to trampling (after 375 paces). The survival of vertebrae varied depending on type, but generally the vertebrae at either end of the spine survived better than central ones (Jones 1999). However, as discussed in Section 3.2, interspecies variation in chemical and physical properties of the skeletal remains means it is likely that trampling forces will affect different species in different ways, affecting their comparative archaeological visibility. Fish trampling is likely to have affected almost all remains within cave deposits (through later use of the sites by animals and humans) this process has been investigated experimentally for three of the most frequently recovered fish species from Palaeolithic deposits, details of which can be found in Chapter 5.

4.5 Factors affecting fish bones during and after excavation

Excavation and Sampling Strategies

Fish remains, especially those of smaller species, were not frequently recovered from archaeological sites excavated before the onset of systematic onsite sampling and sieving. This means that for many sites fish remains that may have been present and preserved were not recovered. Studies on faunal recovery show that even when sieving does take place mesh sizes larger than 0.25 inches (0.6 cm) will lead to the loss of many fish remains (Garson 1980; Gobalet 2005; Zohar & Belmaker 2005). Even when on-site sieving occurs much material can be missed depending on lighting conditions, siever experience, volume of sample, and sediment type. On-site sieving will often lead to the loss of bones of smaller species and therefore cause biases in the representation of small and large fish species, but could also potentially cause a size restricted assemblage to be recovered leading to misinterpretation of fishing strategies. For example, it could lead to the conclusion that gill nets were used or that seasonal fishing occurred, see Chapters 3 and 8.

Fish taxonomy, analysis and dissemination choices

The taxonomy of fish species, and generally any animal species, is incredibly complex. While for some species taxonomic allocations have changed little since descriptions by their discoverers, others have been subjected to extensive changes. Some species have been merged together with others to represent a single, diverse species, sometimes with sub-species recognised within, whereas others may be split into many different species. As a result of improved worldwide communication (transportation links and the internet) many separately assigned species have now been reassigned to the same one - for example when two populations of the same species are assigned different names by different taxonomists because they were unaware of prior descriptions. The introduction of DNA analysis has caused further changes, as it shows sufficient variation in some species to allow them to be attributed to new families and genres (Snoj *et al.* 2002). This can cause confusion; fish documented many years ago may be referred to as a completely different name to those documented today. In recent times taxonomists may use different species and sub-species allocations depending on their judgement.

There are approximately 28,000 extant species of fish (Nelson 2006: 5). The diverse nature of fish means it is often difficult to identify remains to species and sometimes even genus level. The bones of fish are morphologically different from those of mammals, and many are difficult to identify even to element level. As such, the number of people that take on the challenge of becoming a fish remains specialist is drastically less than those pursuing a career in mammal bone identification. This has lead to a lack of fish specialists. Blind tests on fish bone identification have also identified problems in consistency between specialists (Gobalet 2001). Fish bone reports or even just the documentation of fish bone recovery may also be omitted from site reports, or included only as appendices with no discussion of their significance. Erlandson (2001: 303) discovered fish remains from early Upper Palaeolithic strata at Gorham's Cave (Gibraltar) in the Gibraltar Museum, despite no remains being mentioned in site publications, which include reports on the mammal, reptile, birds and shellfish remains. He also records this problem for other Palaeolithic sites (Erlandson 2001: 304).

4.6 Conclusion

Although there is not a lot of quantitative evidence, fish bones clearly differ in chemical and mechanical properties to other vertebrate bones. This makes them more fragile and less likely to survive in the archaeological record. It is also difficult, based on present evidence, to assign agency with confidence because some of the criteria, for example burning, although useful, are not perfect indicators of human agency.

Chapter 5. Taphonomic experiments

5.1 Introduction

As discussed in Chapter 4, understanding the effects of taphonomic processes on fish remains is a vital aspect in the interpretation of archaeological assemblages. The reason that understanding both pre-depositional (discussed in Section 4.3 and experimentally investigated in this chapter) and post-depositional processes (see Section 4.4) is equifinality; for archaeology the significance of this is that natural processes can create assemblages or bone modification that mimic those created by people. At present studies on the impacts of natural processes on fish remains is lacking. It is critical that these processes are considered in detail, so that minute differences between taphonomic signatures can be identified and used to correctly attribute deposits to the correct accumulation agent. In order to address this gap, a series of taphonomic experiments were designed and carried out. They encompass experiments that consider various accumulating agents (e.g. bears) as well as experiments that document typical post-depositional processes.

Controlled feeding experiments

Experiments to investigate the effects of non-human digestion of fish remains (Sections 5.3 and 5.4) were carried out with the aim of developing criteria or ‘taphonomic signatures’ for recognising remains deposited by specific animals. The extent to which animals that may accumulate fish bones are considered has been limited (Erlandson 2001; Erlandson & Moss 2001; Moss & Erlandson 2002). This may be because fish bones themselves have often not been given much attention, and that there are such a wide range of animals that could potentially create or modify fish bone assemblages in caves. Furthermore, to understand each potential accumulator, there needs to be an in depth ecological understanding of the species as well as experimental work to identify taphonomic signatures that may be expected. If digestion by non-human species leads to characteristic modification then the criteria can be applied to archaeological fish bone assemblages to ensure that fish remains can confidently be assigned to human subsistence and not to other cave-using faunas.

Trampling experiments

The second part of this chapter (see Section 5.6) investigates the effects of one of the most critical, yet poorly understood post-depositional process; trampling. While it is also crucial that the effects of other post-depositional processes, such as soil conditions (including pH, moisture levels and particle size) are also understood, trampling remains an area in fish bone studies that has yet to receive considerable attention. Four fish species that are most frequently recovered from Late Pleistocene cave deposits (see Chapter 2) were subjected to the stress and forces inflicted by trampling in order to investigate typical physical/mechanical processes that might affect bones in archaeological sites. The experiments designed for this thesis aimed to mimic, as closely as possible, natural trampling processes. These experiments investigate the possibility that the pattern in species representation across European Late Pleistocene cave sites is not a result of prey choice, but one of inter-species variation in preservation and identifiability. They also investigate the impacts of trampling on element representation patterns, which can be used to assess whether patterning in cranial element and vertebrae presence recorded at archaeological sites could result from natural processes, rather than be interpreted in terms of human processing activities.

Investigation into the effects of taphonomic processes by experimentation has increased the potential for more accurate interpretation of archaeological fish remains (for example, Jones 1984; Jones 1986; Ritcher 1986; Jones 1990; Nicholson 1992b; 1993a; Lubinski 1996; Nicholson 1996a; Bullock & Jones 1998; Butler & Schroeder 1998).

5.2. Identifying potential accumulation agents for fish remains

At present criteria for recognising digestion in fish bone assemblages can only be used to identify digested from un-digested remains on an assemblage wide basis. It is thought that partly digested remains will display:

- Pitting
- Edge rounding
- Vertebral compression
- Staining
- Adhering organic material
  (Smith 1985)

These should not be applied to individual bones, and do not enable identification of specific consumption species, they can also be subjective and miss-leading, providing false positives and negatives depending on burial conditions. As such, the criteria for recognising digestion in fish remains needs to be refined to be more reliable and to allow reliable identification of accumulation agents.

Previous experiments investigating the effects of digestion on fish remains were reviewed in Chapter 4 (Section 4.3, pre-depositional taphonomic processes). Only a small range of species have been previously considered and they do not represent those likely to deposit fish remains on inland, upland, cave sites during the European Late Pleistocene. To identify more appropriate animals the diet, behaviour and preferred habitat of species occupying Late Pleistocene Europe were considered. Kurten (1968) and other published sources (Stuart 1982; Jones & Keen 1993; Rosendahl *et al.* 2007; Von Koenigswald 2007) were used to identify mammal species present in Late Pleistocene Europe, while accounts by Harrison (1979; 1987; Seward *et al.* 2006) were used for birds. Each species listed was ranked from 1 to 5 on two factors: 1) inclusion of fish in the diet and, 2) cave use. The data was then used to identify the species most likely to accumulate fish remains within Late Pleistocene cave deposits. The top two ranking species were bears (*Ursus* spp.) and the Eurasian eagle owl (*Bubo bubo*). An in-depth investigation of these species in terms of their diet, behaviour and habitat allowed a basic taphonomic signature to be recognised, however, to construct a detailed taphonomic signature that is reliable in identifying specific accumulation agents the effects of digestion by these species were investigated by a series of feeding experiments, see Section 5.3 and 5.4.

5.3 Feeding experiments with the Eurasian eagle owl (Bubo bubo)

5.3.1 Eurasian eagle owls during the Late Pleistocene

Skeletal remains of eagle owls have been recovered from many archaeological and paleontological Late Pleistocene sites (Harrison 1979; 1987; Seward *et al.* 2006). Depictions of birds in art dating to the Late Pleistocene are rare (MacCurdy 1924: 39); however, owls (though not specifically recognised as eagle owls) have been identified at the sites of Trois-Frères and Enlène (Bégouen & Breuil 1958: Plate XI and XXXI(b)), Le Portel (Beltrán *et al.* 1966: 41 (Figure 2)), La Viña (Fortea 1990: 64 (Figure 6)) and Chauvet (Lewis-Williams 2003: 192), Figure 5.1.

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Figure 5.1: The owl at Chauvet Cave, France. Source: Agenda de la Préhistoire 2002 – 2003.

5.3.2 Birds of prey as accumulation agents for fish remains in archaeological sites

The number of studies concentrating on recognition of deposits formed by birds of prey, including the Eurasian eagle owl is increasing (e.g. Andrews 1990; Hockett 1991; 1996; Sanchis Serra 2000; Laroulandie 2002; Robert & Vigne 2002; Laudet & Selva 2005; Reed 2005; De Cupere *et al.* 2009). However, to date, research has focussed on their role in depositing mammal and bird remains, with little attention paid to fish, reptiles and amphibians, despite frequent inclusion in their diet.

There are few examples where birds of prey have been considered or identified in the formation of assemblages containing fish remains. Barn owls (*Tyto alba*) have been recognised at potential accumulators and have been studied in relation to fish remains from Homestead Cave, Utah (Broughton *et al.* 2000; Broughton *et al.* 2006) where it is identified as the accumulation agent for freshwater fish remains. A study of just 14 modern barn owl pellets collected at Bitner Ranch, Nevada, yielded 3,294 tui chub (*Gila bicolour*) bones, showing a specialisation towards fish in barn owl diet in this area (Broughton 2006). Fish represented 89.2% of total NISP for the pellets which also contain remains of passerine, including the western meadowlark (*Sturnella neglecta*), shrew (*Sorex* sp.) and rodents including the northern pocket gopher (*Thomomys talpoides*), mouse (*Peromyscus* sp.) and vole (*Microtus* sp.). They found that while elements were recognisable, pitting, rounding and deformation could be observed on some elements. Of the elements studied in detail (basiocipital, articular, opercular, ceratohyal, pharyngeal and vertebrae), pitting could only be observed on the ceratohyal. Rounding was observed on the basioccipital, pharyngeal and vertebrae. Deformation was only observed in vertebrae. In no case did pitting, rounding or deformation occur on every bone in an element group, highlighting that these criteria should not be used on single bones from archaeological sites, but rather only applied to whole assemblages. Their study, which presents a rare insight into owl fishing, provides useful data for future interpretation of fish remains.

In California, nesting sites of bald eagles (*Haliaeetus leucocephalus*) have been investigated to see if the fish remains deposited by this species could potentially be interpreted as human deposits in an archaeological situation. Excavations of the nest and surrounding area yielded almost 10,000 faunal remains, where 40.7% represented the remains of fish (Erlandson *et al.* 2007: 260). Most abundant were rockfish (*Sebastes* sp.) and surfperch (Embiotocidae), with many additional marine species representing 12 families in total also present. Vertebrae were the most frequently recorded element. Many similarities between the accumulations produced by the eagles and those recovered from local archaeological sites were observed, leading to the conclusion that bald eagles have potential to create assemblages that can be similar in characteristics to those produced by people. However, it should also be noted that species representation is likely to result from prey abundances in the local area which would be reflected in both accumulations by eagles and humans (Erlandson *et al.* 2007).

Ramboud and Laroulandie (Laroulandie 2008; Rambaud & Laroulandie 2009) discuss the possibility of owl accumulated fish remains at La Grotte du Taillis des Coteaux, Antigny (France). The fish remains at this site are dominated by grayling ('ombre' – *Thymallus thymallus*) (80%), also present are salmonids ('truites' and 'saumons'), whitefish ('corégone'), cyprinids ('cyprinidés') and European eel ('anguilles'). Length estimation for shad suggests fish up to 45cm in length are present and that fish scales are well represented within the assemblage. Although analysis is still in the early stages they report evidence for digestion on some of the fish remains. They concluded that at La Grotte du Taillis des Coteaux the most likely accumulation agent for the microvertebrates (including mammal, fish and bird) is the Eurasian eagle owl (Grand-duc *Bubo bubo*) (Rambaud & Laroulandie 2009: 130).

5.3.3 Recent diet and ecology of the Eurasian eagle owl

Like most owls, the Eurasian eagle owl (Figure 5.2) is unable the chew its food, as such prey are usually consumed whole (Everett 1977: 78) – in the case of fish head first. Owl pellets generally contain a higher frequency of prey remains than other birds of prey, this results from the pH of owl stomach acids being higher (less acidic). Hunting provides the eagle owl with the main part of its diet, although on occasion consumption of carrion may occur (Everett 1977: 78). Eagle owls produce pellets (casts); these are usually regurgitated around 10 hours after eating. Several prey are amalgamated into a single pellet, further consumption of prey cannot take place once the pellet has formed and it must be ejected before the owl can eat again. Like most owls, the eagle owl tends to deposit pellets at roosts and other frequently used spots. This allows large accumulations to form in predictable areas (Everett 1977: 79).

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Figure 5.2: The Eurasian eagle owl (*Bubo bubo*). Photo: Achim Raschka.

*Fish in the diet of the Eurasian eagle owl (*Bubo bubo*)*

A detailed review of eagle owl dietary studies (see Tables 5.1 and 5.2) indicates that fish are consistently included in prey choice. In the studies considered fish formed between 0.07 and 11% of overall diet, see Table 5.2. The most frequently recorded species were European chub (*Squalius cephalus*) and brown trout (*Salmo trutta fario*), with pike (*Esox lucius*), common carp (*Cyprinus carpio*), burbot (*Lota lota*), European perch (*Perca fluviatilis*), Iberian nase (*Chondrostoma polylepis*) and common barbel (*Barbus barbus*) also present in some cases. Further research on the inclusion of fish in the diet of eagles owls is discussed by Le Gall (Le Gall 1999b). In identification of fish remains from eagle owl pellets by Le Gall and Bayle indicate the consumption of cyprinids; European chub, European dace, roach, nase and barbell as well as brown trout. In the region considered (south-east France) brown trout consumption is less frequently recorded than in the case studies presented in Tables 5.1 and 5.2. In south-east France fish represented 5.8% of eagle owl diet, which was dominated by small mammals (Le Gall 1999b: 60).

However, some studies indicate that fish is not eaten by this species (for example, Von Jánossy & Schmidt 1970; Bustos & Muñoz 1973; Andrews 1990: 188-189; Balluet & Faure 2006; De Cupere *et al.* 2009; Lloveras *et al.* 2009). Absence of fish in the diet may result from seasonal variation in the diet, absence of fish within the ecosystem, loss of less dense, more fragile, bones through digestion, or limited identification due to fragmentation. It does suggest, however, that it is unlikely for this species to produce an assemblage consisting only of fish remains (although fish could potentially represent a dominating proportion of the diet, no examples of this have been found by the author). This observation presents a potential problem in archaeology as it is often the case that fish remains will be identified and interpreted separately from other faunal remains. Ecological studies of the European eagle owl can be used to determine expected fish species and spatial patterning for fish remains deposited by it.

Location	**Fish species (as in text)**	**Common name**	**Source**
High Tatras, Slovakia/Poland	*Salmo trutta*	Brown trout	(Uttendörfer 1939; Schaefer 1971; 1972)
Pieniny Mountains, Slovakia/Poland	*Squalius cephalus* Unidentified fish	European chub Fish	(Bocheński 1960)
'Spain'	*Barbus barbus* *Chondrostoma polylepis*	Common barbel Iberian nase	(Hiraldo *et al.* 1975)
Oberebgadin, Switzerland	Lachsartige Fische Karpfen Alet	Salmon/trout Carp Chub	(Von Wagner *et al.* 1970)
Saillon, Switzerland	Chevaine	Chub	(Desfayes & Géroudet 1949)
Swiss Alps	*Cyprinus carpio* Chevaine (*Squalius cephalus*)	Common carp European chub	(Burnier & Hainard 1948; Bocheński 1960)
Luberon, France ('border')	Unidentified fish	Fish	(Penteriani *et al.* 2002)
Luberon, France ('interior')	Unidentified fish	Fish	(Penteriani *et al.* 2002)
'Sweden'	*Esox lucius* *Perca fluviatilis* *Lota lota* Cyprinidae Salmonidae Unidentified fish	Pike European perch Burbot Cyprinid Salmonid Fish	(Curry-Lindahl 1950; Von Höglund 1966)
Aland Isles (between Sweden and Finland)	Unidentified fish	Fish	(März 1936)
Lapland	Salmonid *Esox lucius* *Lota lota*	Salmon family Pike Burbot	(Schaefer 1970; 1971)
'Germany'	Unidentified fish	Fish	(Uttendörfer 1939)

Table 5.1: Fish remains recovered from Eurasian eagle owl (*Bubo bubo*) pellets in Europe, from Russ (*In press*).

Location	**% based on**	**Fish**	**Mammals**	**Amphibians**	**Birds**	**Reptiles**	**Other**
High Tatras, Slovakia/Poland (1960)	NISP	0.2	47.0	11.1	4.6	0	37.1
High Tatras, Slovakia/Poland (1939)	NISP	1.0	60.0	31.0	8.0	0	0
Pieniny Mountains, Poland/ Slovakia	MNI	2.0	62.5	19.0	11.5	0	5.0
'Spain'	MNI	1.7	70.8	0.2	20.5	0.8	6.1
Oberebgadin, Switzerland	MNI	2.6	75.5	9.5	12.2	0	0.2
Saillon, Switzerland	MNI	0.9	53.6	12.0	32.6	0.4	0.4
Swiss Alps	MNI	5.0	48.0	40.0	7.0	0	0
Luberon, France ('border')	MNI	7.6	61.0	-	29.5	-	1.9
Luberon, France ('interior')	MNI	1.7	80.9	-	17.2	-	0.2
'Sweden' (1966)	MNI	1.6	57.8	16.5	23.6	0	0.3
'Sweden' (1950)	MNI	11.0	54.8	0.8	33.0	0.4	0
Aland Isles (between Sweden and Finland)	MNI	1.0	51.0	5.0	43.0	0	0
Lapland (Beutetiere vom Brutplatz I)	MNI	0.2	73.9	1.5	24.4	0	0
Lapland (Beutetiere vom Brutplatz II)	MNI	2.1	83.0	3.2	11.7	0	0
'Germany'	MNI	0*	59.0	39.6	1.4	0	0

Table 5.2: Dietary profiles for the eagle owl (*Bubo bubo*) at selected European locations. For sources see Table 5.1, and Bocheński (1960: 325 (Table 2)). Where applicable values are rounded to one decimal place. Dates in brackets refer to publication, not pellet collection dates. *0.07%. MNI: minimum number of individuals, NISP: number of individual specimens. (Russ *In press*).

Information regarding the size of fish consumed by eagle owls is limited to the research undertaken by Le Gall (Le Gall 1999b). His data suggest that eagle owls will take 'very small' fish as well as fish up to 40cm in length. Trout (based on nine individuals) ranged between 15 and 35cm in length, while European chub ranged between 20 and 40cm in length (based on six individuals), with most being estimated at 30cm. Unidentified cyprinids seven individuals were much more variable in length, from ‘very small’ (2) to ‘large’ (1), but the representation of small fishes here and not specifically to species is probably due to reduced variation in the skeletal morphology of young (small) specimens, rather than a specific absence of small European chub. Barbel ranged between ‘small’ and ‘large’ and a single ‘medium’ specimen of nase (Le Gall 1999b: 59 + 62). If fish remains are deposited by eagle owls it would be expected that specimens would represent these sizes, and that very large specimens, above 30-40cm, would not be present.

Spatial patterning

Where discussed, the ecological records for prey remains from eagle owl roosting sites suggest material would be concentrated in the areas within, beneath and surrounding the nest. This implies that prey remains deposited by this species are likely to occur in spatially defined deposits. However, this assumes that once the remains are deposited by the eagle owl they are not modified or disturbed by other taphonomic processes, such as trampling, weathering, bioturbation and fluvial action. Where excavation records include detailed spatial information it should be considered in the identification of accumulation agent. Comparing the distributions of small mammal, bird, amphibian, reptile and fish remains may allow the differentiation between material deposited by predatory birds and anthropic deposits, which are likely to display different spatial patterning. Combining spatial, size and species representation data would make accumulation agent identification more reliable as species representation patterns may result from prey abundances which would affect both human and eagle owl prey choice.

5.3.4 Feeding experiments with the Eurasian eagle owl: method

Rebecca Woods, Animal Manager at the Chestnut Centre Otter, Owl and Wildlife Park allowed three Eurasian eagle owls (*Bubo bubo*) to be included in this research. The group comprises three adult specimens, one male (Charlie) and two females (Mindy and Bella). The three birds live in one single enclosure and normally are fed 6 times a week on either one day old chicks (*Gallus gallus domesticus*) or juvenile rats (*Rattus* sp.).

Prior to feeding the eagle owl aviary was cleaned of any previously cast pellets. In initial experiments three heads (including pectoral girdle) of Atlantic salmon (*Salmo salar*) and two whole specimens of trout (*Salmo trutta*) of 280 mm in length were placed on the feeding platform from which the eagle owls usually feed, see Figure 5.3. The fish were placed at 5.30pm for overnight consumption. Pellets would be cast during the night or in the early hours of the next morning. Pellets were to be collected in white panel sample bags with plastic tweezers, wearing neoprene gloves. Each bag was to be labelled with date and description of contents.

Figure 5.3: Fish remains offered to Eurasian eagle owls (*Bubo Bubo*).

Amended method 1

Despite showing interest in the fish offered to the birds, they did not consume either the salmon heads or the whole trout. After discussion with the animal manager it was decided that smaller fish would be better. In the wild the eagle owl is capable of taking very large prey; the fish provided in initial attempts should have been manageable for the birds. However, these three specimens have been in captivity since birth and fed exclusively on day old chicks and juvenile rats; relatively small prey. In light of this the owls were offered smaller specimens of trout (*Salmo trutta fario*) of around 15cm in total length (TL). It was also ensured that the owls had not been fed the day before attempts at fish feeding to ensure that they were at their most hungry. They were offered smaller fish weekly.

Amended method 2

After four attempts at feeding the eagle owls the smaller fish they had still not consumed any. Again discussions with the animal manager suggested that because the owls had only ever eaten day old chick and juvenile rats that the problem was they didn’t recognise the fish as food. So, in a further attempt to get the owls to eat the fish, the trout were concealed within the carcass of a juvenile rat. It was hoped that this would encourage the owls into eating the fish by disguising them as their regular prey. This approach lead to the consumption of fish by one owl on two occasions. As previously, pellets were collected the day after feeding and stored individually in labelled sample bags for transportation to the laboratory at the University of Bradford.

When pellets could not be immediately collected from the Chestnut Centre they were frozen temporarily.

Attempted feeding continued weekly until April 2010, when one of the female birds laid eggs and it became dangerous to enter the pen to collect pellets.

In the laboratory each pellet was assigned a pellet number. Bird pellets may contain hantavirus (*Hantavirus* sp.) or salmonella (*Salmonella* sp.) and should be handled only whilst wearing laboratory coat and gloves. To ensure that any such viruses and bacteria are destroyed the pellets are first lightly boiled, then placed in Biotex solution for 24 hours, this also aids the removal or any remaining flesh. After soaking the pellets can be left to dry at room temperature. It is useful at this stage to disaggregate the pellets to aid dissection once dry. Each skeletal element was removed from the remaining mass of feathers and/or hair.

5.3.5 Feeding experiments with the Eurasian eagle owl: results

In initial feedings it was obvious that the birds had shown interest in the fish, as one of the salmon heads had moved from its original position and been dropped on the floor some distance away. However, no portion of the salmon heads, whole larger trout or smaller trout had been consumed. There are several possible reasons for this:

1) The fish were too big – it is most common for this species to eat its food whole, the specimens offered first were perhaps too big for the birds to manage whole.

2) The owls did not recognise the fish as food – the Chestnut Centre often find that when they take in injured or sick wild birds they will not eat the 1 day old chicks that are given to and eaten by the captive birds, but only young rats. This is because they do not eat chicks in the wild and so do not recognise them as food.
3) The owls were not hungry – in the wild this species would not eat every day. At the chestnut centre they are fed 6 days out of 7. It is perhaps that case that the owls did not need to eat that day.

As discussed in the revised method (Section 5.3.4) offering smaller fish disguised as regular prey items resulted in consumption of fish by one of the three owls on two occasions. On these occasions all pellets were collected from the aviary. Two pellets were obviously different from the others; these were thought to contain the fish remains.

While all the collected pellets were studied initial suspicions were correct, only two pellets contained any fish remains. The fish remains were well preserved with most elements being represented; see Figure 5.4. Fish scales were also present, see Figure 5.5.

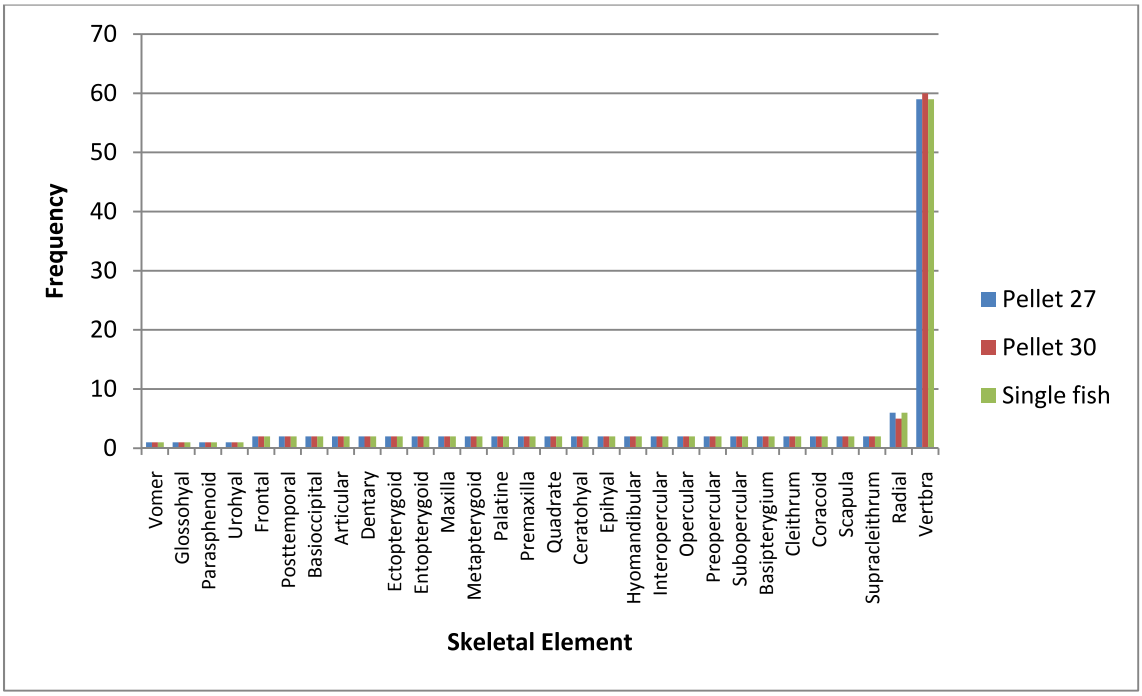

Figure 5.4: Skeletal elements recovered from pellets of Eurasian eagle owl (*Bubo bubo*) compared with expected values for one fish.

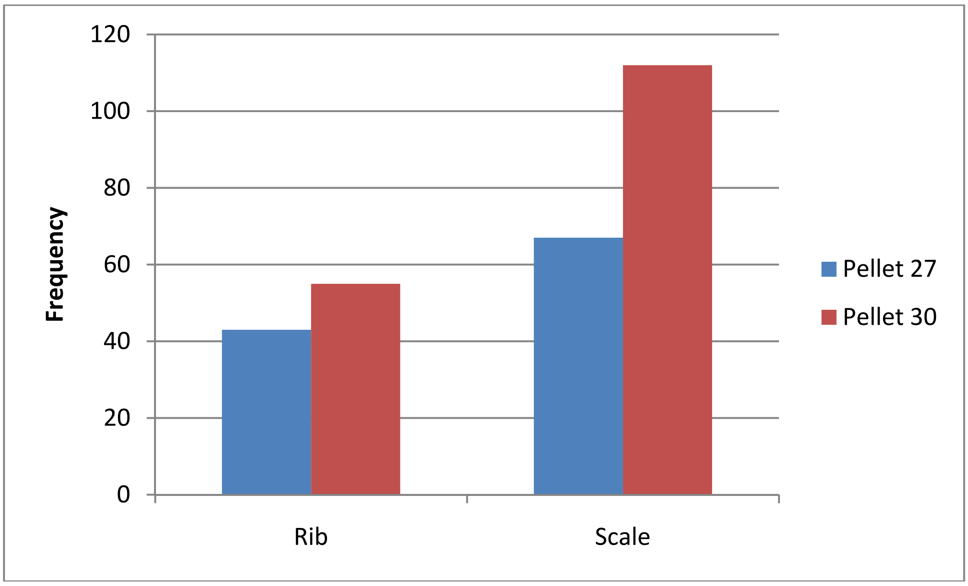

Figure 5.5: Rib and scales recovered from Eurasian eagle owl (*Bubo bubo*) pellets.

5.3.6 Feeding experiments with the Eurasian eagle owl: discussion

The skeletal elements recovered from pellets containing fish remains represented almost complete fish. The decreased frequency of scales and ribs in Pellet 27 (see Figure 5.5) may indicate a longer digestion period where the fish and other prey were held in the stomach for a longer period than Pellet 30. This has little use in archaeology where individual pellets are rarely recovered and where ribs and scales are not routinely subjected to detailed analysis. While the results may reflect the true impact of eagle owl digestion on fish remains, any modification that could have potentially been caused by digestion was prevented by the carcass of the rat in which the fish resided. It is possible that the effects of digestion on fish remains are very minimal, owl digestive juices are less acidic than those of other bird of prey species. However, it would not be useful to claim that Eurasian eagle owl digestion does not impact upon fish bones without first analysing fish remains that have been consumed without their rat ‘disguise’. At present past studies of eagle owl diet permit the identification of expected species: chub and trout (most frequently recorded) as well as pike, carp, burbot, perch, nase and barbel. They also suggest that fishing is a year round activity, although rare in the winter when hunting in general is reduced, and that fish of a range of sizes are taken, up to a maximum of 40cm. Deposition of pellets in and around the nesting site suggests that assemblages deposited by this species can be quite spatially distinct. However, in the archaeological record, spatially modifying taphonomic processes may blur this formation process, or even mimic it. Future experiments with eagle owls may enhance understanding of the effects of owl digestion on fish remains in terms of expected element representation patterns.

5.4 Feeding experiments with brown bears (Ursus arctos)

5.4.1 Bears in the Late Pleistocene

This research also looked to develop criteria for the recognition of bear (*Ursus* sp.) deposited fish remains within Late Pleistocene cave deposits. Bears are just one genus that can be identified as potential accumulation agents for fish remains from Pleistocene cave sites. However, at present, there are no methods by which material deposited by bears can be identified, and the effects of bear mastication and digestion on the skeletal remains of fish are poorly understood. Currently fish, more specifically salmon and trout species, comprises an important part of bear diet during their spawning seasons, see Section 5.4.3.. The use of caves by bears is documented based on the frequency of skeletal remains of both brown (*Ursus arctos*) and cave (*Ursus spelaeus*) in European Pleistocene cave deposits (Kurtén 1968: 127; Stuart 1982; Jones & Keen 1993). Although for brown bears living in more recent times it has been suggested that cave use may not be frequent (Krott 1964). It is apparent however, that the remains of brown bear are more common in British cave deposits than on the continent where cave bear appears to dominate (Kurtén 1976). In addition to the skeletal evidence there are also several depictions of bears (identified as brown bear or cave bear) in Upper Palaeolithic art in Europe, around 100 in total (Kurtén 1976: 92), for example at the caves of Teyjat, Trois Frères, La Colombière and Les Combarelles in France, see Figures 5.6a-5.6d (after Koby 1953; Kurtén 1976: 91-96).

Brown bears are known omnivores, they will consume almost any edible resource (a study on the stomach contents of bears in 1956 in North America even identified paint, cheesecloth, denim and cellophane! (Clark 1957: 149)). Bear predation on spawning salmon and trout populations in recent times are well documented (e.g. Shuman 1950; Clark 1959; Gard 1971; Frame 1974; Hamilton & Archibald 1986; Cederholm *et al.* 1989; Mattson *et al.* 1991; Orians *et al.* 1997; Cederholm *et al.* 2000; Robbins *et al.* 2004). The cave bear is extinct; as such it is more difficult to understand this species' dietary habits. The morphology of cave bear cranial and dental features suggests that it was adapted to a mainly herbivorous diet (Kurtén 1976; Rabeder 1999; Grandal-d'Anglade 2010). Using the same methods as for human bone, see Section 2.5.3, isotopic analyses on bear bone collagen can be used to partially reconstruct cave bear diet. Early research looking at δ^{13}C and δ^{15}N isotope values in cave bear bone collagen suggested that they were herbivores (Bocherens 1990; Nelson *et al.* 1998; Fernández-Mosquera *et al.* 2001; Bocherens *et al.* 2006). However, more recently research has suggested that while this might be true for some populations of cave bear, that in some cases high δ^{15}N values suggest omnivory, and possibly carnivory (Richards *et al.* 2008).

A combination of studies of ancient bear remains and the behavior of brown bears in recent times suggest that for the UK brown bears, as frequent consumers of fish during salmon and trout spawning periods, are likely fish bone accumulators for cave deposits. While brown bears are recorded in cave deposits on the Continent the cave bear is dominant. As previously discussed, the inclusion of fish in the diet of cave bears is difficult to estimate as there are no living cave bears today. The fewer examples of brown bear and evidence that many cave bears did not consume meat protein suggests that in Continental Europe deposition of fish remains by bears in caves might be less likely than in the UK.

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Figures: 5.6a: Engraved bear's head at La Colombière, France. ***5.6b:*** Bear engraving at cave of Teyjat, France. ***5.6c:*** Bear engraving at Trois Frères, France. ***5.6d:*** Bear engraving at Les Combarelles, France. All images from Kurtén (1976: 92-94). Not to scale.

5.4.2 Bears as accumulation agents

Little research has addressed the issue of identifying bears as accumulation agents at archaeological sites but without knowing the effects of digestion by bears on fish bones the recognition of material deposited by them cannot be easily identified. Only one bear feeding experiment has been carried out and remains unpublished (Endacott 2001, unpublished). Previous feeding experiments using Chinook salmon (*Onchorhyncus tschawytscha*) and North American brown bears (*Ursus arctos*) indicate that digestion by bears does cause some pitting and staining as well as vertebrae deformation and rounding (Endacott 2001, unpublished). However, although element representation patterns are considered by Endacott (2001, unpublished), the bears were not fed complete fish in most cases. A total of 21 fish were fed to three bears; 16 were missing 'the anterior half of their head' and one fish had no head at all (Endacott 2001, unpublished: 2). As the 'anterior' half of the head would almost certainly include the dentary, the feeding of fish with partial crania does not appear to have been accounted for in the calculation of % MAU, see Table 5.3, although this may not be the case. It is also unclear whether some elements were absent from the recovered material, or if they were just not recorded. The experiments presented in this thesis used only complete fish in order to investigate element survivorship more fully than in Endacott's previous experiments.

	NISP	**MNE**	**MNI**	**MAU**	**%MAU**
Angular (Articular)	9	8	4	20	20
Vertebrae	909	207	4	21	14.9
Otolith	5	5	3	20	12.5
Exoccipital	4	4	2	20	10
Hypural	14	14	14	21	9.52
Uroneural	11	11	?	21	8.73
Preopercle (Preopercular)	3	3	2	20	7.5
Basipterygium	3	3	2	21	7.14
Dentary	5	2	1	20	5
Ceratohyal	2	2	1	20	5
Parasphenoid	1	1	1	20	5
Postorbital (?suborbital)	5	5	2	20	4.2
Branchiostegal ray	17	16	2	20	3.33
Sphenotic	1	1	1	20	2.5
Quadrate	1	1	1	20	2.5
Opercle (Opercular)	1	1	1	20	2.5
Rib	114	31	?	21	1.94
Branchials	22	6	1	20	1.25

Table 5.3: Salmon remains surviving bear digestion as recorded by Endacott (2001, unpublished). Listed from most to least frequent based on %MAU. MNI values were added by Russ.

5.4.3 Recent diet and ecology of bears

Brown bears often consume large amounts of salmon and trout, but this diet is restricted to salmonid spawning activities. Bears' fishing activities are most frequently recorded to monitor their effects on salmonid spawning populations and implications for human use of salmon resources. Therefore, commonly only numbers of fish taken are recorded and detailed information on the ways in which bears fish and eat fish are not documented. One exception is a study by Frame (1974), which is summarised here to aid the reconstruction of the characteristics of bear derived fish deposits.

In 1967 Frame (1974) observed the fishing behaviour of a population of black bears (*Ursus americanus*) at Olsen Creek, Alaska during the spawning season for chum salmon (*Oncorhynchus keta*) and pink salmon (*Oncorhynchus gorbuscha*). Although his observations indicated that the bears spent only 9% of their time fishing, he noted that 62% of their eating time was spent eating either freshly caught salmon or carcasses previously caught and abandoned by bears. Fishing occurred most frequently at dawn (03.00 - 05.00 hours) and dusk (17.00 – 22.00 hours) (Frame 1974: 27). The bears fished both in the creek and in the smaller streams in the woods. Frame observed bears lying in the surrounding forest consuming fish carcasses of both fresh, but more frequently, decaying fish. Bears most often caught the fish by biting them '*immediately in front of the dorsal fin*' (Frame 1974: 28). The bears frequently discarded the salmon that they had caught, although they were not seen discarding any carcasses of un-spawned females, for which they showed a preference. The fish were abandoned both in the creek and on the creek banks. The Olsen Creek bears retained chum salmon (the larger of the two fish species) much more frequently than pink salmon (340 chum, 37 pink, 5 unidentified) (Frame 1974: 30). The bears ate both dead and live salmon, sometimes consuming only the eggs, but frequently eating other body parts. 40% of the observed freshly caught and eaten carcasses had the top part of the head missing, often including the eyes. This figure rose to 84% for carcasses abandoned by bears after catching. The jaws, gills and operculae were eaten 16% of the time in abandoned carcasses, but only 3% of the time in fresh kills. Carcasses were also completely consumed in some cases. The bears also ate the carcasses of salmon that had died naturally after spawning, even those that were decaying and infested by maggots (Frame 1974: 32). In total Frame (1974) estimated that 2,240 un-spawned females were eaten by 18 bears during 1967.

Similar bear behaviour has been noted by other authors, Innokentii (1840: 330) documented bears (unknown species) consuming salmon on the river banks in the Aleutian Islands:

> "*The bears stand in the river against the stream with the water reaching a little above the knees the bear sees the fish it grasps it with his paw almost always successfully then either throws it or brings it to the river bank. After the bear has caught the last fish it will go out to the bank and begin eating. When there is an abundance of fish the bear eats only the fattiest parts of it—the heads*" (Innokentii 1840: 330).

The consumption of both dead and live salmon was also observed in pink salmon caught by brown bears in Bristol Bay, Alaska (Mossman 1958: 483) and in fish caught by bears in the Aleutian Islands (Innokentii 1840: 330). In both cases it was common for only the top part of the skull, including the eye to be taken (Innokentii 1840; Mossman 1958). In comparison, Walker (1971: 152) notes abandonment of salmon heads close to the stream where the fish had been caught, presumably after consumption of the axial parts. While bears more frequently fish for live prey the consumption of decaying, maggot infested fish was noted by Meehan (1961) in brown bears in British Columbia. Fish bones have been observed in wild bear droppings, which are usually greenish black in colour when fish have been consumed. Walker (1971: 178) also noted that the greenish dropping were also more diarrhoeic than 'normal' droppings.

5.4.3 Feeding experiments with brown bears: method

This study looked to investigate the effects of mastication and digestion by brown bears (*Ursus arctos*) on fish bones. One objective was to identify whether the criteria currently used (pitting, edge rounding, compressed vertebrae, staining, adhering organic material (Jones 1984; Smith 1985; Jones 1986)) in the recognition of digested fish bones can be applied in the identification of those passed though the digestive system of bears (as opposed to mammals in general). Digestive transit time for bears is low, it was predicted that this would reduce the effects of digestion, many of which are caused by digestive acids, and that the traditional criteria might not allow for identification of digested material in this case. Element representation patterns for fish remains after a bear's digestive system were also considered in order to aid the identification of bear deposited fish remains at archaeological sites.

A unique opportunity to feed the four female brown bears (*Ursus arctos*) at Zoological Society London (ZSL) Whipsnade Zoo arose during summer 2009 (see Figure 5.7). Usually the bears inhabit a large enclosed space which is not accessed even by zoo staff, so that under normal circumstances it would not be possible to collect the faecal samples required for this study. However, in July 2009 new viewing panels were added to the bears' enclosure. This work required the bears to be removed from the large enclosure and kept in a smaller area for 4 days. As the digestion period for bears (*Ursus arctos* and *Ursus americanus*) is between 7 hours for plant material (clover) and 13 hours for meat (Pritchard & Robbins 1990: 1645), the time spent in the smaller enclosure allowed feeding and faecal collection before the bears were able to return to their improved, large enclosure.

Figure 5.7: Female brown bear (*Ursus arctos*) at ZSL Whipsnade Zoo, eating fish.

The bears were fed fish over a two day period; this left an additional two days for the fish to pass through the bears' digestive system before they were returned to the large enclosure where faecal collection would not have been possible. On Day One the bears were fed 12 small whole brown trout (*Salmo trutta*), ranging between 12 cm and 20 cm total length (TL) (TL as described by Wheeler (1969)). These fish were consumed in their entirety by 10.00 hours on Day Two. Later on Day Two the bears were fed 10 large whole Atlantic salmon (*Salmo salar*) ranging between 40 cm and 60 cm in TL. On Day Three five whole salmon had been eaten. By the end of Day Three seven whole fish had been consumed. As the bears were being released on Day Four (they were enclosed for an extra day due to extended work on the large enclosure) the three un-eaten fish were removed. The bears also had access to their regular foods during the fish feeding; these include, but are not limited to: horse meat, apples, pears, oranges, bread and cake. After their release back into their large enclosure and the small temporary area could be safely sealed off all faecal material was collected into plastic storage boxes.

Sample preparation and analysis

A total of 8 litres of faecal material was collected from the small enclosure. This represented all the faeces produced by the four bears over the four day period. The faecal material was diluted in water and left to break up for 12 hours. This process aimed to aid the sieving process by allowing plant materials, which would float, to be skimmed off the water’s surface allowing easier sorting of the sieved fraction. The diluted faecal material was sieved at 500µm, dried at room temperature and sorted to extract all surviving fish remains. Bones were identified to species, element and, where possible, left or right using reference material at the University of Bradford and identification guides (Norden 1961; Kazakov *et al.* 1982; Yee Cannon 1987; Feltham & Marquiss 1989).

5.4.4 Feeding experiments with brown bears: results

Despite collecting all faecal material and sieving at 500 µm no fish bones were recovered from the bear droppings. Other materials recovered included apple, orange, poppy, sesame, flax and sunflower seeds.

5.4.5 Feeding experiments with brown bears: discussion

The absence of fish remains in any of the faecal samples collected was unexpected. Fish bones have been observed in bear scats in the wild (e.g. Walker 1971: 174) and fish remains were recovered by Endacott (2001, unpublished) during his controlled feeding experiments. Therefore it was expected that at least some skeletal elements would survive the digestive processes.

Factors impacting fish bone survival are diet and digestion period. The brown bears at Whipsnade Zoo have a very different diet to brown bears living in the wild. As previously mentioned in the wild brown bears have a digestion period of between 7 and 13 hours. If this were to be lengthened in the captive bears, or shortened in wild bears the survival of fish remains in wild bear dropping and loss in captive bear droppings might be explained.

Potentially the diet of the captive bears, which included much bread and cake, may have lead to an increased digestion period. If digestion period in the captive bears was lengthened the fish bones would be subjected to the stomach acids for a longer period which may lead to bone loss. An increase digestion period may also have meant that the fish remains did not leave the bears' digestive system in the time during which faecal material could be collected (while the bears were in the smaller enclosure).

Walker (1971) comments that the greenish droppings of bears (with the colour indicating fish inclusion) are often more diarrheic than those of 'normal' colour. Perhaps this indicates that when bears eat fish, which is a seasonal event when many fish are eaten within a short period, their digestion rate is much quicker than other times of the year. This is at least supported in humans where sudden or increased consumption of fish oils causes diarrhoea (e.g. Belluzzi *et al.* 1996). Perhaps the survival of fish remains in bear droppings is a result of reduced time in contact with digestive juices; this would explain why fish bones might survive in the droppings of wild bears which have consumed many fish over a short period and be lost in the captive bears that were fed only a few fish. However, it does not explain why Endacott (2001, unpublished) recovered bones in his experiments with captive bears. As the diet of the bears used by Endacott is not known it is difficult to comment on this.

It would have been desirable to repeat this feeding experiment. However, this was not possible. The bears are rarely removed from their large enclosure, which is not normally accessed by zoo staff. Sample collection would not have been possible due to restricted access. Future feeding experiments with bears would be very useful in understanding the potential for fish remains deposited by this species to be distinguished from those deposited by people. Ideally future studies should consider both captive and wild bears.

5.5 Bears vs. Eurasian eagle owl taphonomic signatures

The review of bear (*Ursus* spp.) and Eurasian eagle owl (*Bubo bubo*) studies allows a basic taphonomic signature for fish remains deposited by these species to be identified. For bears, which only fish during salmonid spawning one would expect fish bone assemblage to consist only of salmonid species, a restricted size range would also be expected as young (small, immature) salmonids do not spawn. Biases towards elements of the posterior crania might be seen as a result of targeted brain consumption, but all elements could potentially be present, see Table 5.4. The expected assemblage characteristics for the Eurasian eagle owl (*Bubo bubo*) are very different. This species consumes many species of freshwater fish, Table 5.4, which are variable in size. They prey are consumed whole and so element loss would be though digestion rather than selection of certain body parts. For the eagle owl spatial distribution could be an important aspect in recognition as an accumulation agent. Modern excavation and recording techniques should allow this factor to be considered in interpretation of assemblages from archaeological sites; this information has been lost for many sites that were excavated before detailed recording of faunal remains was practised.

	Species	**Size**	**Associated species**	**Element Representation**	**Digestion**
Bear	Salmonid only	Large	Mammals, clams, seeds	Preference for eggs and posterior crania. Will consume whole	Frequently survive (Endacott 2001)
Eagle owl	Chub Trout Pike Carp Burbot Perch Nase Barbel	Various	Birds Small mammals, especially leporids	Consume whole	Survive digestion

Table 5.4: Expected assemblage characteristics for fish remains deposited by bear species (*Ursus* spp.) and the Eurasian eagle owl (*Bubo bubo*).

5.6 Trampling experiments

5.6.1 Previous trampling experiments

After deposition there are many processes that impact upon preservation. Whether by people or animals, trampling is a process that is almost certainly going to have affected materials within cave deposits. Remains may be present on the surface or incorporated into sediments; either way they are subject to the effects of pressure applied through trampling. Previous trampling experiments have focussed on mammalian remains, specifically towards distinguishing scratches caused by trampling and sediment abrasion from stone tool cut-marks (e.g. Courtin & Villa 1982; Behrensmeyer *et al.* 1986; Olsen & Shipman 1988). There has also been some consideration of the effects of trampling on spatial distribution of faunal remains (Andrews & Cook 1985; Fiorillo 1989; Bullock & Jones 1998). For fish remains, the effects of trampling are potentially significant for preservation of certain skeletal elements and species. Experimental trampling on Atlantic cod (*Gadus morhua*) bones indicated that some elements become 'archaeologically invisible' after between 75 and 175 paces (Jones 1999). The term 'archaeologically invisible' was assigned to elements that could not be identified, and therefore would not be recorded in an archaeological assemblage. Results were used to produce an 'Index of Robustness' (IR). Elements were assigned an IR value of 1 if they remained identifiable after 375 paces; elements that could not be identified after 175 paces were assigned an IR value of 5 (maximum value assigned in the study). IR values could then be used to assess the level of preservation recorded in archaeological materials. It was noted that the trampling process produced an assemblage that, if recovered from an archaeological setting, could potentially be interpreted as the remains of fish processed by decapitation and tail removal (Jones 1999). The study provides excellent evidence that the patterning observed in element representation of fish remains can be misleading and that interpretation should be made with caution.

Nicholson (1992b) found that when bones of Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), European plaice (*Pleuronectes platessa*), Atlantic herring (*Clupea harengus*) and dogfish (*Scyliorhinus canicula*) were subjected to trampling and simulated abrasion, element loss and fragmentation varied between species. Notably, results for herring displayed an almost opposite trend to those observed for cod by Jones (1999), with high vertebrae survival and loss of many cranial elements (Nicholson 1992b: 88). Variable preservation of fish species has also been demonstrated in lacustrine environments in Israel, where it was shown that recent death assemblages (recovered from 30-50cm depth) did not reflect the diversity of species observed living in the lake (Zohar *et al.* 2008).

5.6.2 Trampling experiment: method

Based on identified fish remains from 121 Upper Palaeolithic sites in Italy, Belgium, France, Spain and the UK (Appendix II) commonly identified remains include those of salmonids (including trout (*Salmo trutta*) and Atlantic salmon (*Salmo salar*)), cyprinids, burbot (Lota lota), grayling (*Thymallus thymallus*), pike (*Esox lucius*) and European eel (*Anguilla anguilla*), Figure 5.8. Three species were investigated; the trout (the most frequently recorded salmonid species); European chub (*Squalius cephalus*), (the most frequently recorded cyprinind species) and pike. Being in the same genus, the skeletal physical and chemical properties for Atlantic salmon are similar to those of brown trout, see Chapter 4, Tables 4.1-4.3, and it is expected that similar results would be achieved. Therefore for the purposes of this project, *Salmo trutta* bones were used as an analogue for both *Salmo* species. Modern specimens of European eel could not be procured due to an increase in *Anguillicola crassus* a parasitic nematode worm that lives in the swim-bladders of eels which has lead to a drastic reduction in the UK eel population. This species was therefore not included in these experiments.

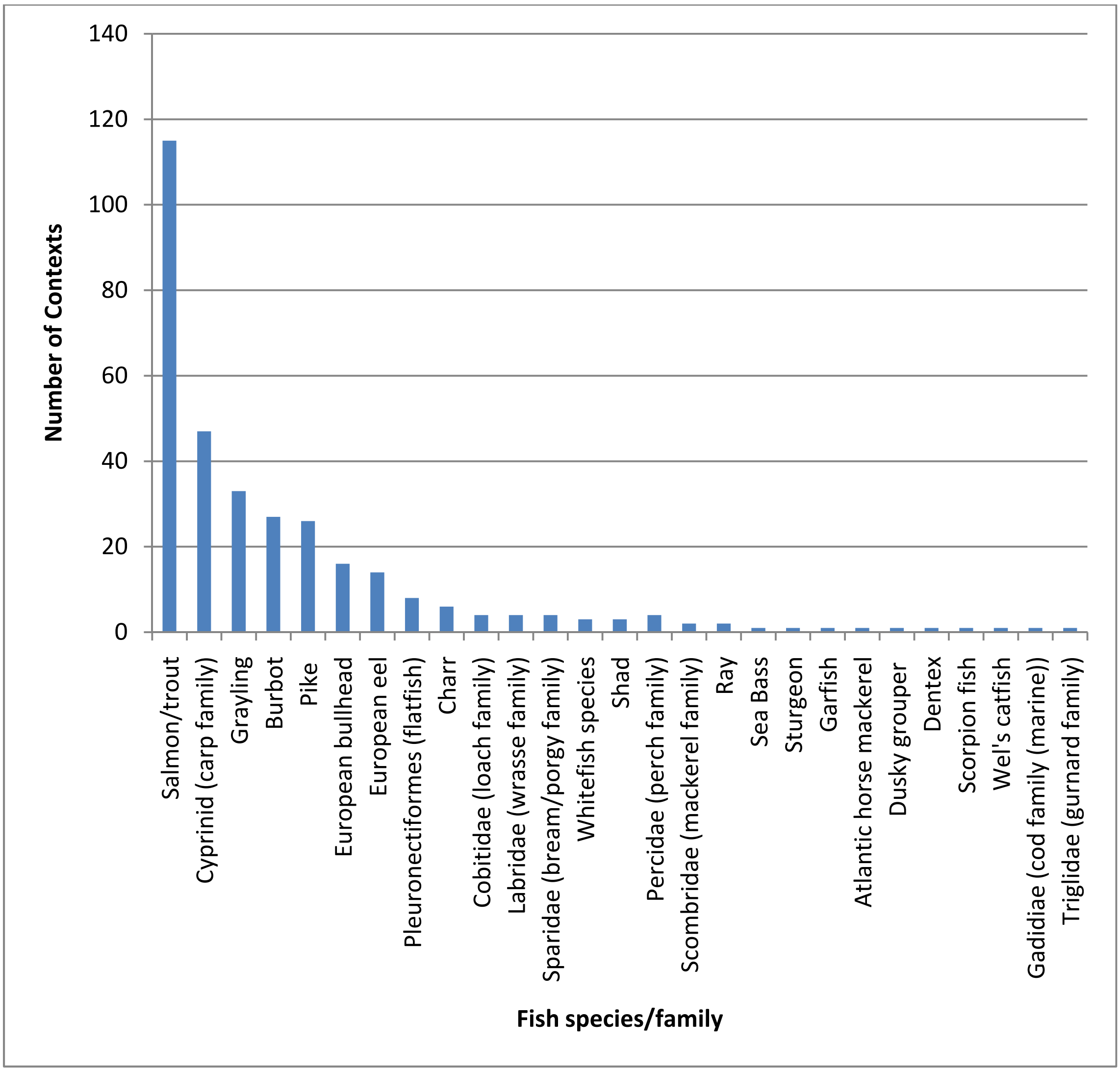

Figure 5.8*:* Freshwater fish remains from 145 Upper Palaeolithic (c. 40,000 – 10,000 BP) contexts from 121 sites in Europe. For site list see Appendix II.

Trampling was carried out on three specimens of each species to ensure that results are not atypical. In total skeletal elements of nine fish were included in these experiments. Specimens were de-fleshed by lightly boiling, manual removal of the bulk of the flesh and adhering tissues by hand, then submerging the skeletal remains in a solution of 40° C water and Biotex for 48 hours. Remains were then rinsed through a 250 µm sieve and left to dry at room temperature for a further 48 hours. This method was used by Jones (1999), it ensures that all skeletal elements are extracted from each specimen, but does not have any adverse affects on skeletal form. To ensure that all bones were present after flesh removal each element was identified prior to trampling using Lepiksaar (1994) as a guide, see Figures 6.2 and 6.3. Vertebrae were differentiated by type; for trout according to Morales Muniz (1984), for pike and European chub vertebrae were divided into first vertebrae, thoracic and caudal categories. Ribs were not included in these trampling experiments; although sometimes recorded in archaeological assemblages they cannot be identified to species and it is near impossible to calculate an MNI from the often fragmentary remains.

The trampling method combines those proposed by Jones (1999) and Nicholson (1992b). In terms of pacing the method follows Jones (1999), which allows intermediate assessments of skeletal loss, showing the progressive loss of material, rather than just an end result as with experiments by Nicholson (1992b). Results were recorded after 25, 75, 175 and 375 paces. The surface on which bones were trampled more closely resembles that used by Nicholson (1992b). This was in an attempt to replicate sedimentary conditions for European cave sites. After being checked for initial completeness (see Figure 5.9 and 5.10) bones were placed on top of a 200mm layer of mixed medium-fine builder's sand (2kg) and 'alpine gold' gravel (1kg) in a plastic gravel tray (380 x 240 x 70 mm). In each case one skeletal specimen was spread in the centre of the tray, Figure 5.11. In total each specimen was walked over for 375 paces, at 25, 75, 175 and 375 the materials from each tray were recovered for recording. With the aid of a 3-sieve stack (5mm, 2mm and 1mm) fish bones were extracted from the sand/gravel mix, identified and recorded as if an archaeological assemblage. After being recorded the bones were returned to the gravel tray as in initial set-up and pacing continued up to 375 paces. The remains were recorded as identifiable or absent, so fragmentary pieces that could be identified to element allowed the bone to remain identifiable, and therefore archaeologically visible. Using Jones (1999) as a guide (see Table 5.5) the results were then translated into index of robusticity (IR) values, first for each individual element, then a mean IR for each specimen, then a mean IR value for each species. The results were then compared to the species presence frequencies in 86 Upper Palaeolithic sites (Figure 5.8) with the aim of establishing the potential for taphonomic processes to lead to the differential species representation during the Upper Palaeolithic period.

Figure 5.9: Pike (*Esox lucius*) cranial bones prior to trampling.

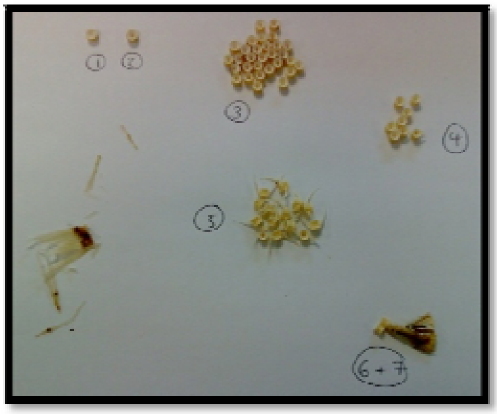

Figure 5.10: Pike (*Esox lucius*) vertebrae prior to trampling.

Figure 5.11: Pike (*Esox lucius*) bones ready to trample.

No. per Fish	175	375	IR
1	1	1	1
1	1	0	3
1	0	0	5
2	2	2	1
2	2	1	2
2	1	1	3
2	1	0	4
2	0	0	5

Table 5.5: Method for attributing IR values to trampling results, as described by Jones (1999).

5.6.3 Trampling experiment: results

Raw data for the trampling experiments can be found in Appendix III. A summary of the IR values for each specimen and element can be found in Table 5.6. No statistical analyses on the trampling result could be performed due to low sample size.

Overall mean IR values (Table 5.7) show that trout bones best survive the trampling process, followed by European chub, then pike. Figure 5.12 shows mean IR values for skeletal elements of the three species subjected to trampling; it indicates that not only are there differences in survival between the three species, but also between specific elements. For example, trout survives the trampling process better than pike overall, however, for some elements, for example the vomer and cleithrum preservation is better for pike. Vertebrae survived well in all species, but especially well in trout. Other elements surviving well in all three species are basioccipital, articular, maxilla, quadrate, ceratohyal, epihyal and scapula (all having mean IR values of 2.0 or less for each species), Table 5.6.

Intra-species variation in IR values was minimal, in many cases fluctuating only by one. However for some elements increase variation between IR values is observed. While the IR values for pike and trout were more frequently variable, those for chub were more constant; the only elements that had IR values fluctuating by more than one were the premaxilla and cleithrum.

	Pike (*Esox lucius*)				**Trout (*Salmo trutta*)**				**Chub (*Squalius cephalus*)**			
	1	**2**	**3**	**Mean**	**1**	**2**	**3**	**Mean**	**1**	**2**	**3**	**Mean**
Neurocranium												
Basioccipital	1	1	1	**1.0**	1	1	1	**1.0**	1	1	1	**1.0**
Frontal	2	4	1	**2.3**	2	1	1	**1.3**	3	4	4	**3.7**
Otolith	3	1	3	**2.3**	1	2.5	1.5	**1.7**	1	1	1	**1.0**
Parasphenoid	1	5	1	**2.3**	3	1	1	**1.7**	1	1	1	**1.0**
Vomer	1	1	1	**1.0**	1	5	1	**2.3**	\	\	\	****
Suspensorium												
Articular	1	3	1	**1.7**	1	1	1	**1.0**	\	1	1	**1.0**
Dentary	1	1	1	**1.0**	1	1	1	**1.0**	3	2	2	**2.3**
Ectopterygoid	1	5	3	**3.0**	1	2	1	**1.3**	2	2	2	**2.0**
Entopterygoid	4	5	5	**4.7**	5	\	3	**4.0**	3	2	2	**2.3**
Maxilla	1	2	3	**2.0**	1	1	1	**1.0**	1	\	\	**1.0**
Metapterygoid	5	5	2	**4.0**	2	1	3	**2.0**	4	3	3	**3.3**
Palatine	3	4	1	**2.7**	1	1	1	**1.0**	\	\	\	****
Premaxilla	1	1	1	**1.0**	1	1	1	**1.0**	1	3	3	**2.3**
Quadrate	1	1	1	**1.0**	1	1	2	**1.3**	1	1	1	**1.0**
Interopercular	4	1	3	**2.7**	2	5	1	**2.7**	2	2	2	**2.0**
Opercular	4	4	1	**3.0**	2	3	1	**2.0**	2	2	2	**2.0**
Preopercular	1	2	2	**1.7**	1	5	1	**2.3**	1	1	1	**1.0**
Subopercular	5	4	5	**4.7**	1	5	1	**2.3**	3	3	3	**3.0**
Hyomandibular												
Ceratohyal	1	3	1	**1.7**	1	1	1	**1.0**	\	1	1	**1.0**
Epihyal	1	4	1	**2.0**	1	1	1	**1.0**	\	\	\	****
Hyomandibular	1	1	1	**1.0**	1	1	1	**1.0**	3	2	2	**2.3**
Urohyal	1	5	5	**3.7**	1	\	1	**1.0**	1	1	1	**1.0**
Branchial Region												
Cleithrum	1	1	1	**1.0**	3	3	5	**3.7**	1	3	3	**2.3**
Post-temporal	5	5	5	**5.0**	1	1	1	**1.0**	3	3	3	**3.0**
Scapula	1	2	1	**1.3**	1	1	1	**1.0**	1	1	1	**1.0**
Supracleithrum	2	3	3	**2.7**	3	2	1	**2.0**	5	5	5	**5.0**
Pharyngeals	\	4	\	**4.0**	\	\	\	****	1	1	1	**1.0**
Vertebrae												
Total vertebrae	1	2	1	**1.3**	1	1	1	**1.0**	2	1	1	**1.3**

Table 5.6: IR values for skeletal elements of trout (*Salmo trutta*), European chub (*Squalius cephalus*) and pike (*Esox lucius*). Shaded elements are those surviving well in all three species (mean IR 2.0 or less).

Species	**Mean IR**
Atlantic cod (*Gadus morhua*)	3.1
Pike (*Esox lucius*)	2.4
Chub (*Squalius cephalus*)	1.9
Trout (*Salmo trutta*)	1.6

Table 5.7: Mean IR values for trout (*Salmo trutta*), European chub (*Squalius cephalus*) and pike (*Esox lucius*). Value for Atlantic cod calculated using data from Jones (1999).

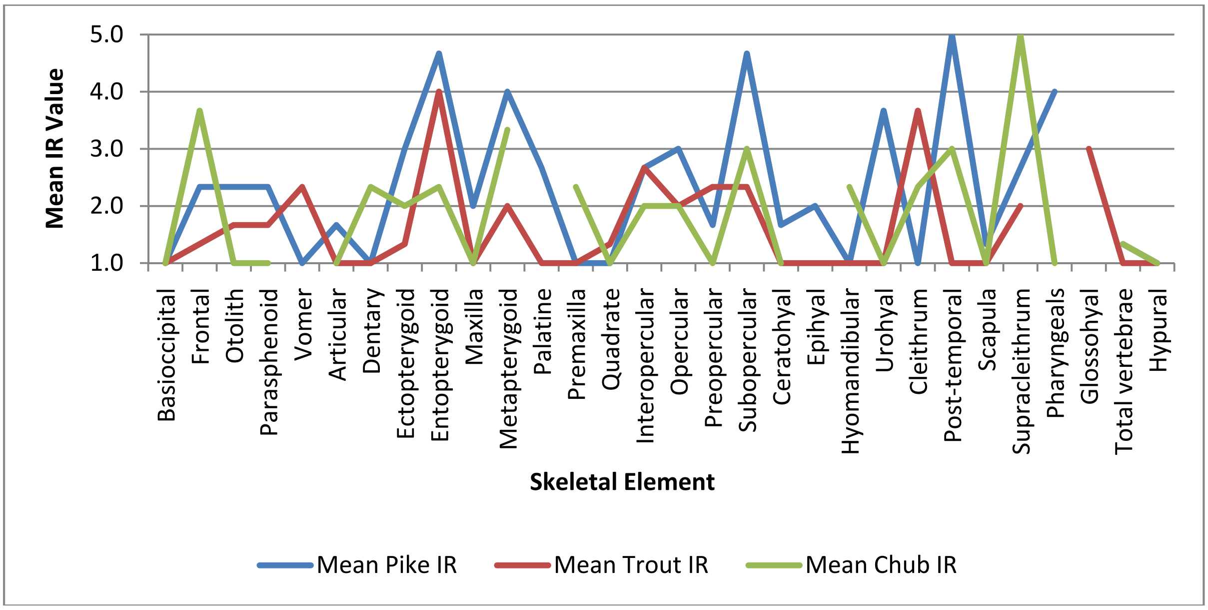

Figure 5.12: Mean IR values for skeletal elements of trout (*Salmo trutta*), European chub (*Squalius cephalus*) and pike (*Esox lucius*).

5.6.4 Trampling experiment: discussion

These experiments represent the first stages of a investigation that is required to differentiate inter-species preservation variability caused by post-depositional taphonomic effects. The IR values for the three species investigated are much lower than that for cod as achieved by Jones (Jones 1999). Either this difference is real, or, it possibly reflects differences in weight of the trampler. Unfortunately IR values cannot be calculated for fish trampled in Nicholson's experiments as her results were recorded in a different manner. Therefore, the results for the species investigated here are only compared between themselves.

The IR values for the three species here strongly suggest that trampling would lead to differential inter-species preservation within archaeological deposits. The lowest mean IR value was achieved for trout, suggesting that this species, and perhaps genus, which also includes Atlantic salmon, survives the trampling process better than the European chub and the pike. The pike has the highest mean IR value indicating that of the three species considered it is the least resistant to trampling processes.

The IR value is useful for giving a general idea of which species will survive trampling processes. However, depending on the type of fish that is being considered there are a different number of species identifiable bones to start with. For example, in many cases vertebrae cannot be identified to species level based on skeletal morphology. This is a disadvantage when dealing with assemblages with many cyprinids, where vertebral morphology varies little between family members and may only allow identification to family, or perhaps genus level. Other species, such as pike can be identified to species based on vertebral morphology as it differs sufficiently from other European fish species. Some species may only have one or two species specific elements, for example, for cyprinids it is often the pharyngeal that allows species identification, see Figure 5.13. In all 3 European chub specimens the pharyngeal remained identifiable after the full 375 paces (IR value = 1), suggesting that while trampling would have an effect on NISP values for chub remains, the MNI should still be representative of the originally deposited assemblage. Similarly, the skeletal remains of species in the *Salmo* genus are also very similar, making identification at species level difficult. The most frequently used element for species identification for

Salmo is the vomer, see Figure 5.14, which can display species specific characteristics. The possibility still remains that some species could have high mean IR values, but maintain their archaeological visibility, while some species with low mean IR values could remain visible only at family or genus level.

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Figure 5.13: Pharyngeal bones of Cyprinidae: a) *Cyprinus carpio* (common carp); b) *Carassius carassius* (Crucian carp); c) *Carassius auratus* (goldfish); d) *Barbus barbus* (barbel); e) *Gobio gobio* (gudgeon); f) *Tinca tinca* (tench); g) *Blicca bjoerkna* (silver bream); h) *Abramis brama* (common bream); i) *Alburnus alburnus* (bleak); j) *Phoxinus phoxinus* (minnow); k) *Rhodeus servceus* (bitterling); l) *Scardinius erythrophthalmus* (rudd); m) *rutilus rutilus* (roach); n) *Squalius cephalus* (chub); o) *Squalius idus* (orfe/ide); p) *Squalius Squalius* (dace). After Maitland (1972: 37).

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Figure 5.14: Vomer bones of Salmonidae: a) *Salmon salar* (Atlantic salmon); b) *Salmo trutta* (trout); c) *Salmo gairdneri* (now *Oncorhynchus mykis* – rainbow trout); d) *Salvelinus alpinus* (Arctic char); e) *Salvelinus fontinalis* (American brook trout/speckled char). After Maitland (1972: 25).

The representation of certain species may be also affected by on-site recovery, where it is more likely that vertebrae are recovered than cranial elements based on the ability of the excavators to recognise fish remains. Fish vertebrae are instantly recognisable as fish remains; many cranial elements may not be. These on-site decisions mean that when material is studied only that identified as fish remains on site are provided for the specialist, it is likely that many fish remains are bagged with those of small mammals, birds, reptiles and amphibians. This issue was observed during analysis of the fish remains from Grotta-Riparo Mariza located in the Fucino Basin, central Italy, where bags and boxes clearly labelled 'fish' contained many remains of small mammals and birds (especially beaks). Presumably fish remains ended up in the small mammal and bird collections too, and were therefore never subject to analysis.

There are many ways in which the method could be modified to investigate the impact of different factors, the main ones being:

- Prior to trampling: frozen/unfrozen
- Mode of de-fleshing: by hand, Biotex, dermestid beetles
- State while trampling: raw, cooked, de-fleshed, with flesh
- Position while trampled: surface, sub-surface, deeper burial
- Weight of trampler

Other species that are more rarely recovered from Late Pleistocene cave deposits, such as shad, barbel and perch, have yet to be considered in such experiments.

5.7 The impact of animals and trampling on fish remains: conclusion

Although feeding experiments with brown bears (*Ursus arctos*) and Eurasian eagle owls (*Bubo bubo*) did not go to plan a detail study of their diet and behaviour allowed identification of basic taphonomic signatures for identifying fish remains deposited by these species. Both of these species have the potential to deposit fish remains in caves (and other areas) which are also being used, are previously used by humans. Further investigation of these species, and other cave using fish eating faunas, will contribute considerably to understanding of site formation processes, aiding interpretation of fish remains from such sites.

Trampling experiments indicate that inter-species preservation is an important factor in the preservation and representation in fish bone assemblages, this is very rarely considered when interpretations are made regarding species abundances and exploitation at archaeological sites. For the Upper Palaeolithic the observed patterns in species frequency, especially the dominance of *Salmo* sp. (Figure 5.8) may not result from human prey selection, but from the impacts of post-depositional taphonomic processes. A study of many more specimens (especially given fluctuating IR values for pike and trout) and fish species will highlight which species are potentially being over or under represented in the archaeological record.

The results of these experiments are discussed in relation to archaeological assemblages from central Italy and northern Spain in Chapters 6 and 7.

Chapter 6. Fish remains from the Fucino Basin (Abruzzo, Italy)

6.1 Introduction

As discussed in Chapter 2, many archaeological fish bone assemblages have not been subjected to formal analysis. This chapter presents the analysis of four fish bone assemblages from Upper Palaeolithic cave sites in central Italy that had not previously been studied in any detail. The exception is material resulting from excavation at Grotta di Pozzo between 1993 and 2005, which was submitted as a Master's dissertation in 2006 at the University of Bradford (Russ 2006) and later published (Mussi *et al.* 2008; Russ 2008; Russ *et al.* 2008; Russ & Jones 2009). Analyses of fish remains from the excavations between 2006 and 2009 at Grotta di Pozzo were conducted as part of this PhD research and are presented here for the first time.

The regions that have been subjected to detailed analysis were selected based on availability of material. Access to material from Belgian sites was secured through Professor Wim van Neer, Koninklijk Belgisch Instituut voor Natuurwetenschappen, Afdeling Antropologie en Prehistorie, (Royal Belgian Institute of Natural Sciences) but these assemblages had been previously studied to a high level (Van Neer *et al.* 2007); priority was given to previously unstudied material. Access to further collections, mainly in France, was sought but denied due to conflicting research projects.

6.2 Archaeological assemblages: method

After establishing sites with fish bone assemblages many museums and academics were contacted in order to gain access to the materials for analysis. Access permission for Fucino and Spanish assemblages can be found in Appendix IV.

Fish remains from all sites were identified to element and species or genus using published identification guides (Desse & Desse 1976a; 1983; Yee Cannon 1987; Feltham & Marquiss 1989; Watt *et al.* 1997; Granadeiro & Silva 2000) and reference material at the University of Bradford. Number of individual specimen (NISP) values were recorded and used to establish minimum number of individuals (MNI) based on the most frequently occurring single element for each site.

To allow estimation of fish length, vertebrae were measured to 0.1mm as described in Morales and Rosenlund (1979) (Figure 6.1). Vertebrae were selected because they were present at all sites that were to be studied, therefore data could be directly compared from site to site. Other elements can be used for length estimation, in hindsight it may have been more appropriate for the Italian sites to estimate length based on dentary measurements, as this is a well represented element at these sites. However, the short time in which the Italian assemblages were studied meant there was not the time to take the additional measurements after establishing that this was the most occurring element. The problem in using vertebrae is that there is potential to over represent a single fish by assuming that each individual vertebra represents a single fish. Another problem is that vertebrae vary in size depending on their type and position along the spinal column. This should be taken into consideration when regarding the data. Most remains represent salmonid species, and therefore length estimations (TL as described by Wheeler (1969)) was made using the equation:

$$TL = 63.38A2 + 81.156$$

(Russ 2006)

Where:

TL = total fish length

A2 = vertebrae width (A2 as described by Morales and Rosenlund (1979))

Vertebrae of 20 modern specimens of brown trout (*Salmo trutta*) and Atlantic salmon (*Salmo salar*) from the reference collection at the University of Bradford were measured. The smallest specimen measured 175mm and the largest 900mm in total length, which included the largest and smallest specimens within the collection. The formula for the relationship was determined using linear regression analysis. The r^2 value, calculated by Pearson's Product Moment Correlation Coefficient, (r^2) was 0.933, significant with 95.4% confidence. The standard error was calculated by using ANOVA and provided a standard error of 14.4mm (95.4% confidence) (Russ 2006).

Estimated fish lengths were grouped into 2cm intervals to establish frequency of size groups. To compare between sites, a percentage presence for each group was calculated. The smallest and largest estimates and the mean size were also calculated for each site.

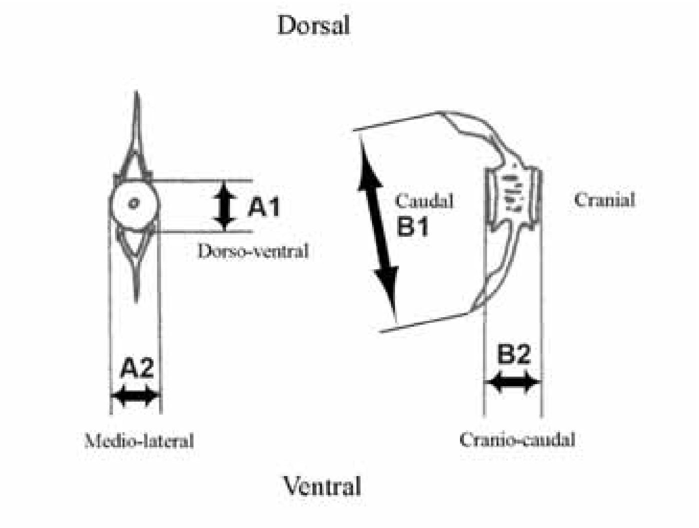

Figure 6.1: Vertebral measurements as proposed by Morales & Rosenlund (1979: 45).

Where possible salmonid vertebrae were allocated to type as described by Morales *et al.* (1994), (Figure 6.2), this allowed a more detailed analysis of body part representation at the sites, which will contribute to taphonomic assessment. Three categories were used for recording vertebrae of other species: first vertebra, thoracic vertebra and caudal vertebra.

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Figure 6.2: Vertebrae types for trout (*Salmo trutta*) (Morales-Muñiz 1984).

Taphonomic assessment included recording any evidence for butchery (cut-marks), burning and animal activity (gnaw and tooth-marks). Any unusual features were also noted during analysis.

6.3 The Fucino Basin sites

6.3.1 Introduction

Archaeological excavations in the caves located on the margins of the Fucino Basin (Figures 6.4 and 6.6) began in 1956, directed by Antonio Mario Radmilli. Between 1956 and the present day a total of 11 cave sites yielding Upper Palaeolithic deposits have been investigated (Table 6.1). Two cave sites have ongoing long-term excavation research projects which began in the early 1990s; Grotta di Continenza, directed by Renata Grifoni Cremonisei (University of Pisa) and Grotta di Pozzo, directed by Margherita Mussi (University of Rome, La Sapienza). Seven sites have yielded fish remains (Figure 6.6 & Table 6.1), remains from five sites have been previously studied by Wilkens (1994). However, her analyses did not extend to element identification. Furthermore the fragment counts (NISP) she presents do not tally with the observations made in this study.

In addition to the sites located at the edges of the Fucino Basin, a further Abruzzo cave site has yielded fish remains from Upper Palaeolithic deposits, Grotta Achille Graziani which is located 25km south-east of the Fucino Basin, close to the village Viletta Barrea, where the River Scerto, coming from Camosciara, meets the River Sangro. Its proximity to the Fucino sites, its elevation above sea level (1,060m) and the suggestion by Radmilli (1997) that this site was used by the same 'Bertonian hunters' as used the Fucino sites warrants its inclusion in this detailed analysis of fishing in the Fucino area. Several bone artefacts that could be interpreted as bone gouges and self-barbed points, comparable with those recovered from Spanish Upper Palaeolithic sites (Pokines & Krupa 1997), were recovered during excavation at Grotta-riparo Maritza (Radmilli 1997). No artefacts typically associated with fishing (e.g. harpoons, hooks or gouges) have been recovered from any of the other Fucino Basin sites, or at Achille Graziani.

Site Name	**Site Director**	**Excavated**	**References**
Grotta Achille Graziani	A. Radmilli	1955	(Radmilli 1955)
Grotta di Cicco Felice	A. Radmilli	1956	(Radmilli 1956b; 1975; 1977)
Grotta Arfa	A. Radmilli	1956	(Radmilli 1975; 1977)
Grotta Clemente Tronci	A. Radmilli	1956-57	(Radmilli 1956a; b; 1975)
Riparo Maurizio	A. Radmilli	1956-57	(Radmilli 1963; 1975; 1977)
Grotta di Ortucchio	A. Radmilli	1957-60	(Radmilli 1956b; Cremonesi 1968a; Radmilli 1975)
Grotta la Punta	A. Radmilli	1958-59	(Radmilli 1956b; Cremonesi 1968a; Radmilli 1975)
Grotta la Cava	C. Tozzi	1959	(Radmilli 1956b; 1975)
Grotta Saint Nicola	E. Boratti	1960	(Radmilli 1956b; 1975)
Grotta-Riparo Maritza	A. Radmilli	1960-62	(Radmilli 1956b; Grifoni & Radmilli 1964; Radmilli 1975)
Grotta di Pozzo	M. Mussi	1993-present	(Agostini *et al.* 1993; Lubell *et al.* 1999; Mussi *et al.* 2000; Burroni *et al.* 2002; Mussi *et al.* 2003; Mussi *et al.* 2004; Russ 2006; Mussi *et al.* 2008; Russ 2008; Russ & Jones 2009)
Grotta di Continenza	R. Grifoni Cremonesi	1993?-present	(Bevilacqua 1994; Peretto *et al.* 2004)

Table 6.1: Summary of excavations at Fucino Basin cave sites with Palaeolithic deposits. Highlighting indicates sites with fish remains.

Figure 6.3: Location of the Fucino Basin in central Italy. Base image source: d-maps. http://d-maps.com/carte.php?lib=italy_map&num_car=2325&lang=en

6.3.2 The Fucino Basin: a changing environment

The Fucine Lake (Lago Fucino, Figure 6.4) once occupied the Fucino Basin which, prior to draining, represented the largest mass of fresh water in the Abruzzo region (Tomassetti *et al*. 2003). The Fucine Lake reached its maximum dimensions during the Pliocene period (5.3-1.8 million years ago). Since this time lake levels have varied with changes in climatic conditions (Giraudi 1989). The lake is fed by small streams of mountain precipitation and melting snow, producing an environment very suited to brown trout (*Salmo trutta*) (Skeates, 1987). The Fucino Basin is closed; the lake did not discharge through a river into the sea, but drained through underground sink holes. Evaporation also controlled lake levels (Wilkens 1994).

By 21,950 – 20,650 cal BP the level of the lake had fallen to around an altitude of 695-710 m (Radmilli 1977; Giraudi 1989). This would have temporarily exposed the caves, prior to which the sites would have been submerged. At this time the sites, which lie between 690 and 725 m above sea level, would have been located close to the lake shore. The sites become submerged again by a rise in lake level between 17,950 – 16,150 cal BP. However, by 13,150 – 12,800 cal BP lake levels dropped to below 658 m (Lubell *et al.* 1999; Giraudi & Mussi 1999a; 1999b) re-exposing all the sites. This corresponds with a brief increase in area occupied by glaciers due to a drop in temperatures seen at this time (Bowen *et al.* 1986).

A pollen core taken from the Lake of Vico in central Italy provides the most local pollen data for the Fucino Basin in the Upper Palaeolithic period. The dates for Upper Palaeolithic contexts at Grotta di Pozzo (Table 6.8) fall into the Bølling-Allerød late glacial interstadial (e.g. Yu & Eicher 2001). During this period vegetation is dominated by Gramineae – grass species, and *Artemisia* sp. (includes many species of hardy herbs and shrubs). *Juniperus* sp. (juniper) and small amounts of *Pinus* sp. (pine) pollen are also represented, here the pine pollen is considered to be a result of long distance transportation (Frank 1969). The dates for the Upper Palaeolithic contexts at the Fucino Basin sites correspond with a brief mild period where temperatures are only <4.8°C less than the mean temperature today (Giraudi 1989; 1998; Giraudi & Mussi 1999a; 1999b; Mussi *et al.* 2000). Additional research has confirmed a colder climate than today, with glaciers at locations above 1800m at this time (Bowen *et al.* 1986; Dramis & Kotarba 1994; Giraudi 1994).

The lake was drained partially by the Romans during the Claudian and Hadrian periods (between 41 and 138 AD) and ‘completely’ drained by 1875 as a result of a 13 year drainage scheme commissioned by Prince Torlonia (Radmilli 1975: 106; Giraudi 1989). However, in 1873, just two years prior to the completion of the drainage scheme the lake supported five hundred fishermen (Nardelli 1883: 29), indicating that, even at the reduced water levels of 1873, the lake was an extremely productive source of fish. Only a small lake survives today (Figure 6.5), brown trout (*Salmo trutta*) and small tench (*Tinca tinca*) are present and fished on small scale by local inhabitants. Rainbow trout (*Oncorhynchus mykiss*) has now been introduced, a species certainly absent during the Upper Palaeolithic (Bruno 1983).

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Figure 6.4: Map of the Fucino Basin from 1838, prior to complete draining in 1875. Source: Wikipedia.

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Figure 6.5: The fully drained Fucino Basin/Plain today. Source: Wikipedia.

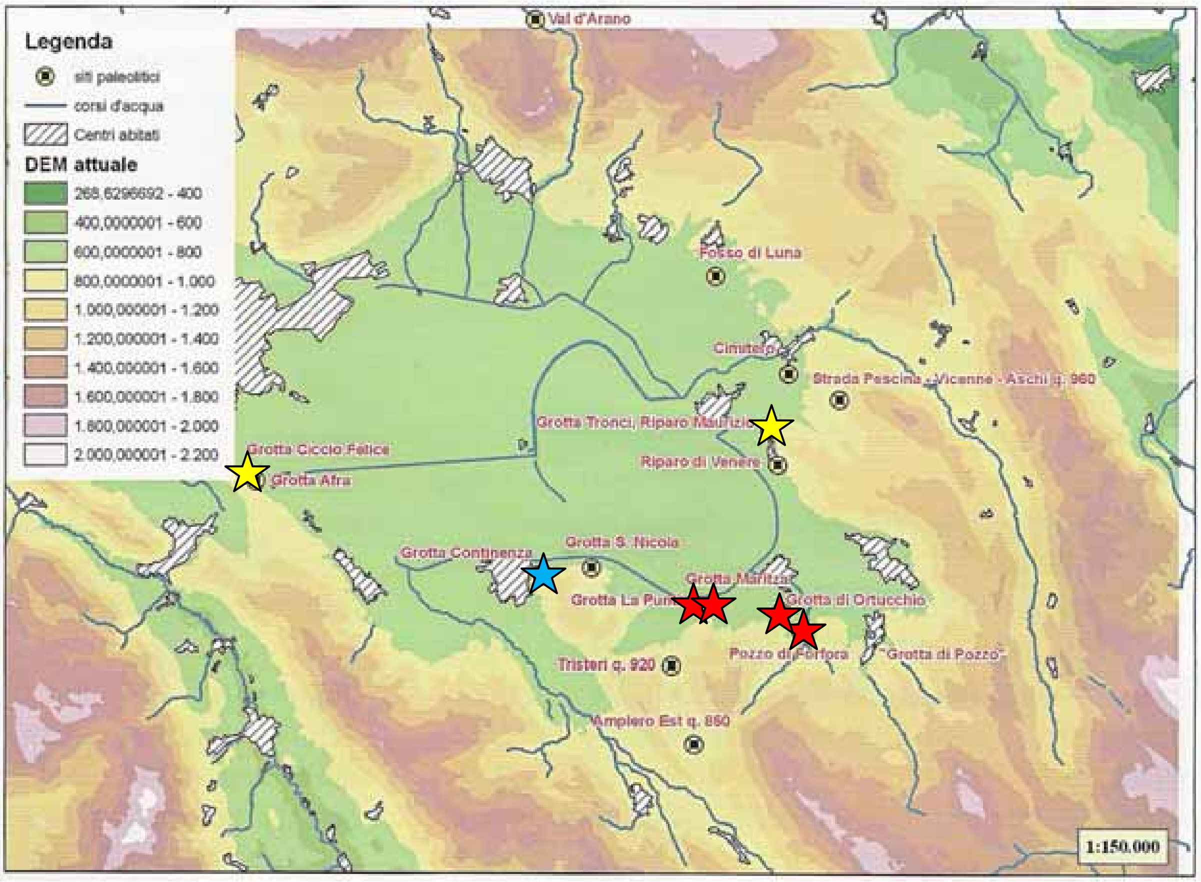

Figure 6.6. Upper Palaeolithic sites in the Fucino Basin. Source: Agostini *et al.* (2008).

★ Sites with fish remains that have been studied by Russ.

★ Site with fish remains that have not yet been studied.

☆ Sites with fish remains studied by Barbara Wilkens, NISP = 1 (Wilkens 1994).

6.3.3 Fish bones from the Fucino Basin: results

Raw data on the analysis of fish remains from Grotta La Punta, Grotta di Ortucchio, Grotta di Pozzo (additional material only) and Grotta Maritza can be found in Appendix V.

Grotta La Punta

Except Grotta di Ciccio Felice and Riparo Maurizio, Grotta La Punta (Figures 6.7 and 6.8) yielded the smallest assemblage of fish remains with a total of just 43 fragments, six of which came from Mesolithic and Neolithic, rather than Upper Palaeolithic contexts, see Table 6.3. The Upper Palaeolithic levels at Grotta La Punta are better dated than those of the other Fucino Basin sites (except Grotta di Pozzo), in total 3 radiocarbon dates spanning 13 levels in all (26-39) have yielded dates of 12,681 – 12,141 cal BP (level 26), 13,791 – 13,427 cal BP (level 27-30) and 19,449 – 15,273 cal BP (level 39) (see Table 6.10 and Figure 6.22), fish remains are found throughout these levels. Skeletal morphology was consistent for that of brown trout (*Salmo trutta*). Unlike Grotta di Ortucchio, Grotta di Pozzo and Grotta-riparo Maritza, the fish remains at Grotta La Punta consist only of cranial elements, see Figure 6.9. The MNI of 15, which is based on dentary frequency (15 left, 12 right and 2 undetermined) is high for an NISP of only 43. The remains almost exclusively represent elements of the oromandibular region of the branchiocranium: dentary, maxilla, articular, ceratohyal and palatine, with the only exceptions being a single cleithrum fragment and two unidentified pieces. Fragmentation was minimal throughout the assemblage with no evidence for butchery, burning or modification by animals being observed. The absence of vertebrae at Grotta La Punta means that no length estimations were carried out for the fish remains at this site.

Level	Period/Date	NISP	Notes
12	Neolithic	2	
18	'Sterile'	2	
20	'Sterile'	1	
21	Mesolithic	1	
23-24	Late Upper Palaeolithic	3	
25	Late Upper Palaeolithic	7	
26	12,681 – 12,141 cal BP	6	
27	13,791 – 13,427 cal BP	3	
28-29	13,791 – 13,427 cal BP	2	
32	> 13791 – 13,427 cal BP	7	
33	> 13791 – 13,427 cal BP	1	Human remains
35	> 13791 – 13,427 cal BP	5	
48	> 19,449 – 15,273 cal BP	1	
\	Unknown	2	

Table 6.2: Fish remains from Grotta La Punta.

Figure 6.7: Grotta La Punta today. Source: M. Mussi.

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Figure 6.8: Grotta La Punta under excavation 1958/9 (Radmilli 1977: 201).

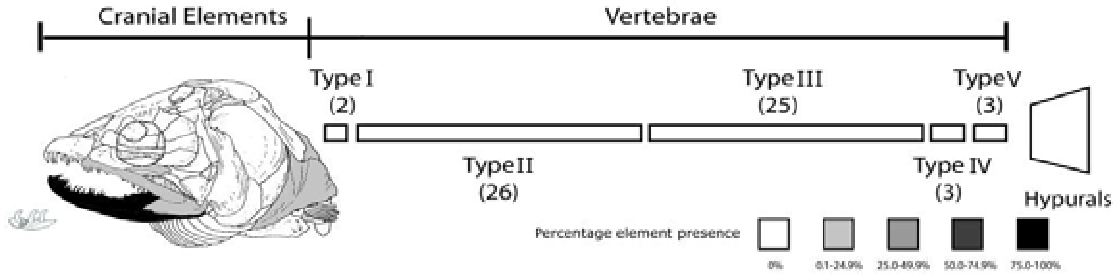

Figure 6.9: Skeletal element representation at Grotta La Punta. Numbers in brackets are number expected per fish, based on Morales Muniz (1984). Crania base image Gregory (1933).

Grotta di Ortucchio

The assemblage at Grotta di Ortucchio was slightly more substantial than that at Grotta La Punta with an NISP of 743, although, as previously discussed, fewer fragments were presented for analysis than expected. Fish remains were recovered from most levels of excavation (Cremonesi 1968a), from the original count presented by Cremonesi (1968) 63 fragments came from levels containing materials dating from Eneolithic to recent times (levels 1-3). Levels 4 and below have artefacts attributed to the Late Upper Palaeolithic, these are comparable with those from the other Fucino Basin sites and Achille Graziani, so also considered Bertonian. The only date for this site comes from level 11 and is a radiocarbon date of 16,570 – 13,800 cal BP (see Table 6.10 and Figure 6.22). Unfortunately, despite being recorded by level in the first instance, most of the fish remains had not been labelled or stored according to level, so it is impossible to be more precise than knowing that only material from levels 4-32 were considered and that these levels also contained Late Upper Palaeolithic stone tools. The fish remains in the assemblage were consistent with brown trout (*Salmo trutta*). The material studied consisted of both cranial and post-cranial elements, with a significant under representation of vertebrae, see Figure 6.10. The MNI of 119 for

Grotta di Ortucchio, like Grotta La Punta, was also based on dentary frequency (119 right, 91 left and 4 undetermined). Although almost half of the NISP were vertebrae (48.3%), the MNI based on vertebrae was only 12, based on first vertebrae. In total 385 vertebrae were present in the Ortucchio assemblage, these represented the whole vertebral sequence, see Figure 6.10, with more vertebrae representing the first and second vertebrae (Types Ia and Ib) than the rest of the spine, with Types IV and V (the final six vertebrae in the vertebral sequence) being least frequent. Apart from four vertebrae which provided estimations over 50cm in total length, the range of fish lengths represented is quite restricted with majority of the bones (92%) giving an estimation between 280mm and 399mm, just a 120mm range, see Figure 6.11. The smallest estimation was 265mm, while the larger vertebrae gave estimations of 512mm, 538mm, 671mm and 924mm, see Table 6.8. Fragmentation was minimal throughout the assemblage with no evidence for butchery, burning or modification by animals being observed.

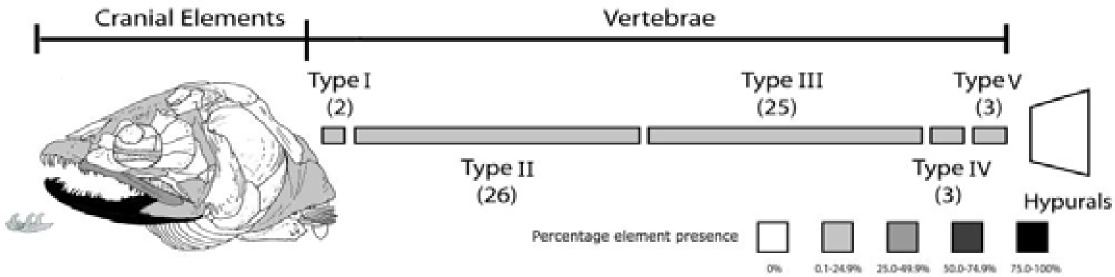

Figure 6.10: Skeletal element representation at Grotta di Ortucchio. Numbers in brackets are number expected per fish, based on Morales Muniz (1984). Crania base image Gregory (1933).

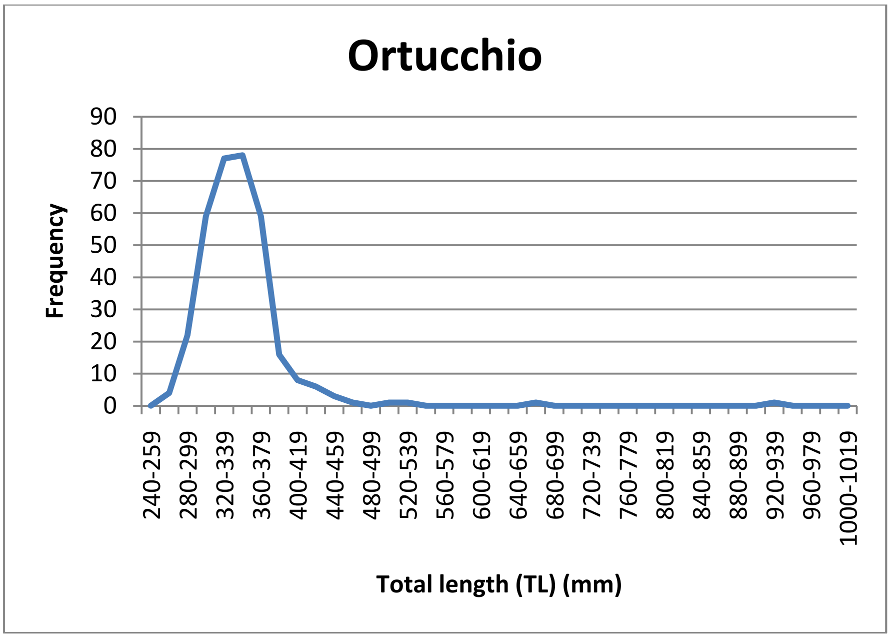

Figure 6.11: Estimated fish length at Grotta di Ortucchio.

Grotta di Pozzo

An additional 1,255 fish bone and fishbone fragments from Grotta di Pozzo (Figure 6.12) were subjected to analysis and can be combined with those previously studied by the author to give a better understanding of the fish remains from this site. The total NISP to date at Grotta di Pozzo is 7,048; all identifiable remains represent brown trout (*Salmo trutta*). The fish remains come from levels PS1-PS8 (Paleolitico Superiore/Upper Palaeolithic 1-8), for which there are three radiocarbon dates, PS1: 14,890 – 14,005 cal BP, PS5: 15,190 – 14,275 cal BP and PS6: 16,210 – 14,635 cal BP, see Table 6.10 and Figure 6.22. Unlike Grotta La Punta and Grotta di Ortucchio, the most frequently recorded element at Grotta di Pozzo was the glossohyal, see Figures 6.13 and 6.14 (Russ 2006; 2008; Russ *et al.* 2008; Russ & Jones 2009), providing an MNI of 155 (Table 6.4), this was closely followed by the dentary which provided and MNI of 144. Like at Grotta di Ortucchio vertebrae are under-represented within the Grotta di Pozzo assemblage. The vertebrae present represent the complete vertebral sequence, with higher representation of types II and III compared with types I, IV and V, see Table 6.8. Again there is a restricted size range represented, see Figure 6.15, with 96% of vertebrae giving length estimations of 300-439mm, a range of 140mm. There are no 'large' specimens in the Grotta di Pozzo assemblage. Fragmentation was minimal throughout the assemblage with no evidence for butchery, burning or modification by animals being observed.

Figure 6.12: Excavations at Grotta di Pozzo in 2005. Source: Author.

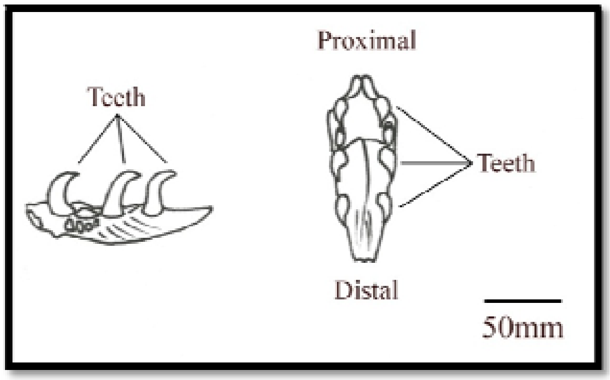

Figure 6.13: Brown trout (*Salmo trutta*) glossohyal. Source: Author.

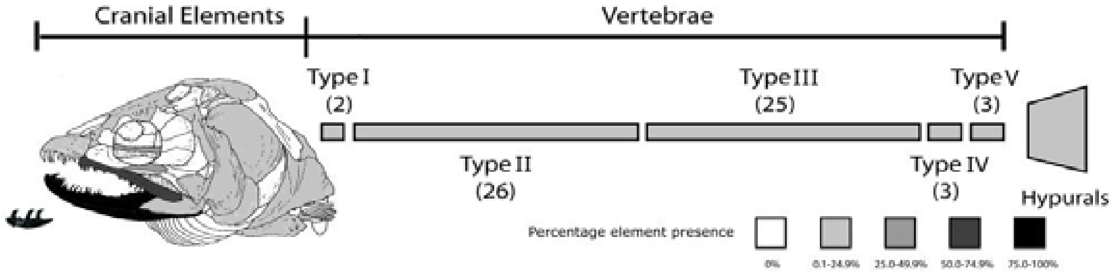

Figure 6.14: Skeletal element representation at Grotta di Pozzo. Numbers in brackets are number expected per fish, based on Morales Muniz (1984). Crania base image Gregory (1933).

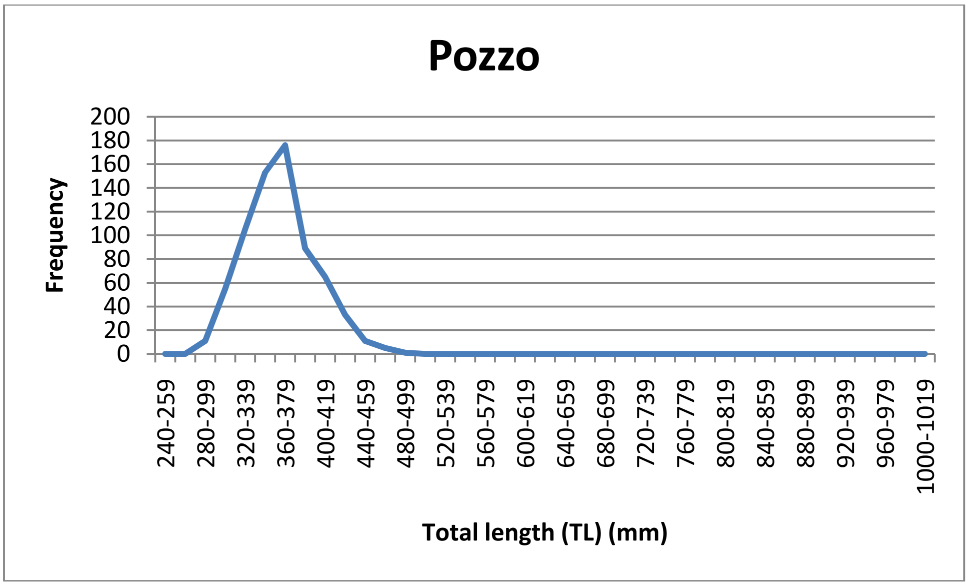

Figure 6.15: Estimated fish length at Grotta di Pozzo.

Grotta-riparo Maritza

By far the site with the largest fish bone assemblage in this region is Grotta-riparo Maritza (Figures 6.16 and 6.17) with an NISP of 51,877. The dentary provided an MNI of 1601 fish, and again vertebrae were under represented, see Figure 6.18, giving an MNI of only 135. The majority of the assemblage (94.4%) came from levels 36-37, which corresponds with 'Bertoniano III', see Table 6.4. There is only a single radiocarbon date for the site, representing levels 30-36, 12,530 – 12,090 cal BP, making this deposit the youngest of all the Fucino Basin Late Upper Palaeolithic deposits, see Table 6.10 and Figure 6.22. Despite being under represented in the Grotta-riparo Maritza assemblage, all vertebrae types are present, see Table 6.8. Types I, II and III are most frequent, but these still give only a maximum MNI of 110.

Level	Period	NISP
31	Bertoniano IV	14
31-38	Bertoniano IV-II	2,888
36	Bertoniano III	40,239
36-37	Bertoniano III	8,734
41-42	Bertoniano I	1
42	Bertoniano I	1

Table 6.3: Fish remains by level at Grotta-riparo Maritza.

As with the other Fucino Basin sites, no evidence for butchery, burning or animal interaction was observed at a macroscopic level. Measuring was restricted to a sub-sample of vertebrae due to time restrictions; it was ensured that vertebrae from all levels were included in the analysis.

Figure 6.16: Fish remains from Maritza. Source: Author.

Figure 6.17: Element identification at Maritza. Source: Author.

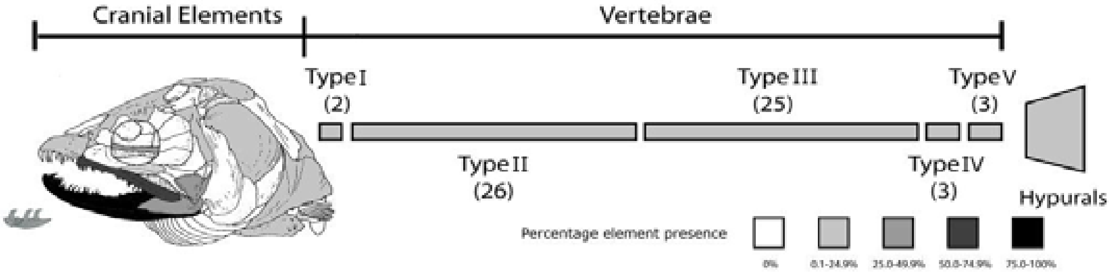

Figure 6.18: Skeletal element representation at Grotta-riparo Martiza. Numbers in brackets are number expected per fish, based on Morales Muniz (1984). Crania base image Gregory (1933).

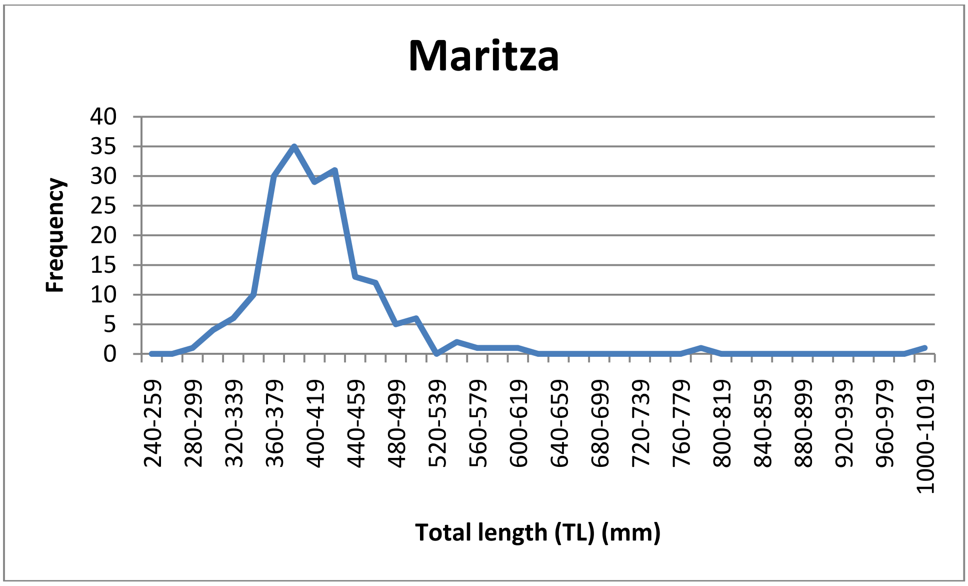

Figure 6.19: Estimated fish length at Grotta-riparo Maritza.

6.3.4 Fish bones from the Fucino Basin: discussion

A single fish bone was recovered from Late Upper Palaeolithic deposits at both Grotta di Ciccio Felice and Riparo Maurizio (Radmilli 1963) (Table 6.3), in both cases these represent brown trout (*Salmo trutta)* (Wilkens 1994). These were requested for analysis, but were not available. It is unknown as to which skeletal elements these bones represent.

Fish remains were rare at Grotta Achille Graziani (Radmilli 1955), but were found in deposits with lithics attributed to the Bertonian stone tool tradition (Bertoniano/ Bertoniana). Bertonian is the stone tool typology associated with Late Upper Palaeolithic activity in the Fucino Basin area, it was first recognised at a cave site in Montebello di Bertona, also located in the Abruzzo region, and corresponds with the Evolved and Final Epigravettian (Bietti 1990: 126), it is not recorded outside the Abruzzo region. The fish remains from this site remain unstudied.

Grotta La Punta, Grotta di Ortucchio, Grotta di Pozzo and Grotta-riparo Maritza yielded more extensive fish bone assemblages. Analysis of the fish remains from Grotta di

Ortucchio and Maritza showed that previously published bone counts were not correct, in comparison with the values published by Wilkens (1994) 375 bones were missing from the Grotta di Ortucchio collection, but there were an additional 26,831 bones in the Grotta-riparo Maritza assemblage. After discussion with laboratory supervisors Dr. Silvano Andreassi and Dr. M. Adelaide Rossi, it appears that the discrepancy in the Grotta di Ortucchio assemblage may result from division of remains between different institutions, and that it was now unlikely that the missing remains could be traced. The Grotta-riparo Maritza discrepancy was more puzzling, 26,831 is a huge difference, my thoughts are that Wilkens was only provided with a partial assemblage for her analysis, or that she chose to study only a sample of the remains. The assemblage was divided into 4 boxes (Table 6.2), the NISP counts suggest that possibly Wilkens only studied material from boxes 1436ii and 1273 giving a total NISP of 25,609 coming close to the 25,046 NISP value published for the site (Wilkens 1994).

Box Number	**NISP**
1273	2,904
1435	8,734
1436i	17,534
1436ii	22,705
Total	**51,877**

Table 6.4: NISP values for boxes of fish remains from Grotta-riparo Maritza, Italy.

Little more can be said about the fish remains from Grotta di Ciccio Felice, Riparo Maurizio and Grotta Achille Graziani. The fact that fish remains were rare at these sites may reflect biases in recovery, rather than an absence of fish, but this cannot be determined.

Fish remains were by far most abundant at Grotta-riparo Maritza, with 51,877 fish bone and fish bone fragments, Grotta La Punta had the fewest fish remains, an NISP of

43 (Table 6.5). The assemblage characteristics for all the Fucino Basin sites considered here in detail do not compare with those expected for fish remains deposited by either raptors or bears (see Chapter 5). Raptors are unlikely to produce a single species assemblage and are more likely to take fish smaller in size that those recovered from the Fucino Basin caves, raptors consume their prey whole, therefore deposition by raptors would also not explain the under representation of vertebrae which is observed at all the sites. While bears are potential agents given that they will preferentially consume cranial parts leading to high cranial representation, they can be ruled out due to absence of any evidence for digestion in the assemblages. The fish remains are preserved very well with no edge rounding, crushing, adhering organic material, staining or acid etching as would be expected in digested remains. Bears would not bring un-consumed fish back to a cave. As these likely alternate accumulation agents can be ruled out, it can be concluded that these bones were deposited by humans. This is supported by criteria suggested by others for identifying human agency for fish remains which are applicable to the Fucino Basin assemblages, such as association with artefacts, skewed element representation patterns, selection of seasonally migrating species and low species diversity (suggested by Stewart 1994; Zohar *et al.* 2001). Burning is often used as an indicator of human agency; however, this is not a useful criterion for the Fucino Basin assemblage, where burning was not observed.

	Grotta di Ciccio Felice	Riparo Maurizio	Grotta La Punta	Grotta di Ortucchio	Grotta di Pozzo	Grotta-Riparo Maritza
NISP	1	1	43	743	7048	51877
Cranial MNI	?	?	15	119	155	1601
Vertebrae MNI	?	?	0	12	33	135
% complete fish	0	0	0	5.1	20.8	7.9

Table 6.5: Fish remains from six cave sites in the Fucino Basin, data for Grotta di Ciccio Felice and Riparo Maurizio from Wilkens (1994).

Fish remains from all the Fucino sites represent a species of the *Salmo* genus, almost certainly *Salmo trutta fario* (brown trout). Although osteologically it is almost impossible to separate the bones of *Salmo trutta trutta* (sea trout) and *Salmo trutta fario*, the fact that the Fucino Basin is not connected to the sea rules out the possibility of an anadromous form (*Salmo trutta trutta)* being present. There are, however, some water bodies that yield their own species of trout that are not found elsewhere. For example, at Lake Garda in northern Italy the trout are referred to as *Salmo carpio* (carpione) (Kottelat 1997; Melotto & Alessio 2006), while at Lago di Posta Fibreno the trout are considered to represent *Salmo fibreni* (Fibreno trout) (Kottelat 1997). Both of these species are restricted to these lakes and their associated river systems. At Lago di Posta Fibreno *Salmo cetti* (Mediterranean trout) is also present, this species is also sometimes referred to as *Salmo trutta macrostigma*, despite *Salmo cetti* being a non-anadromous form while *Salmo trutta macrostigma* is considered a migratory species (Behnke 1984; Kottelat 1997). The taxonomic status and history of the genus *Salmo* is therefore complex. The trout in the Fucine Lake may have represented their own species or sub-species; this however, is not reflected in the osteology, which is comparable with that for *Salmo trutta* (both forms). In this research, more important than being able to attribute the remains to a single species or sub-species, are the aspects of the fishes' ecology that would have impacted upon human behaviour and subsistence choices. The most important aspect in terms of procurement of *Salmo* species is the period during which they spawn. Although many of the Italian *Salmo* species (Table 6.6) are non-anadromous (they do not migrate between marine and freshwater environments), they are often potadromous with migration from a lake environment to rivers or streams for spawning. Prior to migration the fish will school at river and stream entrances, at this time they are in peak physical condition, with females offering the additional nutritional value of roe. The schooling, followed by migration upstream provides the opportunity for the procurement of large numbers of fish with reduced input in terms of time and energy (compared with fishing in the lake). Fishing therefore would be most beneficial to human groups due to increased nutritional value and decreased procurement time and energy.

The absence of any other fish species is unusual for assemblages of this date. While it is possible that the Fucine Lake supported only a single fish species at this time, this scenario is unlikely for a lake so large. Alternatively, single species representation may result from differential interspecies preservation. This suggestion is consistent with the results of trampling experiments presented in this thesis (see Chapter 5) which show that trout bones survive this process better than those of some other fish species that might be expected at Upper Palaeolithic sites. It is also supported by results of research by Zohar *et al*. (2008) who found discrepancies between species of living fish populations and those represented in recent death assemblages on the shore of Lake Kinneret (Sea of Galilee). However, although differential interspecies preservation is a potential factor in the formation of the Fucino Basin assemblages, it is unlikely to lead to the *complete* loss of all elements of other fish species while preserving those of trout very well. For example, although cyprinid bones in general did not survive as well as those of trout in trampling experiments, the pharyngeal, a highly identifiable bone, did survive very well. Had cyprinids been deposited at the site these elements should have been present. Here it is more likely that the single species representation results from human prey choices, fishing methods or both.

	J	F	M	A	M	J	J	A	S	O	N	D
Salmo cettii[1]	🟦	🟦	🟦									
Salmo fibreni[1]	🟦											🟦
Salmo carpio (N)[1]	🟦	🟦										🟦
Salmo carpio (S)[1]							🟦	🟦				
Salmo marmoratus[1]	🟦										🟦	🟦
Salmo trutta macrostigma[2]	🟦										🟦	🟦
Salmo trutta fario[3]	?	?								🟦	🟦	🟦

Table 6.6: Spawning seasons for Italian *Salmo* species and sub-species. [1](Kottelat & Freyhof 2007) [2](Alp *et al.* 2003) [3](Vostradovsky 1973).

The element representation patterns are similar at the four sites studied in detail. Cranial elements dominate, especially those of the oromandibular region, see Table 6.7. Vertebrae are always under-represented, and completely absent at Grotta La Punta, see Tables 6.7 and 6.8. At the sites where vertebrae are present, they represent the whole vertebral sequence, suggesting that some whole fish carcasses were deposited at the site. The under representation of vertebrae cannot be a result of any taphonomic process that has been investigated experimentally to date. Experiments considering pH (Lubinski 1996), sediment abrasion (Nicholson 1992b), trampling (Nicholson 1992b; Jones 1999), digestion (Jones 1984; 1986; Butler & Schroeder 1998) and cooking (Nicholson 1992b; Lubinski 1996) all suggest that vertebrae should survive these processes better than most cranial elements. It is also unlikely that the under representation of vertebrae results from recovery biases as vertebrae are the most recognisable fish skeletal element and are unlikely to have been overlooked or incorrectly attributed to mammal or bird. Although excavated during the late 1950's and early 1960's when sampling and sieving were not routine the fish remains from Maritza and Ortucchio were recovered through the sieving of sediments during excavation, this is documented though a photograph of excavations at Maritza which clearly show this being done (Radmilli 1977). The size of the mesh is not given. At Grotta di Pozzo sampling and sieving were done systematically with dry sieving of all sediments and sediment samples being taken. In some cases at Grotta di Pozzo individual teeth were recovered from the samples, suggesting that vertebrae, which are large in comparison to trout teeth, would have been recovered if present. As suggested previously by Russ *et al*. (Russ 2008; Russ *et al.* 2008; Russ & Jones 2009) it can be suggested that this element representation pattern results from human processing of fish at these sites, where the head is removed and the flesh with vertebrae intact is taken away from the site for consumption. This behaviour has frequently been observed in recent hunter-gatherer populations in both Europe and North America, see Chapter 3. Recent hunter-gatherer groups take advantage of spawning salmonids when fish can be caught with ease in great numbers. As fish will not remain fresh for very long most are dried in the sun or smoked for future consumption. Quite frequently the heads of salmon and trout caught during the spawning period are removed prior to drying to reduce the size and weight of the fish for transportation. It is unknown whether or not the Late Upper Palaeolithic hunter-gatherers had the knowledge of preservation. But if the fish were being processed here for later use this implies that some method of preservation was being used, otherwise the fish would spoil very quickly. The presence of some vertebrae probably represents the fish that were eaten fresh during occupation of the site. It would be unlikely that humans would visit the cave to exploit fish and not consume any during their stay.

	Grotta La Punta	**Grotta di Ortucchio**	**Grotta di Pozzo**	**Grotta-Riparo Maritza**
Olfactory region				
Vomer	0	0	150	1105
Orbital region				
Frontal	0	1	1	101
Otic region				
Exoccipital	0	1	0	0
Posttemporal	0	0	8	92
Basicranial region				
Parasphenoid	0	7	44	783
Oromandibular region				
Articular	2	5	22	1401
Dentary	29	216	290	3202
Maxilla	7	82	170	1628
Palatine	1	7	81	621
Premaxilla	0	1	12	329
Quadrate	0	2	17	853
Hyoid region				
Glossohyal	0	7	155	780
Ceratohyal	1	12	18	623
Epihyal	0	0	3	42
Hyomandibular	0	2	2	95
Interopercular	0	0	1	0
Opercular	0	0	11	87
Preopercular	0	0	3	0
Appendicular skeleton				
Radial	0	0	1	0
Basipterygium	0	1	7	172
Cleithrum	1	3	11	146
Coracoid	0	0	2	0
Vertebral column				
Vertebrae	0	358	1899	7487
Caudal skeleton				
Hypural	0	0	35	711

Table 6.7: Summary of skeletal element representation at Grotta La Punta, Grotta di Ortucchio, Grotta di Pozzo and Grotta-riparo Maritza.

	Per fish	Grotta La Punta	Grotta di Grotta di Ortucchio	Grotta di Pozzo	Grotta-Riparo Maritza
Type I	2	0	17	24	136
Type II	26	0	143	726	2861
Type III	25	0	190	483	1599
Type IV	3	0	5	27	12
Type V	3	0	3	20	84
?		0	0	619	2795
Total	**59**	**0**	**358**	**1899**	**7487**

Table 6.8: Vertebrae at four Fucino Basin cave sites. Per fish values from Morales *et al.* (1994: 46).

Fishing during the spawning period for trout at the Fucino Basin sites is supported by the restricted size of fish specimens, see Table 6.9 and Figure 6.20. The length of fish in a natural population of trout is often multimodal (Figure 6.20 (Deep Creek) and Figure 6.21), therefore the length distributions observed at Grotta di Ortucchio, Grotta di Pozzo and Grotta-riparo Maritza may indicate size selection, either as a result of direct size selection or indirect by fishing during spawning. Trout only spawn once they have reached sexual maturity; therefore the spawning population is already size-restricted. It is likely that the size restriction seen at the Fucino Basin sites is a result of fishing during or just prior to the spawning period, when trout are also more easily caught.

Only sexually mature fish will join the spawning migration, this creates a natural restricted size range, which then maybe restricted further by human fishing techniques. For example, in recent hunter-gatherers that exploit seasonally migrating fish populations it is common to use a weir to block the passage of fish up water, see Chapter 3. While the fish are caught behind the weir they can be collected by spearing, scooping or netting. Spearing and netting would further restrict the size range, as these would select the larger spawning specimens. The weir itself may also restrict the size range, as it is likely that the larger, stronger fish may be able to penetrate the weir by jumping over it, removing very large specimens from human reach.

Although all three sites where size estimation was possible show restricted size representation, there is a general difference in fish size between the sites, see Figure 6.20. The fish are generally smaller at Grotta di Ortucchio, slightly larger at Grotta di Pozzo with the largest fish being found at Grotta-riparo Maritza. The mean values for each site show a small (18.8mm) difference between Grotta di Ortucchio and Grotta di Pozzo, but a larger (52.5mm) difference between Grotta di Pozzo and Grotta-riparo Maritza, see Table 6.9. There are many factors which affect trout size (e.g. Elliott 1975a; b; 1989), these may have contributed to the differences seen in fish size at the Fucino Basin sites. The fish at Grotta di Ortucchio and Grotta di Pozzo are shorter than those from Grotta-riparo Maritza. It is a possibility that site location could have lead to the difference in fish length, for example if fishing occurred in different parts of the lake. However, the three sites where size estimation was possible are all located on the south east edge of the Fucino Basin, with Grotta di Ortucchio positioned between the other two sites, therefore it is unlikely that different parts of the lake were fished. Environmental conditions could have varied during the Late Upper Palaeolithic period leading to changes in the trout’s habitat. The dating evidence suggests that trout were larger over time; this may reflect trout population response to changing environmental conditions, for example trout grow biggest in deep waters with equable temperatures 10-18°C when abundant nutrition of considerable variety is available (Adamson 1955), but may also reflect changes in human fishing strategies. The single date from Ortucchio (level 11, see Table 6.10 and Figure 6.22) where the smallest fish are found, despite having a large range, suggests occupation at a similar time to Grotta di Pozzo and much earlier than Grotta-riparo Maritza, where larger fish are present. However, less than optimal conditions can lead to both increase and de-crease in the average length of trout in a lake population. Trout are often carnivorous, if there were to be a shortage of food, the larger trout would consume the smaller ones, this would reduce the number of fish present in the lake, but increase the average length due to a reduction in the numbers of shorter fishes. A reduction in population numbers may allow the trout to grow bigger as they would then have more space; a factor which often controls fish length. A reduction in lake levels would lead to a reduction in average trout length, a response to restricted space, but the dates for Grotta di Ortucchio and Grotta di Pozzo are similar suggesting that this was not the case. Another factor could be the time of year that fishing took place, earlier harvesting of fish may lead to smaller fish being represented. However, as discussed previously the optimum time for fishing for trout is immediately prior to or during initial spawning. Fishing, while possible earlier in the year, does not make sense in terms of optimal foraging theory, which states that resources are exploited to achieve maximum energy intake from minimal energy and time input. It remains a possibility however, as fishing may have occurred when other resources were sparse, rather than when fishing was most productive. Based on the data collected it is not currently possible to identify which of these factors lead to the variation in trout length at the Fucino Basin sites.

Size estimation also indicates that one or two ‘large’ specimens are present at both Grotta di Ortucchio and Grotta-riparo Maritza, but no large specimens are present at Grotta di Pozzo. At Grotta di Ortucchio one vertebra from level 31 provides an estimate of 924mm, while at Grotta-riparo Maritza two larger vertebrae provide estimates of 791mm and 1013mm in length. These are likely to represent cannibal trout which are often present in large lakes, and frequently referred to as ferox trout (*Salmo ferox*), these fish grow much larger and live much longer than the general trout population as they feed almost exclusively on smaller trout in the lake (Adamson 1955: 27). The record size for ferox trout in the UK is 14.4kg (giving a length estimate of around 1100mm), the fish was 23 years of age (Fisheries Research Services 2010). This record length estimate is very close to that for the largest fish specimen at Grotta-riparo Maritza (1012.8mm, see Table 6.10), supporting the identification of ferox trout in this case. These large cannibal trout may have been lured to weir areas by the schooling fish, bringing them from the deeper lake waters making them easier to catch.

	Grotta di Ortucchio	**Grotta di Pozzo**	**Grotta-Riparo Maritza**
No. vertebrae measured	352	704	245
A2 measurements	337	704	189
Longest fish (TL)	924.1mm	480.5mm (401.6mm)	1012.8mm
Shortest fish (TL)	265.0mm	284.0mm (307.2mm)	296.6.6mm
Mean	345.3mm	364.1mm	416.6mm

Table 6.9: Summary of fish length data for Grotta di Ortucchio, Grotta di Pozzo and Grotta-riparo Maritza. Numbers in brackets refer to data for first vertebrae only (see Russ and Jones (2009)).

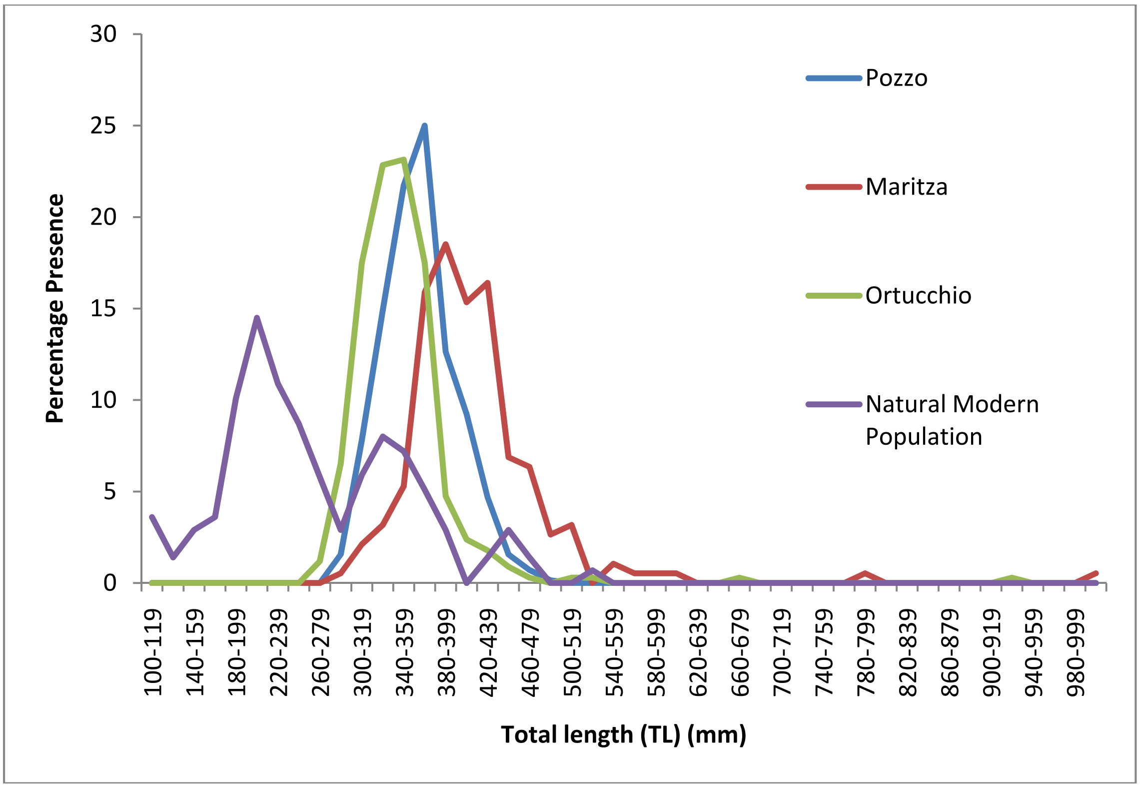

Figure 6.20: Comparing fish length at Grotta di Ortucchio, Grotta-riparo Maritza and Grotta di Pozzo with modern fish length data for brown trout at Deep Creek, Montana (KingFisher Consulting Inc. n.d.).

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Figure 6.21: Generalised fish population frequency by age and fish length (from Cailliet *et al.* 1986: 145).

Site (context)	Radiocarbon determination	Calibrated date BP (curve: IntCal09)	Confidence	Reference
Pozzo (PS1)	12,320 ± 50	14,890 – 14,005	95.4%	(Mussi *et al.* 2003; Mussi *et al.* 2004)
Pozzo (PS5)	12,590 ± 40	15,190 – 14,275	95.4%	(Mussi *et al.* 2003; Mussi *et al.* 2004)
Pozzo (PS6)	12,820 ± 130	16,210 – 14,635	95.4%	Mussi pers. com
La Punta (26)	10,581 ± 100	12,680 – 12,140	95.4%	(Ferrara *et al.* 1961; Alhaique 2003)
La Punta (27-31)	11,770 ±70	13,790 – 13,430	95.4%	(Bietti 1990; Alhaique 2003)
La Punta (39)	14,488 ± 800	19,450 – 15,270	95.4%	(Ferrara *et al.* 1961; Alhaique 2003)
Ortucchio (11)	12,619 ± 410	16,570 – 13,800	95.4%	(Ferrara *et al.* 1959; Oliver 1978: 46; Alhaique 2003)
Maritza (30-39)	10,420 ± 50	12,530 – 12,090	95.4%	(Bietti 1990; Alhaique 2003)

Table 6.10: Calibrated and uncalibrated radiocarbon dates for Fucino Basin sites. All calibrated using IntCal09 curve (Reimer *et al.* 2009) and OxCal 4.1 and rounded to the nearest 5 years.

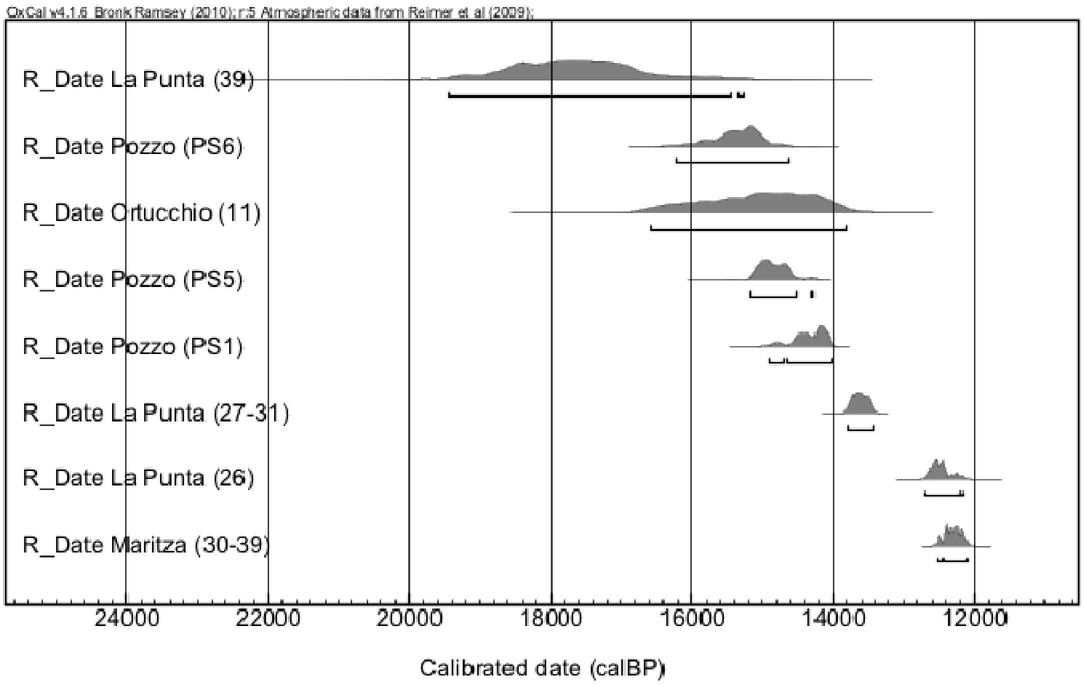

Figure 6.22: Calibrated dates for Fucino Basin cave deposits. Calibrated using IntCal09 curve (Reimer *et al.* 2009) using OxCal4.1. See Table 6.10 for data.

6.5 Fish bones from the Fucino Basin: conclusion

The fish remains from Late Upper Palaeolithic Fucino Basin cave deposits suggest that human groups were exploiting trout fairly regularly, most likely on a seasonal basis, perhaps when other dietary resources were scarce. It is likely that this occurred during the autumn or winter when the trout population is most likely to have been spawning, making exploitation easier. The element representation patterns suggest that the fish caught were processed by removing the head and that the majority of the flesh, with vertebrae intact, was transported from the site for consumption at another location and time. This implies that these hunter-gatherer populations were able to preserve their food, probably by drying or smoking, as fish would not stay fresh for very long after capture. Based on frequency of remains (NISP) fishing became more important in the diet through the Late Upper Palaeolithic period. This may have been a response to changes in other animal populations as environmental and climatic conditions varied, and generally warmed over time. The Fucino Basin would have represented a microclimate, within which conditions were less harsh than in the surrounding mountains. The sites may have served as an autumn/winter refuge, with more favourable conditions in comparison with the surrounding mountains.

Chapter 7: Fish remains from Cantabrian Sites

7.1 Introduction

Several sites in Cantabria, northern Spain, have fish bone assemblages, most of which date to the Solutrean, Magdalenian and the Azilian periods (c. 21,000 – 10,000 BP). Many are poorly studied and published, and their presence is often only indicated by a mention of 'fish' in site reports (for example, Madariaga 1963; 1966; Clark 1983; Straus 1983b; Gutiérrez & Bernaldo de Quirós 1989; Bernaldo de Quirós *et al.* 2000). This study considers in detail the remains from five of the thirteen Cantabrian sites known to have fish remains - Cueva de Altamira, Cueva de El Juyo, Cueva del Rascaño, Cueva de El Salitre and Cueva dell Castillo (Figure 7.1 and Table 7.1).The methods follow those used for the Fucino Basin, see Chapter 6. The results for Cantabrian and Fucino sites are compared along with existing published data in Chapter 8.

Figure 7.1: Location of Cantabrian sites with Upper Palaeolithic fish remains, , including those analysed in this study.

Site	**Period**	**Fishing Gear**	**Fish Bones**	**Reference**
Cueva Chufin	Solutrean		Salmonid	(Straus 1983a: 56, 97)
Hornos de la Peña	Solutrean	None	Salmonid	(Straus 1983a: 92, 97; Pokines & Krupa 1997: 249)
Cueva de Altamira	Solutrean Magdalenian (Lower)	>15 Self barbed points	*Salmo salar* *Salmo trutta* Flatfish Shark	(de Las Heras *pers. comm.* 05/2008; Breuil & Obermaier 1935; Altuna & Straus 1976; Straus 1983b: 101; Pokines & Krupa 1997: 249)
El Juyo	Magdalenian (Lower)	31 Self barbed points	*Salmo* sp. *Raja* sp. Flatfish	(de Las Heras *pers. comm.* 05/2008; Straus 1983b: 101; Barandiaran Maestu *et al.* 1985; Freeman *et al.* 1988: 13; Pokines & Krupa 1997: 243)
Rascaño	Magdalenian	Spears and harpoons	*Salmo salar* *Salmo trutta* Shark Flatfish	(de Las Heras *pers. comm.* 05/2008; González Echegaray & Barandiaran Maestu 1981: 348; Straus 1983b: 101; Pokines & Krupa 1997: 249)
Cueva de la Pila	Upper Magdalenian Azilian	Unknown	Fish	(Le Gall ; Gutiérrez & Bernaldo de Quirós 1989; Bernaldo de Quirós *et al.* 2000)
La Meaza (Loc. 1-2, 5-2)	Solutrean Azilian	Unknown	Fish	(Clark 1983: 114-115)
Salitre	Azilian	Unknown	*Salmo* sp.	
Cueva El Castillo	Mousterian and early Upper Palaeolithic	Several self-barbed points	Salmon *Salmo* sp. European eel	(Pokines & Krupa 1997, 249)
El Mirón	Magdalenian (Lower)	Yes	*Salmo salar* *Salmo trutta*	(Straus *et al.* 2001; Consuegra *et al.* 2002; Straus *et al.* 2002: 1410; González Morales & Straus 2009)
La Chora	Magdalenian (Upper)	2 bone harpoons	Fish	(Madariaga 1963; Straus 1983b: 101)
El Otero	Magdalenian	Unknown	Fish	(Madariaga 1966; Straus 1983b: 101)
El Pendo		>3 bone harpoons		(González Sáinz *et al.* 2003: 66)

Table 7.1: Summary of fish remains from Palaeolithic cave sites in Cantabria (northern Spain). Highlighted sites indicate fish bone assemblages studied in detail in this research.

7.2 Fishing gear in Cantabria

Unlike the Italian sites, where no artefacts recognised as fishing gear were recovered, fishing gear, including harpoons and self-barbed points, have been recovered from several of the Upper Palaeolithic deposits of Cantabrian caves. It is suggested that the bone and antler self-barbed points were hafted in a way that would create a harpoon type tool (see Figure 7.2), which could have been used to spear fish (Pokines & Krupa 1997). Not all sites with fish remains have yielded self-barbed points or harpoons. At these sites it can be assumed that fish were either caught with harpoons, but the harpoons and self-barbed points were taken away from the sites after use, or that other fishing methods were used. To my knowledge there is no site in Cantabria where harpoons and self-barbed points have been recovered but where fish remains were absent. However, in neighbouring regions this is not the case; in Asturias (to the east of Cantabria) El Cierro, Collubil, Cove Rosa and Tres Calabres and in the Basque Country (west of Cantabria) Aitzbitarte and Santimamiñe have all yielded self-barbed points but apparently no fish bone assemblage (see Pokines and Krupa (1997: 249)). If it is indeed the case that there are no fish (and it not quite clear since fish bones were easily missed during earlier excavations that did not use sieving for small-sized materials), it may suggest that the self-barbed points were also used for other tasks in addition to fishing.

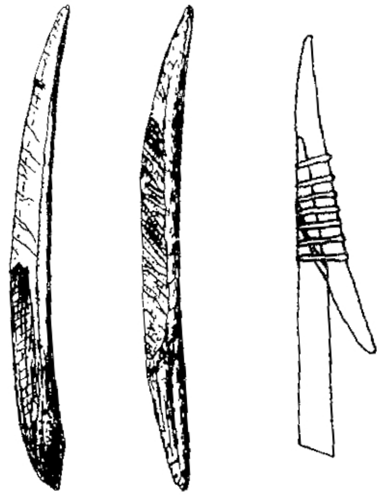

Figure 7.2: Self-barbed points and their probable method of hafting (from Pokines and Krupa (1997), after Obermaier (1924)).

7.3 Fish in Cantabrian art

Chapter 2 summarised fish in Palaeolithic art, however, a more detailed account of fish in art in Cantabria is useful in the understanding of the role of fish during the Upper Palaeolithic period in this region. Depictions of fish in cave and portable art are very rare in the Cantabrian region. Despite the frequent occurrence of engraved and painted portable and parietal art at Cueva de Altamira which portrays a variety of animal species, there are no representations of fish. A single bone artefact from El Pendo, from the Upper Magdalanian, has been carved to resemble the form of a fish see Figure 2.13 (Sieveking 1991). A carving of a fish can be found on the cave wall at El Pindal, see Figure 2.16, a cave site located just west of the Cantabrian region, to the very east of Asturias. This image has a large tail and has been interpreted as a tunny (Sieveking 1991, p244 M. Priem). However, Leroi-Gourhan (1968) pointed out that if the forked tail is removed the fish is indisputably a trout or salmon. A forked tail is a characteristic sometimes used to distinguish salmon from trout; Mithen (1988: 314) suggests that the image is an exaggeration of the difference between salmon, which has a slightly forked tail, and sea trout, which has a square or slightly convex tail, perhaps used to inform other fishers how to differentiate between the two species. It is also interesting to note that three patches of red paint are located in the groin of the fish, close to where the eggs in female salmon are located. In many cases bears will consume salmon eggs and leave the rest of the carcass (Frame 1974; Gende *et al.* 2001). The three marks might conceivably refer to the damage caused by bears in the removal of salmon eggs for consumption.

7.4 Results of fish bone analysis

Fish remains were less frequently recovered from the five Cantabrian sites than at the Fucino sites, Table 7.12. This may result from differences in excavation and sampling strategies.

Site	**NISP**	**Species**	**Common Name**
Altamira	150	*Salmo* sp. Pleuronectidae Elasmobranchii	*Salmon/trout* Flatfish Shark
El Juyo	2916	*Salmo* sp. Pleuronectidae *Raja* sp.	Salmon/trout Flatfish Ray
Rascaño	5 (26)	*Salmo* sp. Pleuronectidae Elasmobranchii	Salmon/trout Flatfish Shark
Castillo	25	*Salmo* sp. *Anguilla anguilla*	Salmon/trout European eel
Salitre	2	*Salmo* sp.	Salmon/trout

Table 7.2: NISP values for fish remains from five Upper Palaeolithic Cantabrian sites. Numbers in brackets for Rascaño indicate NISP listed in site monograph (González Echegaray & Barandiaran Maestu 1981: 274).

7.4.1 Cueva de Altamira

Cueva de Altamira is located close to the river Saja, and the coastline lies only 2 miles away from the site today. In total, 150 fish bone and fish bone fragments were recovered during excavations between 1902-1904 by Alcalde del Rio, 1924-1925 by Obermeier, and 1980-1981 and in 2006 by Joaquín González Echegaray. The fish remains come from levels 2-8 which are Solutrean and Magdalenian deposits, see Figures 7.3 and 7.11 and Table 7.3.

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Figure 7.3*:* Stratigraphic sequence at Cueva de Altamira, units J9 and K9, from (Lasheras Corruchaga *et al.* 2008: 35).

The assemblage from Cueva de Altamira is dominated by vertebrae and vertebrae fragments of two salmonid species, *Salmo salar* (Atlantic salmon) and *Salmo trutta* (sea trout and/or brown trout). In total (and allowing for fragmentation) 78 vertebrae are present, giving an MNI of two for *Salmo* sp. at Cueva de Altamira. MNI remains at two, even when vertebral types are considered, see Figure 7.4. Cranial remains are limited to two frontal bones, one palatine and one left dentary, all of *Salmo* sp. giving an MNI based on cranial remains of one. Ribs and spines numbered 49, due to fragmentation it is not possible to comment regarding the species or number of individuals these might represent. Two vertebrae represent remains of flatfish (Pleuronectidae), see Figure 7.5; these compare most closely with European flounder

(*Platichthys flesus*), but species identification for flatfish can be difficult due to reduced interspecies variation in vertebral form. One vertebra is from the thoracic region; the other was undetermined, the MNI for flatfish at Altamira is one. In addition to *Salmo* sp. and flatfish remains there is a single shark (Selachimorpha) lateral tooth of species unknown, see Figure 7.6.

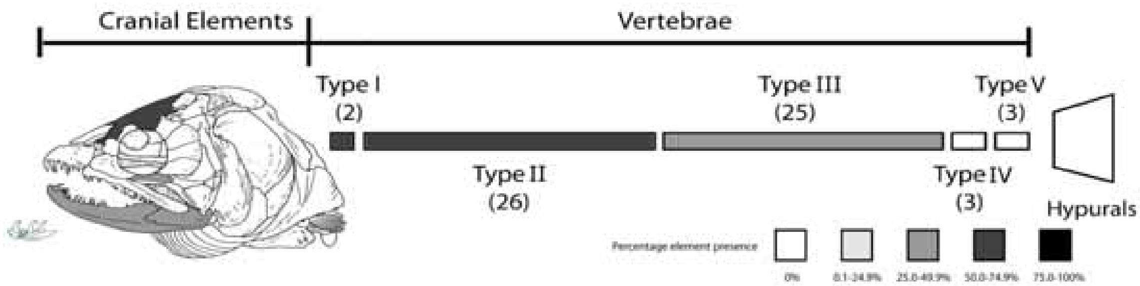

Figure 7.4: Element representation for *Salmo* sp. remains at Cueva de Altamira.

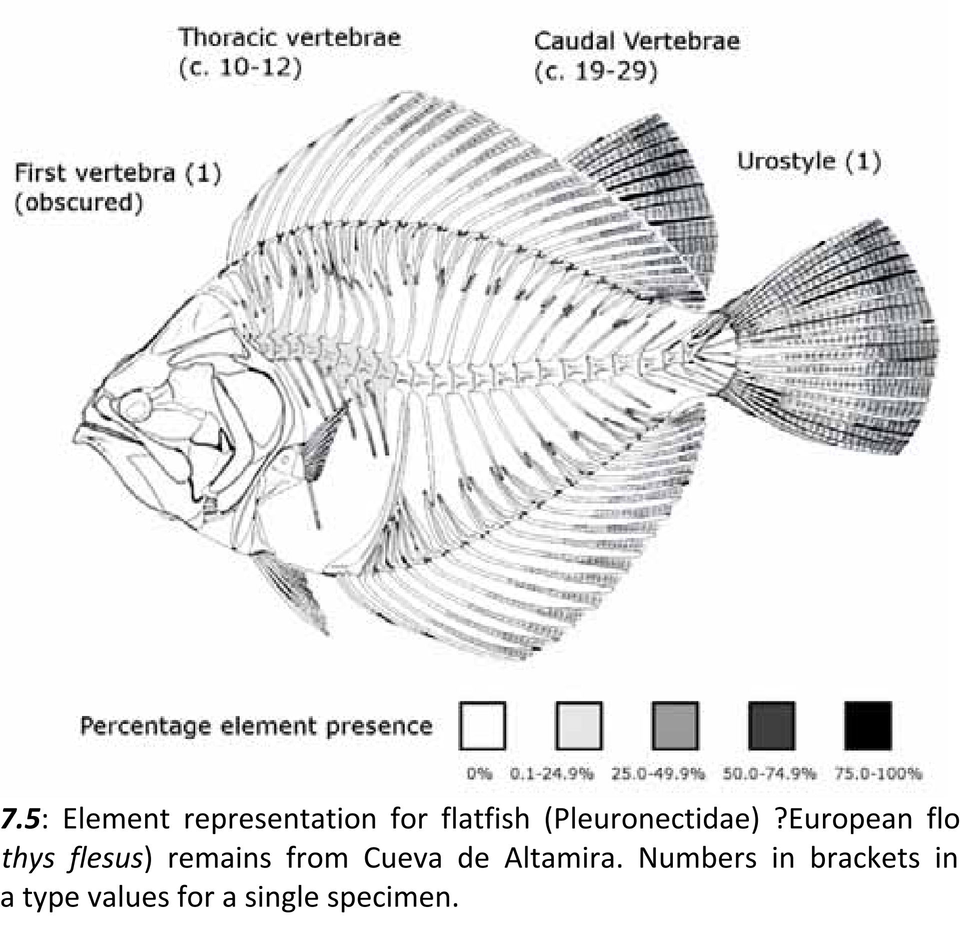

Figure 7.5: Element representation for flatfish (Pleuronectidae) ?European flounder (*Platichthys flesus*) remains from Cueva de Altamira. Numbers in brackets indicate vertebra type values for a single specimen.

Figure 7.6: Shark (Selachimorpha) tooth from Cueva de Altamira.

Unlike the Italian salmonid remains, those from Cueva de Altamira represent a large size range. The smallest salmonid vertebrae providing an A2 measurement gives a length estimation of 239.6mm, the largest *Salmo* sp. specimen from Cueva de Altamira can be estimated at approximately 1292mm, see Figure 7.7. The frequency and range in the length estimations at Cueva de Altamira may be used to further narrow species identification by considering the life cycle of the anadromous salmonids Atlantic salmon (*Salmo salar*) and sea trout (*Salmo trutta trutta*); see Figure 1.1 and Section 7.5.

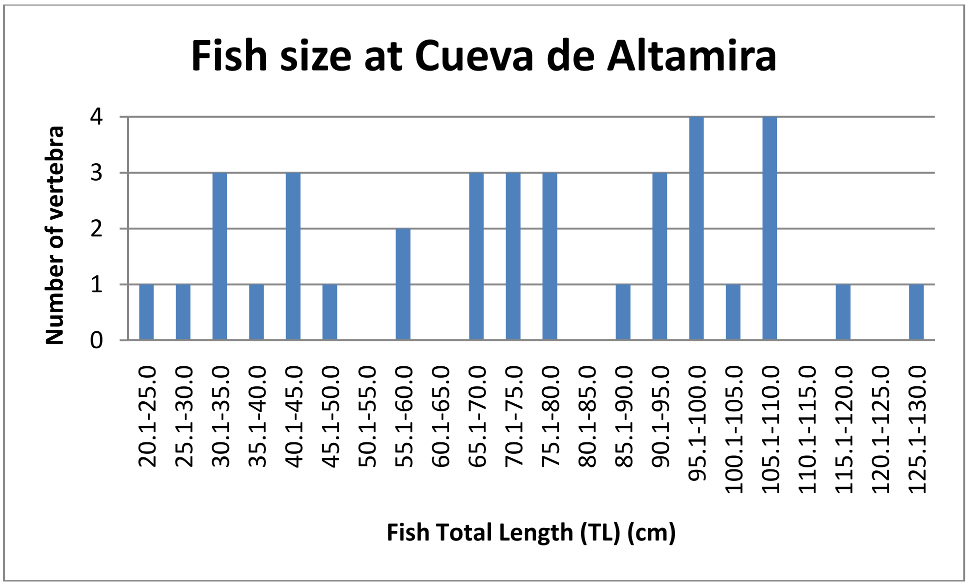

Figure 7.7: Fish length distribution at Cueva de Altamira.

The fish remains from Cueva de Altamira were very fragmentary for the most part. Only 23.2% of vertebrae and vertebrae fragments could be measured in three dimensions (A1, A2 and B2 as described by Morales & Rosenlund (1979)). Some of the fish remains from Cueva de Altamira were heavily concreted, in some cases this has preserved articulated vertebrae, see Figure 7.8, while in other cases disarticulated remains have become concreted with other remains including limpets, see Figure 7.9. No bones bearing evidence for burning or gnawing were recorded. One vertebra of *Salmo* cf. *salar* had two small holes in the vertebral centrum, Figure 7.10.

Figure 7.8: Three articulated vertebrae of *Salmo* sp. from Cueva de Altamira.

Figure 7.9: Fish remains concreted with a limpet at Cueva de Altamira.

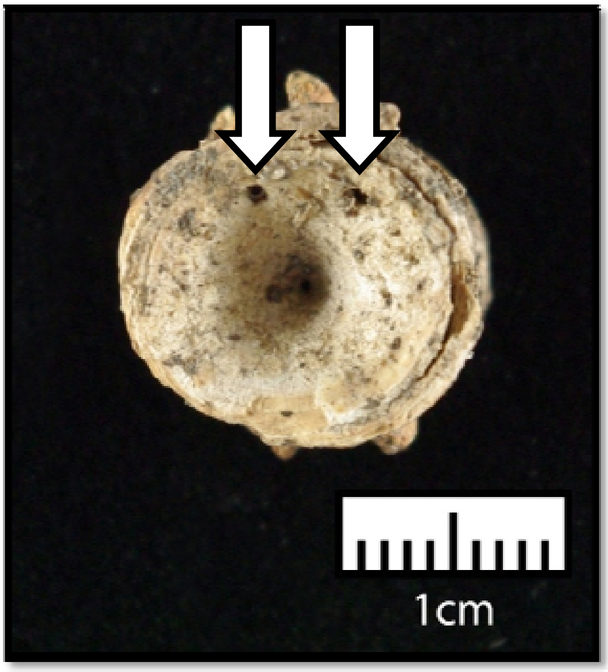

Figure 7.10: Caudal vertebra of the species *Salmo salar* (Atlantic salmon) with two small holes in the vertebral centrum. The holes extend through the bone.

Level	**Radiocarbon Determination**	**Calibrated Date (95.4%)**	**Cultural Period**	**Reference**
2 (1)	15,910 ± 230 BP	19,455 – 18,655 cal BP	Magdalenian Inferior	(Freeman 1988; González Echegaray 1988)
2 (2)	15,500 ± 700 BP	20,305 – 17,170 cal BP	Magdalenian Inferior	(Freeman 1988; González Echegaray 1988)
3	Unknown	Unknown	Solutrean	(Freeman 1988)
?	Unknown	22,900 – 20,200 cal BP	Upper Solutrean	(Altuna & Straus 1976)

Table 7.3: Radiocarbon dates and cultural periods at Cueva de Altamira. Calibrated using IntCal09 curve (Reimer *et al.* 2009) using OxCal4.1.

7.4.2 Cueva del Rascaño

Cueva del Rascaño is located inland, close to the river Miera, in the Miera valley of the Cantabrian Mountains, around ten miles from the current coastline. At the Museo de Altamira only five fish remains were available for study from Cueva del Rascaño, see Table 7.4. This does not correspond with the site monograph, which states that there should be 26 pieces in total, all of which were vertebrae, 9 from level 3 and 17 from level 2b which date to the Magdalenian, see Table 7.5. The note on page 274 states that the fish remains were studied by Dr. Ortea Rato who identified the remains as vertebrae of *Salmo* sp. (González Echegaray & Barandiaran Maestu 1981: 274). We do not know as to whether the five fragments studied and reported here were included in Dr. Ortea Rato's analysis or if they represent previously unstudied remains. The identifications might suggest that at least one was not since no teeth were mentioned in the earlier study. The five fragments include one shark's tooth (Selachimorpha, unknown species, see Figure 7.11), two caudal vertebrae of *Salmo* sp. (type III as described by Morales Muniz (1984)) and two thoracic vertebrae of flatfish (Pleuronectidae), again comparable with European flounder (*Platichthys flesus*) see Figure 7.12. In terms of element representation, based on an MNI of 1, for *Salmo* sp. type III vertebrae have 8% percentage presence as there are 25 type III vertebrae in a single specimen, see Figure 7.13. The calculation is more difficult for the flatfish remains as different flatfish species have a different number of thoracic vertebrae. However the number is usually between 10 and 12, giving percentage presence values between 17 and 20%, see Figure 7.14. The salmonid remains are from medium sized specimens of *Salmo* sp.; vertebrae dimension provide length estimations of 512mm and 626mm. Based on size, these are more likely to represent the anadromous Atlantic salmon (*Salmo salar*) or sea trout (*Salmo trutta trutta*) than brown trout (*Salmo trutta fario*), the non-anadromous/potamodromous, residential form. It is unlikely that they are the remains of the large cannibalistic trout that often inhabit lakes as there were no large lakes in the region.

Species	Common Name	Element	Frequency
Salmo sp.	Salmon or trout	Thoracic vertebra	2
Pleuronectidae ?*Platichthys flesus*	Flatfish ?European flounder	Thoracic vertebra	2
Selachimorpha	Shark	Tooth	1
		Total NISP	5

Table 7.4: Fish remains from Cueva del Rascaño.

Figure 7.11: Shark tooth from Upper Palaeolithic context at Cueva del Rascaño.

Figure 7.12: Fish remains from Cueva del Rascaño. Two left are caudal vertebrae of salmon or trout (*Salmo* sp.) and two on right are thoracic vertebrae of flatfish (Pleuronectidae).

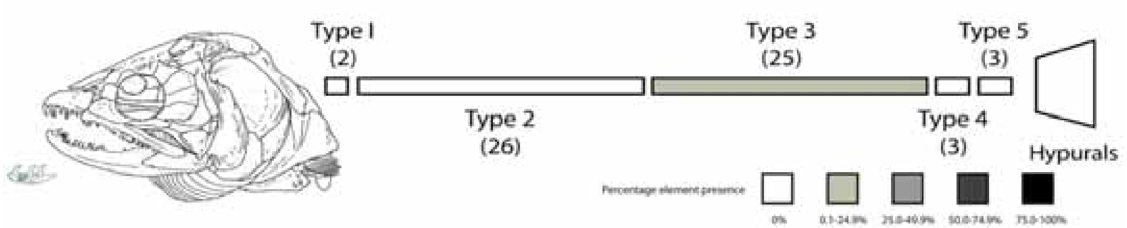

Figure 7.13: Element representation patterns for *Salmo* sp. remains at Cueva del Rascaño.

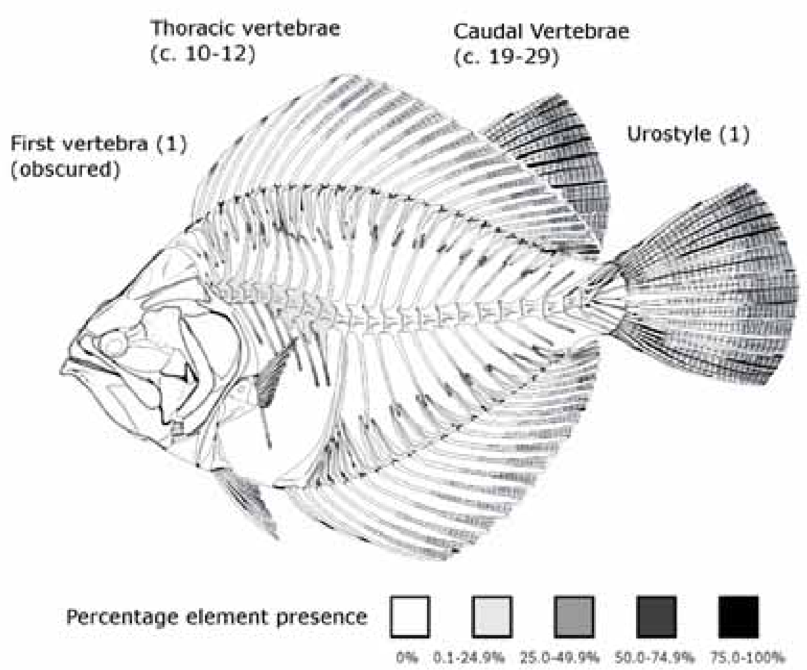

Figure 7.14: Element representation patterns for flatfish (Pleuronectidae) remains at Cueva del Rascaño.

Level	Radiocarbon Determination	Calibrated Date (95.4%)	Geological/Cultural Period	Reference
1	10,480 ± 90	12,595 – 12,094 cal BP	Dryas III Magdalenian	(Utrilla 1996)
2.1	12,280 ± 160	14,995 – 13,825 cal BP	Dryas II Magdalenian	(Utrilla 1996)
2.3	12,895 ± 140	16,400 – 14,936 cal BP	Bölling Magdalenian	(Utrilla 1996)
3	15,173 ± 160	18,705 – 17,986 cal BP	Angles	(Utrilla 1996)
4.2	15,988 ± 193	19,463 – 18,750 cal BP	Dryas I	(Utrilla 1996)
5	16,433 ± 131	20,056 – 19,381 cal BP		(Utrilla 1996)

***Table 7.5**:* Calibrated radiocarbon dates for Cueva del Rascaño. Calibrated using IntCal09 curve (Reimer *et al.* 2009) using OxCal4.1.

7.4.3 Cueva El Juyo

Excavations were carried out at the Cueva El Juyo in 1978-1979, 1983 and 1988-1996 using modern excavation methods. A substantial amount of fish remains were recovered, giving an NISP of 2916. Fish remains were recovered from levels 4 to 9 dating to the Solutrean and Magdalenian periods, see Figure 7.15 and Table 7.6. The species represented are members of the genus *Salmo* (*Salmo salar* (Atlantic salmon) and/or *Salmo trutta* (brown/sea trout)), flatfish (Pleuronectidae) and ray (*Raja* sp.), which is represented by two cross or claw prickle morphotype (see Gravendeel *et al.* (2002: 422)) dermal denticles, Table 7.7. By far the most abundant remains were those of *Salmo* sp. which consisted mostly of vertebrae fragments. *Salmo* sp. cranial elements were restricted to seven loose teeth, one palatine and one fragment of an undetermined bone of the oromandibular region. The fish remains are extremely fragmented, as such the MNI is difficult to calculate for the *Salmo* sp. remains, only 13 vertebrae representing over 50% of the centrum survived, of these 5 were type II and 3 were type III. 1267 fragments representing less than 50% of the vertebral centrum were recovered from the site; this can be used to suggest a minimum of 634 vertebrae in total, plus 13 complete giving a total of 647 vertebrae. Based on 59 vertebrae per fish this gives an estimated MNI of 11. It should be noted that this may be an over estimation, a ‘maximum MNI’, as some fragments represented much less than 50% of the total vertebral centrum. Fragmentation also reduced the number of vertebrae that could be measured to estimate fish length. From the 1290 vertebrae and vertebrae fragments, only seven A2 measurements could be taken, see Table 7.8. There is a range of *Salmo* sp. lengths represented in the El Juyo assemblage, the shortest fish estimation is 233mm, the largest 1051mm.

Level	Radiocarbon Determination	Calibrated Date (BP) (95.4%)	Cultural Period	References
4	13,920 ± 240	17690 – 16545 cal BP		(Utrilla 1996)
6	13,350 ± 700	17975 – 13985 cal BP	Magdalenian	(Barandiaran Maestu *et al.* 1985; Cuenca-Bescós *et al.* 2010)
7	14,440 ± 180	18,020 – 17,030 cal BP		(Utrilla 1996)
11	15,300 ± 700	20,070 – 17,015 cal BP		(Utrilla 1996)

Table 7.6: Radiocarbon determinations for the fish-bearing levels in Cueva del Juyo. Radiocarbon ages were calibrated using IntCal09 curve (Reimer *et al.* 2009) using OxCal4.1.

Species	**Common Name**	**NISP**
Salmo sp.	Atlantic salmon, sea trout or brown trout	542
cf. *Salmo* sp.	Most likely Atlantic salmon, sea trout or brown trout	748
Pleuronectidae	Flatfish	5
Raja sp.	Ray	2
Rib/Spine Fragments	Unknown species	1618
Unidentified	Unknown species	1
	Total	**2916**

Table 7.7: Fish remains from Cueva El Juyo.

A2 (mm)	Length Estimate (mm)
5.2	410.7
8.5	619.9
2.4	233.3
15.7	1076.2
15.3	1050.9
3.0	271.3
14.0	968.5

Table 7.8: Length estimation for *Salmo* sp. remains at Cueva El Juyo.

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Figure 7.15: Stratigraphic sequence at Cueva del Juyo (Barandiaran Maestu *et al.* 1985: 50).

7.4.4 Cueva de El Salitre

Cueva de El Salitre is located inland, close to the river Miera at Ajenado, in the Miera valley of the Cantabrian Mountains, around 13 miles from the current coastline, three miles south of Cueva de Rascaño. Only two fragments of fish bone were recovered during excavations in 1979 at Cueva de El Salitre. These consist of one caudal vertebra fragment of a small *Salmo* sp., which could not be measured for length estimation due to damage, and one spine fragment. Both of these fragments come from the Azillian levels at the site, making them later in age than those from the other Cantabrian sites studied here.

7.4.5 Cueva dell Castillo

Cueva dell Castillo is located close to the river Pas at the foot of the Cantabrian Mountains, approximately 15 km from the current coastline. In total, 25 fragments of fish bone were studied from this site the site. It is not known if these represent the whole fish bone assemblage from the site or just a sample. The remains come from deposits dating to the Mousterian (levels 21 and 21a) and Early Upper Palaeolithic (level 18b) periods, see Table 7.9. Only one fish bone from Early Upper Palaeolithic deposits was studied here, this was a type III vertebra of *Salmo* sp. (Atlantic salmon or sea/brown trout). The assemblage from Mousterian levels contained two species; *Salmo* sp. and European eel (*Anguilla anguilla*). All species are represented by vertebrae only, no cranial elements were present in the sample studied at this time. The eel remains were of large specimens while the *Salmo* sp. remains varied greatly in size from c. 15 cm - 86.7 cm in total length. For eel MNI was one, and for *Salmo* sp. MNI was four based on the size variation in the sample.

Level	Radiocarbon Determination (bp)	Calibrated Date (BP) (95.4%)	Cultural Period	Reference
6	12,390 ± 130	15,055 – 14,010 cal BP		(Utrilla 1996)
6-7	Unknown	17,600 – 15,600 cal BP	Middle Magdalenian	(Obermaier 1924; Cabrera 1984; Álvarez-Lao & García 2010: 123)
8	16,850 ± 220	20,500 – 19,450 cal BP		(Utrilla 1996)
8	Unknown	20,200 – 17,600 cal BP	Lower Magdalenian	(Obermaier 1924; Cabrera 1984; Álvarez-Lao & García 2010: 123)
10	Unknown	24,800 – 20,200 cal BP	Solutrean	(Obermaier 1924; Cabrera 1984; Álvarez-Lao & García 2010: 123)
14	Unknown	42,500 – 32,000 cal BP	Aurignacian	(Obermaier 1924; Cabrera 1984; Álvarez-Lao & García 2010: 123)
18b	37,000 ± 2200	47,475 – 37,800 cal BP	Aurignacian	(Cabrera *et al.* 2001)
18b	37,100 ± 1800	45,730 – 38,745 cal BP	Aurignacian	(Cabrera *et al.* 2001)
?	37,700 ± 1800	46,240 – 39,170 cal BP	Aurignacian	(Valdes & Bischoff 1989)
18b	38,500 ± 1300	45,260 – 41,300 cal BP		(Cabrera *et al.* 2001)
18b	38,500 ± 1800	47,285 – 40,370 cal BP	Aurignacian	(Valdes & Bischoff 1989; Cabrera *et al.* 2001)
18b	40,700 ± 1600	48,485 – 42,420 cal BP	Aurignacian	(Cabrera *et al.* 2001)
18c	39,800 ± 1400	46,570 – 41,938 cal BP	Aurignacian	(Cabrera *et al.* 2001)
18c	40,000 ± 2100	49,110 – 41,715 cal BP	Aurignacian	(Valdes & Bischoff 1989; Cabrera *et al.* 2001)
18c	40,000 ± 5000 (ESR Date)	-		(Cabrera *et al.* 2001)
18c	40,700 ± 1500	48,185 – 42,475 cal BP	Aurignacian	(Cabrera *et al.* 2001)
18c	41,100 ± 1700	49,005 – 42,690 cal BP	Aurignacian	(Zilhão & d'Errico 2000; Cabrera *et al.* 2001)
18c	42,200 ± 2100	49,895 – 43,550 cal BP	Aurignacian	(Cabrera *et al.* 2001)
20	39,300 ± 1900	49,895 – 43,550 cal BP	Mousterian Alfa	(Zilhão & d'Errico 2000)
20	43,000 ± 2900	- 43672 cal BP	Mousterian Alfa	(Zilhão & d'Errico 2000)
26	Unknown	>120,000 cal BP (?)	Acheulean	(Obermaier 1924; Cabrera 1984; Álvarez-Lao & García 2010: 123)

Table 7.9: Radiocarbon dates for Palaeolithic deposits at Cueva dell Castillo. Calibrated using IntCal09 curve (Reimer *et al.* 2009) using OxCal4.1.

7.5 Discussion: fishing in Cantabria during the late glacial

The fish remains from caves in Cantabria represent a more diverse range of species than in the Fucino Basin in Italy. However, the taxonomic diversity remains low in comparison with what would be expected for a “natural” population. The most frequent remains are those of *Salmo* sp., see Figure 7.16, representing the species *Salmo trutta fario*, *Salmo trutta trutta* and/or *Salmo salar*. Identification to species and sub-species can even be difficult in live specimens (Koksvik & Steinnes 2005), and are difficult to distinguish from skeletal remains (Feltham & Marquuis 1989; Kazakov *et al*. 1982). The locations of the Cantabrian sites cannot help rule out any of the *Salmo* species as some of the sites are located close to the coast, such as Altamira and El Juyo, while the other sites lie further inland. However, all the sites reported here are located close to a river (now and in the past) which would have been a potential source of fish. Most sites have yielded other faunal remains that could only derive from visits to the sea shore, or trade with those visiting the coast. For example, at Cueva de Altamira limpets (*Patella vulgata sautuolae*), common periwinkle (*Littorina littorea*), whelk (*Buccinum* sp.), seal and crab remains and three large pierced scallop shells (Pectinidae) were also recovered (Breuil & Obermaier 1935). The remains are similar at El Juyo where fish remains were recovered from contexts also containing common periwinkles, whelks and limpets (Barandiaran Maestu *et al.* 1985). As such, the fish remains at Cueva de Altamira and Cueva El Juyo could derive from either freshwater or marine exploitation. Altamira, El Juyo and Rascaño also yielded flatfish remains; these bones were comparable with the European flounder (*Platichthys flesus*), however, species differentiation using flatfish vertebrae is difficult. Several species of flatfish inhabit marine, esturine and freshwater environments, this is true of the European flounder, which is the only flatfish species found in Spanish freshwater systems today (Cooper & Chapleau 1998). Although the percentage of unidentified remains appear to be high at Juyo, Altamira and Salitre, this is because there were many rib and spine fragments that cannot be identified to species.

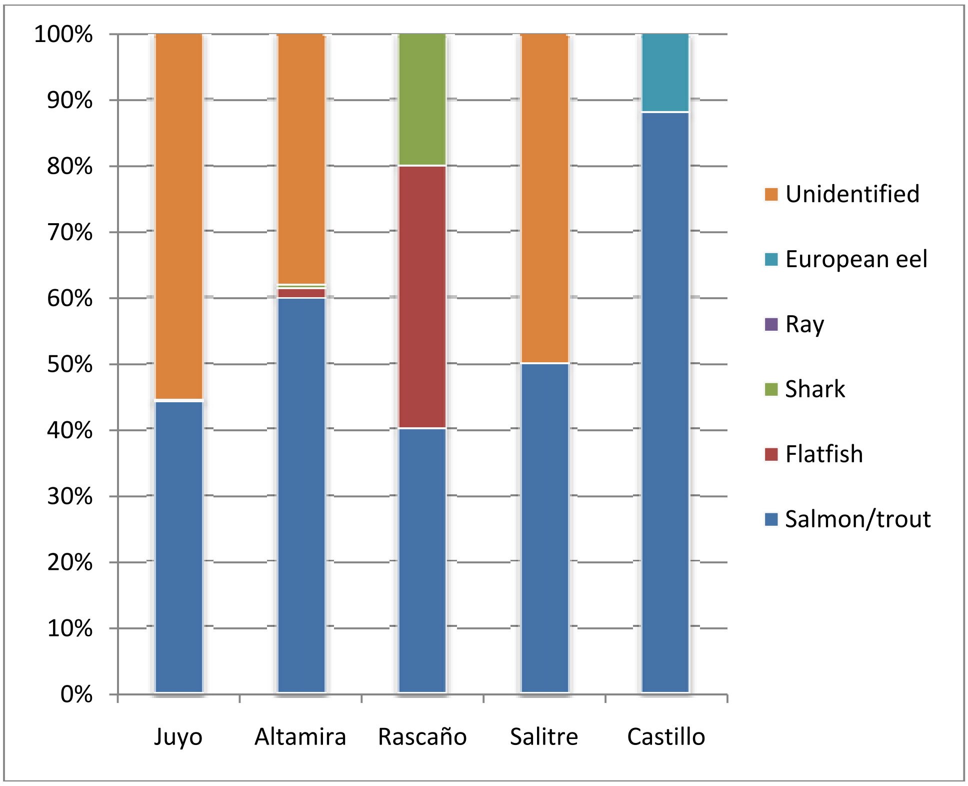

Figure 7.16: Percentage presence for fish species at five Palaeolithic Cantabrian cave sites.

The species recorded at these sites do not fit the characteristics expected for deposition by bears or raptors. Raptors can be excluded based on absence of cranial remains, low taxonomic diversity and the presence of flatfish; flatfish do not form part of the raptor diet. The presence of very large fish specimens (up to 129cm in total length) also rules out raptors, that although capable of taking large prey would struggle with fish of this size and weight (around 22kg). Bears also would not consume flatfish species, this and the presence of articulated vertebrae and close association of fish remains with limpets, another species not generally consumed by bears, indicate that they too are not the accumulation agent for the fish remains at Altamira, El Juyo or Rascaño.

Remains of shark (Elasmobranchii) are present at three of the Cantabrian sites studied in detail. Single shark's teeth were recovered at both Rascaño and Altamira, while at El Juyo two dermal denticles of a ray were present. It is unlikely that the teeth represent the exploitation or consumption of sharks; if this were the case many more sharks' teeth might be expected. It is more likely that these pieces were collected from the shore or from fossil bearing geological deposits and kept, either to use as a tool, or as some sort of amulet. The use of sharks' teeth and is well known in prehistoric and recent hunter-gatherer populations all over the world (e.g. Best 1924: 270; De Laguna 1972: 600; Kan 1989: 89; Emmons 1991: 173; Cione & Bonomo 2003). The dermal denticles of ray at El Juyo may indicate the exploitation of this species as a dietary resource. Rays are cartilaginous fish, meaning that the only evidence usually preserved in archaeological sites are the dermal denticles, which are similar in structure to mammal teeth, and they survive very well. The recovery of only two denticles suggests that ray was not an important dietary resource.

Rays are a demersal (bottom dwelling) marine species generally found at depths between 20 and 577m, but also coming close to shore and into estuarine environments (Stehmann 1990; Mytilineou *et al.* 2005). The Cantabrian Sea reaches 100 m depths very close to the Cantabrian shore (between 0 and 5 km depending on location) (Smith & Sandwell 1997), meaning that these species could have been caught close to the shore, or along estuaries. As such their presence does not necessarily suggest deep sea fishing. Given that both are demersal species, it is likely that ray and flatfish could have been exploited at the same time, using the same fishing gear.

European eel (*Anguilla anguilla*) bones were only recorded at Cueva del Castillo, none were recovered from Altamira, El Juyo, Rascaño or Salitre. Throughout Spain eel remains are rare Palaeolithic deposits, the only other Spanish sites to yield eel remains are Abreda Cave (Upper Palaeolithic deposits) and Cueva Millán (Mousterian deposits). Eels are an anadromous species, but unlike anadromous salmon and trout, eels spawn at sea. Opportunity to exploit this species with ease is during their migration out to the Sargasso Sea for spawning.

Given the presence of bone and antler harpoons and self-barbed points it might be assumed that at least some fish were caught by spearing at many of the Cantabrian sites. The size of salmonids from the Upper Palaeolithic deposits at El Juyo, Rascaño and Altamira are consistent with this interpretation, with an absence of any fish smaller than 23.3 cm in total length and the presence of some very large specimens. Large specimens would have made easier targets for fishing using a spear and at 23cm fish are large enough to be caught by this method. However, it should be considered that absence of smaller fish remains may result from recovery strategies, rather than an actual absence. The presence of flatfish at the sites might also support the case for harpoon fishing as this method is still used today in catching flatfish species.

From the earlier deposits at Cueva dell Castillo it does not appear that fishing did not involve the use of a spear or harpoon. Here, remains of very small fish that could not be caught by spearing were recovered. As discussed in Chapter 2 attribution of fish remains recovered from deposits also yielding Mousterian tool technology has been difficult. While the very small fish remains from Cueva del Castillo are possibly the result of non-human activity, the large eel and *Salmo* sp. remains are unlikely to have been brought to the cave by animals. The presence of large specimens, especially those of eel, suggests that human agency has played a role in fish bone accumulation at this site, even if some remains may result from non-human activity. In light of this, a reassessment of fish bone assemblages from Mousterian deposits might, for the first time, provide an insight into the role fishing played in the diet of Neanderthals.

The small holes in the caudal (type III) *Salmo* sp. vertebrae at Cueva de Altamira, Figure 7.9, may represent animal puncture marks, possibly a boring insect acting upon the bone prior to or during deposition (Locker *et al. pers. comm.* August 2010). They are too fine to have resulted from human or mammal modification.

Many radiocarbon determinations for Altamira, Rascaño, El Juyo and Cueva del Castillo are availabe, Figure 7.17. For the Upper Palaeolithic sites (Altamira, Rascaño and El Juyo) the dates for deposits yielding fish remains are grouped between 16,000 and 20,000 cal BP, with later dates plotted in Figure 7.17 being for deposits that did not include fish remains. As seen in Chapter 2 the Last Glacial Maximum sees the number of cave deposits with fish bones increase, this pattern is also seen here in Cantabria. For these three sites it appears that fishing ceases after c. 16,000 cal BP, even though cave occupation continues. The time span that includes fishing is early in comparison with the general pattern seen across Europe. It may relate to the relatively earlier release of this region from the grip of the glacial, related to more southerly latitude of the Spanish sites combined with greater moderating influence of the Atlantic, which lessened the impact of environmental and climatic changes that affected Western Europe at this time. As discussed in Chapter 3 latitude appears to be broadly correlated with fish consumption (Cordain *et al.* 2000).

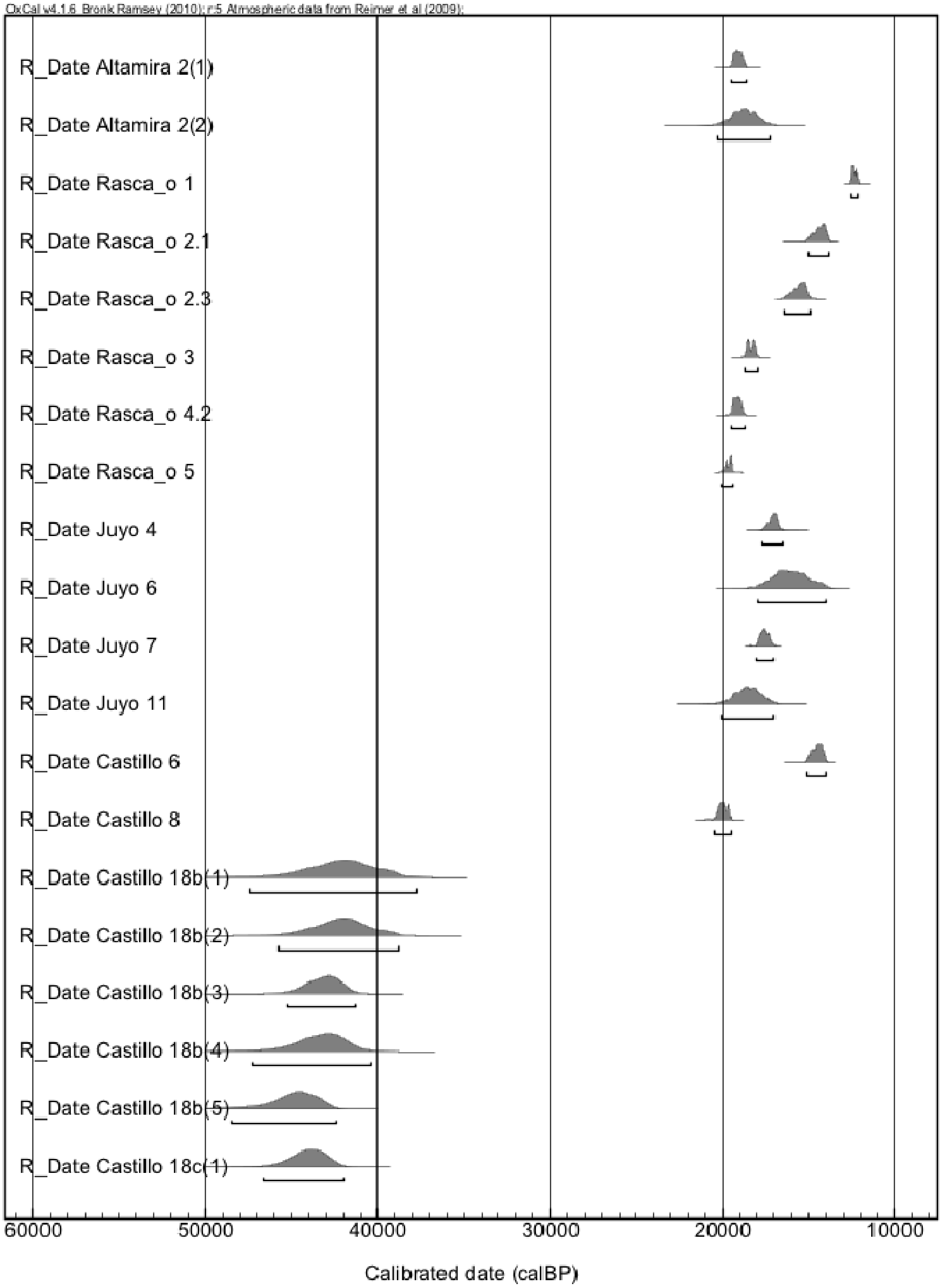

Figure 7.17: Calibrated radiocarbon dates for the Cantabrian sites studied. Calibrated using IntCal09 curve (Reimer *et al.* 2009) using OxCal4.1.

7.6 Conclusion: fishing in Cantabria

Although fish remains have been recovered from Upper Palaeolithic deposits of many of the Cantabrian cave sites, it does not appear that fish represented an important part of the diet at this time at any particular site. However, the consistent recovery and dominance of *Salmo* sp. remains indicates that these were the most frequently exploited resource in this region. While it should never be assumed that harpoons and self-barbed points are used for fishing, in the Upper Palaeolithic the absence of fish smaller than 23cm, with larger fish dominating, but also a large multimodal spread in fish length suggests that spearing may have been used to fish exploitation in this region. The low frequency of cranial remains may suggest that the fish brought to these sites were pre-processed at another location – probably close to the fishing ground. Potential fish processing sites would have been located close to the shore during the Upper Palaeolithic, but these are now submerged due to increased sea levels. Alternatively, cranial element loss may result from various taphonomic processes (see Chapter 4), which more frequently cause cranial element loss over vertebrae. Although *Salmo* sp. and flatfish species can be found in marine, brackish and freshwater environments, ray species are only found in the sea. The presence of this species at El Juyo, and the presence of marine shells at many of the Cantabrian sites suggest that at least some fishing might have taken place at the seashore.

Evidence for large eels and *Salmo* sp. at Cueva del Castillo might suggest that the remains represent human agency, their recovery from deposits with Mousterian stone tools, which are associated with Neanderthal occupation provides one of only a few examples where human agency is likely.

Chapter 8. Discussion, conclusion and future work

8.1 Discussion

8.1.1 Regional variation in fishing during the Upper Palaeolithic

Results and discussion of analysis on fish remains from central Italy can be found in Chapter 6. All Italian and Spanish sites studied here in detail date to the Upper Palaeolithic, from the Last Glacial Maximum (LGM) to the Late Upper Palaeolithic, except in the case of Cueva dell Castillo, which dates to a much earlier period and is associated with Neanderthal rather than anatomically modern human activity. The evidence for fish remains in deposits containing Mousterian type tools has, to date, not been paralleled in Italy, so here only a comparison between the Upper Palaeolithic sites will be made.

Firstly, fish remains from all the Upper Palaeolithic sites appear to have resulted from human activity. For all the sites *Salmo* sp. are the most dominant fish type. However, it is likely that at the Spanish sites these represent a combination of residential trout and anadromous salmon and trout. This is not the case in the Fucino Basin where the *Salmo* sp. remains certainly represent a residential trout form (brown trout – *Salmo trutta fario*). This difference stems entirely from the fact that the rivers located close to the Spanish sites discharge into the sea, allowing access to the anadromous salmonid forms while in Italy the rivers discharge only into the Fucine Lake, allowing only residential forms to access them. Despite the species of fish being different, the spawning behaviour that leads to the congregation of many salmonids for migration is similar – creating conditions for procurement of many fish with minimal effort during certain seasons. Both the Cantabrian region and the Fucino Basin would have had some glacial cover at high altitudes around 20,000 cal BP (Giraudi & Frezzotti 1997; Mithen 2004). With climate warming after the LGM these glaciers would have begun melting, and engorged rivers with ice cold waters, creating good conditions for salmonid spawning.

Probably for similar reasons (location and catchment), in Italy only a single species was exploited. Given the restricted size range (indicating mature fish), fishing was most likely targeted during the spawning season. Fishing during other times would lead to multiple species being caught, by most methods. The exploitation of flatfish in Spain is not seen at the Italian sites. The Italian sites are located too far inland for flatfish, certain species of which do enter brackish and freshwater. In Spain not only were more species present, including some marine, the size ranges are broad (Figure 8.1). Therefore it is possible that fishing occurred on a less seasonal basis. Comparison of the size data for Cantabrian sites versus Fucino sites highlights the restricted size range observed in the latter (Figure 8.1). It should be noted, however, that to account for the low NISP values for the Spanish and allow direct comparison between the size groups at the Italian sites and the Spanish sites Figure 8.1 uses percentage frequency values. The Fucino Basin fish all tend to be medium sized, with none smaller than 255mm. The occasional larger specimen suggests that the maximum trout length for the Fucine Lake was above that seen for many of the length estimations, i.e. larger fish were present. Their presence, even if occasional, suggest that possible explanations relate to fishing practices rather than to environmental controls.

Although the salmonid spawning season would have seen many fish ascend the rivers in the Cantabrian region, low NISP and MNI values suggest that fish were a less significant dietary resource. The very low representation of cranial bones might suggest that fish were caught elsewhere and only pre-processed fish were transported to be consumed at these sites. Use of pre-processed fish would explain the dominance of vertebrae at the Cantabrian sites. Since post cranial bones are less readily identifiable, the pattern contributes to low MNI/NISP values at each site. This idea could be explored further by establishing season of capture for the fish remains, and/or by considering seasonal exploitation and availability of other dietary resources at this time. A better understanding of the taphonomic impacts on waste produced during fish processing would also aid interpretation of these fish bone assemblages.

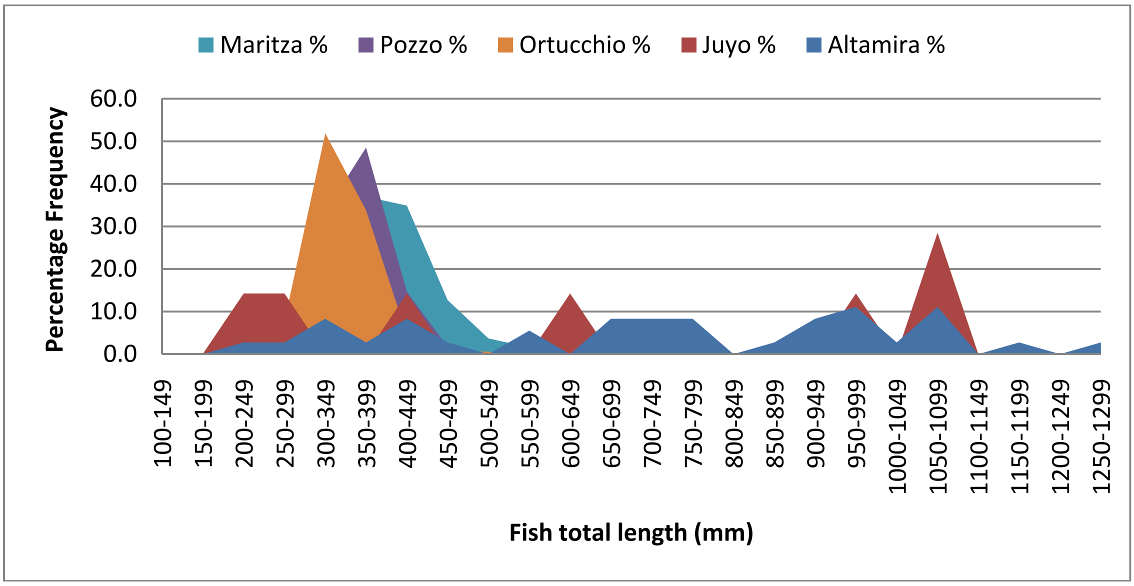

Figure 8.1: Percentage frequency for fish total length at Fucino Basin and Cantabrian cave sites.

8.2 Hypothesis testing

As discussed in Chapter 1 the research presented in this thesis was carried out in order to test several hypotheses regarding the role of fish in European Palaeolithic hunter-gatherer subsistence strategies. Each hypothesis will be discussed in turn referring to evidence presented in the chapters of this thesis.

8.2.1 Hypothesis 1

'Some fish bone assemblages currently interpreted as human accumulations were deposited by non-human faunas'.

Because many fish bone assemblages had been assumed to result from human activity without rigorous consideration for alternate modes of accumulation it was hypothesised that some fish bones recovered from cave sites that also yielded cultural remains were actually deposited by non-human agents. To test this hypothesis two non-human faunal species that were present during the Palaeolithic period that included fish in their diet and used caves were selected for controlled feeding experiments; bears (*Ursus* spp.) and the Eurasian eagle owl (*Bubo bubo*). Although the feeding experiments were unsuccessful, a detailed review of studies of their diets, habitats and behaviour provided sufficient detail to allow construction of taphonomic signatures for recognising fish bone assemblages they might accumulate. One outcome of the review was information about preferred fish prey species, and their typical size ranges. Data on bear fish-eating to date shows a preference for salmonids, and hunting of large specimens while owls have a more diverse fish exploitation pattern.

The results of detailed analysis of fish remains from eight cave sites in the study area (Chapters 6 and 7) indicated that none of these assemblages had been accumulated by either bear or eagle owl. They were also not characteristic of previously studied potential fish bone accumulators, such as otter (Nicholson 2000). By ruling out the more likely natural agents of accumulation it can be concluded that the fish remains from the eight sites considered did result from human activity. For these assemblages the hypothesis does not stand up, however, it should continue to be tested in the future, as other authors are now beginning to question human agency for fish remains at several cave sites (e.g. Le Gall 2008; Rambaud & Laroulandie 2009). If non-human deposition was playing a role in the formation of fish bone accumulations in caves it might be expected that there be a background number of sites with naturally deposited fish remains that remained constant throughout the Palaeolithic period. However, this is not the case, as these are some time periods, even within the Upper Palaeolithic, where no deposits containing fish bones occurred. While this might be seen as evidence supporting human agency for fish remains at cave sites, there are several reasons why the 'background number' might be absent. Fish remains from deposits without any evidence for human activity might not have ever made it to post-excavation, analysis and site report as for the most part archaeologists deal only with materials resulting from human activity. There is also an issue of dating which may prevent some sites of specific periods being accurately dated or dated by absolute methods at all. This issue requires further investigation if overall presence of fish in cave deposits is to be used in ruling out non-human agency.

8.2.2 Hypothesis 2

'Element representation patterns that could be used to identify fish processing sites can be explained by natural taphonomic processes'

The skeletal element representation patterns observed in fish bone assemblages from archaeological sites have been used to imply the presence of processed fish (cranial bone absence) (Barrett *et al.* 1999) or to identify fish processing sites (Van Neer & Pieters 1997; Russ *et al.* 2008; Russ & Jones 2009). As discussed in Chapter 4, density mediated attrition can lead to preferential preservation of vertebrae over cranial elements, suggesting that any interpretation that looks at identifying the used of pre-processed or stored fish should be made with caution. But, are there any situations or taphonomic processes that might lead to either the selected deposition or the preferential preservation of cranial remains? Results of a review of the impacts of bear (*Ursus* sp.) and the Eurasian eagle owl (*Bubo bubo*) consumption of fish (Chapter 5) do not suggest that either of these species would deposit a fish bone assemblage containing few vertebrae. The only exception might be that during the height of spawning (i.e. when the spawning salmon are most abundant) bears have been observed eating only the posterior part of the fish head, presumably to consume the brain. This potentially may lead to a high frequency of posterior cranial remains in bear faeces. However, this behaviour would still not create the skeletal element representation patterns seen in the cranially dominated fish bone assemblages recorded in the Fucino Basin, Italy (see Chapter 7), in which anterior cranial elements (dentary, maxilla, articular and glossohyal) are abundant.

Trampling, a process likely to have impacted fish bone assemblages within cave deposits, was considered as a process that could also lead to the preservation of cranial elements over vertebral remains, see Chapter 5. For the three species investigated, trout (*Salmo trutta*), pike (*Esox lucius*) and European chub (*Squalius cephalus*) vertebrae survived better than most cranial remains. This suggests that 1) trampling does not lead to preferential preservation of cranial remains, and 2) trampling did not play a major role in the species representation of the Fucino Basin assemblages.

This thesis investigated site formation and post-depositional processes in order to identify modes by which cranial elements of fish might be preferentially deposited or preserved in cave deposits. None of the processes reviewed in previous published sources (Chapter 4) or investigated experimentally (Chapter 5) lead to the preferential survivorship of cranial elements. This supports previous interpretations at site where cranial element dominance has been used to imply fish processing.

8.2.3 Hypothesis 3

'Ethnographic and ethnohistorical accounts of recent hunter-gatherers can be used to construct a taphonomic signature for identifying human agency for fish remains'.

There are many accounts of recent hunter-gatherers with regards to their exploitation and consumption of fish. Given a detailed understanding of these groups would it be possible to construct a taphonomic signature, which might include expected species and size of fish, skeletal element representation and expected burning and cut-mark patterns, for human deposited fish remains? A review of fishing behaviour in eight recent hunter-gatherer populations (Chapter 3) allows some observations. For instance, fish exploitation in general appears to be linked with increased latitude (Cordain *et al.* 2000), an observation likely due to increasingly marginal habitats in which there fewer non-faunal resources. Furthermore, hunter-gatherer groups frequently exploit seasonally abundant species over other "background" species available all year round. Due to variation in behaviour and consumption practices, associated with taboo, ritual and dietary preferences for instance, it is not possible to construct a specific taphonomic signature for the recognition of fish bones deposited by humans. These issues, which also affect the application of Optimal Foraging Theory in archaeological situations, mean that even for groups that have similar resource base, in a similar climate and environment with similar group attributes can produce substantially different fish bone deposits. However, once an assemblage from an archaeological site can be identified reliably as a human accumulation, the patterns seen in recent hunter-gatherer populations can be of use in the identification of past fishing methods and fish processing techniques.

8.2.4 Hypothesis 4

'Salmonid exploitation coincided with a broadening of diet (BSR) *seen during the Upper Palaeolithic in Europe; it had a direct impact on hunter-gatherer subsistence and mobility strategies'.*

The frequency of fish remains recovered from archaeological deposits of these periods does not suggest that people exploited fish on any scale until c. 20,000 cal BP (Figure 2.8).

Chapters 2, 6 and 7 all consider the role of fishing during Palaeolithic times, but, how do these changes in fish bone assemblages compare with current understanding of subsistence strategies for Upper Palaeolithic hunter-gatherers in these regions? As discussed in Chapter 1, the Upper Palaeolithic sees a diversification in the exploitation of dietary resources, often referred to as the broad spectrum revolution (BSR) (Stiner *et al.* 1999; Stiner *et al.* 2000; Stiner 2001; Weiss *et al.* 2004). Anadromous and freshwater fish also fits this pattern showing a broadening of resource exploitation through time from the Mousterian to the Magdalenian period, see Figures 2.8 and 2.9. When compared nutritionally with other resources exploited during the BSR salmonids offer a higher fat content, see Table 1.1. The fats and oils of fish would have formed an important part of the diet at this time when it appears that previously exploited species (e.g. bison (*Bison* sp.)) with high fat contents were not longer exploited. The proteins (unsaturated essential fatty acids), minerals (calcium, iron, selenium, zinc) and vitamins (A, B_3, B_6, B_{12}, E and D) make oily fish such as salmon and trout an excellent source of nutrients, some of which are not easily derived from other sources (Sidhu 2003). Omega 3 is also provided by salmon and trout, Omega 3 PUFAs (polyunsaturated fatty acids) have been directly linked to the development of various systems of the human body including the brain, vision and reproductive systems (Rice 1996; Jordan 2010). The introduction of fish in the diet around 20,000 cal BP may therefore have facilitated some of the other changes seen in human behaviour around this time, including the frequent production of art and increased population.

Although marine species are present in one Spanish and a small number of French sites (Figure 5.8), their absence in most Upper Palaeolithic deposits is surprising if the concept of population dynamics is considered to be a forcing factor of the BSR. Surely under the forces of population pressure all possible dietary resources would be exploited. Evidence for marine shellfish exploitation through the Upper Palaeolithic is frequent; for what reason were marine fish ignored as a potential dietary resource? Perhaps the absence of marine species is a result of coastal site loss due to increases in sea level. So sites where marine fish exploitation is most likely to have occurred (i.e.

close to the shore line) are now beneath the sea. It is possible that the lost coastal sites may have functioned as fish processing sites where skeletal remains were removed from fish fillets for preservation and/or transportation. However, in many recent hunter-gatherer populations (Chapter 3) it is rare that all bones are removed from fish that are to be preserved and stored suggesting that use of preserved marine species at inland sites should leave evidence in the archaeological record.

The data for fish remains can also be compared with climate proxies to understand potential impact of climatic and environmental variation on fish exploitation. When compared with Greenland Ice Core Project (GRIP), Vostok and European Project for Ice Coring in Antarctica (EPICA) $\delta^{18}O$ data (climatic proxies), the dates for peaks seen in fish presence in archaeological deposits correlate with peaks in temperature, see Figure 8.2. The largest peak in fish presence in cave deposits coincides with the Bølling-Allerød late glacial interstadial, and also with low mean sea levels. It is also clear that the distribution of sites yielding fish remains is similar to the distribution of glaciers at 20,000 cal BP, see Figures 2.1 and 8.2. Site frequency is high for northern Spain, south-west France and central Italy, all areas with glaciers persisting at this time. At the end of the Last Glacial Maximum, and especially during the Bølling-Allerød interstadial mean temperatures rose, see Figure 8.2 and (Andersen *et al.* 2004). This increase in temperatures would have caused the remaining glaciers to melt. Huge volumes of melt water would have engorged river systems of Western Europe with low temperature water ideal for salmonid spawning. The increased volumes of rivers coming from glacier melt may have also facilitated the migration of salmonids further inland than previous periods, bringing the resource to more inland areas. This transformation of the river systems occurred at a time when terrestrial faunas were in flux. Many cold adapted species would migrate north following the glacial retreat, or become trapped in glacial refugia and eventually become extinct. Fish exploitation appears to become frequent at a time when the large cold adapted animals would have begun to change their ranges, but perhaps before warm adapted faunas could adequately populate Western Europe. A change in the abundance and/or range of terrestrial mammals and an increase in the availability of fish through improved environmental conditions for anadromous species (salmonids) at the end of the LGM probably both contributed to the shift to fish exploitation seen at this time.

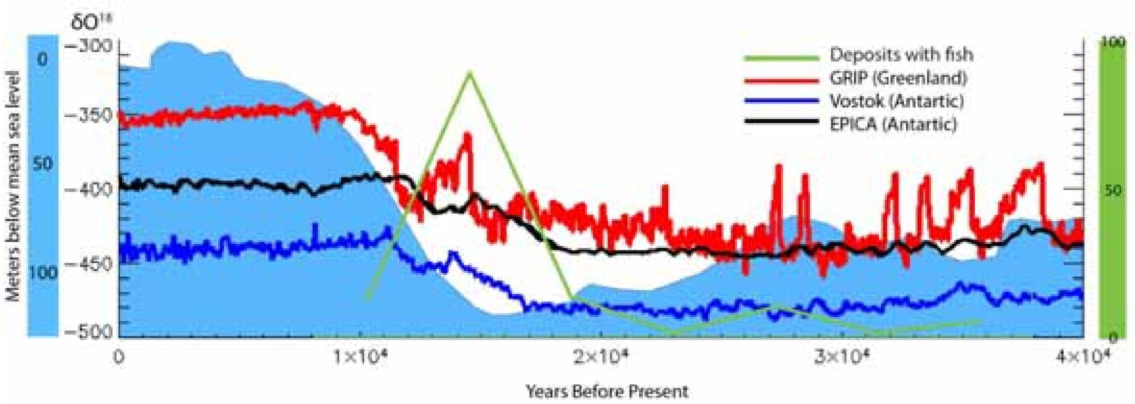

Figure 8.2: Fish frequency (all sites, see Appendix II) compared with climate proxies: GRIP (Andersen *et al.* 2004), Vostok (Augustin *et al.* 2004) and EPICA (Petit *et al.* 1999) data and sea level.

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Figure 8.3: Glaciers and sea levels across Europe c. 20,000 BP. After Mithen (2004) and Giraudi and Frezzotti (1997).

8.3 Conclusion and future analysis

It is clear that freshwater and anadromous fish, especially salmonid fishes, became an important dietary resource at the end of the Last Glacial Maximum (LGM, c. 20,000 BP) until the beginning of the Holocene. This is true especially for Spain, France and Italy; a slightly different pattern is observed in Switzerland and Belgium, where *Salmo* sp. appear to be less dominant. Detailed analysis of Spanish Upper Palaeolithic fish remains suggests that while NISP and MNI values for fish remains may be low at any given site, the consistent find of *Salmo* sp. across the northern Spanish regions (including Cantabria (Chapter 7) and Asturias (Adán *et al.* 2009) confirms that this was an important resource at this time. Though there are far fewer sites, the NISP and MNI values in central Italy are high, again suggesting the importance of the salmonid as a dietary resource.

Taphonomic considerations are an important aspect of fish bone analysis. It is empirical that the agent of accumulation can be accurately identified before any interpretation can be made. For the sites considered in detail (Chapters 6 and 7) none of the fish bone assemblages had characteristics that suggested animal deposition (Chapter 5). However, the role on non-human faunas in the deposition of fish remains should never be underestimated and future taphonomic studies are needed to prevent incorrect interpretation of human fishing behaviour.

The observations by Cordain *et al.* (2000) do suggest that on a large scale the inclusion of fish in hunter-gatherer diet could be predicted based on latitude. However, to appropriately apply their model more precise understanding of past hunter-gatherer diet is first required. Although the pattern is clear, fishing still forms a significant part (up to 25%) of the diet for those living close to the equator (± 20°) (Cordain *et al.* 2000). These accounts can however offer useful insight for the interpretation of fish bone assemblages that are known to result from human activity. Used in this way records of recent hunter-gatherers can be used to recognise aspects of past fishing and fish consumption behaviour such as fishing methods and fish processing.

Comparisons with climate proxies and estimations of past sea levels suggest that the shift to fish exploitation resulted from changes in global temperatures, sea level and glacial activity which lead to terrestrial fauna migration, extinction and/or dispersal and possibly improved river conditions for salmonid spawning. While a region wide (Western Europe) approach is useful, especially given the lacking detail in many of the fish bone reports, detailed analysis of fish bone assemblages for smaller regions (e.g. central Italy (Chapter 6) and Cantabria (Chapter 7)) allows for a high resolution understanding of fishing methods and fish processing. Detailed reports allow the role of fishing in overall subsistence strategies and the potential implications for mobility strategies to be assessed, increasing understanding of Palaeolithic hunter-gatherer lifeways.

The period between the LGM and the beginning of the Holocene signifies a change in the role of fishing in hunter-gatherer subsistence. However, the precision of dating and the fish bone record at many European Upper Palaeolithic sites do not allow a more detailed consideration of the impact of changing climate and environment on fishing behaviour as a part of overall subsistence strategies. Should more sites have detailed fish bone analysis, and material submitted for radiocarbon dating, some future hypotheses to test might include the following:

- The onset of the Younger Dryas (low temperatures and increasing sea levels, re-formation of glaciers) lead to river conditions not suitable for spawning salmonids, therefore fishing became a less frequent part in subsistence strategies.
- Increased sea levels and the knowledge and technology for fishing led to the start of sea fishing in Europe at the beginning of the Holocene.
- Increase in fishing activities in the Late Pleistocene correspond with times of increased global temperatures.

This research was able to demonstrate that fish assemblages were produced by humans (not assumed as in some cases previously). It also has produced a set of criteria which allows robust comparisons across different periods and regions. This will be useful in considering dietary broadening amongst Neanderthals and Upper Palaeolithic anatomically modern humans, since robust data have to date been sparse to non-existent. Results demonstrate a marked peak in fishing activity immediately after the LGM, which are likely to have been influenced by post glacial conditions. These questions can be addressed in future research.

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Appendix I: Late Pleistocene sites with fish remains

bp indicates uncalibrated date. BP indicates calibrated date

Where radiocarbon dates are not available cultural period is listed

Where NISP values are available they are listed in brackets after each species, or provided as total NISP at the end of the species list. Species names are replicated from the original publications.

Site	Date	Species	Common Name	Accumulation agent? Why?	Reference
Pinhole Cave Creswell Crags, England	50-38,000 BP (Jacobi *et al.* 1998)	*Salmo* sp. *Thymallus thymallus* *Esox lucius* *Leuciscus cephalus* Cyprinid *Perca* sp. *Platichthys flesus*	Salmonid Grayling Pike European chub Carp? Perch European flounder	Unknown	(Armstrong 1928; 1931; Jenkinson 1984; Jenkinson & Gilbertson 1984: 122; Currant & Jacobi 2001: 122)
Dog Hole Fissure, Creswell Crags, England	8,000 BP	*Salmo* sp.	Salmonid	Natural – Fox/wildcat? 4 (3) 'Atlantic salmon' *Salmo* sp. (6.25% gnawed) 3b (7) unknown Wide age range	(Briggs *et al.* 1984: 67)
Arbreda Cave, Spain	40-10,000 BP Mousterian Early Aurignacian Evolved Aurignacian Gravettian (lower) Gravettian (upper) Solutrean (lower) Solutrean (upper) Solutrean (SP) Postsolutrean Terra rossa	*Anguilla anguilla* (149) *Barbus* sp. (78) *Leuciscus* sp. (42) *Rutilus* sp. (26) *Salmo salar* (4) *Salmo trutta* (108) *Salmo* sp. (11) Teleostomi (86) Total NISP 504	European eel Cyprinid (Barbels) Chub/ide/dace Cyprinid (roach) Atlantic salmon Trout Salmonid Fish species	Human Association with artefacts Taphonomy discussed in terms of preferential preservation of larger species Only vertebrae	(Muñoz & Casadevall 1997; Rosello-Izquierdo & Morales-Muñiz 2005)

Site	Date	Species	Common Name	Accumulation agent? Why?	Reference
Tito Bustillo, Spain	37-35,000 BC Middle Palaeolithic + Upper Palaeolithic (Magdelanian)	*Salmo trutta* (123 Mo) *Salmo salar* (1 Mo) Pleuronectidae (1 Mo) Total Mo NISP 125	Trout Atlantic salmon Flatfish	Human	(Morales-Muñiz 1984) - Middle Palaeolithic (Straus 1983b; Adán *et al.* 2009) - Upper Palaeolithic
Cueva Millán, Spain	37-35,000 BC Middle Palaeolithic	*Salmo trutta fario* (198) *Anguilla anguilla* (29) *Chondrostoma polylepis* (52) Unidentified fish (10)	Brown trout European eel Iberian nase Fish species	Human	(Morales-Muñiz 1984; Rosello-Izquierdo & Morales-Muñiz 2005)
Gorham's Cave, Gibralter	30-25,000 bp Level III Upper Palaeolithic Level IV Middle palaeolithic	*Thunnus* sp. (Early UP) *Scomber scombrus* (Early UP) MP NISP = 2	Tuna Atlantic mackerel	Unknown	(Waechter 1964; Zeuner & Sutcliffe 1964; Erlandson 2001: 303; Carrión *et al.* 2008)
Vanguard Cave, Gibralter	>45,000 BP	*Diplodus sargus/vulgaris* (1) (total NISP ?)	Sea bream	Unknown	(Stringer *et al.* 2008)
Caverne Marie-Jeanne, Belgium	Middle Palaeolithic Levels 1,3,4 and 5	'Percomorph'	Perch species?	Human Not discussed for the fish	(Gautier & Heinzelin 1980: 15; Van Neer 1997)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Grotte Walou, Belgium	Middle Palaeolithic Aurignacian Upper Palaeolithic	*Thymallus thymallus* (26) *Lota lota* (8) *Salmo trutta* (4) Salmonid (44) NISP Au 82 + 64 misc & scales	Grayling Burbot Trout Salmonid	Animal (small fish) Human (large fish)	(Van Neer & Wouters 2007; Le Gall 2008)
Grotte de la Princesse, March-les-Dames, Belgium	Aurignacian (mixed context with Neolithic)	Freshwater fish	Freshwater fish	?	(Gautier 1981; Van Neer 1997)
Le Flageolet, France (Bezenac)	Aurignacian	*Salmo trutta* *Esox lucius*	Trout Pike	Human	(Cleyet-Merle 1990: 28)
Grotte du Pape, France (Brassempouy)	Aurignacian typique Perigordian Magdalenian s.p.	*Esox lucius* (all periods)	Pike	Human	(Cleyet-Merle 1990: 28)
Sainte-Anastasie, France	Aurignacian ancien	*Barbus* sp. *Rutilus rutilus* *Leuciscus leuciscus*	Barbel Roach Common dace	Human	(Cleyet-Merle 1990: 28)
Gatzarria, French Basque Country, France	Aurignacian	Teleostomi	Fish species	Human Perforated - adornment	(Vanhaeren & d'Errico 2006: 1109)
Roc de Combe, Payrignac, France	Aurignacian	Teleostomi	Fish species	Human Perforated - adornment	(Vanhaeren & d'Errico 2006: 1110)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
La Riera, Asturias, Spain	21-14,000 bp Solutrean Lower Magdalenian Upper Magdalenian	*Salmo salar* *Salmo trutta* Sparidae *Solea* sp. (level B only)	Atlantic salmon Trout Sea breams Sole species (level B only)	Human Mostly vertebrae Marine fish much later (Upper Magdelanian) Associated with self-barbed harpoons	(Straus *et al.* 1981; González Morales 1982: 72; Clark 1983: 143-144; Straus 1983a: 52; 1983b: 101; Straus & Clark 1986; Pokines & Krupa 1997: 249; Straus 2005: 155; Adán *et al.* 2009)
Coberizas Cave, Spain	17-15,000 bp	Teleostomi	Fish species	Human not considered an important dietary resource, alternate accumulation agents not considered	(Clark & Cartledge 1973; González Morales 1982: 72; Clark 1983: 114-116)
Cueva Ambrosio, Almeria, Spain	16,500 bp Solutrean	Salmo salar (44)	Atlantic salmon	?	(López 1988)
Grotto di Pozzo, Italy (Fucino Basin)	14,600 – 14,000 cal BP	*Salmo trutta* NISP 7048	Trout	Human Low species diversity, element representation, spatial distribution, size, seasonality, associated finds	(Mussi *et al.* 2004; Russ 2006; 2008; Russ *et al.* 2008; Russ & Jones 2009) Studied by Russ
Maurizio Shelter, Italy (Fucino Basin)	Upper Palaeolithic	*Salmo trutta* NISP 1	Trout	Human Alternate accumulation agents not considered	(Radmilli 1963; Wilkens 1994)
Ciccio Felice Cave, Italy (Fucino Basin)	Upper Palaeolithic	*Salmo trutta* NISP 1	Trout	Human Alternate accumulation agents not considered	(Radmilli 1956b; Wilkens 1994)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
La Punta Cave, Italy (Fucino Basin)	Upper Palaeolithic 11,800±100 bp 11906-11462 cal BP (La Punta 1, 27-30) c. 10,500 BP (La Punta 25)	*Salmo trutta* NISP 43	Trout	Human Alternate accumulation agents not considered	(Cremonesi 1968b; Bietti 1990: 111; Wilkens 1994) Studied by Russ
Ortucchio Cave, Italy (Fucino Basin)	Upper Palaeolithic 12,615±410 bp 14063-11787 cal BP	*Salmo trutta* NISP 743	Trout	Human Alternate accumulation agents not considered	(Cremonesi 1968b; Bietti 1990: 111; Wilkens 1994) Studied by Russ
Maritza Cave, Italy (Fucino Basin)	Upper Palaeolithic 12,530–12,090 cal BP (Level 39-30)	*Salmo trutta* NISP 51877	Trout	Human Alternate accumulation agents not considered	(Grifoni & Radmilli 1964; Bietti 1990: 111; Wilkens 1994) Studied by Russ
Grotta della Madonna, Italy (Praia a Mare)	Upper Palaeolithic 12,100±150 bp Mesolithic deposits also	*Salmo trutta* (dominant) *Anguilla anguilla* *Sparus auratus* Total NISP 7743	Trout European eel Sea bream	Human Well defined cultural horizon Large specimens only	(Durante 1978; Bietti 1990: 116; Fiore *et al.* 2004; Phoca-Cosmetatou 2009)
Grotta delle Prazziche, Italy	Upper Palaeolithic	Teleostomi	Fish species	?	(Milliken 1998: 279)
Grotta dell'Uzzo, Italy	Late Upper Palaeolithic 10,050±100 bp 10,028-9,312 cal BP	Teleostomi	Fish species	?	(Piperno *et al.* 1980: 279; Bietti 1990: 116)
La Grotte des Eglises, France (Ussat)	13-12,000 bp	*Salmo salar* *Salmo trutta*	Atlantic salmon Trout	Human	(Delibrias & Erin 1974; Clottes *et al.* 1983; Straus 1983b: 101; Le Gall 1984; Cleyet-Merle 1990: 29)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Pont d'Ambon, France (Bourdeilles)	13,000-9,500 bp	*Leuciscus cephalus* *Leuciscus leuciscus* *Anguilla anguilla* *Esox lucius* Salmonidae	European chub Common dace European eel Pike Salmonid (rare)	Human	(Le Gall 1984; Cleyet-Merle 1990; Célérier 1998: 28; Drucker & Bocherens 2004)
Grotte des Eyzies, France (Les Eyzies)	12,500 bp	*Salmo* sp. *Salmo salar* *Salmo trutta* *Esox lucius* *Rutilus rutilus* *Leuciscus sp.* *Leuciscus cephalus* *Leuciscus leuciscus* Cyprinidae	Salmonid Atlantic salmon Trout Pike Roach Chub/ide/dace European chub Common dace Cyprinid	? Human Heated (?)	(Coulston 2000)
Abri Pataud, France (Les Eyzies)	Aurignacian Perigordian V, VI, VII and final	*Salmo salar* (A, PV, PVI, PVII) *Salmo trutta* (P final) *Anguilla anguilla* (P final) *Thymallus* sp. (P final)	Atlantic salmon Trout European eel Shadow fishes (inc. Grayling)	Human	(Cleyet-Merle 1990: 28)
La Balauziére, France (Remoulins)	Aurignacian typique	Teleostomi (rare)	Fish species	Human	(Cleyet-Merle 1990: 28)
Fourneau du Diable, France (Bourdeilles)	Solutrean (late)	Teleostomi	Fish species	Human	(Cleyet-Merle 1990: 28)
Badegoule, France	Solutrean	*Salmo salar* Cyprinidae	Atlantic salmon Carp?	Human	(Cleyet-Merle 1990: 28)
Liveyre, France	Solutrean	*Salmo salar*	Atlantic salmon	Human	(Cleyet-Merle 1990: 28)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Hornos de la Peña, Spain (Santander)	Solutrean	Teleostomi Salmonidae?	Fish species Atlantic salmon?	?	(Straus 1983a: 92, 97; Pokines & Krupa 1997: 249)
Cueto de la Mina, Spain (Asturias)	Solutrean Aurignacian Azilian	Teleostomi (S & Az) Salmonidae? (S) Condrichthyos (Au) *Raja* spp. (Au)	Fish species Atlantic salmon? Shark/skate/ray/chimaera Ray species	Human Associated self-barbed points	(Straus 1983a: 92, 97; Rasilla Vives 1990; Pokines & Krupa 1997: 249; Rosello-Izquierdo & Morales-Muñiz 2005; Adán *et al.* 2009)
Cueva Chufín, Spain (Santander)	Solutrean	Teleostomi Salmonidae?	Fish species Salmonid?	Human	(Straus 1983a: 56, 97)
Lachaud, France (Terrasson)	Solutrean (late)	Cyprinidae Teleostomi	Cyprinids Fish species	Human Not discussed	(Cleyet-Merle 1990: 28)
Laugerie Haute, France (Les Eyzies)	Proto Magdalenian	Salmonidae Teleostomi	Salmonid Fish species	Human Not discussed	(Cleyet-Merle 1990: 28)
Bolinkoba, Spain (Cantabria)	Upper Palaeolithic Lower Magdalenian	Teleostomi	Fish species	?	(Utrilla 1981; Pokines & Krupa 1997: 249)
La Lloseta, Spain (Cantabria)	Upper Palaeolithic Lower Magdalenian	Teleostomi	Fish species	?	(Pokines & Krupa 1997: 249; Adán *et al.* 2009)
Ekain, Spain (Cantabria)	Upper Palaeolithic Lower Magdalenian	Teleostomi	Fish species	?	(Pokines & Krupa 1997: 249)
Abri Fritsch, France (Pouligny)	Magdalenian ancien	*Salmo salar* *Salmo trutta* *Thymallus* sp.	Atlantic salmon Trout Shadow fishes (inc. Grayling)	Human Not discussed	(Cleyet-Merle 1990: 28)
Le Peyrat, France (Saint-Rabier)	Magdalenian II ancien	Cyprinidae Salmonidae *Esox lucius*	Cyprinid Salmonid Pike	Human Not discussed	(Cleyet-Merle 1990: 28)

Site	Date	Species	Common Name	Accumulation agent? Why?	Reference
Lachaud, France (Terrasson)	Proto-Magdalenian 1b, 1c, IIb Magdalenian IIa	Teleostomi (P-M, P-M 1b, P-M 1c) *Salmo salar* (P-M) *Salmo trutta* (P-M) Cyprinidae (P-M IIb, M IIa) Salmonidae (M IIa)	Fish species Atlantic salmon Trout Cyprinid Salmonid	Human Not discussed	(Cleyet-Merle 1990: 28)
Bois des Brousses, France (Aniane)	Magdalenian	*Salmo trutta* *Anguilla anguilla* *Thymallus* sp. *Lota lota*	Trout European eel Shadow fish (inc. Grayling) Burbot	Human Not discussed	(Cleyet-Merle 1990: 28)
Laroque, France	Magdalenian middle	*Salmo trutta*	Trout	Human Not discussed	(Cleyet-Merle 1990: 28)
Néviau, Belgium	Upper Palaeolithic Magdalenian	*Silurus glanis*	European catfish	?	(Giltay 1931; Van Neer 1997)
Cave of Rey, Les Eyzies, France	Upper Palaeolithic	Teleostomi	Fish species	Human Perforated	(MacCurdy 1923)
Barma Grande Cave, Italy (Sometimes listed as Menton, France)	Late Upper Palaeolithic	*Salmo salar* *Salmo trutta* *Anguilla anguilla* (?)	Atlantic salmon Trout European eel (?)	Human Perforated	(De Villeneuve *et al.* 1906-1919; MacCurdy 1923; Cleyet-Merle 1990: 29; Mussi 2001)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Bois de Laterie, Belgium	Upper Palaeolithic Magdalenian	*Salmo trutta fario* (37 + 4 scales) *Thymallus thymallus* (3) *Lota lota* (23)	Brown trout Grayling Burbot	Human cave also used by carnivores mostly foxes, but also bear, hyena, wolf and small mustelids size of fish – too big for mustelids does not consider deposition via faecal material some dietary information for some species is incorrect	(Van Neer 1997)
Trou de Chaleux, Belgium	Upper Palaeolithic	*Chondrostoma nasus* (1) Cyprinidae cf. *Leuciscus* (1) Cyprinidae(5) *Esox lucius* (1) *Thymallus thymallus* (7) *Salmo trutta fario* (5) *Lota lota* (1) Total NISP 21	Nase Cyprinid, cf. chub/ide/dace Cyprinid Pike Grayling Brown trout Burbot	Human	(Van Neer *et al.* 2007)
Trou du Sureau, Begium	Upper Palaeolithic	Cyprinidae (3) *Thymallus thymallus* (37) *Salmo trutta fario* (16) Salmonidae (9) *Lota lota* (10) Teleostomi (2) Total NISP 77	Cyprinid Grayling Brown trout Salmonid Burbot Fish species	Human	(Van Neer *et al.* 2007)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Trou du Frontal, Belgium	Upper Palaeolithic	*Anguilla anguilla* (3) Cyprinid cf. *Barbus barbus* (3) Cyprinid cf. *Leuciscus* (3) Cyprinidae (17) *Esox lucius* (4) *Thymallus thymallus* (9) *Salmo salar* or *Salmo trutta trutta* (5) *Salmo trutta fario* (9) Salmonidae (2) *Lota lota* (37) Teleostomi (4) Total NISP 96	European eel Cyprinid, cf. barbell Cyprinid, cf. chub/ide/dace Cyprinid Pike Grayling Atlantic salmon or sea trout Brown trout Salmonid Burbot Fish species	Human	(Van Neer *et al.* 2007)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Cueva de Nerja, Spain (1979, 1980 & 1982 excavations)	Upper Palaeolithic 16,945-14,236 cal BP (95.4%) 11,833-10,907 cal BP (95.4%)	*Acipenser sturio*	European sea sturgeon	Human Alternate accumulation agents not considered. looks at fishing practices	(Morales-Muñiz *et al.* 1994; Morales-Muñiz & Roselló-Izquierdo 2004)
		Gadidae	Cod family		
		Pollachius pollachius	Pollock		
		Belone belone	Garfish		
		Dicentrachus labrax	European sea bass		
		Trachurus trachurus	Atlantic horse mackerel		
		Epinephelus guaza	Dusky grouper		
		Sparidae	Breams and Porgies		
		Dentex dentex	Common dentex		
		Diplodus sp.	Bream		
		Pagellus erythrinus	Common Pandora (bream)		
		Pagrus pagrus	Red porgy		
		Sparus aurata	Gilthead (sea) bream		
		Labridae	Wrasses		
		Labrus merula	Brown wrasse		
		Scomber sp.	Mackerels		
		Thunnus thynnus	Northern or giant bluefin tuna		
		Scorpaena sp.	Scorpion fish		
		Tryglidae	Gurnards (?)		
		Trygla sp.	Gurnard (?)		
La Madeleine, France (Les Eyzies)	Upper Palaeolithic	Cyprinid NISP 1	Cyprinid	Human Fishing gear In a child burial	(MacCurdy 1924)
Abeurador, France (Felines)	Upper Palaeolithic Epipaleolithic	*Salmo salar*	Atlantic salmon	Human Not discussed	(Le Gall 1984; Cleyet-Merle 1990: 29; Muñoz & Casadevall 1997)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Fonfría B, Spain	Late Upper Palaeolithic	*Solea* sp. Teleostomi	Sole species Fish	Human not considered an important dietary resource alternate accumulation agents not considered	(González Morales 1982: 72; Clark 1983: 114-116; Adán *et al.* 2009)
Bricia A, Asturias, Spain	Late Upper Palaeolithic	*Solea* sp. Teleostomi	Sole Fish	Human not considered an important dietary resource alternate accumulation agents not considered	(González Morales 1982: 72; Clark 1983: 114-116)
Balmori, E-1, C-1, Spain	Late Upper Palaeolithic Lower Magdalenian Asturian	*Solea* sp. Teleostomi	Sole Fish	Human associated self-barbed harpoons not considered an important dietary resource alternate accumulation agents not considered	(Clark 1974-75; 1976; 1983: 114-116; Straus 1983b: 101; Pokines & Krupa 1997: 249; Adán *et al.* 2009)
Penicial Conchero, Spain	Upper Palaeolithic - Asturian	Teleostomi	Unidentified fish	Human not considered an important dietary resource alternate accumulation agents not considered	(González Morales 1982: 72; Clark 1983: 114-116)
Arnero A, Spain	Upper Palaeolithic - Asturian	Teleostomi	Unidentified fish	Human not considered an important dietary resource. alternate accumulation agents not considered	(González Morales 1982: 72; Clark 1983: 114-116; Adán Álvarez 1997; Adán *et al.* 2009)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Sofoxo, Spain	Upper Palaeolithic Magdelanian & Azilian	*Salmo salar* Salmonidae	Atlantic salmon Salmonid	Human considered a significant and regular resource in this area alternate accumulation agents not considered	(Straus 1983b: 101; Adán *et al.* 2009: 897)
Altamira, Spain (Santander)	Upper Palaeolithic Lower Magdalenian	Salmonidae Pleuronectidae Elasmobranchii Total NISP 150	Salmonid Flatfish Shark (tooth)	Human Associated self-barbed harpoons considered a significant and regular resource in this area alternate accumulation agents not considered a seal also found (Altuna & Straus 1976 – fish not mentioned here)	(de Las Heras *pers. comm.* 05/2008; Breuil & Obermaier 1935; Altuna & Straus 1976; Straus 1983b: 101; Pokines & Krupa 1997: 249) Studied by Russ
El Juyo, Spain (Santander)	Upper Palaeolithic 14,400±180 bp 16,022-14,713 cal BP 13,920±240 bp 15,483-13,935 cal BP	Salmonidae Pleuronectidae *Raja* sp. Total NISP 2916	Salmonid Flatfish cf. European flounder Ray species (dermal denticles)	Human associated self-barbed points Mostly vertebrae and ribs, few cranial elements considered a significant and regular resource in this area alternate accumulation agents not considered	(de Las Heras *pers. comm.* 05/2008; Straus 1983b: 101; Freeman *et al.* 1988: 13; Pokines & Krupa 1997: 243) Studied by Russ

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Rascaño, Spain	Upper Palaeolithic	*Salmo* sp. Pleuronectidae Elasmobranchii Total NISP 5 (but says 26 in monograph report)	Atlantic salmon and trout Flatfish cf. European flounder Shark (tooth)	Human considered a significant and regular resource in this area * alternate accumulation agents not considered	(de Las Heras *pers. comm.* 05/2008; González Echegaray & Barandiaran Maestu 1981: 348; Straus 1983b: 101; Pokines & Krupa 1997: 249) Studied by Russ
El Otero, Spain Cueva del Otero	Upper Palaeolithic	Teleostomi NISP 1	Fish species	Human considered a significant and regular resource in this area alternate accumulation agents not considered	(Madariaga 1966; Straus 1983b: 101)
La Chora, Spain Cueva de la Chora	Upper Palaeolithic	Teleostomi 14.53grams	Fish species	Human considered a significant and regular resource in this area alternate accumulation agents not considered	(Madariaga 1963; Straus 1983b: 101)
Lumentxa, Spain	Upper Palaeolithic	Teleostomi		Human considered a significant and regular resource in this area alternate accumulation agents not considered	(Straus 1983b: 101)
Isturitz, Spain	Upper Palaeolithic	Teleostomi	Fish species	Human considered a significant and regular resource in this area alternate accumulation agents not considered	(Straus 1983b: 101)

Site	Date	Species	Common Name	Accumulation agent? Why?	Reference
Duruthy, France (Sordes)	Upper Palaeolithic Magdalenian IV Magdalenian VI	*Salmo salar* (both periods)	Atlantic salmon	Human considered a significant and regular resource in this area alternate accumulation agents not considered	(Straus 1983b: 101; Rigaud 1984; Cleyet-Merle 1990: 28-29)
El Valle, Spain	Upper Palaeolithic	Teleostomi (traces)	Fish species	Human Not discussed	(Straus *et al.* 2002: 1408)
El Mirón, Spain	Upper Palaeolithic	*Salmo salar* *Salmo trutta*	Atlantic salmon Trout	Human Not discussed	(Straus *et al.* 2001; Straus *et al.* 2002: 1410)
Dufaure, France (Sordes)	Upper Palaeolithic Magdalenian final + Azilian	*Salmo salar* *Esox lucius* Salmonidae	Atlantic salmon Pike Salmonid	Human considered a significant and regular resource in this area alternate accumulation agents not considered	(Straus 1983b: 101; Cleyet-Merle 1990: 29)
Lespugue, France	Upper Palaeolithic	Teleostomi	Fish species	Human considered a significant and regular resource in this area alternate accumulation agents not considered	(Straus 1983b: 101)
Gourdan, France	Upper Palaeolithic	Teleostomi	Fish species	Human considered a significant and regular resource in this area alternate accumulation agents not considered	(Straus 1983b: 101)
Mas d'Azil, France	Upper Palaeolithic	Telesotomi	Fish species	Human considered a significant and regular resource in this area alternate accumulation agents not considered	(Straus 1983b: 101)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Aurensan, France	Upper Palaeolithic Magdalenian sup.	*Salmo salar* *Leuciscus* sp.	Atlantic salmon Chub/ide/dace	Human considered a significant and regular resource in this area alternate accumulation agents not considered	(Straus 1983b: 101; Cleyet-Merle 1990: 28)
Bédeilhac, France	Upper Palaeolithic	Teleostomi	Fish species	Human considered a significant and regular resource in this area alternate accumulation agents not considered	(Straus 1983b: 101)
Fontanet, France	Upper Palaeolithic	Teleostomi	Fish species	Human considered a significant and regular resource in this area alternate accumulation agents not considered	(Desse & Desse 1976b; Straus 1983b: 101)
Rhodes II, France (Tarascon)	Upper Palaeolithic Early Azilian	*Salmo salar* *Salmo trutta*	Atlantic salmon Trout	Human considered a significant and regular resource in this area alternate accumulation agents not considered	(Straus 1983b: 101; Cleyet-Merle 1990: 29)
La Vache, France	Upper Palaeolithic Magdalenian sup. and Azilian	*Salmo trutta* Salmonidae Teleostomi	Trout Salmonid species Fish species	Human considered a significant and regular resource in this area alternate accumulation agents not considered	(Straus 1983b: 101; Cleyet-Merle 1990: 28)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Grotte de l'Oeil, France (Puilaurens)	Upper Palaeolithic Magdalenian VI	*Salmo trutta* *Alosa* sp.	Trout Shad	Human considered a significant and regular resource in this area alternate accumulation agents not considered	(Straus 1983b: 101; Cleyet-Merle 1990: 28)
Bevis, France Cauno de Belvis	Upper Palaeolithic Magdalenian VI	*Salmo salar* *Salmo trutta*	Atlantic salmon Trout	Human considered a significant and regular resource in this area alternate accumulation agents not considered	(Straus 1983b: 101; Le Gall 1984; Cleyet-Merle 1990: 29; Muñoz & Casadevall 1997: 114)
Gare de Conduché, France	Upper Palaeolithic Magdalenian final	*Salmo salar* *Salmo trutta* *Leuciscus* sp.	Atlantic salmon Trout Chub/ide/dace	Human	(Cleyet-Merle 1990: 28)
Les Peyrugues, France (Orniac)	Upper Palaeolithic Magdalenian ancien (Ma) Magdalenian sup (Ms)	Salmonidae (Ma) *Leuciscus leuciscus* (Ma) *Salmo salar* (Ms) *Salmo trutta* (Ms) Cyprinidae (Ms) *Anguilla anguilla* (Ms)	Salmonid Common dace Atlantic salmon Trout Cyprinid European eel	Human Not discussed	(Cleyet-Merle 1990: 28-29)
Canecaude, France (Villardonnel)	Magdalenian middle	*Salmo trutta*	Trout	Human Not discussed	(Cleyet-Merle 1990: 28)
Cottier, France (Retournac)	Magdalenian IV	*Salmo trutta*	Trout	Human Not discussed	(Cleyet-Merle 1990: 28)
Reignac, France (Tursac)	Upper Palaeolithic Magdalenian s.p.	Salmonidae	Salmonid	Human Not discussed	(Cleyet-Merle 1990: 28)
Saut-du-Perron, France (Villerest)	Upper Palaeolithic Magdalenian s.p.	Teleostomi	Fish species	Human Not discussed	(Cleyet-Merle 1990: 28)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Le Calvaire, France (Lourdes)	Upper Palaeolithic Epi-Palaeolithic	Teleostomi	Fish species	Human Not discussed	(Cleyet-Merle 1990: 29)
Espelugues, France (Lourdes)	Upper Palaeolithic Magdalenian sup Magdalenian final	Cyprinidae Teleostomi	Carp (?) Fish species	Human Not discussed	(Cleyet-Merle 1990: 29)
Grotte des Fées, France (Marcamps)	Upper Palaeolithic Magdalenian sup	Teleostomi	Fish species	Human Not discussed	(Cleyet-Merle 1990: 29)
La Colombière, France (Neuville)	Upper Palaeolithic Magdalenian sup	Teleostomi	Fish species	Human Not discussed	(Cleyet-Merle 1990: 29)
Bruniquel, France	Upper Palaeolithic Magdalenian sup.	*Salmo* sp.	Atlantic salmon/trout	Human Not discussed	(Cleyet-Merle 1990: 29)
Casteljau, France	Upper Palaeolithic Magdalenian final	Salmonidae	Salmonid	Human Not discussed	(Cleyet-Merle 1990: 29)
Faustin, France (Cessac)	Upper Palaeolithic Magdalenian final	Salmonidae Cyprinidae	Salmonid Cyprinid	Human Not discussed	(Cleyet-Merle 1990: 29)
Couze, France	Upper Palaeolithic Magdalenian final	*Rutilus rutilus*	Roach	Human Not discussed	(Desse & Desse 1976b; Cleyet-Merle 1990: 29)
Bois Ragot, France (Gouex)	Upper Palaeolithic Magdalenian final + Epi-Palaeolithic (Same species in each)	*Salmo salar* *Salmo trutta* *Thymallus* sp. *Leuciscus leuciscus* *Perca fluviatilis* *Anguilla anguilla*	Atlantic salmon Trout Shadow (inc. Grayling) Common dace Perch European eel	Human Not discussed	(Cleyet-Merle 1990: 29)
Laroque, France	Upper Palaeolithic Magdalenian sup.	*Salmo trutta*	Trout	Human Not discussed	(Cleyet-Merle 1990: 29)
Grotte de Harpons, France (Lespuge)	Upper Palaeolithic Magdalenian final + Azilian	*Esox lucius* *Leuciscus cephalus*	Pike European chub	Human Not discussed	(Cleyet-Merle 1990: 29)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Limeuil, France	Upper Palaeolithic Magdalenian (sup ?)	Cyprinidae *Salmo salar*	Cyprinids Atlantic salmon	Human Not discussed	(Cleyet-Merle 1990: 29)
Rochereil, France (Lisle)	Upper Palaeolithic Magdalenian VI Magdalenian final	*Esox lucius* *Rutilus rutilus* *Leuciscus cephalus*	Pike Roach European chub	Human Not discussed	(Cleyet-Merle 1990: 29)
Laugerie Basse, France	Upper Palaeolithic Magdalenian middle Magdalenian V-VI	Teleostomi (both periods)	Fish species	Human Not discussed	(Cleyet-Merle 1990: 29)
Pegourie, France (Pegourie)	Upper Palaeolithic Magdalenian sup.	*Alosa* sp.	Shad	Human Not discussed	(Cleyet-Merle 1990: 29)
Le Courbet, France (Penne)	Upper Palaeolithic Magdalenian sup.	Teleostomi	Fish species	Human Not discussed	(Cleyet-Merle 1990: 29)
Morin, France (Pessac)	Upper Palaeolithic Magdalenian IV	*Esox lucius* *Salmo trutta*	Pike Trout	Human Not discussed	(Cleyet-Merle 1990: 29)
Rocamadour, France (Rocamadour)	Upper Palaeolithic Magdalenian sup. Magdalenian final Azilian	*Teleostomi* (all periods)	Fish species	Human Not discussed	(Cleyet-Merle 1990: 29)
Fontalès, France (Saint-Antonin)	Upper Palaeolithic Magdalenian V-VI	Salmonidae	Salmonids	Human Not discussed	(Cleyet-Merle 1990: 29)
La Garenne, France (Saint-Marcel)	Upper Palaeolithic Magdalenian VI	*Salmo salar* *Salmo trutta*	Atlantic salmon Trout	Human Not discussed	(Cleyet-Merle 1990: 29)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Le Peyrat, France (Saint-Rabier)	Upper Palaeolithic Magdalenian VI Azilian	*Rutilus rutilus* (M VI only) *Salmo trutta* (M VI only) *Anguilla anguilla* (M VI only) *Leuciscus cephalus* (M VI only) Cyprinidae (Azilian only) Salmonidae (Azilian only)	Roach Trout European eel Chub Cyprinid Salmonid	Human Not discussed	(Cleyet-Merle 1990: 29)
Souilhac, France (Souilhac)	Upper Palaeolithic Magdalenian sup VI	*Tinca tinca* or Cyprinidae (?)	Tench or carp (?)	Human Not discussed	(Cleyet-Merle 1990: 29)
La Tourasse, France (La Tourasse)	Upper Palaeolithic Magdalenian Azilian	Teleostomi	Fish species	Human Not discussed	(Cleyet-Merle 1990)
Villepin, France (Tursac)	Upper Palaeolithic Magdalenian VIb	Teleostomi	Fish species	Human Not discussed	(Cleyet-Merle 1990: 29)
Rochedane, France (Villars)	Upper Palaeolithic Azilian	*Salmo trutta* *Thymallus* sp. *Lota lota* *Rutilus rutilus*	Trout Shadow fish (inc. grayling) Burbot Roach	Human Not discussed	(Cleyet-Merle 1990: 29)
Pierre Chatel, France (Virgnin)	Upper Palaeolithic Magdalenian sup.	*Salmo trutta* *Lota lota* *Leuciscus leuciscus* *Coregonus* sp.	Trout Burbot Common dace Whitefish	Human Not discussed	(Cleyet-Merle 1990: 29)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Oullins, France (Oullins)	Late Upper Palaeolithic	Study in progress	Study in progress	?	(Cleyet-Merle 1990: 29)
Salpêtrière, France (Remoulins)	Late Upper Palaeolithic	Study in progress	Study in progress	?	(Cleyet-Merle 1990: 29)
La Grotte du Bourrouilla, France	Late Upper Palaeolithic & Mesolithic	Salmonidae *Esox lucius* Cyprinidae *Anguilla anguilla*	Salmonid Pike Cyprinid European eel	Human Seasonality	(Chauchat *et al.* 1999; Le Gall 1999c)
Abri du Pape, Belgium	Mesolithic	*Anguilla anguilla* (2) *Alosa alosa* (1) *Leuciscus cephalus* (16) *Leuciscus* sp. (2) *Rutilus rutilus* (5) Cyprinidae (147) *Silurus glanis* (11) *Esox lucius* (34) *Salmo* sp. (2) *Perca fluviatilis* (1) Teleostomi (44)	European eel Allis shad European chub Chub/ide/dace Roach Cyprinid European catfish Pike Salmonid Perch Fish species	Human Alternate accumulation agents well considered. No fishing gear River fishing (River Meuse)	(Van Neer 1999)
Place Saint-Hilaire, Namur, Belgium	Mesolithic	*Leuciscus cephalus* *Esox lucius* Teleostomi (total NISP 15)	European chub Pike Fish species	Human	(Van Neer 1995)
Cueva Oscura, Asturias, Spain	Upper Palaeolithic Azilian (12-10,000 bp)	Salmonidae	Salmonid	Human Not disgussed	(Adán Álvarez *et al.* 2000; Adán *et al.* 2009)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
El Buxu, Asturias, Spain	Upper Palaeolithic Solutrean	*Salmo trutta* *Salmo salar* Study in Progress	Trout Atlantic salmon	Human Not discussed	(Soto Rodríguez 1984: 804; Adán *et al.* 2009)
El Cierro, Asturias, Spain	Upper Palaeolithic Asturian	Teleostomi	Fish species	Human Not discussed	(Clark 1976; Adán *et al.* 2009)
La Güelga Asturias, Spain	Upper Palaeolithic	Teleostomi	Fish species	Human Not discussed	(Turrero 2007; Adán *et al.* 2009)
La Lluera Asturias, Spain	Upper Palaeolithic Magdelainian and Azilian	Salmonidae	Salmonid	Human Not discussed	(Adán *et al.* 2009: 896)
La Paloma Asturias, Spain	Upper Palaeolithic	Teleostomi	Fish species	Human Not discussed	(Hernández Pacheco 1919; Adán *et al.* 2009)
Las Caldas Asturias, Spain	Upper Palaeolithic Magdalenian	Salmonidae Study in Progress	Salmonid	Human Not discussed	(Corchón *et al.* 1981; Adán *et al.* 2009)
Les Pedroses, Asturias, Spain	Upper Palaeolithic Asturian	Teleostomi	Fish species	Human Not discussed	(Clark 1976; Adán *et al.* 2009)
Los Azules Asturias, Spain	Upper Palaeolithic Azilian	*Salmo salar* Teleostomi	Atlantic salmon Fish species	Human Not discussed	(Fernández-Tresguerres & Rodríguez Fernández 1990; Adán *et al.* 2009)
Mazaculos Asturias, Spain	Upper Palaeolithic	*Labros* spp. Teleostomi Study in Progress	*Labrus*? Wrasse? Fish species	Human Not discussed	(González Morales 1982: 72; Adán *et al.* 2009)
La Meaza (Loc. 1-2, 5-2) Cantabria	Upper Palaeolithic Austurian	Teleostomi	Fish species	Human Not discussed	(Clark 1983: 114-115)
Picareiro Cave Portugal		*Alosa alosa?* *Alosa fallex?* *Sardina pilchardus* Cyprinid	Shad Shad Sardine Cyprinid	Human Association with cultural materials	(Bicho *et al.* 2000: 504-505; Bicho *et al.* 2006: 495)

Site	Date	Species	Common Name	Accumulation agent? Why?	Reference
Aitzbitarte III, Basque Country, Spain	Upper Palaeolithic Solutrean	*Salmo trutta* *Salmo salar* Study in Progress	Trout Atlantic salmon	Human Not discussed	(Altuna 1997; Morales-Muñiz 2009)
Aridos, Madrid, Spain	Upper Palaeolithic	Teleostomi	Fish species	?	(Morales-Muñiz 2009)
Bora Gran d'en Carrera, Catalonia, Spain	Upper Palaeolithic	Teleostomi	Fish species	?	(Morales-Muñiz 2009)
Cova dels Ermitons, Catalonia, Spain	Middle Palaeolithic Mousterian	*Salmo trutta fario* (1)	Brown trout	?	(Rosello-Izquierdo & Morales-Muñiz 2005; Morales-Muñiz 2009)
Cueva de Abauntz, Basque Country, Spain	Upper Palaeolithic	Teleostomi	Fish species	?	(Morales-Muñiz 2009)
Cueva de Amalda, Basque Country, Spain	Middle Palaeolithic	*Salmo* sp. (3)	Salmon/Trout	?	(Rosello-Izquierdo & Morales-Muñiz 2005; Morales-Muñiz 2009)
Cueva de Los Canes, Asturias, Spain	Upper Palaeolithic	Teleostomi	Fish species	?	(Morales-Muñiz 2009)
Cueva del Castillo, Santander, Spain	MiddlePalaeolithic and Early Upper Palaeolithic	*Salmo* sp. (21 MP, 1UP) *Anguilla anguilla* (3 MP) (total NISP 25+)	Salmon/trout European eel	?	(Morales-Muñiz 2009) Studied by Russ
Davant Pau, Catalonia, Spain	Upper Palaeolithic	Teleostomi	Fish species	?	(Morales-Muñiz 2009)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
El Cingle Vermell, Catalonia, Spain	Upper Palaeolithic	Teleostomi	Fish species	?	(Morales-Muñiz 2009)
Laminak II, Basque Country, Spain	Upper Palaeolithic	Teleostomi	Fish species	?	(Morales-Muñiz 2009)
Mollet I, Catalonia, Spain	Upper Palaeolithic	Teleostomi	Fish species	?	(Morales-Muñiz 2009)
Reclau Viver, Catalonia, Spain	Upper Palaeolithic 40-30,000 bp	Teleostomi	Fish species	?	(Morales-Muñiz 2009)
Santa Catalina, Basque Country, Spain	Upper Palaeolithic	Study in Progress	Fish species	?	(Morales-Muñiz 2009)
Santimamiñe, Basque Country, Spain	Upper Palaeolithic	Study in Progress	Fish species	?	(Morales-Muñiz 2009)
Tossal de la Roca, Valencia, Spain	Upper Palaeolithic	Teleostomi	Fish species	?	(Morales-Muñiz 2009)
Monruz, Switzerland	Upper Palaeolithic Magdalenian	*Lota lota* (2) *Salvelinus alpinus* (cf.) (1) *Thymallus thymallus* (2+?765 scales) Salmonidae (1 tooth) Unidentified (121)	Burbot Arctic char Grayling Salmonid Fish species	Human 3 harpoon barbs	(Müller 2008)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Champréveyres, Switzerland	Upper Palaeolithic Magdalenian	*Lota lota* (78) *Salmo trutta* (1) *Salvelinus alpinus* (3) *Thymallus thymallus* (2 scales) *Salmonidae* (1 tooth) *Rutilus rutilus* (1 tooth) Unidentified (5 + 22 scales)	Burbot Trout Arctic char Grayling Salmonid Roach Fish species	Human Not discussed	(Müller 2008)
Achille Graziani, Italy	Upper Palaeolithic	Teleostomi (rare)	Fish species	Human Not discussed	(Radmilli 1955; 1977; Phoca-Cosmetatou 2009: 7)
Riparo di Biarzo, Friuli, Italy	Upper Palaeolithic Final Epigravettian	Teleostomi NISP 2	Fish species	Human Not discussed	(Rowley-Conwy 1996; Albertini & Tagliacozzo 2004a; Phoca-Cosmetatou 2009)
Riparo Cogola Italy	Upper Palaeolithic Final Epigravettian	*Leuciscus cephalus* (3) Cyprinid (13) *Esox lucius* (2) Unidentified (78)	European chub Cyprinid Pike Fish species	Carnivore/owl Based on spatial distribution/species presence	(Albertini & Tagliacozzo 2004b; Phoca-Cosmetatou 2009)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Riparo Dalmeri, Trento, Italy	Upper Palaeolithic Final Epigravettian	*Barbus plebejus* (46) *Leuciscus cephalus* (64) Cyprinidae (325) *Salmo trutta trutta/marmoratus* (27) *Thymallus thymallus* (22) *Esox lucius* (2) Teleostomi (1769) Total NISP 1902	Italian barbel European chub Cyprinid Trout Grayling Pike Fish species	Human No associated microfauna – not owl	(Albertini & Tagliacozzo 2004a; Phoca-Cosmetatou 2009)
Grotta delle Mura, Italy	Upper Palaeolithic Final Epigravettian	Teleostomi (present)	Fish species	Human Not discussed	(Phoca-Cosmetatou 2009)
Grotta Romanelli, Italy	Upper Palaeolithic Final Epigravettian	Teleostomi (NISP 496)	Fish species	Human Not discussed	(Tagliacozzo 2003; Phoca-Cosmetatou 2009)
Riparo Slavini, Italy	Upper Palaeolithic Final Epigravettian	Teleostomi (?1.54)	Fish species	Human Not discussed	(Phoca-Cosmetatou 2009)
Grotta della Serratura, Italy	Upper Palaeolithic Final Epigravettian	Teleostomi (NISP 346)	Fish species	Human Not discussed	(Phoca-Cosmetatou 2009)
Riparo Soman, Italy	Upper Palaeolithic Final Epigravettian	Teleostomi (NISP 7)	Fish species	Human Not discussed	(Tagliacozzo & Cassoli 1994; Albertini & Tagliacozzo 2004a; Phoca-Cosmetatou 2009)
Pradestel, Alps, Italy	Late Glacial	Teleostomi	Fish species	Human Not discussed	(Albertini & Tagliacozzo 2004a)
Romagnano III, Alps Italy	Late Glacial	Teleostomi	Fish species	Human Not discussed	(Albertini & Tagliacozzo 2004a)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Salitre, Cantabria, Spain	Azillian	*Salmo* sp. (NISP 2)	Salmonid	Unknown NISP too low	Studied by Russ
La grotte du Taillis des Coteaux, Vienne, France	Upper Palaeolithic Magdalenian	*Thymallus thymallus* (dominant) *Salmo* sp. *Coregonus* sp. Cyprinidae (rare) *Anguilla anguilla* (rare)	Grayling Salmon/trout Whitefish species Cyprinid European eel	Part human part animal	(Rambaud & Laroulandie 2009)
Sous-Balme Culoz, France	Upper Palaeolithic Sauveterrian (early)	*Salmo trutta* *Anguilla anguilla* *Alosa alosa* *Squalius cephalus* *Leuciscus leuciscus*	Trout European eel Shad European chub European Dace	Human Not discussed	(Le Gall 1993; 1994)
Chenelaz (Grotte de), Hostias, France	Upper Palaeolithic Magdalenian (upper0	*Salmo trutta* *Thymallus thymallus*	Trout Grayling	Human Not discussed	(Le Gall 1999a)
Romains de Pierre-Chatel (Grotte des), Virignin, France	Upper Palaeolithic Magdalenian (upper)	*Salmo trutta* *Lota lota* *Coregonus* *Leuciscus leuciscus*	Trout Burbot Whitefish Dace	Human Not discussed	(Le Gall 1992a; b; 1999a)
Lazaret (Grotte du), Nice, France	Lower Palaeolithic Acheulean (middle)	*Salmo trutta* *Anguilla anguilla* Percidae Gadidae Sparidae	Trout European eel Perch family Cod family Breams and porgies	Natural	(Desse & Granier 1976)
Vallonnet (Grotte du), Roquebrune-Cap-Martin, France	Lower Palaeolithic	Sparidae Labridae	Breams and Porgies Wrasses	Natural	(Cleyet-Merle 1990)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Pêcheurs (Abri des), Casteljau, France	Upper Palaeolithic Magdalenian (upper)	Salmonidae	Salmon family	Human Not discussed	(Cleyet-Merle 1990)
Orgnac, Orniac-l'Aven, France	Lower Palaeolithic Acheulean (late)	*Salmo trutta* *Barbus barbus* *Salvelinus*	Trout Barbel Charr		(Desse & Granier 1976; Cleyet-Merle 1990)
Crouzade (La), Gruissan, France	Upper Palaeolithic Azilian/ Sauveterrean	*Salmo trutta* *Sparidae*	Trout Breams and porgies		(Desse & Granier 1976; Cleyet-Merle 1990; Le Gall 1992b; 1999a)
Gazel (grotte), Sallèles-Cabardès, France	Upper Palaeolithic Magdelanian (middle)	*Salmo salar* *Salmo trutta* Cyprinidae	Atlantic salmon Trout Carp family		(Cravinho 2009)
Vaufrey (abri), Cenac-et-Saint-Julien	Middle Paleolithic Mousterian	*Salmo salar* *Salmo trutta* *Anguilla anguilla* *Thymallus thymallus* *Esox lucius* Percidae *Leuciscus leuciscus* *Squalius cephalus* *Rutillus rutillus*	Atlantic salmon Trout European eel Grayling Pike Perch family European Dace European Chub Roach		(Le Gall 1984; 1988a; b; 1992b; 1994)
Abzac (Grottes d'), Les Eyzies-de-Tayac, France	Upper Palaeolithic Magdalenian (final)	Salmonidae	Salmon family		(Le Gall 1992a; b)
Font-Brunel, Limeuil, France	Upper Palaeolithic Magdalenian	*Salmo salar* Cyprinidae	Atlantic salmon Carp family		(Capitan & Bouyssonie 1924; Cleyet-Merle 1990; Le Gall 1992b)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Combe Saunière (La), Sarliac-sur-l'Isle, France	Upper Palaeolithic, Solutrean	*Salmo trutta* Cyprinidae	Trout Carp family		(Le Gall 1992b)
Castanet (Abri), Sergeac, France	Upper Palaeolithic Aurignacian	*Salmo salar* *Salmo trutta*	Atlantic salmon Trout		(Cravinho 2009)
Jolivet, Terrasson, France	Upper Palaeolithic Magdalenian	Teleostomi	Fish		(Le Gall 1992a; b)
Mandrin (Grotte), Malataverne, France	Middle Palaeolithic Mousterian	*Salmonidae*	Salmon family		(Cravinho 2009)
Durfort, Durfort-et-Saint-Martin-de-Saussenac, France	Lower Palaeolithic	*Salmo trutta* *Cyprinidae* *Esox lucius*	Trout Carp family Pike	Natural	(Desse & Granier 1976)
Monclus (Baume de), Monclus, France	Upper Palaeolithic Magdalenian (final)	*Teleostomi*	Fish		(Escalon De Fonton 1976; Le Gall 1992a; b)
Salpêtre (Grotte du), Pompignan, France	Middle Palaeolithic Mousterian	*Salmo trutta* *Anguilla anguilla*	Trout European eel		(Le Gall 1992b)
Esquicho-Crapaou (Grotte de l'), Sainte-Anastasie, France	Upper Palaeolithic Aurignacian (lower)	*Leuciscus leuciscus* *Barbus barbus* *Rutillus rutillus*	European Dace Barbel Roach		(Cleyet-Merle 1990; Le Gall 1992b)
Balauzière (La), Vers-Pont-du-Gard, France	Upper Palaeolithic Aurignacian	*Raja sp.*	Ray		(Cleyet-Merle 1990)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Vidon (Abri du), Juillac, France	Upper Palaeolithic Magdalenian (upper)	*Teleostomi*	Fish		(Le Gall 1992a; b)
Roc de Marcamps, Marcamps, France	Upper Palaeolithic Magdalenian (IV)	*Salmo salar* *Salmo trutta*	Atlantic salmon Trout		(Le Gall 1992a; b)
Pair-Non-Pair, Marcamps, France	Middle Palaeolithic Mousterian	*Telestomi*	Fish		(Le Gall 1992b)
Buholoup (Abri de), Montberaud, France	Upper Palaeolithic Azilian	*Salmonidae* *Cyprinidae* *Anguilla anguilla* *Esox lucius*	Salmon family Carp family European eel Pike		(Le Gall 1993)
Rond-du-Barry, Polignac, France	Upper Palaeolithic Magdalenian (I and II (lower))	*Salmo salar* *Salmo trutta* *Esox lucius*	Atlantic salmon Trout Pike		(Le Gall 1992a; b)
Vieille Eglise (Abri de la), La Balme de Thuy, France	Upper Palaeolithic	*Salmo trutta*	Trout		(Bintz *et al.* 1995)
Noisetier (Grotte du), Frechet-Aure, France	Middle Palaeolithic Mousterian	*Salmonidae* *Cyprinidae*	Salmon family Carp family		(Le Gall 1992b; 2000)
Carrière (Grotte de la), Gerde, France	Middle Palaeolithic Mousterian	*Salmo trutta* *Anguilla anguilla* *Lota lota*	Trout European eel Burbot		(Desse & Granier 1976; Le Gall 1992b; 2000)
Moulin (Grotte abri du), Troubat, France	Upper Palaeolithic Magdalenian, Azilian and Sauvetterien	*Salmo salar* *Salmo trutta* *Esox lucius* *Squalius cephalus*	Atlantic salmon Trout Pike European chub		(Barbaza 1988; Le Gall 1993)

Site	Date	Species	Common Name	Accumulation agent? Why?	Reference
Mas de Caves (Grottes du), Lunel-Viel, France	Middle Pleistocene Lower Palaeolithic	Teleostomi	Fish		(Cleyet-Merle 1990)
Baume de Gigny, Gigny sur Suran, France	Middle Palaeolithic Mousterian	*Salmo trutta* *Cyprinid* *Esox lucius* *Thymallus tymallus* *Lota lota*	Trout Carp family Pike Grayling Burbot		(Desse & Desse 1989)
Fieux (Les), Miers, France	Middle Palaeolithic Mousterian	*Salmonid* *Cyprinid* *Anguilla anguilla* *Esox lucius*	Salmon family Carp family European eel Pike		(Le Gall 1992b; 2000)
Pointe du Rozel (Abri-sous-roche de la), Rozel, France	Upper Palaeolithic Magdalenian	*Labridae*	Wrasses		(Cleyet-Merle 1990)
Erguillère-Port-Racine, Saint-Germain-des-Vaux, France	Middle Palaeolithic Mousterian	*Teleostomi*	Fish		(Cleyet-Merle 1990)
Olha (Abri), Cambo, France	Middle Palaeolithic Mousterian	Salmonidae Cyprinidae *Anguilla anguilla*	Salmon family Carp family European eel		(Le Gall 1992b; 2000)
Embulla, Villefranche-de-Conflent, France	Upper Palaeolithic Solutrean (upper)	*Salmo trutta*	Trout		(Le Gall 1999a)
Jean Pierre 1 and 2, Saint-Thibaud-de-Couz, France	Upper Palaeolithic Magdalenian (upper)	*Salmo salar* *Salmo trutta* *Lota lota*	Atlantic salmon Trout Burbot		(Desse & Granier 1976; Bintz *et al.* 1995)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Unnamed site, Sonnaz, France	Middle Palaeolithic Mousterian	*Esox lucius*	Pike		(Desse & Granier 1976)
Cure (Grottes de la), Arcy-sur-Cure, France	Middle and Upper Palaeolithic	*Salmonidae* *Thymallus thymallus*	Salmon family Grayling		(Baffier *et al.* 2005)
Renne (Grotte du), Arcy-sur-Cure, France	Châtelperronien	*Thymallus thymallus*	Grayling		(Baffier *et al.* 2005)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Zigeunerfels, Germany	Upper Palaeolithic				(Torke 1998)
D	Final Upper Palaeolithic	Salmonid *Salmo trutta* *Thymallus thymallus* *Hucho hucho* *Esox lucius* *Cottus gobio* *Lota lota*	Salmon family Trout Grayling Danube salmon Pike European bullhead Burbot		
E, F, G	Late Magdalenian	Salmonid (not E) *Salmo trutta* (not E) *Thymallus thymallus* (not E) *Hucho hucho* (not E) *Squalius cephalus* *Chondrostoma polylepis* *Barbus barbus* *Cottus gobio* (not E) *Gymnocephalus cernuus* (E only ?) *Lota lota* (not E)	Salmon family Trout Grayling Danube salmon European chub Nase Barbel European bullhead Ruffe (?) Burbot		
H	Magdalenian	*Barbus barbus*	Barbel		

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Burghöhle, Germany (370-300) (455-350)	Upper Palaeolithic Late Magdalenian	*Salmonid* *Salmo trutta* *Thymallus thymallus* *Hucho hucho* *Squalius cephalus* *Chondrostoma polylepis* *Barbus barbus* *Cottus gobio* *Gymnocephalus cernuus?* *Lota lota*	Salmon family Trout Grayling Danube salmon European chub Nase Barbel European bullhead Ruffe? Burbot		(Torke 1998)
Brillenhöhle, Germany IV, V-VII	Late Magdalenian Gravettian	Teleostomi Salmonid *Hucho hucho* *Thymallus thymallus*	Fish species Salmon family Danube salmon Grayling		(Torke 1981; 1998; Hahn 2000; Hockett & Haws 2005; Smith 2007)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Geißenklösterle, Germany	Upper Palaeolithic				(Torke 1981; Hahn 1988; Torke 1998; Münzel 2001; Münzel & Conard 2004)
Io	Magdalenian	*Salmonid*	Salmon family		
		Salmo trutta	Trout		
		Thymallus thymallus	Grayling		
		Hucho hucho	Danube salmon		
		Esox lucius	Pike		
		Cottus gobio	European bullhead		
		Phoxinus sp.	Minnow		
		Lota lota	Burbot		
GH5, GH6-9	Gravettian	Salmonid	Salmon family		
		Salmo trutta	Trout		
		Thymallus thymallus	Grayling		
		Esox lucius (6-9 only)	Pike		
		Cottus gobio	European bullhead		
		Phoxinus sp.	Minnow sp.		
		Lota lota	Burbot		
		Salvelinus sp. (5 only)	Charr		
GH11-13, GH14-16, GH18, GH 19	Aurignacian	Salmonid	Salmon family		
		Thymallus thymallus	Grayling		
		Hucho hucho (14-16 only)	Danube salmon		
		Cottus gobio	European bullhead		
		Phoxinus sp. (14-16 only)	Minnow		
		Lota lota (not 18)	Burbot		

Site	Date	Species	Common Name	Accumulation agent? Why?	Reference
Malerfels, Germany GH GK	Upper Palaeolithic Magdalenian	Salmonid *Salmo trutta* *Thymallus thymallus* *Hucho hucho* *Esox lucius* *Cottus gobio* *Phoxinus* sp. *Lota lota*	Salmon family Trout Grayling Danube salmon Pike European bullhead Minnow Burbot		(Torke 1998)
Felsställe, Germany III b	Upper Palaeolithic Magdalenian	Salmonid *Salmo trutta* *Thymallus thymallus* *Hucho hucho* *Esox lucius* *Cottus gobio* *Phoxinus* sp. *Lota lota*	Salmon family Trout Grayling Danube salmon Pike European bullhead Minnow Burbot		(Torke 1998)
Spitzbubenhöhle, Germany 8/9	Upper Palaeolithic Magdalenian	*Squalius cephalus* Cobitidae	European chub Loach family		(Torke 1998)

Site	**Date**	**Species**	**Common Name**	**Accumulation agent? Why?**	**Reference**
Hohlefels, Germany Iia	Upper Palaeolithic Magdalenian	*Squalius cephalus* Cobitidae	European chub Loach family		(Torke 1981; 1998; Hahn 2000; Hockett & Haws 2005; Smith 2007)
AH I	Early Magdalenian	Salmonid *Salmo trutta* *Thymallus thymallus* *Esox lucius* *Squalius cephalus* *Cottus gobio* *Phoxinus* sp. *Lota lota* *Salvelinus sp.*	Salmon family Trout Grayling Pike European chub European bullhead Minnow Burbot Charr		
Iib-d, AHIII	Gravettian	Salmonid *Salmo trutta*(not AHIII) *Thymallus thymallus* *Esox lucius* (not AHIII) Squalius cephalus (not AHIII) Cobitidae(not AHIII) *Cottus gobio* *Phoxinus* sp. (not AHIII) *Lota lota* (not AHIII) *Salvelinus* sp. (not AHIII?)	Salmon family Trout Grayling Pike European chub Loach family European bullhead Minnow Burbot Charr		
Buttentalhöhle, Germany	Upper Palaeolithic Magdalenian	*Squalius cephalus* Cobitidae	European chub Loach family		(Torke 1998)

Site	Date	Species	Common Name	Accumulation agent? Why?	Reference
Kogelstein, Germany	Middle Palaeolithic	*Thymallus thymallus* (53) *Lota lota* (31) *Cottus gobio* (5) Salmonid (3) Unidentified (2)	Grayling Burbot European bullhead Salmon family Fish species		(Böttcher *et al.* 2000)
Bilzingsleben, Germany	Lower Palaeolithic	*Phoxinus* cf. *phoxinus* *Tinca tinca* *Lota lota* *Silurus glanis* Cyprinidae *Cottus* cf. *gobio*	Minnow Tench Burbot Wels catfish Carp family European bullhead	Natural	(Böhme 1998)

Appendix II: Upper Palaeolithic sites with identified fish remains

Site	Country	Site	Country
Abeurador	France	Brillenhöhle	Germany
Abri Fritsch	France	Burghöhle	Germany
Abri Pataud	France	Buttentalhöhle	Germany
Abri Pataud	France	Felsställe	Germany
Abzac	France	Geißenklösterle	Germany
Aurensan	France	Hohlefels	Germany
Badegoule	France	Malerfels	Germany
Belvis	France	Spitzbubenhöhle	Germany
Bois des Brousses	France	Zigeunerfels	Germany
Bois Ragot	France	Gorham's Cave	Gibralter
Bruniquel	France	Barma Grande	Italy
Canecaude	France	Ciccio Felice Cave	Italy
Castanet	France	Grotta della Madonna	Italy
Casteljau	France	Grotta di Pozzo	Italy
Chenelaz	France	La Punta Cave	Italy
Combe Saunière	France	Maritza Cave	Italy
Cottier	France	Maurizio Shelter	Italy
Couze	France	Ortucchio Cave	Italy
Crouzade	France	Riparo Cogola	Italy
Cure	France	Riparo Dalmeri	Italy
Dufaure	France	Picareiro Cave	Portugal
Duruthy	France	Aitzbitarte	Spain
Embulla	France	Altamira	Spain
Espelugues	France	Arbreda Cave	Spain
Esquicho-Crapaou	France	Cueto de la Mina	Spain
Faustin	France	Cueva Chufin	Spain
Fontalès	France	Cueva de Nerja	Spain
Font-Brunel	France	Cueva del Castillo	Spain
Gare de Conduché	France	Cueva Oscura	Spain
Gazel	France	El Buxu	Spain
Grotte de Harpons	France	El Juyo	Spain
Grotte de l'Oeil	France	El Mirón	Spain
Grotte des Eyzies	France	Fonfría B	Spain
Grotte du Pape	France	Hornos de la Peña	Spain
Jean-Pierre 1	France	La Lluera	Spain
Jean-Pierre 2	France	La Riera	Spain

La Balauziere	France	Las Caldas	Spain
La Garenne	France	Mazaculos	Spain
La Grotte des Eglises	France	Rascaño	Spain
La Grotte du Bourrouilla	France	Salitre	Spain
La grotte du Taillis des Coteaux	France	Sofoxo	Spain
La Madeleine	France	Tito Bustillo	Spain
La Vache	France	Champréveyres	Switzerland
Lachaud	France	Monruz	Switzerland
Laroque	France	Bois de Laterie	Belgium
Laugerie Haute	France	Grotte da la Princesse	Belgium
Le Flageolet	France	Néviau	Belgium
Le Peyrat	France	Trou de Chaleux	Belgium
Les Peyrugues	France	Trou du Frontal	Belgium
Limeuil	France	Trou du Sureau	Belgium
Liveyre	France	Pin Hole Cave	England
Mas d'Azil	France		
Morin	France		
Moulin	France		
Pégourié	France		
Pierre Chatel	France		
Pointe du Rozel	France		
Pont d'Ambon	France		
Reignac	France		
Renne	France		
Rhodes II	France		
Roc de Combe	France		
Roc de Marchamps	France		
Rochereil	France		
Romains de Pierre Chatel	France		
Rond-du-Barry	France		
Sainte-Anastasie	France		
Souilhac	France		
Sous-Balme	France		
Vieille Eglise	France		

Appendix III: Trampling experiment raw data

PIKE 1	Per fish	25 Paces	75 Paces	175 Paces	375 Paces	IR
Neurocranium						
Basioccipital	1	1	1	1	1	1
Frontal	2	2	2	2	1	2
Otolith	2	2	1	1	1	3
Parasphenoid	1	1	1	1	1	1
Vomer	1	1	1	1	1	1
Suspensorium						
Articular	2	2	2	2	2	1
Dentary	2	2	2	2	2	1
Ectopterygoid	2	2	2	2	2	1
Entopterygoid	2	2	2	1	0	4
Maxilla	2	2	2	2	2	1
Metapterygoid	2	2	2	0	0	5
Palatine	2	2	2	1	1	3
Premaxilla	2	1	1	1	1	1
Quadrate	2	2	2	2	2	1
Interopercular	2	2	2	1	0	4
Opercular	2	2	1	1	0	4
Preopercular	2	2	2	2	2	1
Subopercular	2	1	0	0	0	5
Hyomandibular etc.						
Ceratohyal	2	2	2	2	2	1
Epihyal	2	2	2	2	2	1
Hyomandibular	2	2	2	2	2	1
Urohyal	1	1	1	1	1	1
Branchial Region						
Cleithrum	2	2	2	2	2	1
Post-temporal	2	1	1	0	0	5
Scapula	2	1	1	1	1	1
Supracleithrum	2	2	2	2	1	2
Pharyngeals	\	\	\	\	\	\
Vertebrae						
Type 1	1	1	1	1	1	1
Type 2	40	40	40	40	40	1
Type 3	12	12	12	12	12	1
Type 4	5	5	5	5	5	1
Type 5	2	2	2	2	2	1
Total vertebrae	60	60	60	60	60	1
Basipterygium	2	1	1	1	1	1
Hypural	1	1	1	1	1	1
Coracoid	2	1	1	0	0	5

PIKE 2	Per fish	25 Paces	75 Paces	175 Paces	375 Paces	IR
Neurocranium						
Basioccipital	1	1	1	1	1	1
Frontal	2	2	1	1	0	4
Otolith	2	2	2	2	2	1
Parasphenoid	1	1	1	0	0	5
Vomer	1	1	1	1	1	1
Suspensorium						
Articular	2	2	2	2	0	3
Dentary	2	2	2	2	2	1
Ectopterygoid	2	2	1	0	0	5
Entopterygoid	2	2	0	0	0	5
Maxilla	2	2	2	2	1	2
Metapterygoid	2	2	2	0	0	5
Palatine	2	2	2	2	1	4
Premaxilla	2	2	2	2	2	1
Quadrate	2	2	2	2	2	1
Interopercular	2	2	2	2	2	1
Opercular	2	2	2	1	0	4
Preopercular	2	2	2	2	1	2
Subopercular	2	2	2	1	0	4
Hyomandibular etc.						
Ceratohyal	2	2	2	2	0	3
Epihyal	2	2	2	1	0	4
Hyomandibular	2	2	2	2	2	1
Urohyal	1	1	1	0	0	5
Branchial Region						
Cleithrum	2	2	2	2	2	1
Post-temporal	2	2	1	0	0	5
Scapula	2	2	2	2	1	2
Supracleithrum	2	2	2	2	0	3
Pharyngeals		2	2	1	0	4
Vertebrae						
Type 1	1	1	1	1	1	1
Type 2	1	1	1	1	1	1
Type 3	30	30	30	30	30	1
Type 4	8	8	8	8	7	2
Type 5	14	14	14	14	13	2
Type 6	5	5	5	5	4	2
Type 7	1	1	1	1	1	1
Total vertebrae	60	60	60	60	57	

PIKE 3	Per fish	25 Paces	75 Paces	175 Paces	375 Paces	IR
Neurocranium						
Basioccipital	1	1	1	1	1	1
Frontal	2	2	2	2	2	1
Otolith	1	1	1	2frags	2frags	3
Parasphenoid	1	1	1	1	1	1
Vomer	1	1	1	1	1	1
Suspensorium						
Articular	2	2	2	2	2	1
Dentary	2	2	2	2	2	1
Ectopterygoid	2	2	2	1	1	3
Entopterygoid	2	2	0	0	0	5
Maxilla	2	2	2	1	1	3
Metapterygoid	2	2	2	2	1	2
Palatine	2	2	2	2	2	1
Premaxilla	2	2	2	2	2	1
Quadrate	2	2	2	2	2	1
Interopercular	2	2	2	1	1	3
Opercular	2	2	2	2	2	1
Preopercular	2	2	2	2	1	2
Subopercular	2	1	0	0	0	5
Hyomandibular etc.						
Ceratohyal	2	2	2	2	2	1
Epihyal	2	2	2	2	2	1
Hyomandibular	2	2	2	2	2	1
Urohyal	1	1	0	0	0	5
Branchial Region						
Cleithrum	2	2	2	2	2	1
Post-temporal	2	1	0	0	0	5
Scapula	2	2	2	2	2	1
Supracleithrum	2	1	1	1	1	3
Vertebrae						
Type 1	1	1	1	1	1	1
Type 2	38	38	38	38	38	1
Type 3	13	13	13	13	13	1
Type 4	5	5	5	5	5	1
Type 5	2	2	2	2	2	1
Total vertebrae	59	59	59	59	59	1
Hypural	1	1	1	1	1	1
Coracoid	2	0	0	0	0	5

CHUB 1	Per fish	25 Paces	75 Paces	175 Paces	375 Paces	IR
Neurocranium						
Basioccipital	1	1	1	1	1	1
Frontal	2	2	2	1	1	3
Otolith	2	2	2	2	2	1
Parasphenoid	1	1	1	1	1	1
Vomer	1	0	0	0	0	\
Suspensorium						
Articular	2	2	0	0	0	\
Dentary	2	2	2	1	1	3
Ectopterygoid	2	2	2	2	1	2
Entopterygoid	2	2	2	1	1	3
Maxilla	2	1	1	1	1	1
Metapterygoid	2	2	1	1	0	4
Palatine	2	0	0	0	0	\
Premaxilla	2	2	2	2	2	1
Quadrate	2	1	1	1	1	1
Interopercular	2	2	2	2	1	2
Opercular	2	2	2	2	1	2
Preopercular	2	2	2	2	2	1
Subopercular	2	1	1	1	1	3
Hyomandibular etc.						
Ceratohyal	2	0	0	0	0	\
Epihyal	2	0	0	0	0	\
Hyomandibular	2	2	2	1	1	3
Urohyal	1	1	1	1	1	1
Branchial Region						
Cleithrum	2	2	2	2	2	1
Post-temporal	2	2	1	1	1	3
Scapula	2	1	1	1	1	1
Supracleithrum	2	1	0	0	0	5
Pharyngeals	\	2	2	2	2	1
Vertebrae						
Type 1a	1	1	1	1	1	1
Type 1b	1	1	1	1	1	1
Type 1c	1	1	1	1	1	1
Type 1d	1	1	1	1	1	1
Type 1e	1	1	1	1	1	1
Type 2	15	15	15	11	11	2
Type 3	4	4	4	3	3	2
Type 4	17	17	16	16	16	2
Type 5	1	1	1	1	1	1
Total vertebrae	42	42	42	37	37	2

CHUB 2	Per fish	25 Paces	75 Paces	175 Paces	375 Paces	IR
Neurocranium						
Basioccipital	1	1	1	1	1	1
Frontal	2	2	2	1	0	4
Otolith	2	2	2	2	2	1
Parasphenoid	1	1	1	1	1	1
Vomer	1	0	0	0	0	\
Suspensorium						
Articular	2	1	1	1	1	1
Dentary	2	2	2	2	1	2
Ectopterygoid	2	2	2	2	1	2
Entopterygoid	2	2	2	2	1	2
Maxilla	2	0	0	0	0	\
Metapterygoid	2	2	2	1	1	3
Palatine	2	0	0	0	0	\
Premaxilla	2	2	1	1	1	3
Quadrate	2	1	1	1	1	1
Interopercular	2	2	2	2	1	2
Opercular	2	2	2	2	1	2
Preopercular	2	2	2	2	2	1
Subopercular	2	2	2	1	1	3
Hyomandibular etc.						
Ceratohyal	2	1	1	1	1	1
Epihyal	2	0	0	0	0	\
Hyomandibular	2	2	2	2	1	2
Urohyal	1	1	1	1	1	1
Branchial Region						
Cleithrum	2	2	1	1	1	3
Post-temporal	2	2	2	1	1	3
Scapula	2	1	1	1	1	1
Supracleithrum	2	1	1	0	0	5
Pharyngeals	2	2	2	2	2	1
Vertebrae						
Type 1a	1	1	1	1	1	1
Type 1b	1	1	1	1	1	1
Type 1c	1	1	1	1	1	1
Type 1d	1	1	1	1	1	1
Type 1e	1	1	1	1	1	1
Type 2	16	16	16	16	15	2
Type 3	4	4	4	4	4	1
Type 4	17	17	15	15	14	2
Type 5	1	1	1	1	1	1
Total vertebrae	43	43	41	41	39	

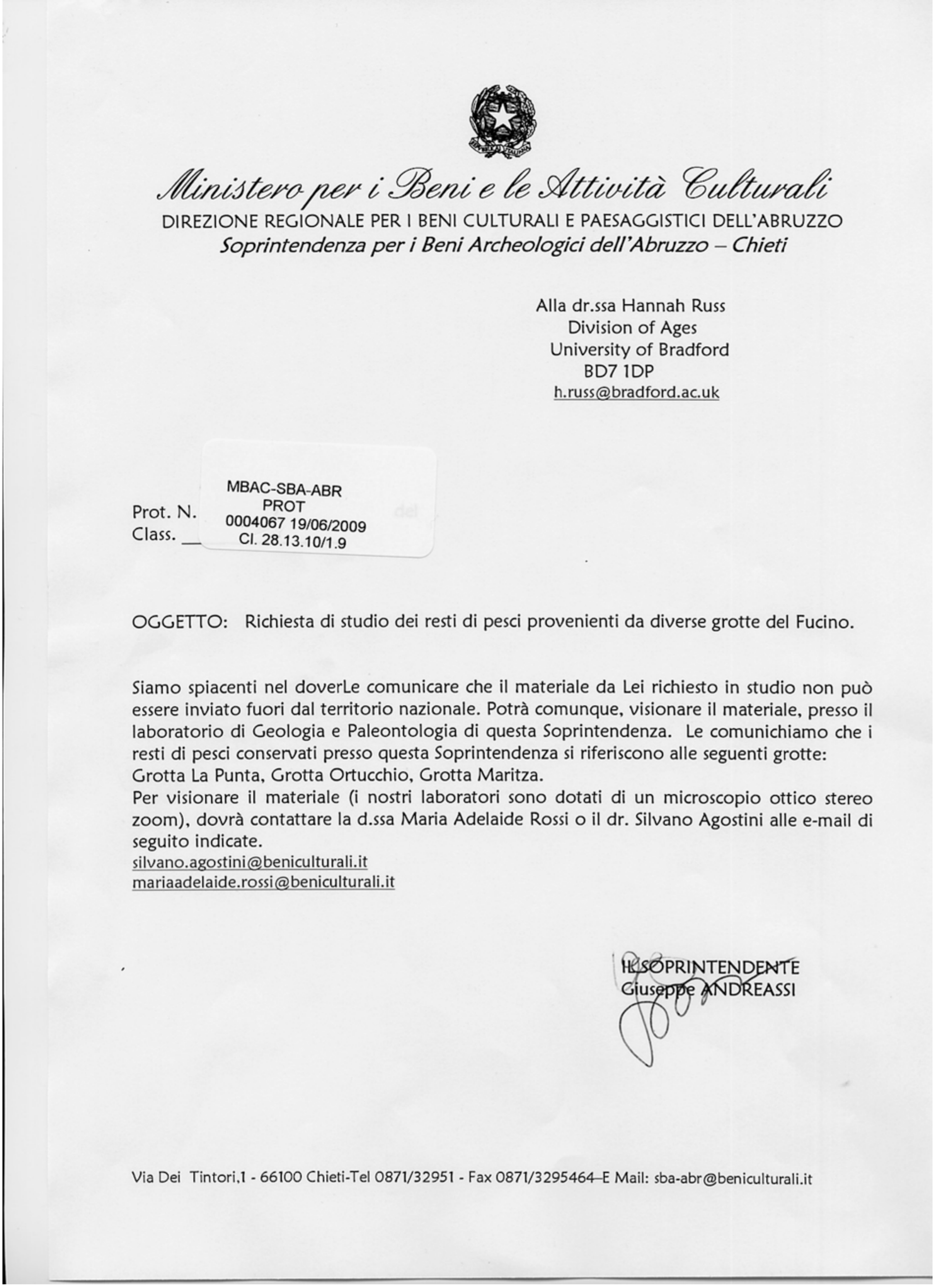
CHUB 3	Per fish	25 Paces	75 Paces	175 Paces	375 Paces	IR
Neurocranium						
Basioccipital	1	1	1	1	1	1
Frontal	2	2	2	1	0	4
Otolith	2	2	2	2	2	1
Parasphenoid	1	1	1	1	1	1
Vomer	1	0	0	0	0	\
Suspensorium						
Articular	2	1	1	1	1	1
Dentary	2	2	2	2	1	2
Ectopterygoid	2	2	2	2	1	2
Entopterygoid	2	2	2	2	1	2
Maxilla	2	0	0	0	0	\
Metapterygoid	2	2	2	1	1	3
Palatine	2	0	0	0	0	\
Premaxilla	2	2	1	1	1	3
Quadrate	2	1	1	1	1	1
Interopercular	2	2	2	2	1	2
Opercular	2	2	2	2	1	2
Preopercular	2	2	2	2	2	1
Subopercular	2	1	1	1	1	3
Hyomandibular etc.						
Ceratohyal	2	1	1	1	1	1
Epihyal	2	0	0	0	0	\
Hyomandibular	2	2	2	2	1	2
Urohyal	1	1	1	1	1	1
Branchial Region						
Cleithrum	2	2	1	1	1	3
Post-temporal	2	2	2	1	1	3
Scapula	2	1	1	1	1	1
Supracleithrum	2	1	1	0	0	5
Pharyngeals	2	2	2	2	2	1
Vertebrae						
Type 1a	1	1	1	1	1	1
Type 1b	1	1	1	1	1	1
Type 1c	1	1	1	1	1	1
Type 1d	1	1	1	1	1	1
Type 1e	1	1	1	1	1	1
Type 2	16	16	16	16	15	2
Type 3	4	4	4	4	4	1
Type 4	15	15	14	14	13	2
Type 5	1	1	1	1	1	1
Total vertebrae	41	41	39	39	37	

TROUT 1	Per fish	25 Paces	75 Paces	175 Paces	375 Paces	IR
Neurocranium						
Basioccipital	1	1	1	1	1	1
Frontal	2	2	2	2	1	2
Otolith	2	2	2	2	2	1
Parasphenoid	1	1	1	1	0	3
Vomer	1	1	1	1	1	1
Suspensorium						
Articular	2	2	2	2	2	1
Dentary	2	2	2	2	2	1
Ectopterygoid	2	2	2	2	2	1
Entopterygoid	2	2	0	0	0	5
Maxilla	2	2	2	2	2	1
Metapterygoid	2	2	2	2	1	2
Palatine	2	2	2	2	2	1
Premaxilla	2	2	2	2	2	1
Quadrate	2	2	2	2	2	1
Interopercular	2	2	2	2	1	2
Opercular	2	2	2	2	1	2
Preopercular	2	2	2	2	2	1
Subopercular	2	2	2	2	2	1
Hyomandibular etc.						
Ceratohyal	2	2	2	2	2	1
Epihyal	2	2	2	2	2	1
Hyomandibular	2	2	2	2	2	1
Urohyal	1	1	1	1	1	1
Branchial Region						
Cleithrum	2	2	1	1	1	3
Post-temporal	2	2	2	2	2	1
Scapula	2	2	2	2	2	1
Supracleithrum	2	2	1	1	1	3
Pharyngeals	\	\	\	\	\	
Vertebrae						
Type 1a	1	1	1	1	1	1
Type 1b	1	1	1	1	1	1
Type 2	26	26	26	26	26	1
Type 3	28	28	28	28	28	1
Type 4	3	3	3	3	2	2
Type 5	3	3	3	3	3	1
Total vertebrae	62	62	62	62	61	
Basipterygium	2	2	2	2	2	1
Glossohyal	1	1	0	0	0	5
Hypural	1	1	1	1	1	1

TROUT 2	Per fish	25 Paces	75 Paces	175 Paces	375 Paces	IR
Neurocranium						
Basioccipital	1	1	1	1	1	1
Frontal	2	2	2	2	2	1
Otolith	2	2	2	1.5	1	2.5
Parasphenoid	1	1	1	1	1	1
Vomer	1	0	0	0	0	5
Suspensorium						
Articular	2	2	2	2	2	1
Dentary	2	2	2	2	2	1
Ectopterygoid	2	2	2	2	1	2
Entopterygoid	\	\	\	\	\	
Maxilla	2	2	2	2	2	1
Metapterygoid	2	2	2	2	2	1
Palatine	2	2	2	2	2	1
Premaxilla	2	2	2	2	2	1
Quadrate	2	2	2	2	2	1
Interopercular	2	0	0	0	0	5
Opercular	2	2	1	1	1	3
Preopercular	2	1	1	0	0	5
Subopercular	2	2	1	0	0	5
Hyomandibular etc.						
Ceratohyal	2	2	2	2	2	1
Epihyal	2	2	2	2	2	1
Hyomandibular	2	2	2	2	2	1
Urohyal	\	\	\	\	\	
Branchial Region						
Cleithrum	2	2	2	2	0	3
Post-temporal	2	2	2	2	2	1
Scapula	2	2	2	2	2	1
Supracleithrum	2	2	2	2	1	2
Pharyngeals	\	\	\	\	\	
Vertebrae						
Type 1a	1	1	1	1	1	1
Type 1b	1	1	1	1	1	1
Type 2	28	27	27	27	27	1
Type 3	28	28	28	28	27	1
Type 4	3	3	3	3	3	1
Type 5	2	2	2	2	2	1
Total vertebrae	62	61	61	61	60	
Basipterygium	2	2	2	2	2	1
Glossohyal	1	1	1	1	0	3
Hypural	1	1	1	1	1	1

TROUT 3	**Per fish**	**25 Paces**	**75 Paces**	**175 Paces**	**375 Paces**	**IR**
Neurocranium						
Basioccipital	1	1	1	1	1	1
Frontal	2	2	2	2	2	1
Otolith	2	2	2	2	1.5	1.5
Parasphenoid	1	1	1	1	1	1
Vomer	1	1	1	1	1	1
Suspensorium						
Articular	2	2	2	2	2	1
Dentary	2	2	2	2	2	1
Ectopterygoid	2	2	2	2	2	1
Entopterygoid	2	2	2	1	1	3
Maxilla	2	2	2	2	2	1
Metapterygoid	2	2	2	2	0	3
Palatine	2	2	2	2	2	1
Premaxilla	2	2	2	2	2	1
Quadrate	2	2	2	2	1	2
Interopercular	2	2	2	2	2	1
Opercular	2	2	2	2	2	1
Preopercular	2	2	2	2	2	1
Subopercular	2	2	2	2	2	1
Hyomandibular etc.						
Ceratohyal	2	2	2	2	2	1
Epihyal	2	2	2	2	2	1
Hyomandibular	2	2	2	2	2	1
Urohyal	1	1	1	1	1	1
Branchial Region						
Cleithrum	2	2	2	0	0	5
Post-temporal	2	2	2	2	2	1
Scapula	2	2	2	2	2	1
Supracleithrum	2	2	2	2	2	1
Pharyngeals	\	\	\	\	\	
Vertebrae						
Type 1a	1	1	1	1	1	1
Type 1b	1	1	1	1	1	1
Type 2	25	25	25	25	25	1
Type 3	29	29	29	29	29	1
Type 4	3	3	3	3	3	1
Type 5	2	2	2	2	2	1
Total vertebrae	61	61	61	61	61	1
Basipterygium	2	2	2	2	2	1
Glossohyal	1	1	1	1	1	1
Hypural	1	1	1	1	1	1

Appendix IV: Access to archaeological assemblages



Ministero per i Beni e le Attività Culturali
DIREZIONE REGIONALE PER I BENI CULTURALI E PAESAGGISTICI DELL'ABRUZZO
Soprintendenza per i Beni Archeologici dell'Abruzzo – Chieti

Alla dr.ssa Hannah Russ
Division of Ages
University of Bradford
BD7 1DP
h.russ@bradford.ac.uk

Prot. N. del
Class.

MBAC-SBA-ABR
PROT
0004067 19/06/2009
Cl. 28.13.10/1.9

OGGETTO: Richiesta di studio dei resti di pesci provenienti da diverse grotte del Fucino.

Siamo spiacenti nel doverLe comunicare che il materiale da Lei richiesto in studio non può essere inviato fuori dal territorio nazionale. Potrà comunque, visionare il materiale, presso il laboratorio di Geologia e Paleontologia di questa Soprintendenza. Le comunichiamo che i resti di pesci conservati presso questa Soprintendenza si riferiscono alle seguenti grotte: Grotta La Punta, Grotta Ortucchio, Grotta Maritza.
Per visionare il materiale (i nostri laboratori sono dotati di un microscopio ottico stereo zoom), dovrà contattare la d.ssa Maria Adelaide Rossi o il dr. Silvano Agostini alle e-mail di seguito indicate.
silvano.agostini@beniculturali.it
mariaadelaide.rossi@beniculturali.it

IL SOPRINTENDENTE
Giuseppe ANDREASSI

Via Dei Tintori,1 - 66100 Chieti-Tel 0871/32951 - Fax 0871/3295464–E Mail: sba-abr@beniculturali.it

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7 de Septiembre de 2009

Hannah Russ
Division of AGES
University of Bradford
BRADFORD, West Yorkshire BDT 1DP
GRAN BRETAÑA

Estimada Hannah Russ:

En respuesta a su amable carta, le comunico que por mi parte tiene Vd. permiso para acceder a las colecciones paleolíticas de las cuevas por mí excavadas del Juyo, Rascaño y Altamira.

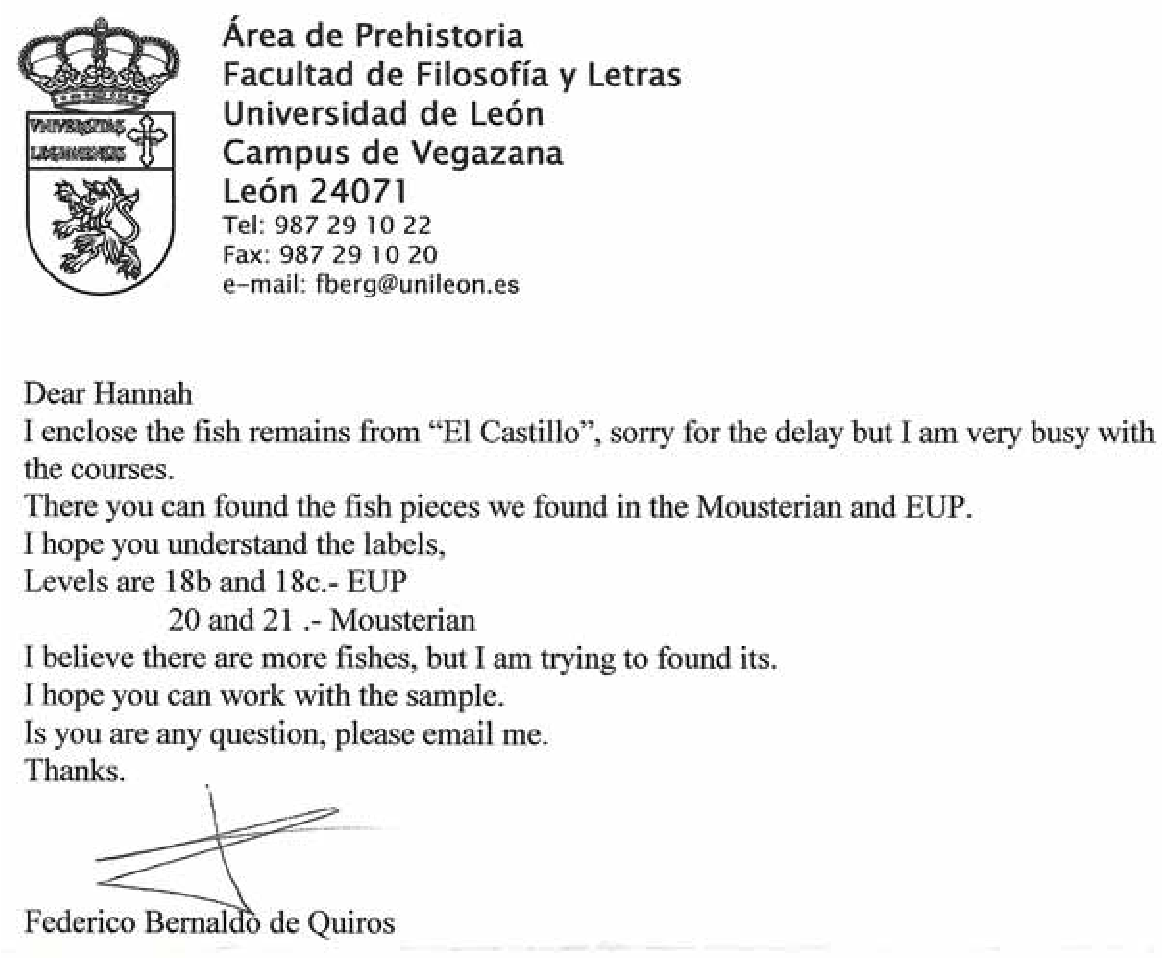
Ahora bien, los materiales están depositadps en el Museo Nacional de Altamira, SANTILLANA DEL MAR, 39330 CANTABRIA. El director es José Antonio de Lasheras. El es quien debe darle autorización para la consulta de los materiales y eventualmente de los registros del inventario.

De todas maneras, yo me pondré en contacto con él, para recomendarle a Vd. Pero debe escribirle Vd. directamente para solicitar la autorización y concretar las condiciones de su trabajo en el museo.

Salvo referencias ailadas en la bibliografía (Pokiness 1998, Freeman et alii 1988 para El Juyo, y Madariaga en González Echegaray et alli para Rascaño), no hay hasta ahora ningun estudio sobre los restos de peces en esos yacimientos.

Con mucho gusto tendré una entrevista con Vd. cuando se encuentre en Santander haciendo su estudio. Entre tanto, reciba un cordial saludo.

Joaquín González Echegaray



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Dear Hannah
I enclose the fish remains from "El Castillo", sorry for the delay but I am very busy with the courses.
There you can found the fish pieces we found in the Mousterian and EUP.
I hope you understand the labels,
Levels are 18b and 18c.- EUP
20 and 21 .- Mousterian
I believe there are more fishes, but I am trying to found its.
I hope you can work with the sample.
Is you are any question, please email me.
Thanks.

Federico Bernaldo de Quiros

Appendix V: Catalogue of fish remains from Fucino Basin sites

Attribution to season as listed in the comments column are based on determinations by Barbara Wilkens . These were noted during analysis but no estimation of season of death was done by Russ.

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.2	4.5	4.4	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.0	3.8	3.1	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.2	4.0	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.3	3.4	3.0	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.3	3.6	3.2	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.1	4.2	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	3.8	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	\	\	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.1	4.3	4.3	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.6	4.0	3.6	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.0	3.2	3.0	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.1	3.8	3.4	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.7	3.2	3.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.3	4.4	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.4	3.5	3.4	
Ortucchio	121h	31	Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.5	4.1	3.7	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.8	4.7	3.8	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.0	3.3	3.3	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.6	3.5	3.7	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	4.2	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	\	\	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	4.1	4.1	

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.3	3.6	3.3	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	4.1	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.6	3.8	3.6	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.2	3.7	3.1	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	\	\	3.8	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	4.2	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.2	3.9	3.2	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	4.0	3.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.2	3.9	3.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.5	4.5	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.0	4.3	3.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.3	3.5	3.4	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	5.0	4.9	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.2	3.4	3.6	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.0	3.5	3.2	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	\	\	4.4	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.2	3.4	\	
Ortucchio	121h	C11	Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.2	4.3	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	3.8	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	4.1	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.6	4.4	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.1	3.1	2.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	4.1	4.0	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.6	4.1	3.7	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.6	3.6	3.4	Primavera = Spring

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	4.3	4.1	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.7	3.8	3.7	Primavera = Spring
Ortucchio	121h	p11	Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.9	4.4	3.8	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.1	4.5	3.6	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.7	4.7	4.0	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	3.6	3.7	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.6	4.1	\	Primavera = Spring
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	4.1	3.8	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.1	4.1	4.0	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.4	3.5	3.5	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.5	4.1	\	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.6	3.8	3.6	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.7	3.8	3.0	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.6	3.7	3.4	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	4.0	3.9	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.6	4.0	3.9	Primavera = Spring
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.7	4.6	4.0	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.5	4.8	\	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	\	\	\	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		Ia	4.2	5.4	3.8	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.4	3.6	3.3	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.0	4.2	4.0	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.7	3.9	\	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	3.8	3.5	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.6	3.9	3.6	Primavera = Spring

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.0	3.0	3.0	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.8	4.3	3.9	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.7	3.9	3.5	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.3	4.1	3.4	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.5	3.5	3.7	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	4.3	3.7	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.9	3.8	3.2	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.0	4.2	3.3	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	4.1	3.9	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.1	4.4	4.2	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.1	4.2	4.1	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	3.8	3.9	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.7	3.8	3.7	Primavera = Spring
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.1	4.6	4.0	Primavera = Spring
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.3	4.7	4.4	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	4.3	4.0	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.0	4.2	4.1	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.0	4.6	4.2	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.1	4.5	4.0	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.8	4.4	4.0	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.6	4.0	3.5	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.1	4.3	4.0	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	4.3	3.1	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.1	4.6	4.3	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.2	3.6	\	Primavera = Spring

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.5	5.4	3.4	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	4.1	3.8	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.0	4.4	4.3	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.7	3.7	3.6	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.2	4.1	3.6	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	3.7	2.9	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.9	4.2	\	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.6	3.7	3.6	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.6	3.7	3.6	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.4	3.8	3.7	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.3	3.6	3.0	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.2	3.6	3.3	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.3	3.5	3.6	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.7	4.1	\	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.1	3.2	\	Primavera = Spring
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.2	3.8	3.6	Spring
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.2	4.3	\	Autumn
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Vertebra	1		III	\	\	5.6	Autumn
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.7	5.0	5.0	Autumn
Ortucchio	121h	C13	Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.8	4.2	3.9	Autumn
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.2	4.6	4.7	Autumn
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	4.5	4.0	Autumn
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	\	\	Autumn
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	3.9	4.5	Autumn
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.1	4.5	4.2	Autumn

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	4.4	3.7	Autumn
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.6	4.2	3.7	Autumn
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.0	4.5	4.0	Autumn
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	4.2	3.4	Autumn
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.3	3.2	3.3	Autumn
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.2	3.8	3.2	Autumn
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.3	3.3	2.8	Autumn
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.6	3.8	3.5	Autumn
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.8	4.3	3.6	Autumn
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	3.9	3.9	Autumn
Ortucchio	121h	C11	Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.6	4.4	3.9	Autumn
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		Ia	3.9	4.7	3.4	Inverno = Winter
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		III	5.7	5.9	5.7	Inverno = Winter
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.7	4.1	3.6	Inverno = Winter
Ortucchio	121h	G	Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.7	4.8	4.9	Inverno = Winter
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.7	4.7	4.6	Inverno = Winter
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.5	3.8	3.9	Inverno = Winter
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	4.4	4.0	Inverno = Winter
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		II	5.0	6.1	5.0	Inverno = Winter
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.5	5.5	4.9	Inverno = Winter
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.6	5.0	4.6	Inverno = Winter
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	4.0	3.3	Inverno = Winter
Ortucchio	121h	E5	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Ceratohyal	1	L					
Ortucchio	121h	16	Upper Pal.	*Salmo trutta*	Dentary	1	R					

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Ortucchio	121h	3B	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	o12	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	C12	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	19	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	16	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	3B	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	B3	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	10	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	C8	Upper Pal.	*Salmo trutta*	Ceratohyal	1	L					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	17	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	8E	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	3B	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	8	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	E5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	16	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	C11	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	C11	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	6B	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	c3	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	3B	Upper Pal.	*Salmo trutta*	Dentary	1	R					

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Ortucchio	121h	6E	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	E5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Ceratohyal	1	R					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	E5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	D16	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	20	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	18	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	D9	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	17	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	19	Upper Pal.	*Salmo trutta*	Cleithrum	1	?					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Vertebra spine	1	\					
Ortucchio	121h	C11	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Ceratohyal	1	R					
Ortucchio	121h	3B	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	13	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	c7	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	t9 or 61	Upper Pal.	*Salmo trutta*	Dentary	1	L					

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	c12	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	20	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	4	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	14	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	E5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	E5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	7B	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	D12	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	10E	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	c3	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h		Upper Pal.	*Salmo trutta*	vertebra	1		II	4.4	3.6	3.1	
Ortucchio	121h	4	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	B3	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	20	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	6E	Upper Pal.	*Salmo trutta*	Parasphenoid	1						
Ortucchio	121h	4	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Maxilla	1	R					

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Ortucchio	121h	c12	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Glossohyal	1						
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	E5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	9	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	D12	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	E12	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	13	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	6B	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	16	Upper Pal.	*Salmo trutta*	palatine	1	R					
Ortucchio	121h	14	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	4	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	20	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	E5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	vertebra	1		III	3.5	3.7	3.5	
Ortucchio	121h	4	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	13	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	17	Upper Pal.	*Salmo trutta*	Dentary	1	R					

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	C5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	c10	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	c5	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	16	Upper Pal.	*Salmo trutta*	Vomer	1						
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	C11	Upper Pal.	*Salmo trutta*	Parasphenoid	1						
Ortucchio	121h	4	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	6E	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	17	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	16	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	2	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	11D	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	E5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	vertebra	1		II	3.8	4.6	3.8	
Ortucchio	121h	E12	Upper Pal.	*Salmo trutta*	Ceratohyal	1	R					

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Ortucchio	121h	c12	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	c8	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	17	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	6E	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	G	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Glossohyal	1						
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	3B	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	vertebra	1		III	3.1	3.4	3.1	
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	b4	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	16	Upper Pal.	*Salmo trutta*	Ceratohyal	1	L					
Ortucchio	121h	11D	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	spine	1						
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	L or 1	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	palatine	1	R					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	R					

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Ceratohyal	1	R					
Ortucchio	121h	14	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	10E	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	11	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	14	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	8B	Upper Pal.	*Salmo trutta*	palatine	1	R					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Articular	1	L					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	c9	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	palatine	1	R					
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Maxilla	1	?					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	palatine	1	R					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Frag dentary	1	?					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Dentary	1	L					

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Frag dentary	1	?					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Glossohyal	1						
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Glossohyal	1						
Ortucchio	121h		Upper Pal.	*Salmo trutta*	vertebra	1		II	3.5	4.2	3.6	
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	premaxilla	1	?					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	quadrate	1	L					
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	D17	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	c10	Upper Pal.	*Salmo trutta*	Vomer	1						
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	C12	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	c12	Upper Pal.	*Salmo trutta*	Vomer	1						
Ortucchio	121h	3B	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	79	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vomer	1						
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	4	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	spine	1						
Ortucchio	121h	E5	Upper Pal.	*Salmo trutta*	Dentary	1	L					

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Ortucchio	121h	3B	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	7	Upper Pal.	*Salmo trutta*	Ceratohyal	1	R					
Ortucchio	121h	E5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	c3	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	14	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Glossohyal	1						
Ortucchio	121h	c3	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	3B	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	E5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Ceratohyal	1	L					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	B3	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	10	Upper Pal.	*Salmo trutta*	Vomer	1						
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Ceratohyal	1	L					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	spine	1						

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Ortucchio	121h	B3	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Parasphenoid	1						
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	9	Upper Pal.	*Salmo trutta*	Dentary	1	?					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	20	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	4	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	c12	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	14	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	16	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	b3	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	16	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Dentary	1	R					

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	vomer	1						
Ortucchio	121h	c12	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	E5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	16	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	9\10	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	B3	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	c3	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	c12	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	14	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	6E	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Ceratohyal	1	R					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	dentary	1	R					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Maxilla	1	?					
Ortucchio	121h	16	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	13	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	16	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	spine	1						
Ortucchio	121h	3B	Upper Pal.	*Salmo trutta*	Parasphenoid	1						
Ortucchio	121h	15	Upper Pal.	*Salmo trutta*	Vomer	1						
Ortucchio	121h	7	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	4	Upper Pal.	*Salmo trutta*	Dentary	1	L					

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Ortucchio	121h	c3	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	20	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Glossohyal	1						
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	vomer	1						
Ortucchio	121h	16	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	c8	Upper Pal.	*Salmo trutta*	Maxilla	1	?					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	loose tooth	1						
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	3b	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	13	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	6E	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	c3	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Maxilla	1	?					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Maxilla	1	R					
Ortucchio	121h	6E	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	6E	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	spine	1						
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Cleithrum	1	?					

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	c15	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	13	Upper Pal.	*Salmo trutta*	Maxilla	1	?					
Ortucchio	121h	c12	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	4	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Maxilla	1	?					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Maxilla	1	?					
Ortucchio	121h	2\3	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	16	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	10\13	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	C?	Upper Pal.	*Salmo trutta*	Parasphenoid	1						
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	4	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	b3	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Glossohyal	1						
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	palatine	1	L					
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	?					
Ortucchio	121h	6E	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	16	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	E5	Upper Pal.	*Salmo trutta*	Dentary	1	R					

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Ortucchio	121h	E5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	16	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	?3	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	3b	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	R	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	16	Upper Pal.	*Salmo trutta*	Articular	1	L					
Ortucchio	121h	7B	Upper Pal.	*Salmo trutta*	vomer	1						
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	11	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	urostyle	1						
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	7E	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	3	Upper Pal.	*Salmo trutta*	Vomer	1						
Ortucchio	121h	3B	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	7b	Upper Pal.	*Salmo trutta*	vomer	1						
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	hyomandibular	1	L					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	spine	1						
Ortucchio	121h	7\8\9	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	c13	Upper Pal.	*Salmo trutta*	Articular	1	L					
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	spine	1						
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	spine	1						
Ortucchio	121h	7	Upper Pal.	*Salmo trutta*	Dentary	1	?					
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	loose tooth	1						
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	loose tooth	1						

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	loose tooth	1						
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	palatine	1	R					
Ortucchio	121h	11E	Upper Pal.	*Salmo trutta*	Maxilla	1	L					
Ortucchio	121h	c4	Upper Pal.	*Salmo trutta*	Articular	1	R					
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		Ib	3.4	3.6	2.7	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	vertebra	1		III	3.7	3.7	3.9	
Ortucchio	121h	C11	Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.8	5.1	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	vertebra	1		II	\	\	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	2.8	2.9	2.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	vertebra	1		III	3.7	4.1	3.7	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	4.0	3.5	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	quadrate	1	L					
Ortucchio	121h	c8	Upper Pal.	*Salmo trutta*	hyomandibular	1	R					
Ortucchio	121h	6	Upper Pal.	*Salmo trutta*	Unidentified	1						
Ortucchio	121h	16	Upper Pal.	*Salmo trutta*	Unidentified	1						
Ortucchio	121h	c8	Upper Pal.	*Salmo trutta*	Parasphenoid	1						
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	Unidentified	1						
Ortucchio	121h	c?	Upper Pal.	*Salmo trutta*	Unidentified	1						
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	Unidentified	1						
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Unidentified	1						
Ortucchio	121h	\	Upper Pal.	*Salmo trutta*	exoccipital	1	?					
Ortucchio	121h	c11	Upper Pal.	*Salmo trutta*	basipterygium	1	R					
Ortucchio	121h	Buca 17-18	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	Buca 17-18	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	Buca 17-18	Upper Pal.	*Salmo trutta*	Dentary	1	R					

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Ortucchio	121h	Buca 17-18	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	Buca 17-18	Upper Pal.	*Salmo trutta*	Dentary	1	L					
Ortucchio	121h	Buca 17-18	Upper Pal.	*Salmo trutta*	Maxilla	1	R					re-fit
Ortucchio	121h	Buca 17-18	Upper Pal.	*Salmo trutta*	Maxilla	1	R					re-fit
Ortucchio	121h	Buca 17-18	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	Buca 17-18	Upper Pal.	*Salmo trutta*	Ceratohyal	1	L					
Ortucchio	121h	Buca 17-18	Upper Pal.	*Salmo trutta*	Cleithrum	1	?					
Ortucchio	121h	Buca 17-18	Upper Pal.	*Salmo trutta*	loose tooth	1						
Ortucchio	121h	Buca 17-18	Upper Pal.	*Salmo trutta*	loose tooth	1						
Ortucchio	121h	Buca 17-18	Upper Pal.	*Salmo trutta*	loose tooth	1						
Ortucchio	121h	buce 13	Upper Pal.	*Salmo trutta*	Articular	1	R					
Ortucchio	121h	buce 13	Upper Pal.	*Salmo trutta*	Parasphenoid	1						
Ortucchio	121h	buce 13	Upper Pal.	*Salmo trutta*	Unidentified	1						
Ortucchio	121h	buce 13	Upper Pal.	*Salmo trutta*	Unidentified	1						
Ortucchio	121h	buce 13	Upper Pal.	*Salmo trutta*	Unidentified	1						
Ortucchio	121h	buce 13	Upper Pal.	*Salmo trutta*	Unidentified	1						
Ortucchio	121h	buce 14	Upper Pal.	*Salmo trutta*	Dentary	1	R					
Ortucchio	121h	Buce 14	Upper Pal.	*Salmo trutta*	Frontal	1	?					
Ortucchio	121h	Buce 14	Upper Pal.	*Salmo trutta*	Dentary	1	?					
Ortucchio	121h	31	Upper Pal.	*Salmo trutta*	Vertebra	1		II	11.9	13.3	8.8	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.3	4.6	4.6	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		II	7.5	9.3	7.1	
Ortucchio	121h	19	Upper Pal.	*Salmo trutta*	Vertebra	1		III	6.3	6.8	5.7	
Ortucchio	121h	13	Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.1	4.2	4.2	

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.6	4.6	4.3	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	4.4	4.2	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		Ib	4.2	4.5	3.1	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.7	5.1	4.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.0	4.7	4.1	
Ortucchio	121h	14	Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.7	4.8	4.0	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.7	4.0	4.3	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.3	3.6	3.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.4	3.6	3.3	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		Ib	2.9	3.6	4.0	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.9	4.5	3.4	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.7	4.0	3.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.3	3.8	3.2	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		Vb	3.7	3.5	3.2	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.0	4.4	3.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	\	\	3.4	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	\	\	3.4	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	4.1	3.8	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	3.8	3.3	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.5	3.4	3.4	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	4.1	3.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.7	4.0	3.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.6	4.3	3.4	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.3	3.5	2.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.5	4.1	3.7	

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.2	5.3	4.1	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		IV	3.5	3.7	2.7	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		Vb	2.9	3.5	2.7	
Ortucchio	121h	15	Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.0	4.6	3.6	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	4.2	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.5	4.5	3.7	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.7	3.4	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.4	4.2	4.1	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.8	4.0	3.2	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	\	\	\	
Ortucchio	121h	14	Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.3	4.6	3.6	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.0	4.0	4.0	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.9	4.8	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	\	\	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.5	3.7	2.8	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.6	3.9	3.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	5.0	5.7	4.7	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.5	3.7	3.2	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	3.7	3.8	
Ortucchio	121h	13	Upper Pal.	*Salmo trutta*	Vertebra	1		Ia	4.6	5.6	3.7	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	3.6	3.0	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	\	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.1	3.7	3.2	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		Ia	4.5	5.2	3.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	\	4.7	3.6	

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.0	4.0	3.6	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	4.0	\	
Ortucchio	121h	5	Upper Pal.	*Salmo trutta*	Vertebra	1		III	5.6	5.9	4.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		Ia	4.2	5.3	3.6	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	3.8	3.7	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.8	4.4	3.4	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.2	4.7	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.5	3.8	3.6	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.5	5.1	3.6	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.7	4.0	3.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.1	4.2	3.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.6	3.6	3.6	
Ortucchio	121h	31	Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.6	5.0	4.2	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.5	3.4	3.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		Ib	4.4	4.2	3.0	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.7	4.8	3.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.6	3.7	3.3	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	4.9	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	3.3	2.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.6	4.4	3.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		Ia	3.9	4.6	3.1	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.6	3.6	3.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.7	4.5	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	\	\	3.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.5	3.5	\	

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.2	3.3	3.4	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		Ia	4.3	4.8	3.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.1	3.9	3.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.3	5.0	4.1	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.8	\	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		Ib	3.5	4.0	2.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	4.7	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.0	4.2	3.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		Ia	4.2	4.7	3.2	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	4.5	4.0	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.2	3.9	3.6	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.0	3.8	3.1	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.4	4.9	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.2	3.9	3.1	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		Iva	3.7	3.9	3.7	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.3	4.7	3.4	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.6	3.8	3.6	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.2	4.5	4.4	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	\	\	\	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.5	3.5	3.4	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.6	4.6	3.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.7	4.1	3.8	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.0	4.5	3.7	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		Ia	4.4	5.4	4.1	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.7	3.8	3.6	

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.7	3.7	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.5	4.2	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.4	4.8	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.1	4.3	4.2	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.7	4.0	3.4	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.3	4.0	3.6	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.7	3.6	3.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	\	\	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	4.2	3.8	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.1	4.3	3.8	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.4	3.7	3.7	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.4	3.9	2.9	
Ortucchio	121h	14	Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.1	4.4	4.1	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.9	4.0	3.3	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.6	3.6	3.6	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.5	4.3	3.6	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.7	4.2	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.0	3.1	2.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.0	4.2	3.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	4.0	3.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.6	3.8	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.6	4.1	3.7	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	4.0	3.4	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	3.9	3.8	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.2	4.5	3.9	

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		Ia	4.3	5.3	3.8	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	3.9	\	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	4.2	3.6	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.8	4.2	3.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.0	4.6	3.9	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.1	4.1	4.3	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.7	3.8	2.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	4.3	3.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.0	4.1	3.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.1	3.6	3.2	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.4	3.5	3.2	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	4.1	3.6	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.7	4.4	3.8	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	\	\	3.7	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.6	3.7	3.7	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	3.9	3.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.5	4.8	3.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.5	3.6	3.3	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.5	4.1	3.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.3	5.2	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.7	4.3	3.8	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		Ia	\	\	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.0	4.8	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.8	4.4	4.0	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	\	\	3.2	

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.0	4.2	3.2	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.6	4.2	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.3	4.4	3.3	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.6	4.0	3.7	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	3.6	3.2	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.4	3.8	3.5	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	4.0	3.7	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	4.0	3.7	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.0	4.1	3.3	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.5	4.4	3.7	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.6	3.7	3.6	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.4	3.4	3.4	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.8	4.6	4.0	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.9	4.2	3.9	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		IVa	3.5	3.4	2.8	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		Ivb	3.3	3.5	2.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.5	3.7	3.4	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		Ia	4.5	5.4	4.0	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.4	3.2	3.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		Vb	3.4	3.7	3.0	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.3	3.9	3.6	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.5	4.3	3.6	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.0	4.2	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.4	3.6	3.3	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.3	3.9	3.7	

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.6	3.7	\	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	4.3	4.1	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.1	3.3	2.8	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.1	4.0	3.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	2.8	3.2	3.0	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.8	3.9	3.8	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	4.3	3.7	
Ortucchio	121h	12	Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.3	4.2	3.6	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.1	3.8	3.4	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	4.0	3.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	4.3	4	3.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3	3.5	3	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.2	3.9	4.2	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	4	3.6	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.3	3.9	3.2	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	2.9	3.3	3	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.4	4	3.5	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		IVb	3.2	3.3	2.8	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	3.4	3.7	3.4	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	\	\	3.3	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		II	3.9	4.2	3.2	
Ortucchio	121h		Upper Pal.	*Salmo trutta*	Vertebra	1		III	4.1	4.4	\	
La Punta	1138	12	Neolithic	*Salmo trutta*	Palatine	1	R					
La Punta	1138	12	Neolithic	*Salmo trutta*	Maxilla	1	L					
La Punta	1138	18	Sterile	*Salmo trutta*	Maxilla	1	L					

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
La Punta	1138	18	Sterile	*Salmo trutta*	Dentary	1	L					
La Punta	1138	20	Sterile	*Salmo trutta*	Maxilla	1	L					
La Punta	1138	21	Mesolithic	*Salmo trutta*	Dentary	1	R					
La Punta	1138	23-24	Late Upper Pal	*Salmo trutta*	Dentary	1	L					
La Punta	1138	23-24	Late Upper Pal	*Salmo trutta*	Cleithrum	1	?					
La Punta	1138	24	Late Upper Pal	*Salmo trutta*	Dentary	1	L					
La Punta	1138	25	Late Upper Pal	*Salmo trutta*	Dentary	1	R					
La Punta	1138	25	Late Upper Pal	*Salmo trutta*	Dentary	1	L					
La Punta	1138	25	Late Upper Pal	*Salmo trutta*	Dentary	1	L					
La Punta	1138	25	Late Upper Pal	*Salmo trutta*	Dentary	1	L					
La Punta	1138	25	Late Upper Pal	*Salmo trutta*	Dentary	1	\					
La Punta	1138	25	Late Upper Pal	*Salmo trutta*	Maxilla	1	R					
La Punta	1138	25	Late Upper Pal	*Salmo trutta*	Dentary	1	R					
La Punta	1138	26	12,681 – 12,141	*Salmo trutta*	Ceratohyal	1	R					
La Punta	1138	26	12,681 – 12,141	*Salmo trutta*	Dentary	1	L					
La Punta	1138	26	12,681 – 12,141	*Salmo trutta*	Dentary	1	R					
La Punta	1138	26	12,681 – 12,141	*Salmo trutta*	Dentary	1	R					
La Punta	1138	26	12,681 – 12,141	*Salmo trutta*	Dentary	1	L					
La Punta	1138	26	12,681 – 12,141	*Salmo trutta*	Maxilla	1	L					
La Punta	1138	27	13,791 – 13,427	*Salmo trutta*	Dentary	1	?					
La Punta	1138	27	13,791 – 13,427	*Salmo trutta*	Dentary	1	L					
La Punta	1138	27	13,791 – 13,427	*Salmo trutta*	Maxilla	1	R					
La Punta	1138	28-29		*Salmo trutta*	Dentary	1	L					
La Punta	1138	29	13,791 – 13,427	*Salmo trutta*	Maxilla	1	L					
La Punta	1138	32		*Salmo trutta*	Dentary	1	L					

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
La Punta	1138	32		*Salmo trutta*	Dentary	1	R					
La Punta	1138	32		*Salmo trutta*	Dentary	1	R					
La Punta	1138	32		*Salmo trutta*	Dentary	1	R					
La Punta	1138	32		*Salmo trutta*	Dentary	1	R					
La Punta	1138	32		*Salmo trutta*	Dentary	1	L					
La Punta	1138	32		*Salmo trutta*	Dentary	1	L					
La Punta	1138	33		*Salmo trutta*	Dentary	1	L					
La Punta	1138	35		*Salmo trutta*	Dentary	1	R					
La Punta	1138	35		*Salmo trutta*	Dentary	1	R					
La Punta	1138	35		*Salmo trutta*	Dentary	1	R					
La Punta	1138	35		*Salmo trutta*	Articular	1	L					
La Punta	1138	35		*Salmo trutta*	Dentary	1	L					
La Punta	1138	48	>19,449–15,273	*Salmo trutta*	Articular	1	L					
La Punta	1138	\			Unidentified	1	\					
La Punta	1138	\			Unidentified	1	\					
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	glossohyal	253						100-50% complete
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	glossohyal	90						1-50% complete
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Dentary	101	L					
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Dentary	162	R					
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Dentary	77	?					
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	articular	303	all					
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	quadrate	213	all					
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Palatine	257	all					
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	preMaxilla	86	all					
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Vomer	309						

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Maxilla	248	all					
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Parasphenoid	67						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Vertebrae	2		Ia				Spring
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Vertebra	1		Ib				Spring
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Vertebrae	141		II				Spring
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Vertebrae	136		III				Spring
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Vertebrae	3		?				Spring
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Vertebrae	18		II				Summer
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Vertebrae	9		III				Summer
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Vertebrae	20		II				Autumn
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Vertebrae	7		III				Autumn
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Vertebrae	1		?				Autumn
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia				Winter
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Vertebrae	70		II				Winter
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Vertebrae	43		III				Winter
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Vertebrae	2		Ivb				Winter
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Vertebrae	1		?				Winter
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	Articular	264						
Maritza	1273	31-38	Upper Pal.		Ribs/Spines	22						
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	Palatine	14						
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	cleithrum	54						
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	Vomer	165						
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	Maxilla	333						
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	ceratohyal	109						
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	Parasphenoid	136						

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	Dentary	1303						
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	preMaxilla	3						
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	glossohyal	22						
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	epihyal	3						
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	basipterygium	8						
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	quadrate	1						
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	hyomandibular	14						
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	Hypural	9						
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		Ia	5.6	6.2	5.2	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		Ia	5.6	6.9	3.7	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	7	7.4	6.1	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	5.5	6.2	5.6	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	5.2	5.9	5.4	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	\	\	\	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	\	\	\	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.8	5	4.7	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.8	4.9	4.8	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	3.6	3.7	3.5	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.7	5.5	4.9	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.6	4.4	4.4	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.3	4.8	4.3	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	5.3	5.4	5.2	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.5	4.8	4.1	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	6.5	7.6	6	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.6	4.9	\	

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	\	\	3.9	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	\	\	\	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.6	5.2	4.8	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	3.5	3.4	3.5	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.3	4.6	4.3	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.8	5.2	4.8	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.3	4.4	4.2	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.6	5.1	4.6	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.4	4.8	\	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	3.9	4	3.9	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	5.1	5.6	5.1	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	5	5.4	5.1	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	5.2	5.2	5	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.9	5.5	5.2	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.2	4.4	\	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	3.7	4	3.7	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4	4.8	\	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	3.8	4.3	3.8	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	5	5.6	4.6	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.9	5.3	4.6	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.6	4.6	\	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	3.8	4	3.7	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	3.4	3.7	3.5	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	5.5	6.1	\	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	\	\	4.5	

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	5.8	6.5	5.9	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.4	4.9	4.5	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	5.4	5.2	5.5	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.1	4.1	4.3	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	\	\	\	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	3.5	3.6	3.5	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	5.6	6.3	6	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	5.1	4.8	5.2	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	5	5.1	4.6	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	3.9	4	4	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.5	4.9	4.3	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.8	4.4	4.8	
Maritza	1273	41-42	Upper Pal.	*Salmo trutta*	vertebra	1		II	10.9	15	9.8	
Maritza	1273	42	Upper Pal.	*Salmo trutta*	vertebra	1		II	\	11	7.2	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.8	4.7	3.7	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.9	6.5	4.8	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.7	5.3	3.8	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.5	5.5	4.4	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	3.8	4.5	3.9	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4	4.7	4.1	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	\	5.5	\	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4	4.5	4	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	5.8	7.9	5.8	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.9	5.6	4.6	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	\	\	\	

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	5.6	6.7	5.4	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.4	4.9	3.8	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	5.3	6.2	5.1	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	5.5	6.7	5.5	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.7	4.7	3.4	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	3.7	4.1	3.7	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.1	4.6	4.2	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	5.2	6.2	4.7	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.4	5.8	4.6	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	\	\	5	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	5.6	6.9	5.4	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	5.8	6.9	5.5	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	3.9	5.1	4.8	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	\	\	\	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.2	4.7	3.8	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	6.2	8.2	5.9	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	5.2	5.9	5	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	5	5.1	3.5	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.1	5	4.5	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	6.1	7.3	5.6	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	5.7	6.2	5.2	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	5.2	6.4	4.9	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.1	5.6	4.8	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.9	5.6	4.9	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	5	6.1	5.1	

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.6	5.8	4.4	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	3.6	4.8	4.1	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.4	5.1	4.3	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.2	5.1	4.2	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	5.5	5.9	4.5	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4	4.5	3.8	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	3.8	4.3	3.8	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	\	\	\	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.3	4.8	\	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4	4.9	3.7	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	3.7	3.9	3.1	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4	4.6	3.8	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	\	\	4.7	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.3	4.6	\	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.9	5.8	4.8	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	5.2	5.6	4.7	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		III	4.1	4.4	4.3	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	\	\	5.5	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	\	\	3.9	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	\	\	4.6	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	5	5.4	4.9	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	5.2	5.9	\	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	vertebra	1		II	4.4	4.2	4	
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	urohyal	1						
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	opercular	10						

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Maritza	1273	31-38	Upper Pal.		Unidentified	266						
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	frontal	32						
Maritza	1273	31-38	Upper Pal.	*Salmo trutta*	Supracliethrum	6						
Maritza	1273	31	Upper Pal.	*Salmo trutta*	Dentary	7						
Maritza	1273	31	Upper Pal.	*Salmo trutta*	Vomer	1						
Maritza	1273	31	Upper Pal.	*Salmo trutta*	Parasphenoid	2						
Maritza	1273	31	Upper Pal.	*Salmo trutta*	Articular	1						
Maritza	1273	31	Upper Pal.	*Salmo trutta*	Maxilla	2						
Maritza	1273	31	Upper Pal.		Unidentified	1						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	Articular	396						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	Scapula	73						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	Palatine	239						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	Maxilla	487						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	Ceratohyal	166						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	Quadrate	381						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	Posttemporal	40						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	PreMaxilla	152						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	Glossohyal	305						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	Hypural	346						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	Parasphenoid	231						
Maritza	1436 i	36	Upper Pal.		Ribs/Spines	223						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	Supracleithrum	9						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	Vomer	415						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	Dentary	504						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	Vertebrae	742						

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	Hyomandibular	17						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	Urohyal	4						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	Epihyal	11						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	basipterygium	64						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	Basioccipital	8						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	cleithrum	4						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	opercular	25						
Maritza	1436 i	36	Upper Pal.	*Salmo trutta*	frontal	4						
Maritza	1436 i	36	Upper Pal.		Unidentified	12688						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Articular	321						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Scapula	2						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Palatine	27						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Maxilla	333						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Ceratohyal	183						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Quadrate	11						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Posttemporal	2						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	PreMaxilla	2						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Glossohyal	34						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Hypural	19						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Parasphenoid	220						
Maritza	1435	36-37	Upper Pal.		Ribs/Spines	38						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Supracleithrum	22						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vomer	113						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Dentary	867						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Hyomandibular	31						

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Urohyal	0						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Epihyal	2						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Basipterygium	15						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Basioccipital	4						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	cleithrum	75						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	opercular	8						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	frontal	53						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Unidentified	752						
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	2551		II				
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1352		III				
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	10		Iva				
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	52		Va				
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	32		Vb				
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1473		?				
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.4	4.9	4.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.5	6.6	5.3	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.8	4.6	5.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.0	5.4	4.5	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.9	5.2	4.2	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.1	5.7	4.5	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.1	5.2	4.4	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.7	5.9	5.1	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.0	5.1	4.1	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.6	5.0	4.6	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.3	4.4	4.0	

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.4	\	4.7	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.5	4.7	4.4	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.7	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.4	5.3	4.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.1	5.2	4.4	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.0	4.2	4.2	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.4	4.9	3.5	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	5.2	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.6	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	3.5	\	3.5	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.7	5.2	4.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.8	5.0	3.8	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.5	4.9	4.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.1	5.6	4.5	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	5.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.5	\	4.2	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.2	5.1	4.5	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.4	4.5	4.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.8	5.0	4.6	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	3.8	4.1	3.3	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.5	5.9	4.7	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.7	5.8	4.9	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.6	5.5	5.5	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.1	5.3	4.4	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.4	\	4.7	

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.0	4.7	4.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.0	5.4	4.1	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.1	5.2	4.3	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	5.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.2	\	3.7	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.1	6.0	4.8	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.9	5.4	4.2	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.3	6.0	4.8	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.7	5.0	4.7	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.8	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	5.1	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.8	4.9	4.9	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.5	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.6	4.9	4.2	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	3.9	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.9	5.6	5.6	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.3	5.1	4.3	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.5	4.9	4.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.5	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.1	5.4	4.7	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.5	4.7	4.2	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.2	\	3.8	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.9	5.5	4.5	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.6	

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.8	4.9	4.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.9	5.5	4.8	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.8	6.8	5.8	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.4	\	4.5	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.7	4.5	4.5	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.6	5.6	4.8	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.9	5.2	4.6	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.3	4.5	4.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.1	5.5	3.9	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.7	5.5	4.6	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.3	5.0	4.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.8	5.6	4.1	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.5	4.7	4.3	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.3	\	5.1	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.4	5.1	4.1	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.4	6.0	5.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	5.2	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.2	5.5	4.5	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.2	5.6	4.9	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.1	4.1	3.9	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.4	5.0	3.9	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.1	\	4.4	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.3	5.3	5.3	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.6	5.5	4.6	

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.2	4.9	4.1	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	3.6	4.6	3.7	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.9	4.9	4.6	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.8	5.8	5.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.2	5.4	5.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.8	4.8	4.6	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.6	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.9	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	3.8	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	3.4	\	3.3	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.7	5.2	4.4	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.1	4.2	3.7	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.8	6.1	4.8	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.9	\	4.4	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.7	5.0	4.6	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.3	\	4.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.5	5.4	4.8	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.5	5.2	4.3	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.2	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.6	6.1	4.5	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.7	4.9	\	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.6	4.9	4.7	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.7	4.4	3.9	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.4	4.6	4.4	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	\	

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.1	4.8	4.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.1	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.3	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.6	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	3.9	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	3.8	3.6	3.5	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.1	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.0	4.7	3.9	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.2	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.3	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	5.3	4.2	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.1	3.9	3.9	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	5.3	5.3	4.5	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.8	5.9	4.8	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.0	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	\	\	4.8	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	3.8	4.3	3.8	
Maritza	1435	36-37	Upper Pal.	*Salmo trutta*	Vertebrae	1		Ia	4.5	\	4.5	
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Articular	116						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Scapula	110						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Palatine	84						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Maxilla	225						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Ceratohyal	165						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Quadrate	247						

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Posttemporal	50						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	PreMaxilla	86						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Glossohyal	76						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Hypural	346						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Parasphenoid	127						
Maritza	1436 ii	36	Upper Pal.		Ribs/Spines							
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Supracleithrum	14						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Vomer	102						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Dentary	181						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Hyomandibular	33						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Urohyal	21						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Epihyal	26						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	basipterygium	85						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Basioccipital	4						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	cleithrum	13						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	opercular	44						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	frontal	12						
Maritza	1436 ii	36	Upper Pal.		Unidentified	17342						
Maritza	1436 ii	36	Upper Pal.	*Salmo trutta*	Vertebrae	575		?				Fragments only. <50%
Pozzo	K8	15.07	6	*Salmo trutta*	Unidentified	1						
Pozzo	K8	15.07	6		Ribs/Spines	13						
Pozzo	K8	12.07	3/6		Ribs/Spines	5						
Pozzo	K8	12.07	3/6	*Salmo trutta*	Vertebra	1		II				
Pozzo	K8	12.07	3/6	*Salmo trutta*	Urohyal	1						
Pozzo	H8/H9	9.07	1-6		Ribs/Spines	1						

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Pozzo	H8/H9	9.07	1-6	*Salmo trutta*	Vertebra	1		II				
Pozzo	H9	24.07	6D	*Salmo trutta*	Vomer	1						
Pozzo	L8	10.07	3	*Salmo trutta*	Vertebra	1		III				
Pozzo	H10	21.07	6		Ribs/Spines	9						
Pozzo	H10	21.07	6	*Salmo trutta*	Vertebrae	6		?				<50% complete
Pozzo	H10	16.07	6	*Salmo trutta*	Vertebra	1		I				
Pozzo	H10	16.07	6	*Salmo trutta*	Vertebrae	32		II				
Pozzo	H10	16.07	6	*Salmo trutta*	Vertebrae	12		III				
Pozzo	H10	16.07	6	*Salmo trutta*	Vertebrae	4		IV				
Pozzo	H10	16.07	6	*Salmo trutta*	Vertebra	1		V				
Pozzo	H10	16.07	6	*Salmo trutta*	Glossohyal	2						
Pozzo	H10	16.07	6	*Salmo trutta*	Dentary	1	L					
Pozzo	H10	16.07	6	*Salmo trutta*	Vomer	1						
Pozzo	H10	16.07	6	*Salmo trutta*	Basioccipital	1						
Pozzo	I8	24.07	6	*Salmo trutta*	Maxilla	1	?					
Pozzo	G8	19.07	1	*Salmo trutta*	Vertebra	1		III				
Pozzo	G8	19.07	1	*Salmo trutta*	Glossohyal	1						
Pozzo	G8	13.07	Pink	*Salmo trutta*	Vertebra	1		III				
Pozzo	I10	14.07	6	*Salmo trutta*	Vertebra	2		II				
Pozzo	I10	14.07	6	*Salmo trutta*	Vertebra	2		?				<50% complete
Pozzo	G10	21.07	5/6	*Salmo trutta*	Glossohyal	1						
Pozzo	G10	21.07	5/6	*Salmo trutta*	Vomer	3						
Pozzo	G10	21.07	5/6	*Salmo trutta*	Maxilla	1	L					
Pozzo	G10	18.07	1		Ribs/Spines	31						
Pozzo	G10	18.07	1	*Salmo trutta*	Vertebrae	7		II				

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Pozzo	G10	18.07	1	*Salmo trutta*	Vertebrae	8		III				
Pozzo	G10	18.07	1	*Salmo trutta*	Vertebrae	2		IV				
Pozzo	G10	18.07	1	*Salmo trutta*	Vertebrae	12		?				<50% complete
Pozzo	G10	18.07	1	*Salmo trutta*	Glossohyal	2						
Pozzo	G10	18.07	1	*Salmo trutta*	Dentary	1	L					
Pozzo	G10	18.07	1	*Salmo trutta*	Dentary	1	R					
Pozzo	G10	18.07	1	*Salmo trutta*	Vomer	1						
Pozzo	G10	18.07	1	*Salmo trutta*	Maxilla	1	R					
Pozzo	G10	18.07	1	*Salmo trutta*	Interopercular	1						
Pozzo	G10	18.07	1	*Salmo trutta*	Hypural	2						
Pozzo	G10	18.07	1	*Salmo trutta*	PreMaxilla	1						
Pozzo	G10	18.07	1	*Salmo trutta*	Teeth	2						
Pozzo	G10	18.07	1		Unidentified	18						
Pozzo	G10	17.07	1	*Salmo trutta*	Dentary	1	L					
Pozzo	G10	17.07	Buce 10		Ribs/Spines	1						
Pozzo	G10	17.07	Buce 10	*Salmo trutta*	Vertebrae	5		II				
Pozzo	G10	17.07	Buce 10	*Salmo trutta*	Vertebrae	6		III				
Pozzo	G10	17.07	Buce 10	*Salmo trutta*	Vertebra	1		IV				
Pozzo	G10	17.07	Buce 10	*Salmo trutta*	Vertebra	1		V				
Pozzo	G10	17.07	Buce 10	*Salmo trutta*	Maxilla	1						
Pozzo	G10	18.07	5/6		Ribs/Spines	3						
Pozzo	G10	18.07	5/6	*Salmo trutta*	Vertebra	1		I				
Pozzo	G10	18.07	5/6	*Salmo trutta*	Vertebrae	7		II				
Pozzo	G10	18.07	5/6	*Salmo trutta*	Vertebrae	13		III				
Pozzo	G10	18.07	5/6	*Salmo trutta*	Vertebrae	13		?				<50% complete

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Pozzo	G10	18.07	5/6	*Salmo trutta*	Glossohyal	3						
Pozzo	G10	18.07	5/6	*Salmo trutta*	Dentary	2	L					
Pozzo	G10	18.07	5/6	*Salmo trutta*	Dentary	1	R					
Pozzo	G10	18.07	5/6	*Salmo trutta*	Dentary	2	?					
Pozzo	G10	18.07	5/6	*Salmo trutta*	Vomer	5						
Pozzo	G10	18.07	5/6	*Salmo trutta*	Parasphenoid	1						
Pozzo	G10	18.07	5/6	*Salmo trutta*	Palatine	1						
Pozzo	G10	18.07	5/6	*Salmo trutta*	Supracleithrum	1						
Pozzo	G10	18.07	5/6	*Salmo trutta*	Hypural	1						
Pozzo	G10	18.07	5/6		Unidentified	8						
Pozzo	G10	18.07	4	*Salmo trutta*	Vertebra	1		II				
Pozzo	G10	18.07	4	*Salmo trutta*	Vertebrae	2		?				<50% complete
Pozzo	G10	18.07	4	*Salmo trutta*	Paraspenoid	1						
Pozzo	H11/H10		PS	*Salmo trutta*	Vertebrae	2		II				
Pozzo	H11/H10		PS	*Salmo trutta*	Vertebrae	4		III				
Pozzo	H11/H10		PS	*Salmo trutta*	Vertebrae	2		?				
Pozzo	H11/H10		PS	*Salmo trutta*	Glossohyal	2						
Pozzo	H11/H10		PS	*Salmo trutta*	Vomer	1						
Pozzo	H11/H10		PS	*Salmo trutta*	Maxilla	1						
Pozzo	G10	19.07	6	*Salmo trutta*	Vertebra	1		II				
Pozzo	G10	22.07	20cm	*Salmo trutta*	Maxilla	1	L					

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Pozzo	G10/H10	13.07	\	*Salmo trutta*	Vertebra	1		?				<50% complete
Pozzo	H9/G9	14.07	Buca 9	*Salmo trutta*	Vertebra	1		II				
Pozzo	J7	11.07	\	*Salmo trutta*	Vertebra	1	?					<50% complete
Pozzo	H8	14.07	\	*Salmo trutta*	Vertebra	1		III				
Pozzo	J7	13.07	\	*Salmo trutta*	Vertebra	1		III				
Pozzo	G8/G9	24.07	Buca 9	*Salmo trutta*	Vertebrae	4		?				<50% complete
Pozzo	G10	17.07	PS	*Salmo trutta*	Vertebrae	7		II				
Pozzo	G10	17.07	PS	*Salmo trutta*	Vertebrae	4		?				<50% complete
Pozzo	I10/I11	14.07	\		Unidentified	2						
Pozzo	G10	18.07	1+3		Ribs/Spines	24						
Pozzo	G10	18.07	1+3	*Salmo trutta*	Vertebrae	5		II				
Pozzo	G10	18.07	1+3	*Salmo trutta*	Vertebrae	2		III				
Pozzo	G10	18.07	1+3	*Salmo trutta*	Vertebrae	17		?				<50% complete
Pozzo	G10	18.07	1+3	*Salmo trutta*	Glossohyal	2						
Pozzo	G10	18.07	1+3	*Salmo trutta*	Dentary	2						
Pozzo	G10	18.07	1+3	*Salmo trutta*	Vomer	1						
Pozzo	G10	18.07	1+3	*Salmo trutta*	Maxilla	4						
Pozzo	G10	18.07	1+3	*Salmo trutta*	Articular	1						
Pozzo	G10	18.07	1+3		Unidentified	17						
Pozzo	H10/H11	14.07	3		Ribs/Spines	9						
Pozzo	H10/H11	14.07	3	*Salmo trutta*	Vertebra	1		II				
Pozzo	H10/H11	14.07	3	*Salmo trutta*	Vertebra	1		III				
Pozzo	H10/H11	14.07	3	*Salmo trutta*	Vertebrae	6		?				<50% complete
Pozzo	H10/H11	14.07	3	*Salmo trutta*	Glossohyal	3						

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Pozzo	H10/H11	14.07	3	*Salmo trutta*	Dentary	1	L					
Pozzo	H10/H11	14.07	3	*Salmo trutta*	Dentary	1	R					
Pozzo	H10/H11	14.07	3	*Salmo trutta*	Vomer	1						
Pozzo	H10/H11	14.07	3	*Salmo trutta*	Maxilla	1						
Pozzo	H10/H11	14.07	3	*Salmo trutta*	Parasphenoid	1						
Pozzo	H10/H11	14.07	3	*Salmo trutta*	Articular	1	L					
Pozzo	H10/H11	14.07	3	*Salmo trutta*	Articular	1	R					
Pozzo	H10/H11	14.07	3	*Salmo trutta*	Hypural	1						
Pozzo	H10/H11	14.07	3		Unidentified	36						
Pozzo	I11/I10	14.07	\	*Salmo trutta*	Maxilla	1						
Pozzo	H11/H10	13.07	\	*Salmo trutta*	Vertebra	1		II				
Pozzo	H11/H10	13.07		*Salmo trutta*	Vertebra	1		III				
Pozzo	H8	21.07	3	*Salmo trutta*	Vertebra	1		III				
Pozzo	H11	15.07	4		Ribs/Spines	15						
Pozzo	H11	15.07	4	*Salmo trutta*	Vertebra	1		I				
Pozzo	H11	15.07	4	*Salmo trutta*	Vertebrae	4		II				
Pozzo	H11	15.07	4	*Salmo trutta*	Vertebrae	3		III				
Pozzo	H11	15.07	4	*Salmo trutta*	Vertebrae	8		?				<50% complete
Pozzo	H11	15.07	4	*Salmo trutta*	Dentary	2	L					
Pozzo	H11	15.07	4	*Salmo trutta*	Maxilla	1	L					
Pozzo	H11	15.07	4	*Salmo trutta*	Quadrate	1						
Pozzo	H11	15.07	4	*Salmo trutta*	Articular	1	L					
Pozzo	H11	15.07	4	*Salmo trutta*	Articular	1	R					
Pozzo	H11	15.07	4	*Salmo trutta*	Hypural	2						
Pozzo	H11	15.07	4		Unidentified	42						

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Pozzo	J8	30.07	6		Ribs/Spines	7						
Pozzo	J8	30.07	6	*Salmo trutta*	Palatine	1						
Pozzo	J8	30.07	6		Unidentified	1						
Pozzo	H11	15.07	5/6		Ribs/Spines	1						
Pozzo	H11	15.07	5/6	*Salmo trutta*	Vomer	1						
Pozzo	H11	15.07	5/6		Unidentified	1						
Pozzo	H11	15.07	5/6		Ribs/Spines	19						
Pozzo	H11	15.07	5/6	*Salmo trutta*	Vertebra	1		II				
Pozzo	H11	15.07	5/6	*Salmo trutta*	Vertebrae	2		III				
Pozzo	H11	15.07	5/6	*Salmo trutta*	Vertebrae	9		?				<50% complete
Pozzo	H11	15.07	5/6	*Salmo trutta*	Glossohyal	1						
Pozzo	H11	15.07	5/6	*Salmo trutta*	Dentary	2	L					
Pozzo	H11	15.07	5/6	*Salmo trutta*	Vomer	1						
Pozzo	H11	15.07	5/6	*Salmo trutta*	Parasphenoid	1						
Pozzo	H11	15.07	5/6	*Salmo trutta*	Palatine	1						
Pozzo	H11	15.07	5/6	*Salmo trutta*	Ceratohyal	2						
Pozzo	H11	15.07	5/6	*Salmo trutta*	cleithrum	1						
Pozzo	H11	15.07	5/6	*Salmo trutta*	Posttemporal	1						
Pozzo	H11	15.07	5/6	*Salmo trutta*	basipterygium	1						
Pozzo	H11	15.07	5/6	*Salmo trutta*	Hyomandibular	1						
Pozzo	H11	15.07	5/6		Unidentified	28						
Pozzo	H11	21.07	6		Ribs/Spines	1						
Pozzo	H11	21.07	6	*Salmo trutta*	Vertebra	1		I				
Pozzo	H11	21.07	6	*Salmo trutta*	Vertebrae	12		II				

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Pozzo	H11	21.07	6	*Salmo trutta*	Vertebrae	12		III				
Pozzo	H11	21.07	6	*Salmo trutta*	Vertebrae	3		?				<50% complete
Pozzo	L8	25.07	6	*Salmo trutta*	Vertebrae	2		II				
Pozzo	L8	24.07	6	*Salmo trutta*	Vertebra	1		I				
Pozzo	L8	24.07	6	*Salmo trutta*	Vertebrae	2		II				
Pozzo	L8	24.07	6	*Salmo trutta*	Vertebra	1		III				
Pozzo	J9/J8	16.07	\	*Salmo trutta*	Vertebra	1		II				
Pozzo	H11	16.07	6		Ribs/Spines	11						
Pozzo	H11	16.07	6	*Salmo trutta*	Vertebrae	3		II				
Pozzo	H11	16.07	6	*Salmo trutta*	Vertebrae	2		III				
Pozzo	H11	16.07	6	*Salmo trutta*	Vertebrae	3		?				<50% complete
Pozzo	H11	16.07	6	*Salmo trutta*	Dentary	1	L					
Pozzo	H11	16.07	6	*Salmo trutta*	Dentary	2	R					
Pozzo	H11	16.07	6	*Salmo trutta*	Dentary	4	?					
Pozzo	H11	16.07	6	*Salmo trutta*	Maxilla	1	L					
Pozzo	H11	16.07	6	*Salmo trutta*	Maxilla	1	R					
Pozzo	H11	16.07	6	*Salmo trutta*	Epihyal	1						
Pozzo	H11	16.07	6	*Salmo trutta*	opercular	1						
Pozzo	H11	16.07	6	*Salmo trutta*	Quadrate	1						
Pozzo	H11	16.07	6	*Salmo trutta*	cleithrum	1						
Pozzo	H11	16.07	6	*Salmo trutta*	Articular	1						
Pozzo	H11	16.07	6		Unidentified	23						
Pozzo	G8	25.07	3		Ribs/Spines	8						
Pozzo	G8	25.07	3	*Salmo trutta*	Vertebra	1		II				
Pozzo	G8	25.07	3	*Salmo trutta*	Dentary	1	L					

Site	**Box**	**Context**	**Period**	**Species**	**Element**	**Freq**	**L/R**	**Type**	**A1**	**A2**	**B2**	**Comments**
Pozzo	G8	25.07	3	*Salmo trutta*	Maxilla	1						
Pozzo	G8	25.07	3	*Salmo trutta*	Quadrate	1						
Pozzo	G8	25.07	3	*Salmo trutta*	Hypural	1						
Pozzo	G8	25.07	3		Unidentified	19						
Pozzo	G9	30.07	6F	*Salmo trutta*	Dentary	1						
Pozzo	G8	20.07	1-3	*Salmo trutta*	Vertebra	1		III				
Pozzo	G8	20.07	1-3		Unidentified	9						
Pozzo	J7	28.07	1		Ribs/Spines	10						
Pozzo	J7	28.07	1	*Salmo trutta*	Vertebrae	2		II				
Pozzo	J7	28.07	1	*Salmo trutta*	Vertebra	1		IV				
Pozzo	J7	28.07	1	*Salmo trutta*	Vomer	1						
Pozzo	J7	28.07	1		Unidentified	25						
Pozzo	J9	15.07	7		Ribs/Spines	4						
Pozzo	J9	15.07	7	*Salmo trutta*	Vertebrae	2		II				
Pozzo	J9	15.07	7	*Salmo trutta*	Vertebrae	4		III				
Pozzo	J9	15.07	7	*Salmo trutta*	Vertebra	1		?				<50% complete
Pozzo	J9	15.07	7	*Salmo trutta*	Glossohyal	1						
Pozzo	J9	15.07	7		Unidentified	5						
Pozzo	H11	16.07	5/6		Ribs/Spines	127						
Pozzo	H11	16.07	5/6	*Salmo trutta*	Vertebrae	13		II				
Pozzo	H11	16.07	5/6	*Salmo trutta*	Vertebrae	8		III				
Pozzo	H11	16.07	5/6	*Salmo trutta*	Vertebra	1		V				
Pozzo	H11	16.07	5/6	*Salmo trutta*	Vertebrae	18		?				<50% complete
Pozzo	H11	16.07	5/6	*Salmo trutta*	Frontal	1						
Pozzo	H11	16.07	5/6	*Salmo trutta*	Glossohyal	4						

Site	Box	Context	Period	Species	Element	Freq	L/R	Type	A1	A2	B2	Comments
Pozzo	H11	16.07	5/6	*Salmo trutta*	Dentary	6						
Pozzo	H11	16.07	5/6	*Salmo trutta*	Vomer	4						
Pozzo	H11	16.07	5/6	*Salmo trutta*	Maxilla	8						
Pozzo	H11	16.07	5/6	*Salmo trutta*	Parasphenoid	2						
Pozzo	H11	16.07	5/6	*Salmo trutta*	Palatine	6						
Pozzo	H11	16.07	5/6	*Salmo trutta*	Ceratohyal	7						
Pozzo	H11	16.07	5/6	*Salmo trutta*	Epihyal	2						
Pozzo	H11	16.07	5/6	*Salmo trutta*	opercular	1						
Pozzo	H11	16.07	5/6	*Salmo trutta*	Quadrate	2						
Pozzo	H11	16.07	5/6	*Salmo trutta*	Scapula	1						
Pozzo	H11	16.07	5/6	*Salmo trutta*	Supracleithrum	2						
Pozzo	H11	16.07	5/6	*Salmo trutta*	Articular	5	L					
Pozzo	H11	16.07	5/6	*Salmo trutta*	Articular	2	R					
Pozzo	H11	16.07	5/6	*Salmo trutta*	Posttemporal	1						
Pozzo	H11	16.07	5/6	*Salmo trutta*	Urohyal	1						
Pozzo	H11	16.07	5/6	*Salmo trutta*	basipterygium	6						
Pozzo	H11	16.07	5/6	*Salmo trutta*	Hyomandibular	1						
Pozzo	H11	16.07	5/6		Unidentified	211						

Appendix VI: Catalogue of fish remains from Cantabrian sites

Site	**Level**	**Sector**	**Context**	**Cat. No.**		**Species**		**Element**	**Type**	**Freq**	**A1**	**A2**	**B2**
Altamira			Solutrean			*Salmo*	sp.	VF		1	11.5		10.3
Altamira			Magdaleniense inferior			*Salmo*	sp.	Vertebra	II	1			12.1
Altamira			Magdaleniense inferior			*Salmo*	sp.	Vertebra	II	1	8.9	10.3	8.3
Altamira			Magdaleniense inferior			*Salmo*	sp.	Vertebra		1			
Altamira			Magdaleniense inferior			*Salmo*	sp.	Vertebra	II	1	12.9	15.2	11.7
Altamira			Magdaleniense inferior			*Salmo*	sp.	Vertebra		1			11.2
Altamira			Magdaleniense inferior			*Salmo*	sp.	Vertebra	II	1	11.6	13.1	10.9
Altamira			Magdaleniense inferior			*Salmo*	sp.	Vertebra	II	1	12.0	14.4	10.6
Altamira			Magdaleniense inferior			*Salmo*	sp.	Vertebra		1			
Altamira			Magdaleniense inferior			*Salmo*	sp.	Vertebra		1			
Altamira			Magdaleniense inferior			*Salmo*	sp.	Vertebra	II	1	11.0	13.3	9.8
Altamira			Magdaleniense inferior			*Salmo*	sp.	Vertebra	II	1	12.5	12.9	9.6
Altamira			Magdaleniense inferior			*Salmo*	sp.	Vertebra	II	1	12.5	13.8	11.2
Altamira			Magdaleniense inferior			*Salmo*	sp.	Vertebra	III	1	14.8	15.6	
Altamira			Magdaleniense inferior			*Salmo*	sp.	Vertebra	III	1			12.1
Altamira			Magdaleniense inferior			*Salmo*	sp.	Vertebra	III	1	15.3		9.2
Altamira			Magdaleniense inferior			*Salmo*	sp.	Vertebra		1			
Altamira			Magdaleniense inferior			*Salmo*	sp.	Vertebra		1			8.5
Altamira			Magdaleniense inferior			*Salmo*	sp.	Vertebra	II	1	9.0	10.3	8.1
Altamira			Magdaleniense inferior			*Salmo*	sp.	Vertebra	II	1	7.7	9.0	8.2
Altamira			Magdaleniense inferior		cf.	*Salmo*	sp.	VF		3			
Altamira			Magdaleniense inferior					Rib/spine Fragments		10			

Altamira				1838		*Salmo*	sp.	Vertebra	III	1			
Altamira	2					*Salmo*	sp.	Palatine		1			
Altamira	2					*Salmo*	sp.	VF	II	1			
Altamira	2					*Salmo*	sp.	VF	II	1			9.0
Altamira	2			3642		*Salmo*	sp.	VF		2			
Altamira	2			3606				Rib/spine Fragments		5			
Altamira	2			3604				Rib/spine Fragments		34			
Altamira	3-6	N8	Limpieza corte	40489		*Salmo*	sp.	Frontal		1			
Altamira	3-6	N9	Limpieza corte	40489		*Salmo*	sp.	Vertebra	III	1	15.3	15.9	12.3
Altamira	3-6	N10	Limpieza corte	40489		?		Vertebra		1	3.7	3.5	4.5
Altamira	3-6	N8		40478		*Salmo*	sp.	Vertebra		1	15.1	17.5	
Altamira	3-6	N8		40478		*Salmo*	sp.	Vertebra		1	9.9	9.7	8.9
Altamira	3-6	N8		40478		*Salmo*	sp.	Vertebra	III	1	11.2	13.9	
Altamira	3-6	N8		40478		*Salmo*	sp.	Dentary (L)		1			
Altamira		L8	Limpieza corte	40485		*Salmo*	sp.	VF		2			
Altamira	3-6	N8	Corte este	40493		*Salmo*	sp.	Vertebra	II	1	16.2	19.1	13.8
Altamira	3-6	N8	Limpieza corte	40484		*Salmo*	sp.	Vertebrae	III	3			
Altamira	1-2	O7		40492		*Salmo*	sp.	Vertebra	III	1	3.4	3.6	3.4
Altamira	7	N7	Limpieza corte	40494				VF		1			
Altamira	8	K8		40498		*Salmo*	sp.	VF		2			
Altamira	3-6	N8	Corte este	40499		*Salmo*	sp.	Vertebra	II	1	2.6	2.5	2.0
Altamira	8	K8		40482		*Salmo*	sp.	Vertebra	II	1	7.1	8.0	6.7
Altamira	8	K8		40483		*Salmo*	sp.	Vertebrae		2		9.9	
Altamira	3-6	N8	Limpieza corte	40501		*Salmo*	sp.	Vertebra	II	1	10.3	11.1	
Altamira	3-6	N8	Limpieza corte	40501		*Salmo*	sp.	Vertebra	II	1			8.8

Altamira	3-6	N8	Limpieza corte	40501		*Salmo*	sp.	Vertebra	II	1			11.1
Altamira	3-6	N8	Limpieza corte	40501		*Salmo*	sp.	Vertebra	II	1	4.7	4.9	
Altamira	3-6	N8	Limpieza corte	40501		*Salmo*	sp.	VF		1			
Altamira	7	N8	Corte este	40503		*Salmo*	sp.	Vertebra	III	1	14.1	15.4	12.4
Altamira	7b	K8	Corte este	40480		*Salmo*	sp.	Vertebrae	II	2			
Altamira	1-2	O7		40491		*Salmo*	sp.	Vertebra		1			5.2
Altamira		L8	Limpieza corte	40502		*Salmo*	sp.	Vertebra	III	1	5.2	5.8	
Altamira		L8	Limpieza corte	40502		*Salmo*	sp.	Vertebra	III	1		3.8	3.2
Altamira		L8	Limpieza corte	40502		*Salmo*	sp.	Vertebra		1			
Altamira		L8	Limpieza corte	40490		*Salmo*	sp.	VF		2			
Altamira	2-6	L8		40495		*Salmo*	sp.	Vertebra	I	1	12.2	13.2	8.1
Altamira		L8	Limpieza corte	40497		*Salmo*	sp.	Vertebra	III	1			8.3
Altamira	7	N8	Corte este	40496		*Salmo*	sp.	Vertebra		1			
Altamira	7	N8	Corte este	40496		Unidentified				1			
Altamira	3-6	M8	Corte norte	40487		*Salmo*	sp.	VF		1			
Altamira	7	N7	Corte este	40500		*Salmo*	sp.	Vertebra	II	1			7.1
Altamira	7	N7	Corte este	40500		*Salmo*	sp.	Vertebra		1	3.2	3.1	
Altamira		L8	Limpieza corte	40479		*Salmo*	sp.	Vertebra	II	1	5.3	5.7	
Altamira	3-6	O7	Corte este	40475		*Salmo*	sp.	Vertebra	II	1			10.7
Altamira	3-6	N7		40483		*Salmo*	sp.	Vertebra	III	1			
Altamira	3-6	N7		40483		*Salmo*	sp.	Vertebra		1			
Altamira	7	N7	Corte este	40488		*Salmo*	sp.	Vertebra		1			
Altamira	8	L8	Limpieza corte	40486		*Salmo*	sp.	Vertebra	III	1	7.0	7.6	5.7
Altamira	8	K8		40481		Pleuronectidae		Vertebrae	Thoracic	1			
Altamira	3-6	O7		40474		*Salmo*	sp.	Vertebra	II	1	7.9		
Altamira	3-6	O7		40474		*Salmo*	sp.	Vertebra	III	1			9.6

Altamira	3-6	N7		40477		*Salmo*	sp.	VF		1			
Altamira	3-6	N7		40477		Unidentified		VF		1			
Altamira	7	N8	Corte este	40176		Pleuronectidae		Vertebra		1			
Altamira			Escomrera antigua	42521		*Salmo*	sp.	Vertebra	II	1			9.5
Altamira			Escomrera antigua	42522		*Salmo*	sp.	Vertebra	II	1			11.1
Altamira			Escomrera antigua	42517		*Salmo*	sp.	VF		1			6.9
Altamira			Escomrera antigua	42520		*Salmo*	sp.	VF		1	9.9	10.6	
Altamira			Escomrera antigua	42514		*Salmo*	sp.	Vertebra	I	1			
Altamira			Escomrera antigua	42518		*Salmo*	sp.	Vertebra	II	1			
Altamira			Escomrera antigua	42515		*Salmo*	sp.	Vertebra	III	1	5.6	5.2	5.3
Altamira			Escomrera antigua	42519		*Salmo*	sp.	Vertebra		1		10.6	
Altamira			Escomrera antigua	42516		*Salmo*	sp.	VF		1			
Altamira			Escomrera antigua	42523		Selachimorpha		Tooth		1			
Altamira	2			3703		*Salmo*	sp.	Vertebra	II	1		15.5	9.0
Altamira	2			3855		*Salmo*	sp.	Vertebra	III	1	11.9	14.3	9.9
Altamira	2			3855		*Salmo*	sp.	Frontal		1			
Altamira	D1					*Salmo*	sp.	Vertebra	II	1	6.9	9.2	
Altamira	D2					*Salmo*	sp.	Vertebra		1			
Altamira	D4					*Salmo*	sp.	Vertebra	II	1			3.4
Altamira	D5					*Salmo*	sp.	Vertebra	II	1	5.9	6.2	7.2
Rascaño	5					Selachimorpha		Tooth		1			
Rascaño						*Salmo*	sp.	Vertebra	III	1	6.2	6.8	6.0
Rascaño						*Salmo*	sp.	Vertebra	III	1	7.7	8.6	6.7
Rascaño						Pleuronectidae		Vertebra		1	3.7	4.0	3.8
Rascaño						Pleuronectidae		Vertebra		1	3.6	3.7	3.6
El Juyo	4	11Q/7	156-160					Rib/Spine		3			

El Juyo	4	10R/8	200-200					Rib/Spine		4			
El Juyo	4	12Q/7	131-136					Rib/Spine		1			
El Juyo		11Q/5	190-195	83433	cf.	*Salmo*	sp.	VFs		3			
El Juyo		11Q/5	190-195	83433	cf.	*Salmo*	sp.	VFs		4			
El Juyo		10Q/8	195-200	83432	cf.	*Salmo*	sp.	VFs		1			
El Juyo		10Q/8	190-195	83431		*Salmo*	sp.	VFs		1			
El Juyo		10Q/8	190-195	83431	cf.	*Salmo*	sp.	VFs		1			
El Juyo		10Q/8	190-195	83428	cf.	*Salmo*	sp.	VFs		1			
El Juyo		10Q/9	191-196	83427	cf.	*Salmo*	sp.	VFs		1			
El Juyo		10Q/6	176	83426	cf.	*Salmo*	sp.	VFs		4			
El Juyo		10Q/6	176	83426		*Salmo*	sp.	VFs		2			
El Juyo		10Q/5	191-193	83422	cf.	*Salmo*	sp.	VFs		9			
El Juyo		10Q/5	191-193	83422		*Salmo*	sp.	VFs		2			
El Juyo	9	11M/4, 5	202-210	83416	cf.	*Salmo*	sp.	VFs		2			
El Juyo	9	11M/4, 5	202-210	83416		*Salmo*	sp.	VFs		1			
El Juyo		11Q/3	130-135	83412	cf.	*Salmo*	sp.	VFs		3			
El Juyo	9	11M/4, 5	202-208	83412		*Salmo*	sp.	VFs		1			
El Juyo		11Q/3	155-160	83410	cf.	*Salmo*	sp.	VFs		2			
El Juyo	8	9M/9	174-176	83409	cf.	*Salmo*	sp.	VFs		4			
El Juyo		10Q/8	155-160	83408	cf.	*Salmo*	sp.	VFs		2			
El Juyo		10Q/8	155-160	83408		*Salmo*	sp.	VFs		1			
El Juyo		10Q/1	176-180	83407	cf.	*Salmo*	sp.	VFs		1			
El Juyo		11Q/1	170-175	83402	cf.	*Salmo*	sp.	VFs		7			
El Juyo		11Q/3	155-160	83401	cf.	*Salmo*	sp.	VFs		3			

El Juyo		11Q	165-170	83400	cf.	*Salmo*	sp.	VFs		6			
El Juyo		11Q	165-170	83400		*Salmo*	sp.	VFs		1			
El Juyo		10Q/3	165-170	83397	cf.	*Salmo*	sp.	VFs		4			
El Juyo	8	9N/7	174-179	83396	cf.	*Salmo*	sp.	VFs		8			
El Juyo	8	9N/7	174-179	83396		*Salmo*	sp.	VFs		5			
El Juyo	8	9N/4	177-181	83395	cf.	*Salmo*	sp.	VFs		1			
El Juyo	8	9N/5	183-186	83394	cf.	*Salmo*	sp.	VFs		4			
El Juyo	8	9N/5	183-186	83394		*Salmo*	sp.	VFs		4			
El Juyo	45	10Q/1	161-175	83393	cf.	*Salmo*	sp.	VFs		6			
El Juyo	45	10Q/1	161-175	83392	cf.	*Salmo*	sp.	VFs		3			
El Juyo	45	10Q/1	161-175	83392		*Salmo*	sp.	VFs		1			
El Juyo	8	9N/9	176-184	83392	cf.	*Salmo*	sp.	VFs		3			
El Juyo	8	9N/9	176-184	83392		*Salmo*	sp.	VFs		3			
El Juyo	8	11N/5	214-224	83391	cf.	*Salmo*	sp.	VFs		8			
El Juyo	45/T3	10Q/5	185-190	82280	cf.	*Salmo*	sp.	VFs		3			
El Juyo	45/T3	11Q/1	130-135	83378	cf.	*Salmo*	sp.	VFs		14			
El Juyo	45/T3	11Q/1	130-135	83378		*Salmo*	sp.	VFs		5			
El Juyo	7	8N/8	198-201	83378	cf.	*Salmo*	sp.	VFs		1			
El Juyo	45/T3	11Q/5, 8	187-189	83376	cf.	*Salmo*	sp.	VFs		2			
El Juyo	8	9M/3	175-180	83367		*Salmo*	sp.	VFs		1			
El Juyo	7	8N/3	187-191	83366	cf.	*Salmo*	sp.	VFs		1			
El Juyo	6	8N/3	210-212	83361	cf.	*Salmo*	sp.	VFs		5			
El Juyo	45/T3	11Q/5, 6	162-165	83350	cf.	*Salmo*	sp.	VFs		2			
El Juyo				83349	cf.	*Salmo*	sp.	VFs		15			
El Juyo				83349		*Salmo*	sp.	VFs		2			

El Juyo	8	9N/7	174-177	83338	cf.	*Salmo*	sp.	VFs		1			
El Juyo	45	9Q/8,9	185-195	83337	cf.	*Salmo*	sp.	VFs		8			
El Juyo	45/T3	11P/6	168-172	83331	cf.	*Salmo*	sp.	VFs		4			
El Juyo	45	9Q/7,8	160-190	83330	cf.	*Salmo*	sp.	VFs		10			
El Juyo	45	9Q/7,8	160-190	83330		*Salmo*	sp.	VFs		1			
El Juyo	45	10Q/8	178-180	83327	cf.	*Salmo*	sp.	VFs		1			
El Juyo	45	10Q/8	178-180	83327		*Salmo*	sp.	VFs		1			
El Juyo	45	10Q/2, 5	173-178	83325	cf.	*Salmo*	sp.	VFs		1			
El Juyo	45/T3	11P/6	163-168	83324	cf.	*Salmo*	sp.	VFs		9			
El Juyo	45/T3	11P/6	163-168	83324		*Salmo*	sp.	VFs		1			
El Juyo	45/T3	11Q/4	165-170	83321		*Salmo*	sp.	VFs		3			
El Juyo	8	12N/1, 2,3	175-198	83319	cf.	*Salmo*	sp.	VFs		5			
El Juyo	45	10Q/2	164-168	83312	cf.	*Salmo*	sp.	VFs		3			
El Juyo	45	10Q/4, 7	171-174	83310	cf.	*Salmo*	sp.	VFs		6			
El Juyo	45/T3	11O/5	150-155	83297	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45/T3	9Q/4,7	152-166	83278	cf.	*Salmo*	sp.	VFs		6			
El Juyo	4R	12P/5, 6	140-150	83277	cf.	*Salmo*	sp.	VFs		1			
El Juyo	45/T1-2	9Q/4,7	155-160	83274	cf.	*Salmo*	sp.	VFs		1			
El Juyo	45	10Q/2	166-173	83273	cf.	*Salmo*	sp.	VFs		6			
El Juyo	45	10Q/2	166-173	83273		*Salmo*	sp.	VFs		1			
El Juyo	45/T2	10Q/5	164-165	83252	cf.	*Salmo*	sp.	VFs		1			
El Juyo	7	9N/7	167-169	83238		*Salmo*	sp.	VFs		1			
El Juyo	45/T3	11Q	W34	83180004		*Salmo*	sp.	VFs		1			

El Juyo	45/T3	11Q	W34	83180004				Rib/Spine		4			
El Juyo	45/T3	11Q	W34	8317627		*Salmo*	sp.	Vertebra		1			
El Juyo	45/T3	11Q	W34	8317627				Rib/Spine		3			
El Juyo	45/T3	11Q	W34	837729		Pleuronectidae		VF	Caudal	1			
El Juyo	45/T3	10Q/5, 8	171-173	832304		*Salmo*	sp.	VFs		6			
El Juyo	9	9O	W40	831372		*Salmo*	sp.	Vertebra	Caudal	1			
El Juyo	D/9?	10Q/5	172-175	83229		*Salmo*	sp.	VFs		3			
El Juyo	45/T2-3	10P/6, 9	161-165	83230		*Salmo*	sp.	VFs		10			
El Juyo	45/T3	11P/4	162-167	83		*Salmo*	sp.	VFs		27			
El Juyo	4	9Q	206-239			Pleuronectidae		Vertebra	Thoracic	1			
El Juyo	4	11P/4	162-167			*Salmo*	sp.	Vertebra	II	1	4.8	5.2	4.9
El Juyo	4	11P/4	162-167			Pleuronectidae		Vertebra	First	1	5.5	5.2	1.8
El Juyo		11N/7-8.5	214-224	3631		Pleuronectidae		Vertebra	Thoracic	1	5.7	6.2	6.5
El Juyo	6	8N/8	255	255?		*Salmo*	sp.	Vertebra		1			
El Juyo		12S/3	70-72	910746/91365		*Salmo*	sp.	Urostyle		1			
El Juyo	4	11S/1	90-93	91183		*Salmo*	sp.	Vertebra		1			
El Juyo	F	9O/7				*Salmo*	sp.	Vertebra		1			
El Juyo	4	11R/8	120-127					Rib/Spine		1			
El Juyo	8	9M/5						No ID remains surviving		0			
El Juyo		12P/7		49896		*Salmo*	sp.	VFs		2			

El Juyo	45	10Q/6,9	167-173	49895		*Salmo*	sp.	VFs	II	4			
El Juyo		10Q/8	W39	49894				Rib/Spine		45			
El Juyo	45	10Q/7	180-181	49893	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T1-3	10Q/6,9	MK3	49892	cf.	*Salmo*	sp.	VFs		2			
El Juyo	MK13	9N/4	175-178	49891	cf.	*Salmo*	sp.	VF		1			
El Juyo	Mk11	8N/7	194-195	89890		*Salmo*	sp.	VFs		2			
El Juyo	MK16	9O/7	182	49889		*Salmo*	sp.	VF		1			
El Juyo	45/T1-2	9Q/7,4	169-170	49888		*Salmo*	sp.	VF		1			
El Juyo	MK14	9N/4	179-182	49887		*Salmo*	sp.	VFs		5			
El Juyo	MK23	9Q/8,9	185-195	49886		*Salmo*	sp.	VFs		5			
El Juyo	MK21	9Q/7,8	183-188	49885	cf.	*Salmo*	sp.	VFs		5			
El Juyo	MK20	9Q/7,8	175-180	49884		*Salmo*	sp.	VFs		2			
El Juyo	45	10R/7	165-180	49883	cf.	*Salmo*	sp.	VFs		4			
El Juyo	45	10R/7	185-190	49882	cf.	*Salmo*	sp.	VFs		4			
El Juyo	45/T3	10Q/7	185-190	49881	cf.	*Salmo*	sp.	VF		1			
El Juyo		8O/?	W36	49880		*Salmo*	sp.	Vertebra		1			
El Juyo	45/T1-2	9Q	170-178	49879	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45/T3	10Q/5	205-215	49878		*Salmo*	sp.	VFs	II	2			
El Juyo	4R	12F/9	168	960767				Rib/Spine		8			
El Juyo	4R	12R/6	89	961939				Rib/Spine		2			
El Juyo	4R	12S/3	79	961215				Rib/Spine		3			
El Juyo		9N/2	187	87130		*Salmo*	sp.	VF	II	1			
El Juyo	4	10Q/8	139-147	50060		*Salmo*	sp.	VFs		2			
El Juyo	4	10Q/borde sur	155	50059		*Salmo*	sp.	VF		1			

El Juyo	4	9Q/3	133	50058	cf.	*Salmo*	sp.	VF		1			
El Juyo		10R/8				*Salmo*	sp.	Vertebra	II	1			
El Juyo		11Q/?				*Salmo*	sp.	VFs		2			
El Juyo		11Q/?			cf.	*Salmo*	sp.	VFs		18			
El Juyo		10O/8				*Salmo*	sp.	VFs		3			
El Juyo		8N			cf.	*Salmo*	sp.	VFs		5			
El Juyo		8N				*Salmo*	sp.	VFs		2			
El Juyo	4R	12Q/4	115-120	50062		*Salmo*	sp.	VFs		3			
El Juyo	MK3	9Q/3	45bajo losa			*Salmo*	sp.	VFs		2			
El Juyo	Mk1	10R/west	45bajo losa			*Salmo*	sp.	VFs		3			
El Juyo		11Q/5	165-200	880721		*Salmo*	sp.	VF		1	7.4	8.5	
El Juyo		11M/1	196	89087		*Salmo*	sp.	VFs		3			
El Juyo		10R/4		891165				Rib/Spine		1			
El Juyo		10N/8		891062				Rib/Spine		6			
El Juyo		10N	8	891062		*Salmo*	sp.	VF		1			
El Juyo		10N/2		890825				Rib/Spine		6			
El Juyo	4	11P/9	140-145	83218	cf.	*Salmo*	sp.	VFs		3			
El Juyo	4	11P/9	140-145	83218		*Salmo*	sp.	VF		1			
El Juyo	6	8O/12		83211		*Salmo*	sp.	VF	II	1			
El Juyo		11O/2	168-172	83199	cf.	*Salmo*	sp.	VFs		4			
El Juyo		10Q/7	161-163	83195	cf.	*Salmo*	sp.	VF		1			
El Juyo		10Q/7	161-163	83195		*Salmo*	sp.	VF		1			
El Juyo		8N/2	202-206	83188		*Salmo*	sp.	VF		1			
El Juyo		8O/1		83182		*Salmo*	sp.	VFs		2			
El Juyo	4	10Q/7	159-164	83175		*Salmo*	sp.	VFs		1			
El Juyo	4	10Q/7	159-164	83175		*Salmo*	sp.	VFs		6			

El Juyo		10Q/7	150-155	83163	cf.	*Salmo*	sp.	VFs		6			
El Juyo		10Q/7	150-155	83163		*Salmo*	sp.	VFs	II	2			
El Juyo	8	10N/3	177-184	83161	cf.	*Salmo*	sp.	VFs		10			
El Juyo	8	10N/3	177-184	83161		*Salmo*	sp.	VFs		3			
El Juyo	9	10M/9	180-	83160		*Salmo*	sp.	VF		1			
El Juyo	9	10M/8	170-	83159	cf.	*Salmo*	sp.	VF		1			
El Juyo	9	10N/2	180-182	83158	cf.	*Salmo*	sp.	VFs		2			
El Juyo	9	10N/2	180-182	83158		*Salmo*	sp.	VFs		1			
El Juyo	9	9N/7	-167	83159		*Salmo*	sp.	Vertebra	II	1			
El Juyo	7	7M/9	197-200	83152		*Salmo*	sp.	Vertebra	III	1			
El Juyo	7	7M/9	197-200	83152		*Salmo*	sp.	VF		1			
El Juyo	6	7M/8	187-188	83151		*Salmo*	sp.	VF		1			
El Juyo	4	12R/1	124-128	83140	cf.	*Salmo*	sp.	VF		1			
El Juyo	4	12R/1	124-128	83140		*Salmo*	sp.	VF		1			
El Juyo	7	10N/1	182-185	83136		*Salmo*	sp.	VFs		3			
El Juyo	7	10N/1	182-185	83136	cf.	*Salmo*	sp.	VFs		3			
El Juyo	9	10M,N/11M,N	176-187	83131		*Salmo*	sp.	Vertebra	II	1			
El Juyo	9	10M,N/11M,N	176-187	83131		*Salmo*	sp.	Vertebra	III	1			
El Juyo	4	10M,N/11M,N		83130		*Salmo*	sp.	VF		1			
El Juyo	9	10M,N/11M,N		83128		*Salmo*	sp.	VF	III	1			

El Juyo	6	9N/3	195-200	83126		*Salmo*	sp.	VF		1			
El Juyo	4R	12P/6	140-146	83118	cf.	*Salmo*	sp.	VFs		5			
El Juyo	45	10Q/9	157-162	83115		*Salmo*	sp.	VF	II	1			
El Juyo	45	10Q/9	157-162	83115	cf.	*Salmo*	sp.	VF		1			
El Juyo	45	10Q/4, 9	160-169	83114	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45/T1	10Q/9	153-159	83112		*Salmo*	sp.	VFs		2			
El Juyo	8	10N/7	192-193	83100	cf.	*Salmo*	sp.	VFs		2			
El Juyo	4	11R/2	116-120	83080	cf.	*Salmo*	sp.	VF		1			
El Juyo		11Q/	86-100	83068		*Salmo*	sp.	VF	II	1			
El Juyo		11Q/	86-100	83068		*Salmo*	sp.	VF		1			
El Juyo		11Q/	86-100	83068		*Salmo*	sp.	Oromandibular bone		1			
El Juyo	45/T3	10Q/8	162	83063		*Salmo*	sp.	VF		1			
El Juyo	45/T3	10Q/5	160-163	83061	cf.	*Salmo*	sp.	VFs		2			
El Juyo	8	10N/8	194-195	83059	cf.	*Salmo*	sp.	VFs		2			
El Juyo	8	10N/9	188-189	83058	cf.	*Salmo*	sp.	VFs		4			
El Juyo	8	10N/9	188-189	83058		*Salmo*	sp.	VF		1			
El Juyo	8	10N/1	177-182	83050		*Salmo*	sp.	VFs		3			
El Juyo	8	10N/1	177-182	83050	cf.	*Salmo*	sp.	VFs		3			
El Juyo	8	9M/4	169-170	83048		*Salmo*	sp.	VF	II	1			
El Juyo	8	10N/5	185-186	83047		*Salmo*	sp.	VFs		3			
El Juyo	8	10N/5	185-186	83047	cf.	*Salmo*	sp.	VFs		7			
El Juyo	a/1	12R/11R/2	114-116	83046		*Salmo*	sp.	Vertebra	II	1		2.4	2.7
El Juyo	8	8M/9	187-188	83027	cf.	*Salmo*	sp.	VFs		5			
El Juyo	4R	12S/5	77-84	96287				Rib/Spine		3			

El Juyo	4R	12Q/9	153-155	96064		*Salmo*	sp.	VF		1	11.5	15.7	
El Juyo	4R	12Q/9	153-155	96064		*Salmo*	sp.	VF		1	11.7	15.3	
El Juyo	8	9M/3	188-199	96092	cf.	*Salmo*	sp.	VFs		2			
El Juyo	4R	12R/6	87-92	96084				Rib/Spine		1			
El Juyo	45/T3	11Q/5	191-196	96411				Rib/Spine		2			
El Juyo	4	7Q/2	146-148	96233				Rib/Spine		5			
El Juyo	4R	12P		96067				Rib/Spine		1			
El Juyo	8	9M/1	179-184	96238				Rib/Spine		1			
El Juyo	8	12P/8	165-167	96311				Rib/Spine		1			
El Juyo	8	12P/8	165-167	96311	cf.	*Salmo*	sp.	VF		1			
El Juyo		12R/all		96006	cf.	*Salmo*	sp.	VFs		3			
El Juyo		12R/all		96006		*Salmo*	sp.	VF		1			
El Juyo		12O	south wall cleaning	96061				Rib/Spine		1			
El Juyo		11N/3	west wall cleaning	96192				Rib/Spine		2			
El Juyo	4R	12Q/6	160-164	96081				Rib/Spine		1			
El Juyo	4R	12Q/7	166-170	96086				Rib/Spine		2			
El Juyo	4R	12Q/7	170-173	96111				Rib/Spine		1			
El Juyo	4R	11Q/6	157-165	96065				Rib/Spine		3			
El Juyo	4R	12Q/4	169-176	96129				Rib/Spine		5			
El Juyo		12Q/5	170-173	96138	cf.	*Salmo*	sp.	VF		1			
El Juyo		12P/7	161-162	96259				Rib/Spine		1			
El Juyo		9M/9	200-203	96651				Rib/Spine		1			
El Juyo	4	12P/4	152-159	96142				Rib/Spine		1			
El Juyo	8	9N/2	188-190	96173				Rib/Spine		2			
El Juyo	4R	12P/9	170-172	96446				Rib/Spine		3			
El Juyo				96618	cf.	*Salmo*	sp.	VF		1			

El Juyo	4R	12Q/9	170-173	96218				Rib/Spine		2			
El Juyo	4R	12Q/9	170-173	96218		*Salmo*	sp.	VF	II	1			
El Juyo	4R	12Q/1	172-176	94355		*Salmo*	sp.	VFs		3			
El Juyo	4R	12Q/1	172-176	94355	cf.	*Salmo*	sp.	VF		1			
El Juyo	9	9O/5	176-182	94357	cf.	*Salmo*	sp.	VF		1			
El Juyo	9	11O/7	182-184	94358	cf.	*Salmo*	sp.	VFs		2			
El Juyo	8-9	9O/7	197-	94252				Rib/Spine		2			
El Juyo	8	8N/7	215-216	94340		*Salmo*	sp.	VF		1			
El Juyo		8N/2	198-200	94320		*Salmo*	sp.	VFs		2			
El Juyo	4R	12q/4	169-170	94304	cf.	*Salmo*	sp.	VF		1			
El Juyo	4R	12Q/1	166-169	94293	cf.	*Salmo*	sp.	VF		1			
El Juyo	4R	12Q/2	160-162	94281		*Salmo*	sp.	VFs		2			
El Juyo	6	8N/2	216-222	94264		*Salmo*	sp.	VF	III	1			
El Juyo	6	8N/1	220-224	94250		*Salmo*	sp.	VFs		3			
El Juyo	6	8N/1	220-224	94250	cf.	*Salmo*	sp.	VF		1			
El Juyo		10N/8	197-231	94237		*Salmo*	sp.	VFs		3			
El Juyo	6	8N/2	220-224	94235		*Salmo*	sp.	VFs		2			
El Juyo	6	8N/2	220-224	94235		*Salmo*	sp.	VF	II	1			
El Juyo	9	11O/2	172-175	94224	cf.	*Salmo*	sp.	VF		1			
El Juyo	6	8N/2	216-220	94215		*Salmo*	sp.	VF	II	1			
El Juyo	6	7N/7	214-221	94198		*Salmo*	sp.	VF	II	1			
El Juyo	4R	12Q/8	148-152	94197	cf.	*Salmo*	sp.	VFs		2			
El Juyo	9	11O/7	168-173	94173		*Salmo*	sp.	VF		1			5
El Juyo	9	11O/4	174-175	94139		*Salmo*	sp.	VFs		2			
El Juyo	9	8N/2	210-219	94101		*Salmo*	sp.	VFs	II	2			
El Juyo	9	8N/2	210-219	94101		*Salmo*	sp.	VF		1			

El Juyo	8	10M/2	198-201	93107				Rib/Spine		1			
El Juyo	45/T	10Q/6	195-200	93005	cf.	*Salmo*	sp.	VFs		4			
El Juyo	45/T	10Q/6	195-200	93005		*Salmo*	sp.	VFs		3			
El Juyo	45/T1	10R/4	305-310	93278		*Salmo*	sp.	VF	III	1			
El Juyo	45/T1	10Q/6	295-300	93268		*Salmo*	sp.	VF		1			
El Juyo	45/T1	12Q/6	141-144	93263		*Salmo*	sp.	VF		1			
El Juyo	45/T1	10Q/3	295-300	93255		*Salmo*	sp.	VF	III	1			
El Juyo	11	11M/5	221-222	93248	cf.	*Salmo*	sp.	VF		1			
El Juyo	6	7M/5	217-223	93203		*Salmo*	sp.	VF	III	1			4.7
El Juyo	45/T4	10Q/6	255-260	93202	cf.	*Salmo*	sp.	VF		1			
El Juyo	8	10M/4	189-208	93183		*Salmo*	sp.	VF	III	1			
El Juyo	45/T1	10R/6	240-245	93177		*Salmo*	sp.	VF	II	1			
El Juyo	45/T1	10Q/5	240-245	93174		*Salmo*	sp.	VF		1			
El Juyo	45/T1	10Q/6	235-240	93170		*Salmo*	sp.	VFs	Ii	2			
El Juyo	45/T1	10R/1	225-230	93154	cf.	*Salmo*	sp.	VF		1			
El Juyo	9	10O/6	179-189	93151	cf.	*Salmo*	sp.	VF		1			
El Juyo	4R	12Q/6	124-128	93146	cf.	*Salmo*	sp.	VFs		3			
El Juyo	45/T1	10Q/6	230-235	93138	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T1	10R/4	220-225	93132		*Salmo*	sp.	VF		1			
El Juyo	8	10M/2	200-206	93131		*Salmo*	sp.	VF		1			
El Juyo	8	10M/2	201-206	93113		*Salmo*	sp.	VF		7			
El Juyo	8	10M/2	201-206	93113		*Salmo*	sp.	VF	II	1			
El Juyo	8	10M/9	204-206	93111		*Salmo*	sp.	VF		1			
El Juyo	45/T1	10R/1	192-197	93109		*Salmo*	sp.	VF		1			
El Juyo	45/T1	10R/1	192-197	93109	cf.	*Salmo*	sp.	VF		1			
El Juyo	9	10O/4	180-187	93100	cf.	*Salmo*	sp.	VF		1			

El Juyo	9	10O/4	180-187	93100		*Salmo*	sp.	VF		1			
El Juyo	8	10M/3	201-208	93091		*Salmo*	sp.	VF	III	1			
El Juyo	8	10M/3	201-208	93091		*Salmo*	sp.	VF	II	1			
El Juyo	45/T1	10Q/6	215-220	93079		*Salmo*	sp.	VF	II	1			3.5
El Juyo	6	7M/6	216-220	93076		*Salmo*	sp.	VF		1			
El Juyo	10	11M/5	214-218	93062		*Salmo*	sp.	VF		1			
El Juyo	45/T1	10Q/3	208-213	93054	cf.	*Salmo*	sp.	VFs		2			
El Juyo	4R	12Q/2	157-RS	93050		*Salmo*	sp.	VF		1			
El Juyo	6	7M/9	218-221	93049		*Salmo*	sp.	VF	II	1			3.9
El Juyo	8	10M/5	193-200	93040		*Salmo*	sp.	VF	II	1			5.4
El Juyo	45/T1	10Q/3	195-202	93033		*Salmo*	sp.	VF	II	1			
El Juyo	10	11M/2	214-215	93023		*Salmo*	sp.	VF	II	1			5.6
El Juyo	4R	12Q/2	148-155	93017	cf.	*Salmo*	sp.	VF		1			
El Juyo	4R	12Q/1	154-155	93003	cf.	*Salmo*	sp.	VFs		3			
El Juyo	4R	12Q/1	154-155	93003		*Salmo*	sp.	VF		1			
El Juyo	4R	12Q/5	144-147	92664	cf.	*Salmo*	sp.	VFs		3			
El Juyo	4R	12Q/5	144-147	92664		*Salmo*	sp.	VFs		2			
El Juyo	4R	12Q		92561	cf.	*Salmo*	sp.	VF		1			
El Juyo	4R	12Q		92561		*Salmo*	sp.	VF		1			
El Juyo	45/T2	10Q/1	210-215	92559	cf.	*Salmo*	sp.	VFs		4			
El Juyo	6	8M/1	190-198	92550		*Salmo*	sp.	VF	III	1			
El Juyo	45/T1	10Q/	205-210	92549	cf.	*Salmo*	sp.	VFs		3			
El Juyo	4R	12Q/5	133-147	92547	cf.	*Salmo*	sp.	VFs		4			
El Juyo	4R	12Q/1	148-155	92517	cf.	*Salmo*	sp.	VFs		3			
El Juyo	4R	12Q/1	148-155	92514	cf.	*Salmo*	sp.	VFs		4			
El Juyo	4R	12Q/1	148-155	92514		*Salmo*	sp.	VF		1			

El Juyo	4R	11Q/7	156-160	92196	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45/T2	10Q/1	185-190	92195		*Salmo*	sp.	VF		1			
El Juyo	45/T5	12R/3	104-107	92191	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T2	10Q/5	185-190	92190		*Salmo*	sp.	VF	II	1			
El Juyo	45/T2	10Q/5	185-190	92190		*Salmo*	sp.	VF		1			
El Juyo	6	8M/3	216-218	92189	cf.	*Salmo*	sp.	VFs		2			
El Juyo	6	8M/3	216-218	92189		*Salmo*	sp.	VF	II	1			
El Juyo	45/T2	10Q/5	188-190	92188	cf.	*Salmo*	sp.	VFs		6			
El Juyo	45/T3	10Q/5	195-200	92186		*Salmo*	sp.	VF		1	3.2	3.0	
El Juyo	45/T2	10Q/4	200-205	92182	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T3	10Q/4	200-205	92176	cf.	*Salmo*	sp.	VFs		3			
El Juyo	45/T3	10Q/4	185-190	92175	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T5	11R/5	185-190	92165	cf.	*Salmo*	sp.	VFs		5			
El Juyo	45/T5	11R/6	195-200	92147		*Salmo*	sp.	VF		1			
El Juyo	4R	12Q/4	146-153	92115	cf.	*Salmo*	sp.	VF		2			
El Juyo	4R	12R/5	109-111	92111	cf.	*Salmo*	sp.	VFs		6			
El Juyo	4R	12R/5	109-111	92111		*Salmo*	sp.	VF		1			
El Juyo	4R	11R/7	165-170	92110	cf.	*Salmo*	sp.	VF		1			
El Juyo	4R	11R/7	165-170	92110		*Salmo*	sp.	VF		1			
El Juyo	4R	11R/4	175-180	92104	cf.	*Salmo*	sp.	VF		1			
El Juyo	4R	11R/5	175-180	92102		*Salmo*	sp.	VFs		2			
El Juyo	4R	12R/7	110-111	92099	cf.	*Salmo*	sp.	VF		1			
El Juyo	4R	11R/4	195-200	92097		*Salmo*	sp.	VFs		2			
El Juyo	4R	11Q/7	150-155	92090	cf.	*Salmo*	sp.	VFs		3			
El Juyo	4R	11Q/7	150-155	92090		*Salmo*	sp.	VFs		2			
El Juyo	4R	11R/7	185-190	92086		*Salmo*	sp.	VF		1			

El Juyo	45/T5	11R/4	190-195	92082	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45/T5	11R/4	190-195	92082		*Salmo*	sp.	VF		1			
El Juyo	8	10M/3	184-192	92076	cf.	*Salmo*	sp.	VF		1			
El Juyo	8	10M/3	184-192	92076		*Salmo*	sp.	VF		1			
El Juyo	4R	12Q/2	140-145	92063	cf.	*Salmo*	sp.	VFs		3			
El Juyo	4R	12Q/2	140-145	92063		*Salmo*	sp.	VF		1			
El Juyo	45/T5	11R/7	155-160	92048	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45/T5	11R/7	155-160	92048		*Salmo*	sp.	VF		1			
El Juyo	45/T5	11R/7	155-160	92046		*Salmo*	sp.	VF		1			
El Juyo	4R	12Q/4	141-142	92045	cf.	*Salmo*	sp.	VFs		4			
El Juyo	4R	12Q/4	141-142	92045		*Salmo*	sp.	VFs		2			
El Juyo	45/T5	11R/7	145-150	92035	cf.	*Salmo*	sp.	VF		1			
El Juyo	4R	12Q/1	152-146	92033	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T4	11R/8	130-135	92022	cf.	*Salmo*	sp.	VF		1			
El Juyo	6	8M/1	112-116	92021	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T4	11R/8	130-135	92020	cf.	*Salmo*	sp.	VFs		31			
El Juyo	45/T4	11R/8	130-135	92020		*Salmo*	sp.	VFs		2			
El Juyo	45/T4	11R/9	130-135	92016	cf.	*Salmo*	sp.	VF		1			
El Juyo	45	?	?	90130		*Salmo*	sp.	VF		1			
El Juyo	6	8M/1,2,4	195	90280		*Salmo*	sp.	VFs		4			
El Juyo	4	9S/8	77-	90247		*Salmo*	sp.	VF		1			
El Juyo	6	8M/1	192-	90239		*Salmo*	sp.	VF		1			
El Juyo	4	9R/4,1,7	95	90232		*Salmo*	sp.	VF		1			
El Juyo	8	10N/7	196	90227	cf.	*Salmo*	sp.	VF		1			
El Juyo	8	10N/9	190	90207	cf.	*Salmo*	sp.	VF		1			

El Juyo	6	8M/3	203	90194		*Salmo*	sp.	VFs		2			
El Juyo	45	11P/1	164	90186		*Salmo*	sp.	VF		1			
El Juyo	4	10S/1	82	90175		*Salmo*	sp.	VF		1			
El Juyo	4	10S/4	83	90133		*Salmo*	sp.	VF	II	1			
El Juyo	4	10S/6	73	90101	cf.	*Salmo*	sp.	VF		1			
El Juyo	4	11R/8	127	90148	cf.	*Salmo*	sp.	VF		1			
El Juyo	45	11R/7	133	90157	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45	11R/7	133	90157		*Salmo*	sp.	VF		1			
El Juyo	4	11R/4	126	90169		*Salmo*	sp.	VF		1			
El Juyo	45	11R/6	117-	90177	cf.	*Salmo*	sp.	VF		1			
El Juyo	4	11R/1	164-	90182		*Salmo*	sp.	VF	II	1			
El Juyo	4	11R/5	137	90229	cf.	*Salmo*	sp.	VF		1			
El Juyo	8	11M/1		89009	cf.	*Salmo*	sp.	VFs		2			
El Juyo	8	11M/1		89009		*Salmo*	sp.	VFs		2			
El Juyo	7	11O/5	162-	89012	cf.	*Salmo*	sp.	VFs		5			
El Juyo	45	10R/2	185-190	89017	cf.	*Salmo*	sp.	VFs		3			
El Juyo	8	10N/6	188	89020		*Salmo*	sp.	VF		1			
El Juyo	8	10N/4	192	89021	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45	10R/2	197-202	89025	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45	10R/2	197-202	89025		*Salmo*	sp.	VFs		3			
El Juyo	45	10R/1	197-202	89026	cf.	*Salmo*	sp.	VFs		5			
El Juyo	45	10R/1	197-202	89026		*Salmo*	sp.	VFs		2			
El Juyo	45	10Q-R/7-1	171-189	89030		*Salmo*	sp.	VF		1			
El Juyo	45	10Q-R/7-1	171-189	89030		Pleuronectidae		VF		1			

El Juyo	45	10Q-R/7-1	171-189	89030	cf.	*Salmo*	sp.	VFs		4			
El Juyo	45	10R/1	200-215	89032	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45	10R/1	200-205	89033	cf.	*Salmo*	sp.	VFs		3			
El Juyo	45	10Q/3	200-215	89035		*Salmo*	sp.	VFs	III	2			
El Juyo	45	10Q/3	200-215	89035		*Salmo*	sp.	VFs	II	2			
El Juyo	8	10O/		89036		*Salmo*	sp.	VFs		2			
El Juyo	8	10N/		89041	cf.	*Salmo*	sp.	VFs		3			
El Juyo	8	10N/		89041		*Salmo*	sp.	VFs		3			
El Juyo	8	10N		89042		*Salmo*	sp.	VFs		3			
El Juyo	8	10N		89042	cf.	*Salmo*	sp.	VFs		3			
El Juyo	45/T4	10Q/9	220-225	89049	cf.	*Salmo*	sp.	VFs		7			
El Juyo	45/T4	10Q/9	220-225	89049	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45/WT4	10Q/9	225-230	89050	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/WT4	10Q/9	225-230	89050		*Salmo*	sp.	VFs		2			
El Juyo	45/WT4	10Q/9	220-234	89051	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/WT4	10Q/9	220-234	89051		*Salmo*	sp.	VFs		2			
El Juyo	8	10N/7	187	89065	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T1	10Q/8	230-235	89057	cf.	*Salmo*	sp.	VF		1			
El Juyo	45	10Q/8	140-145	89073	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T3	10Q/8	130-135	89076	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T3	10Q/8	135-140	89078	cf.	*Salmo*	sp.	VFs		2			
El Juyo	8	10M/8	181-182	89079	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T3	10Q/8	235-240	89080	cf.	*Salmo*	sp.	VF		1			
El Juyo		11M/1	190-195	89086	cf.	*Salmo*	sp.	VFs		2			
El Juyo		11M/1	190-195	89086		*Salmo*	sp.	VFs		2			
El Juyo	8	9M/8	173	89093	cf.	*Salmo*	sp.	VFs		2			

El Juyo	8	10N/3, 6,9		89095	cf.	*Salmo*	sp.	VFs		1			
El Juyo	8	9M/6	180-185	89098	cf.	*Salmo*	sp.	VF		1			
El Juyo	8	9M/4	174-179	89099	cf.	*Salmo*	sp.	VF		1			
El Juyo	8	10N/2	187-188	89100	cf.	*Salmo*	sp.	VF		1			
El Juyo	8	9M/1	177-182	89102	cf.	*Salmo*	sp.	VF		1			
El Juyo	8	9M/1	177-182	89102		*Salmo*	sp.	VF		1			
El Juyo	8	9M/3	179-184	89104				Rib/Spine		1			
El Juyo	8	11O/4	186-188	95108	cf.	*Salmo*	sp.	VFs		2			
El Juyo	9	11O/6	204-205	95495	cf.	*Salmo*	sp.	VFs		7			
El Juyo	9	11O/6	184-189	95178	cf.	*Salmo*	sp.	VF		1			
El Juyo	9	11O/7	193-197	95338	cf.	*Salmo*	sp.	VF		1			
El Juyo	9	11O/6	196-198	95319	cf.	*Salmo*	sp.	VFs		2			
El Juyo	9	11O/3	198-202	95336		*Salmo*	sp.	VF		1			
El Juyo	9	11O/5	184-185	95107	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T4	12R/4	124-125	95103		*Salmo*	sp.	VF	II	1			8.1
El Juyo	8	11O/4	186-188	95108	cf.	*Salmo*	sp.	VFs		3			
El Juyo	4R	12R/4	125-128	95113	cf.	*Salmo*	sp.	VFs		4			
El Juyo	9	9N/4	199-202	95120	cf.	*Salmo*	sp.	VFs		3			
El Juyo	9	9N/4	199-202	95120		*Salmo*	sp.	VF		1			
El Juyo	4R	12R/7	128/129	95130		*Salmo*	sp.	VF		1			
El Juyo	4R	12R/4	130-133	95132	cf.	*Salmo*	sp.	VFs		7			
El Juyo	4R	12R/4	130-133	95132		*Salmo*	sp.	VF		1			
El Juyo	9	9N/1	202-204	95203		*Salmo*	sp.	VF		1			
El Juyo	45	9S/2	67-76	95194		*Salmo*	sp.	VF		1			
El Juyo	9	11O/6	189-191	95189	cf.	*Salmo*	sp.	VFs		7			
El Juyo	9	11O/6	189-191	95189		*Salmo*	sp.	VFs		2			

El Juyo	6	7N/5	233-235	95153		*Salmo*	sp.	VFs		2			
El Juyo	6	7N/3	226-228	95187		*Salmo*	sp.	VF	II	1			
El Juyo	6	7N/3	226-228	95187		*Salmo*	sp.	VF		1			
El Juyo	7	11O/2	184-187	95150	cf.	*Salmo*	sp.	VFs		2			
El Juyo	11	11M/5	228-232	95147		*Salmo*	sp.	VF	II	1			
El Juyo	6	7N/7	230-232	95146		*Salmo*	sp.	VF	III	1			
El Juyo	9	11O/6	184-187	95138	cf.	*Salmo*	sp.	VFs		3			
El Juyo	9	11O/2	187-189	95145	cf.	*Salmo*	sp.	VF		1			
El Juyo	6	7N/9	229-230	95233		*Salmo*	sp.	VF		1			
El Juyo	4	9S/6	75-78	95249		*Salmo*	sp.	VF	III	1			
El Juyo	6	7N/2	230-233	95260	cf.	*Salmo*	sp.	VF		1			
El Juyo	6	7N/8	232-233	95278	cf.	*Salmo*	sp.	VF		1			
El Juyo	6	7N/3	228-231	95283		*Salmo*	sp.	VF	III	1			
El Juyo	45/T1	9Q/9	180-182	95506		*Salmo*	sp.	VF		1			
El Juyo	45	9Q/8	165-170	95511		*Salmo*	sp.	VFs	II	2			
El Juyo	45	9Q/8	165-170	95511		*Salmo*	sp.	VF		1			
El Juyo	4R	11Q/9	167-174	95536	cf.	*Salmo*	sp.	VF		1			
El Juyo	4R	11Q/9	167-174	95536		*Salmo*	sp.	VF		1			
El Juyo	4R	11Q/7	170-172	95525	cf.	*Salmo*	sp.	VFs		7			
El Juyo	4R	10Q/7	170-173	95525		*Salmo*	sp.	VFs		3			
El Juyo	6	6M/5	193-199	95385		*Salmo*	sp.	VF	II	1			2.5
El Juyo	4R	12R/7	125-128	95118		*Salmo*	sp.	VF		1			
El Juyo	4R	12R/4	128-130	95128	cf.	*Salmo*	sp.	VF		1			
El Juyo	4	9S/6	78-79	95241		*Salmo*	sp.	VFs		2			
El Juyo	4	9S/6	78-79	95241	cf.	*Salmo*	sp.	VF		1			
El Juyo	4	7Q/6	133-134	95386		*Salmo*	sp.	VF	II	1			

El Juyo	4	7Q/6	133-134	95386	cf.	*Salmo*	sp.	VF		1			
El Juyo	6	7N/7	222-226	95033	cf.	*Salmo*	sp.	VF		1			
El Juyo	6	7N/7	222-226	95033		*Salmo*	sp.	VFs		4			
El Juyo	11	11M/1	223-229	95037		*Salmo*	sp.	VF		1			
El Juyo	6	7N/6	224-228	95045		*Salmo*	sp.	VF	II	1			
El Juyo	6	7N/6	224-228	95045		*Salmo*	sp.	VF		1			
El Juyo	6	7N/6	224-228	95045	cf.	*Salmo*	sp.	VF		1			
El Juyo	6	7N/9	217-220	95049		*Salmo*	sp.	VF		1			
El Juyo	8	11O/1	186-188	95065		*Salmo*	sp.	VF	II	1			
El Juyo	4	7Q/6	109-111	95076				unidentified		1			
El Juyo	4R	12R/4	118-119	95083	cf.	*Salmo*	sp.	VFs		2			
El Juyo	4R	12R/7	121-125	95091	cf.	*Salmo*	sp.	VFs		2			
El Juyo	4R	12R/4	119-125	95087	cf.	*Salmo*	sp.	VFs		3			
El Juyo	4	7Q/9	111-113	95098		*Salmo*	sp.	VF		1			
El Juyo	4	7Q/8	125-129	95314	cf.	*Salmo*	sp.	VF		1			
El Juyo	9	12O/2	167-169	95322	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T4	12Q/5	160-162	95332		*Salmo*	sp.	VFs		2			
El Juyo	8	9N/7	202-204	95334	cf.	*Salmo*	sp.	VFs		2			
El Juyo	8	9N/7	202-204	95334		*Salmo*	sp.	VF	III	1			
El Juyo	6	6N/3	223-226	95387	cf.	*Salmo*	sp.	VFs		2			
El Juyo	4R	11Q/7	165-169	95440	cf.	*Salmo*	sp.	VFs		2			
El Juyo	11	11M/2		95442		*Salmo*	sp.	VF		1			
El Juyo	11	11M/2		95442	cf.	*Salmo*	sp.	VF		1			
El Juyo	6	6M/1	193-196	95453	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45	9S/2	82-87	95454		*Salmo*	sp.	VF	III	1			
El Juyo	45/T1	9Q/9	165-170	95473	cf.	*Salmo*	sp.	VF		1			

El Juyo	45/T1	9Q/9	165-170	95473		*Salmo*	sp.	VF		1			
El Juyo	45/T1	9Q/9	170-172	95476		*Salmo*	sp.	VF	III	1			
El Juyo	45/T1	9Q/8	180-182	95505		*Salmo*	sp.	VF		1			
El Juyo	45	12Q/1	134-137	91297		*Salmo*	sp.	VF		1			
El Juyo	45	12Q/1	134-137	91297	cf.	*Salmo*	sp.	VF		1			
El Juyo	45	10R/9	109-115	91263		*Salmo*	sp.	VF		1			
El Juyo	8	10N/2	189-190	91248	cf.	*Salmo*	sp.	VFs		2			
El Juyo	8	9M/7	171-178	91173		*Salmo*	sp.	VF		1			
El Juyo	4	11S/7	83	91170		*Salmo*	sp.	VF		1			
El Juyo	4R	12Q/9	112-116	91157		*Salmo*	sp.	VF		1			
El Juyo	6	8M/2	199-205	91144	cf.	*Salmo*	sp.	VF		1			
El Juyo	6	8M/2	199-205	91144		*Salmo*	sp.	VF		1			
El Juyo	4	11Q/	171	91147	cf.	*Salmo*	sp.	VFs		2			
El Juyo	4	11S/4	88-91	91141		*Salmo*	sp.	VF		1			
El Juyo	6	8M/5	200-201	91133	cf.	*Salmo*	sp.	VFs		2			
El Juyo	6	8M/5	200-201	91133		*Salmo*	sp.	VF		1			
El Juyo	4	12P		91130		*Salmo*	sp.	VF		1			
El Juyo	4	12P		91130	cf.	*Salmo*	sp.	VFs		6			
El Juyo	8	9M/5	180-181	91123	cf.	*Salmo*	sp.	VFs		5			
El Juyo	45/T4	11R/7	142-148	91151		*Salmo*	sp.	VF		1			
El Juyo	45	11R/2	147-152	91158	cf.	*Salmo*	sp.	VF		1			
El Juyo	45	11R/2	147-152	91158		*Salmo*	sp.	VFs		3			
El Juyo	45	11R/3	150-155	91164	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45	11R/3	150-155	91164		*Salmo*	sp.	VFs	II	1			
El Juyo	45	11R/3		91184	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45	11R/3		91184		*Salmo*	sp.	VF		1			

El Juyo	45	11R/3	155-157	91187	cf.	*Salmo*	sp.	VFs		3			
El Juyo	45/T3-4	11R/1	155-160	91366		*Salmo*	sp.	VFs		2			
El Juyo	45	11R/8	147-152	91214	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T4	11R/8	135-140	91220		*Salmo*	sp.	VFs		2			
El Juyo	45/T4	11R/5	120-130	91233	cf.	*Salmo*	sp.	VFs		3			
El Juyo	45/T4	11R/6	125-130	91230	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45	11R/5	140-180	91224		*Salmo*	sp.	VF	II	1			
El Juyo	45/T4	11R/6	132-150	91246		*Salmo*	sp.	VF		1			
El Juyo	45/T3-4	11R/1	159-170	91265	cf.	*Salmo*	sp.	VFs		4			
El Juyo	45/T4	11R/1	155-160	91388		*Salmo*	sp.	VF		1			
El Juyo	45/T4	11R/2	175-180	91463		*Salmo*	sp.	VF		1			
El Juyo	45/T4	11R/3	180-185	91411	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T4	11R/2	200-205	91506	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T4	11R/1	170-175	91505		*Salmo*	sp.	VFs		2			
El Juyo	45/T4	11R/1	170-175	91505	cf.	*Salmo*	sp.	VFs		4			
El Juyo	45/T4	11R/3	190-195	91514	cf.	*Salmo*	sp.	VF		1			
El Juyo	45	11R/1	180-185	91510	cf.	*Salmo*	sp.	VFs		3			
El Juyo	45	11R/1	180-185	91510		*Salmo*	sp.	VF		1			
El Juyo	45/T4	11R/3	190-195	91518	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45/T4	11R/3	180-190	91531	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T4	11R/3	180-190	91531		*Salmo*	sp.	VF		1			
El Juyo	45/T4	11R/3	240-250	91550	cf.	*Salmo*	sp.	VF		4			
El Juyo	45/T4	11R/2	208-210	91561	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T4	11R/1	230-235	91538	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45/T4	11R/1	205-210	91563	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45/T4	11R/1	205-210	91563		*Salmo*	sp.	VF	II	1			

El Juyo	6	8M/2	199-205	91144		*Salmo*	sp.	VF	III	1			
El Juyo	45/Wall	12Q/3	131-134	91334		*Salmo*	sp.	VF	III	1			
El Juyo	45/T4	11Q/2	218-223	91576	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T4	10Q/9	250-260	91553	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T4	10Q/9	250-260	91553		*Salmo*	sp.	VF		1			
El Juyo	45/T4	10R/3	204-205	91538	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T3-4	11Q/3	195-200	91526		*Salmo*	sp.	VF	II	1			
El Juyo	45/T3-4	11Q/3	195-200	91526		*Salmo*	sp.	VF		1			
El Juyo	45/T3-4	11Q/3	195-200	91526	cf.	*Salmo*	sp.	VF		1			
El Juyo	45/T3-4	11Q/3	200-205	91525	cf.	*Salmo*	sp.	VFs		4			
El Juyo	45/T3-4	11Q/3	200-205	91525		*Salmo*	sp.	VF		1			
El Juyo	45/T4	10R/5	190-195	91515	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45	10R/8	195-200	91509	cf.	*Salmo*	sp.	VF		1			
El Juyo	4R	12Q/5	136-138	91431	cf.	*Salmo*	sp.	VFs		2			
El Juyo	4R	12Q/5	136-138	91431		*Salmo*	sp.	VF		1			
El Juyo	6	8M/1	201-202	91430		*Salmo*	sp.	VFs		2			
El Juyo	6	8M/1	201-202	91430	cf.	*Salmo*	sp.	VF		1			
El Juyo	6	11O/2	167-169	91406	cf.	*Salmo*	sp.	VFs		2			
El Juyo		12S	74-77	91394		*Salmo*	sp.	VF		1			
El Juyo	4R	12Q	134-136	91359		*Salmo*	sp.	VF		1			
El Juyo	6	8M/4	197-199	91348	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45	11Q/9	132-148	91320		*Salmo*	sp.	VF		1			
El Juyo	45	11Q/7	136-140	91317	cf.	*Salmo*	sp.	VFs		2			
El Juyo	45	11Q/7	136-140	91317		*Salmo*	sp.	VF		1			
El Juyo	45	11Q/8	132-143	91314		*Salmo*	sp.	VF		1			
El Juyo	45/T1-4	10R/8	160-180	91292	cf.	*Salmo*	sp.	VF		1			

El Juyo	45	11O/4	166-168	91288	cf.	*Salmo*	sp.	VF		1			
El Juyo	45	10R/8	130-150	91286	cf.	*Salmo*	sp.	VF		1			
El Juyo	45	10R/8	130-150	91286		*Salmo*	sp.	VF		1			
El Juyo	6	8M/4	192-197	91280		*Salmo*	sp.	VFs	II	2			
El Juyo	6	8M/4	192-197	91280	cf.	*Salmo*	sp.	VF		1			
El Juyo	6	11O/6	164-165	91275		*Salmo*	sp.	VF		1			
El Juyo	6	8M/5	207	91274		*Salmo*	sp.	VF		1			
El Juyo	45	12Q/1	133-134	91258		*Salmo*	sp.	VF		1			
El Juyo	4	10N/5	192	91242		*Salmo*	sp.	VF		1			
El Juyo	6	7M/4	183-184	91221	cf.	*Salmo*	sp.	VFs		2			
El Juyo	8	9M/4		91219	cf.	*Salmo*	sp.	VFs		4			
El Juyo	45	12Q/2	126-131	91213	cf.	*Salmo*	sp.	VFs		2			
El Juyo				91205	cf.	*Salmo*	sp.	VFs		2			
El Juyo	4R	12Q/6	118-123	91203		*Salmo*	sp.	VF	II	1			
El Juyo	45	12Q/1	126-130	91200		*Salmo*	sp.	VF	II	1			
El Juyo	8	10N/1	183-190	91194	cf.	*Salmo*	sp.	VFs		2			
El Juyo	8	10N/1	183-190	91194		*Salmo*	sp.	VF		1			
El Juyo	4?	11S/1	90-93	91191	cf.	*Salmo*	sp.	VFs		2			
El Juyo	4?	11S/1	90-93	91191		*Salmo*	sp.	VF		1			
El Juyo	6	8M/1	195-196	91186	cf.	*Salmo*	sp.	VFs		2			
El Juyo	6	8M/1	195-196	91186		*Salmo*	sp.	VF		1			
El Juyo	4R	12Q/5	121-126	91181	cf.	*Salmo*	sp.	VF		1			
El Juyo	4	11S/1	85-90	91176	cf.	*Salmo*	sp.	VF		1			
El Juyo	4	11S/7	64-76	91175	cf.	*Salmo*	sp.	VF		1			
El Juyo	45	12R/8	105-108	92109				Rib/Spine		1			
El Juyo	45/T4	12R/6	106-108	92158				Rib/Spine		6			

El Juyo	45/T4	12R/6	106-108	92158		*Salmo*	sp.	VFs		4			
El Juyo	45/T4	11Q/3	170-180	91537				Rib/Spine		8			
El Juyo	45/T5	10Q/5	185-190	92188				Rib/Spine		3			
El Juyo	45/T5	10Q/5	185-190	92188		*Salmo*	sp.	VF		1			
El Juyo	45	10Q/6	202-207	93027				Rib/Spine		1			
El Juyo	45	11R/8	115-120	92007		*Salmo*	sp.	VF		1	11.9	14.0	
El Juyo	45	11R/4	160-165	92091		*Salmo*	sp.	VFs	III	2			
El Juyo	45	11R/7	180-185	92095	cf.	*Salmo*	sp.	VFs		7			
El Juyo	45	11R/7	180-185	92095		*Salmo*	sp.	VFs		2			
El Juyo	45	11R/7	180-185	92095		*Salmo*	sp.	VF	II	1			
El Juyo	45/T1	10R/4	185-190	94296				Rib/Spine		2			
El Juyo	45/T4	10R/3	200-205	91538		*Salmo*	sp.	VF	III	1			7.1
El Juyo	45	11R/5	175-180	92102				Rib/Spine		3			
El Juyo	45	11R/2	175-180	91501				Rib/Spine		1			
El Juyo	45	11R/1	190-195	91524				Rib/Spine		3			
El Juyo	45/T5	11R/8	195-200	92152		*Salmo*	sp.	VF	III	1			7.2
El Juyo	45	11R/8	130-135	92017		*Salmo*	sp.	VFs		3			
El Juyo	45	11R/8	130-135	92017	cf.	*Salmo*	sp.	VF		1			
El Juyo	45	11R/8	130-135	92017				Rib/Spine		1			
El Juyo	45	11R/2	175-180	91501		*Salmo*	sp.	VFs		5			
El Juyo	4R	11Q/9	156	941376				Rib/Spine		4			
El Juyo	4R	11R/5	170-175	92103				Rib/Spine		1			
El Juyo	45/T3	10Q/5		92533				Rib/Spine		25			
El Juyo	45/T3	10Q/5		92533		*Raja*	sp.	Dermal dentical		1			
El Juyo	4R	12Q/2	161	930265				Rib/Spine		1			
El Juyo	4R	12Q/6	146	93086				Rib/Spine		2			

El Juyo	4R	12Q/8	143	930793				Rib/Spine		3			
El Juyo	4R	12Q/8	150	93085				Rib/Spine		2			
El Juyo	4R	12Q/2	150	930267				Rib/Spine		2			
El Juyo	4R	12Q/		95224		*Raja*	sp.	Dermal dentical		1			
El Juyo	4R	12/Q		95224				Rib/Spine		2			
El Juyo	4R	12Q/2	166-167	94414				Rib/Spine		17			
El Juyo	4R	12Q/2	166-167	94414		*Salmo*	sp.	Tooth		1			
El Juyo	4R	12Q/2	166-167	94414	cf.	*Salmo*	sp.	VF		1			
El Juyo	4R	12Q/2	166-167	94414		*Salmo*	sp.	VFs		2			
El Juyo	4R	12Q/4	146-155	92556				Rib/Spine		2			
El Juyo	4R	12Q/2	158	930274				Rib/Spine		1			
El Juyo	4R	12Q/4	154	930347				Rib/Spine		1			
El Juyo	4R	12Q/6	133	930849				Rib/Spine		4			
El Juyo	9	11O/3	186-189	95188				Rib/Spine		58			
El Juyo	9	11O/3	186-189	95188	cf.	*Salmo*	sp.	VFs		2			
El Juyo	9	11O/3	186-189	95188		*Salmo*	sp.	VFs		3			
El Juyo	9	11O/5	198-203	95370				Rib/Spine		5			
El Juyo	9	11O/4	176-180	94305				Rib/Spine		3			
El Juyo	9	11O/7	174-178	94268				Rib/Spine		3			
El Juyo	9	11O/5	176	941039				Rib/Spine		10			
El Juyo	9	11O/9	175-178	945910				Rib/Spine		2			
El Juyo	9	11O/3	187-194	94251				Rib/Spine		2			
El Juyo	9	11O/5	170-174	94143	cf.	*Salmo*	sp.	VFs		5			
El Juyo	9	11O/6	174-175	94372		*Salmo*	sp.	VF		1			
El Juyo	9	11O/6	174-175	94372				Rib/Spine		67			
El Juyo	9	9N/4	194-195	94383		*Salmo*	sp.	VF		1			

El Juyo	9	9N/4	194-195	94383				Rib/Spine		3			
El Juyo		11M/5	225-235	94388	cf.	*Salmo*	sp.	VF		1			
El Juyo		11M/5	225-235	94388				Rib/Spine		11			
El Juyo		11M/5	225-235	94388		*Salmo*	sp.	Tooth		2			
El Juyo	4R	12Q/8	154-155	94369		*Salmo*	sp.	VF	III	1			
El Juyo	4R	12Q/8	154-155	94369				Rib/Spine		21			
El Juyo	45	10R/4	224-228	94408				Rib/Spine		1			
El Juyo	11	11M/9	227-230	94400				Rib/Spine		21			
El Juyo	11	11M/6	225-235	94416				Rib/Spine		9			
El Juyo	4R	12O/12P	wall fall	94396				Rib/Spine		17			
El Juyo	4R	12O/12P	wall fall	94396		*Salmo*	sp.	VFs		2			
El Juyo	9	11O/4	183-185	94374				Rib/Spine		26			
El Juyo	9	11O/4	183-185	94374	cf.	*Salmo*	sp.	VF		1			
El Juyo	9	11O/4	183-185	94374		*Salmo*	sp.	VF		1			
El Juyo	11	11M/6	225-230	94395				VF		1			
El Juyo	11	11M/6	225-230	94395				Rib/Spine		7			
El Juyo	8	11O/1	181-185	95050				Rib/Spine		5			
El Juyo	9	11O/3	203-205	95552				Rib/Spine		3			
El Juyo	9	11O/3	203-205	95552	cf.	*Salmo*	sp.	VF		1			
El Juyo	9	11O/3	203-205	95552		*Salmo*	sp.	VF		1			
El Juyo	4R	12Q/4	170-172	94385				Rib/Spine		14			
El Juyo	4R	12Q/4	170-172	94385	cf.	*Salmo*	sp.	VF		1			
El Juyo	9	11O/5	182-183	94370				Rib/Spine		18			
El Juyo	8	9N/4,8,7,9	196-197	94373				Rib/Spine		5			

El Juyo	8	9N/9	200-206	94376				Rib/Spine		2			
El Juyo	4R	11Q/8	162-168	94389				Rib/Spine		41			
El Juyo	4R	11Q/8	162-168	94389		*Salmo*	sp.	VF		1			
El Juyo	4R	11Q/6	145-158	94397				Rib/Spine		16			
El Juyo	4R	12Q/6	151-154	94378				Rib/Spine		10			
El Juyo	4R	12Q/6	151-154	94378	cf.	*Salmo*	sp.	VFs		2			
El Juyo	6	8O/6	200-202	94368				Rib/Spine		6			
El Juyo	9	11O/5	185-188	95127				Rib/Spine		97			
El Juyo	9	11O/5	185-188	95127	cf.	*Salmo*	sp.	VF		1			
El Juyo	9	11O/5	185-188	95127		*Salmo*	sp.	VFs		2			
El Juyo	45	10R/4	192-195	94387				Rib/Spine		15			
El Juyo	45/T1	10R/4	240-245	94380				Rib/Spine		7			
El Juyo	45	10R/1	199-203	94415				Rib/Spine		2			
El Juyo	45	10R/1	199-203	94415		*Salmo*	sp.	Tooth		1			
El Juyo	8	10N/3	198-202	94367	cf.	*Salmo*	sp.	VF		1			
El Juyo	8	10N/3	198-202	94367				Rib/Spine		5			
El Juyo	45	10R/1	194-198	94403				Rib/Spine		1			
El Juyo	8	10N/5	206-211	94402				Rib/Spine		2			
El Juyo	45	10R/1	235-240	94409				Rib/Spine		1			
El Juyo	11	11M/4	220-224	94410				Rib/Spine		2			
El Juyo	8	10N/1	193-207	94413				Rib/Spine		10			
El Juyo	9	11O/7	203-204	95497				Rib/Spine		3			
El Juyo	9	11O/7	203-204	95497		*Salmo*	sp.	VF		1			
El Juyo	9	11O/8	200-205	95469				Rib/Spine		5			
El Juyo	9	11O/8	200-205	95469		*Salmo*	sp.	VF	II	1			
El Juyo	9	12O/8	165-169	95344				Rib/Spine		136			

El Juyo	9	12O/8	165-169	95344	cf.	*Salmo*	sp.	VF		1			
El Juyo	9	12O/8	165-169	95344		*Salmo*	sp.	VFs	II	3			
El Juyo	9	12O/8	165-169	95344		*Salmo*	sp.	VFs		2			
El Juyo	9	12O/8	165-169	95344		*Salmo*	sp.	Palatine		1			
El Juyo	9	12O/3	168-170	95373				Rib/Spine		20			
El Juyo	9	12O/3	168-170	95373		*Salmo*	sp.	VF		1			
El Juyo	9	12O/3	174-176	95549				Rib/Spine		1			
El Juyo	9	12O/3	174-176	95549		*Salmo*	sp.	Tooth		1			
El Juyo	4R	12Q/3, 6,9	cleaning	95227				Rib/Spine		21			
El Juyo	4R	12Q/3, 6,9	cleaning	95227		*Salmo*	sp.	VF		1			
El Juyo	9	11O/7	195-200	95416	cf.	*Salmo*	sp.	VF		1			
El Juyo	9	11O/7	195-200	95416		*Salmo*	sp.	VFs		3			
El Juyo	9	11O/7	195-200	95416				Rib/Spine		52			
El Juyo	9	11O/6	180-182	95093				Rib/Spine		27			
El Juyo	9	11O/6	180-182	95093		*Salmo*	sp.	VF		1			
El Juyo	9	12O/5	168-169	95342				Rib/Spine		32			
El Juyo	9	12O/5	168-169	95342		*Salmo*	sp.	VFs		3			
El Juyo	6	7N/7	211-219	93283		*Salmo*	sp.	VF	III	1			
El Juyo	6	7N/7	211-219	93283		*Salmo*	sp.	VF		1			
El Juyo	6	8N/2	215	94134				Rib/Spine		1			
El Juyo	6	9O/3	198-199	94109		*Salmo*	sp.	VF	II	1			
El Juyo	9	9O/6	193-199	94209		*Salmo*	sp.	VF	II	1			
El Juyo	9	10O/7	185-186	93140		*Salmo*	sp.	VF		1			
El Juyo	9	9N/2	197-198	94363		*Salmo*	sp.	VFs		2			
El Juyo	9	12O/2	175-176	95468				Rib/Spine		6			

El Juyo	9	9N/1	limpieza	94284		*Salmo*	sp.	VF	II	1			
El Juyo	6	7M/3	211-224	93134		*Salmo*	sp.	VFs		2			
El Juyo	6	7M/2	207-216	93194	cf.	*Salmo*	sp.	VF		1			
El Juyo	6	7M/8	207-216	935033				Rib/Spine		1			
El Juyo	6	7M/5	218-220	93060		*Salmo*	sp.	VF	III	1			
El Juyo	6	7M/8	220-222	93081		*Salmo*	sp.	VFs	II	3			
El Juyo	6	7M/9	215-218	93051				Rib/Spine		1			
El Juyo	6	7M/9	206-211	92557		*Salmo*	sp.	VFs	II	3			
El Juyo	6	7M/9	206	92124		*Salmo*	sp.	VF		1			
El Juyo	4	12Q/4	172-176	94355				Rib/Spine		1			
El Juyo	10	11M/6	221-227	94183				Rib/Spine		2			
El Juyo	10	11M/3	226	94128	cf.	*Salmo*	sp.	VFs		3			
El Juyo	10	11M/3	226	94128		*Salmo*	sp.	VF	III	1			
El Juyo	10	11M/3	226	94128		*Salmo*	sp.	VF	II	1			
El Juyo	8	10M/3	201-208	93091		*Salmo*	sp.	VFs	II	2			
El Juyo	8	10M/9	206-210	93119				Rib/Spine		3			
El Juyo	8	10M/7	191-194	93144				Rib/Spine		1			
El Juyo	8	10M/4	189-208	93183				Rib/Spine		1			
El Juyo	8	10M/9		93078				Rib/Spine		1			
El Juyo	8	10M/3	208-209	93245				Rib/Spine		1			
El Juyo	8	10M/2	190-194	92126				Rib/Spine		1			
El Juyo	8	10M/6	196-203	93077				Rib/Spine		2			
El Juyo	8	10M/2	200-206	93131				Rib/Spine		1			
El Juyo	8	10M/9	194-198	93073	cf.	*Salmo*	sp.	VF		1			
El Juyo	8	10M/8	196-201	93133		*Salmo*	sp.	VFs	II	2			
El Juyo	8	8N/7	215-216	94340				Rib/Spine		5			

El Juyo	8	10N/4	205-208	94386				Rib/Spine		13			
El Juyo	8	10N/4	205-208	94386	cf.	*Salmo*	sp.	VF		1			
El Juyo	8	10N/4	205-208	94386		*Salmo*	sp.	VFs		3			
El Juyo	9	11O/5	182	95022	cf.	*Salmo*	sp.	VFs		3			
El Juyo	9	11O/5	182	95022		*Salmo*	sp.	VFs		2			
El Juyo	9	11O/5	182	95022				Rib/Spine		45			
El Juyo	9	11O/5	196-198	95367				Rib/Spine		19			
El Juyo	9	11O/6	181-184	95143				Rib/Spine		82			
El Juyo	9	11O/6	181-184	95143	cf.	*Salmo*	sp.	VFs		2			
El Juyo	9	11O/6	181-184	95143		*Salmo*	sp.	VFs		6			
El Juyo	9	11O/4	197-199	95467				Rib/Spine		10			
El Juyo	9	11o/4	197-199	95467	cf.	*Salmo*	sp.	VF		1			
El Juyo	9	11O/2	178-180	95010				Rib/Spine		12			
El Juyo	9	11O/5	193-195	95512				Rib/Spine		136			
El Juyo	9	11O/5	193-195	95512	cf.	*Salmo*	sp.	VFs		6			
El Juyo	9	11O/5	193-195	95512		*Salmo*	sp.	VFs		2			
El Juyo	9	11O/3	191-194	95269				Rib/Spine		121			
El Juyo	9	11O/3	191-194	95269	cf.	*Salmo*	sp.	VFs		2			
El Juyo	9	11O/3	191-194	95269		*Salmo*	sp.	VFs		7			
El Juyo	8	10N/1	206-213	94390				Rib/Spine		6			
El Juyo	4R	12Q/1	176-177	94382				Rib/Spine		9			
El Juyo	45	10R/4	230-235	94406				Rib/Spine		2			
El Juyo	4R	12Q/5	162-163	94371				Rib/Spine		4			
El Juyo	4R	12Q/5	162-163	94371		*Salmo*	sp.	Tooth		2			
El Juyo	45	10R/4	195-198	94407				Rib/Spine		2			
El Juyo	4R	12Q/3	159-164	94384				Rib/Spine		41			

El Juyo	4R	12Q/3	159-164	94384		*Salmo*	sp.	VF		1			
El Juyo	9	11O	183-186	95122				Rib/Spine		37			
El Juyo	9	11O/7	182-186	95122		*Salmo*	sp.	VFs		3			
Castillo	18b	N14.3	Early Upper Palaeolithic			*Salmo*	sp.	Vertebra	III	1			
Castillo	21	N17.2	Mousterian	\		*Salmo*	sp.	Vertebra	II	1	4.2	4.8	3.4
Castillo	21	N17.2	Mousterian	\		*Salmo*	sp.	Vertebra	II	1	\	\	2.4
Castillo	21	N17.2	Mousterian	\		*Anguilla anguilla*		Vertebra		1	\	\	\
Castillo	21	N17.2	Mousterian	\		Unidentified				0			
Castillo	21	N17.2	Mousterian	\		Unidentified				0			
Castillo	21a	N16.2	Mousterian	\		*Salmo*	sp.	Vertebra	II	1	7.2	8.8	6.4
Castillo	21	N16.1	Mousterian	\		*Salmo*	sp.	Vertebra	III	1	to do		
Castillo	21	N16.1	Mousterian	\		*Salmo*	sp.	Vertebra	IV	1	to do		
Castillo	21	N16.1	Mousterian	\		*Salmo*	sp.	Vertebra	II	1	to do		
Castillo	21	N16.1	Mousterian	\		*Anguilla anguilla*		Vertebra		1			
Castillo	21super	N18.4	Mousterian	\		*Anguilla anguilla*		Vertebra		1			
Castillo	21a	N18.2	Mousterian	\		*Salmo*	sp.	Vertebra	III	1			
Castillo	21a	N16.1	Mousterian	\		*Salmo*	sp.	Vertebra	II	1	\	12.4	10.6
Castillo	21a	N18.3	Mousterian	\		*Salmo*	sp.	Vertebra	III	1			
Castillo	21a	N18.3	Mousterian	\		*Salmo*	sp.	Vertebra	III	1			
Castillo	21a	N18.3	Mousterian	\		*Salmo*	sp.	Vertebra	III	1			
Castillo	21a	N18.3	Mousterian	\		*Salmo*	sp.	Vertebra	II	1			
Castillo	21a	N18.3	Mousterian	\		*Salmo*	sp.	Vertebra	II	1			
Castillo	21a	N18.3	Mousterian	\		*Salmo*	sp.	Vertebra	III	1			
Castillo	21a	N18.3	Mousterian	\		*Salmo*	sp.	Vertebra	III	1			

Castillo	21a	N18.3	Mousterian	\		*Salmo*	sp.	Vertebra	III	1			
Castillo	21a	N18.3	Mousterian	\		*Salmo*	sp.	Vertebra	III	1			
Castillo	21a	N18.3	Mousterian	\		*Salmo*	sp.	Vertebra	III	1			
Castillo	21a	N18.3	Mousterian	\		*Salmo*	sp.	Vertebra	III	1		1.8	1.4
Castillo	21a	N17.1	Mousterian	\		*Salmo*	sp.	Vertebra	II	1	6.9	8.7	\
Castillo	21a	N17.1	Mousterian	\		*Salmo*	sp.	Vertebra	III	1	6.1	6.4	5.5