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The social and economic role of freshwater fish in Medieval England: a zooarchaeological approach.

Doctor of Philosophy (PhD)

2020

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November 2020

Sheffield

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Abstract

Historical sources report how some species of freshwater fish were considered - from the 11th to the 15th c. AD - as a luxury food in England. The high retail price associated with species such as pike, salmon and sturgeon, as well as restrictions of fishing rights on rivers, estuaries and natural and artificial ponds demonstrate the role of these species as symbols of social privilege. The value of other freshwater and estuarine species, such as Cyprinidae and eel, is more complex and was associated with their size or source of fishing (fishponds). By analysing 11 English sites of different status and type (castles, religious establishments and urban sites), this thesis evaluates the extent to which the archaeological evidence supports the documentary sources. In particular, species selection and fish size are investigated as potentially meaningful variables. By and large, the historical information is supported but many further details are provided. Higher proportions of freshwater fish are found at high status sites. The size of a selected number of freshwater and migratory species is consistently larger in castles and distributed across a wide range of measurements. This suggests a managed use of the freshwater water resources and the availability of fresh fish throughout the year, probably as a consequence of the tenure of private fishponds. In religious establishments, the evidence of high status is less pronounced than in castles as widespread meat avoidance led to a different way to manage fish resources. The archaeological evidence from towns suggests an overall lower status but is also indicative of the complex and diversified social background of the urban dwellers. It is concluded that freshwater fish represent a valid indicator of high status in medieval England, though different lines of evidence - such as taxonomic frequencies and diversity, as well as fish size and age - need to be considered for sound archaeological interpretation.

Aknowledgments

There are a number of people that I would like to truly thank as they supported me in many ways during the fantastic experience that I had in producing this PhD thesis.

First and foremost, I would like to thank my supervisor Umberto Albarella, for his constant academic support throughout the last eight years, his friendship and for reminding me every day that there is always a way to conduct a research (and a life) in an ethically sound way. Thanks to all the past and present colleagues of the Sheffield Zooarchaeology Lab for creating such a pleasant and constructive working environment. A special thanks to Mauro Rizzetto and Veronica Aniceti, for answering my infinite questions about biometry, quantification, editing, language, food, wine (…) and Lenny Salvagno for her moral support during the countless coffee breaks and for being an example to follow. I have much appreciated their company and precious friendship (and I hope I still will). Thanks to Marina Chorro Giner for helping me with the recording of some material (she now knows more about herring that she might have ever want). Thank you to Tracy Platts for the precious help with notes and corrections on some sections of the thesis (spelling/grammar mistakes are mine though!).

I am also grateful to my second supervisors, Hugh Willmott and David Orton, for their support, especially for laying the basis of the project in early times, when we were still uncertain it could happen.

This project was funded by a Faculty of Arts and Humanities PhD Scholarship Award granted by the University of Sheffield. This work was supported by the Arts & Humanities Research Council (grant number AH/L503848/1) through the White Rose College of the Arts & Humanities. For both, I am profoundly grateful.

I am indebted to a number of zooarchaeologists for different reasons. The research group of Wim Van Neer hosted me at the Royal Belgian Institute of Natural Science (Brussels) several times and gave me fundamental guidance through my whole research also by sharing unpublished data and methods. A special mention must be done to Wim Wouters, who taught me all I know in fish species identification (but all mistakes are mine) and became a key element of this research and a good friend. Another person who tirelessly replied to my infinite questions and shared her data was Alison Locker, to whom I am very grateful. During this research I followed her steps and learned from her, I hope I manage, if only a little, to live up to her work. Thanks to Sheila Hamilton-Dyer, Rebecca Nicholson, László Bartosiewicz, Arturo Morales-Muñiz, Alfred Galik, Harry Robson, Rebecca Reynolds, Aurélia Borvon; I am sure I am forgetting many, but if you have been to one of the last Fish Remains Working Groups there is a high chance I have approached you with a question, and I thank you for the help.

Thanks to Kristine Richter, Jen Harland, Zoe Bottomley, Kenneth Ritchie, Matthew Collins with whom I wrote a paper based on the identifications of Stafford Castle Cyprinidae and that we hopefully will be able to publish soon.

I am indebted to the many archive curators I met in the past few years, who have been extremely helpful in identifying, providing and contextualising suitable assemblages for this research. Among the many, I would like to thank Alison Nicholls and Joe Perry (The Potteries Museum & Art Gallery, Stoke-on-Trent), Polydora Baker and Claire Tsang (Historic England), Eloise Chapman and David Moon (The Oxfordshire Museum), Enid Allison (Canterbury Archaeological Trust), Ben Donnelly-Symes (Cambridgeshire County Council). A special thanks to Michol Stocco, today the Archaeological archive manager of the Archive of the Museum of London, who not only helped me in getting my head around old excavation diaries but also became a great friend.

Thanks also to Carlo e Stefania Maccarinelli for the precious help with the map drawings.

Nowadays animals and food seem to be perceived as detached concepts; this seems peculiar, considering the fact that the main way in which western modern people interact with animals is principally as food. This degeneration and, in some instance, total disappearance of human-animal relationships, together with the lack of any food ethic awareness seem unfortunately far from a daily concern for most people. I strongly believe that bringing back the focus on the importance and centrality of animals in human life may help future generations in keeping this planet going. This awareness was passed on to me from my incredible sister Stefania Maccarinelli, who also thought me the fundamental principles around which I have funded all my existence: the respect for the animals and the nature. And I truly thank her for this.

Ultimi nella lista (ma non nel cuore), voglio ringraziare il resto della mia famiglia per il loro sostegno e supporto (e per avermi sopportata) durante questi anni. Un grazie speciale a mia mamma (Lina Chillon) e papá (Carlo Maccarinelli), per essere sempre dei genitori meravigliosi, da cui imparo qualcosa ogni singolo giorno; grazie a Lorenzo Faes per aver aggiunto quel pezzettino prezioso che mancava alla nostra famiglia (folle). A Lola, Lilith, Salem, Nina, Darko & Kuma, grazie per aver riempito e riempire ancora oggi la mia vita di risate ed affetto (non corrisposto).

Vielen Dank Irene, Bernd und Robert Heller für die Unterstützung und dafür, dass Ihr mich so herzlich in Eure Familie aufgenommen habt.

To Adrian, thank you for being my rock and my shelter.

Sheffield, 28th November 2020

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Chapter 1. Introduction

The study of past animal consumption is part of zooarchaeological investigations, where zooarchaeology is defined as the study of ‘the remains of animals that contributed to characterize human life’ (Albarella 2017, 4). In particular, ichthyoarchaeology, as a subdivision of zooarchaeology, focuses on the analysis of fish remains. Fish can be fascinating animals both from a biological and socio-cultural point of view. They represent staple food for many human communities, but their consumption can also be associated with special occasions and the diet of the wealthy. The importance of fish is therefore social and symbolic, in addition to economic. The implications entwined with fish consumption were even more marked in medieval society, where every feast was impregnated with religious symbolism, rituals and glorification of personal wealth (Klemettilä 2012, 8-14).

In this context, freshwater fish can have an important impact on our knowledge of the life and status of medieval people thanks to its heterogeneous role as food, being potentially considered both a luxury item and a peasant dish (Dyer 1994, 108).

1.1 Research questions

Before the 11th c. in England, rivers and estuaries were the most common sources of fish; freshwater fish was commonly found on dining tables, while marine fish was rarely consumed, especially inland (Serjeantson & Woolgar 2006). From around 1000 AD, however, with the advent of the so-called ‘fish event horizon’ (Barrett *et al.* 2004a), a substantial increase in marine fish, paralleled by a decrease in freshwater fish, emerges. Freshwater fish became less important in dietary terms but acquired greater status value. Species such as freshwater bream and pike became more expensive and mainly associated with moated sites, castles and monasteries (Dyer 1994). Additionally, after the Norman Conquest, fishing rights on rivers, estuaries and natural ponds were established (Serjeantson & Woolgar 2006).

Historical research has investigated the exploitation of freshwater fish in medieval England and its rise as a symbol of social privilege (e.g. Dyer 1994). However, parallel work in archaeology is needed.

This project aims to clarify the social and economic roles of freshwater and migratory fish (e.g. eel, salmon/trout), in medieval England from the Norman Conquest until the start of the Early Modern Period (11th to 15th c).

Freshwater fish consumption will be explored in view of the historical events characterising the medieval period; the Black Death of the mid-14th c. in particular caused a deep economic crisis and a population decline, which did not see any substantial recovery until the 16th c. (Wrigley & Schofield 1981; Dyer 1988); the increased level of urbanisation and expansion of the market also impacted animal exploitation, including fish (Albarella 2019). From a social perspective, the level of inequality reached unprecedented peaks during medieval period and this must have influenced the type of food people of different wealth were able to putting on the table (*ibid.*).

Historical sources for the 11th-15th c. (e.g. Domesday Book, household accounts, statutes regulating fishing activities and recipe books) indicate that some species of freshwater fish began to be considered a luxury item. What were the key factors involved in the evaluation of fish? How were selection of species, size, catching methods and the source of fishing involved in this process?

This phenomenon will be investigated through zooarchaeological analysis of the fish remains and contextualised by reviewing the most relevant historical data and other lines of archaeological evidence. This integration is necessary in order to clarify eating habits throughout the whole social scale of the population. Written references may lead to different interpretations than those based on archaeological evidence; one of the potential causes of this discrepancy is that lower classes are less represented in written sources. Cookery books, recipe collections, testaments, and diaries were written principally by and for a limited rich elite (Klemettilä 2012, 8).

A number of sites (see Table 5.1 in Chapter 5) was selected on the basis of the typology and status (but also availability of the material) in order to try to answer the following questions:

- How is the consumption of freshwater and marine fish interrelated during these five centuries?
- Is the relative consumption of marine and freshwater fish linked with the status of the sites (both laic and religious)?
- How are species, size, catching methods and source of fishing related with the economic and social value of freshwater fish?

1.2 Description of the structure of the thesis

Information about modern freshwater fish populations in British waters and an overview of ichthyoarchaeology as discipline will be found in this chapter, following this section. **Chapter 2** will explore the role and exploitation of medieval freshwater fish from an archaeological and historical perspective. **Chapter 3** will focus on the zooarchaeological background. **Chapter 4** will provide a description of the methodologies adopted for the recording and analysis of the fish assemblages discussed in this thesis. Results from different assemblages will be provided in **Chapter 5**; each section is dedicated to one site with related information to history, archaeological excavations and nature of the osteological material. Results will be presented by type of analysis (e.g. species frequencies and anatomical element distribution), following a chronological order. In **Chapters 6** and **7** (Discussion and Conclusions), the evidence will be interpreted and integrated in view of other lines of archaeological evidence, and summarised in order to highlight what contribution this study has made towards a better understanding of the social and economic role of freshwater fish in medieval England.

1.3 Freshwater fishes of England

Being part of an island, England is surrounded by water but is also richly endowed by a variety of inland waterbodies; yet freshwater habitats are not as rich in fish as they used to be in the past. Pollution and alteration of aquatic ecosystems, especially in the last 200 years, have drastically depleted the number of wild fish in the country (Maitland & Campbell 1992, 15).

Before exploring in more detail what freshwater fish can be currently found in England, some information relating to fish habitats and taxonomy is provided. All the following definitions, where not otherwise indicated, are sourced from the ‘Handbook of European Freshwater Fishes’ (Kottelat & Freyhof 2007).

The word ‘freshwater’ is generally used to describe fishes with low or no tolerance to saline water. There are ‘primary division’ freshwater fishes, which typically are fully intolerant to saline water (stenohaline), such as some members of the Cyprinidae and Cobitidae families. The group of ‘secondary division’ freshwater fishes embraces families that typically live in freshwater but can tolerate (or were able to tolerate) saline water for a short time, such as some members of the Cottidae and Lotidae family. Both primary and secondary division freshwater fishes have been considered and called ‘freshwater’ taxa in this research. Furthermore, there are fishes that can live both in fresh and marine waters. Diadromous species are those species that during spawning season migrate from freshwater to sea (catadromous, e.g. eel or flounder) or from sea to freshwater (anadromous, e.g. Atlantic salmon). Diadromous species, regardless of the modality of their life cycles, have been grouped under the term ‘migratory’ taxa in this research. Some species seem rather indifferent to salinity (euryhaline) and can occur inland despite being primarily marine fishes; these are called ‘sporadic species’ and some examples can be found in the Mugilidae family. Sporadic fish, together with species that live in costal water and estuaries (e.g. seabass) have been grouped with the other ‘marine’ taxa during this research. Definition of habitat distribution for each species is indicated in Table 1.1. Grouping together such a large variety of species into three habitat types may look like an oversimplification; however, such a high variability of ecological needs to be categorised in order to have a comparative view of the sources of fishing exploited from different sites. A more critical analysis of the ecologies of the species, when relevant, will be given in the next sections and particularly in the Discussion Chapter (6).

Taxonomy is a discipline constantly developing and as such it can lead to mistakes and misunderstandings. This is particularly true in relation to ichthyology, considering that fish, as the largest group of vertebrates, are not yet completely known and classified. Every year new species are discovered, making the nomenclature system rather complex. The nomenclature of species will follow the up-to-date nomenclature by Kottelat and Freyhof (2007), Camphuysen and Henderson (2017) and Froese and Pauly (2019). This latter is an online compendium of information of more than 34,300 fish species (as of today, July 2020) and regularly updated with newly discovered species, modified names and data, as opposed to papers and atlases that can quickly become obsolete.

Latin name	**Common name**	**Habitat**
Abramis brama	Freshwater bream	FW
Acipenser oxyrinchus	American Atlantic sturgeon	MI
Acipenser sturio	Atlantic sturgeon	MI
Alburnus alburnus	Bleak	FW
Alosa alosa	Allis shad	MI
Alosa fallax	Twaite shad	MI
Ammodytae tobianus	Small sandeel	MA
Anguilla anguilla	European eel	MI
Barbatula barbatula	Stone loach	FW

Barbus barbus	Barbel	FW
Belone belone	Garfish	MA
Blicca bjoerkna	Silver bream	FW
Carassius auratus	Goldfish	FW
Carassius carassius	Crucian carp	FW
Chelidonichthys cuculus	Red gurnard	MA
Chelidonichthys lucerna	Tub gurnard	MA
Clupea harengus	Atlantic herring	MA
Cobitis taenia	Spined loach	FW
Conger conger	European conger	MA
Coregonus oxyrinchus	Hounting	FW
Cottus perifretum	Bullhead	FW
Cyprinus carpio	Common carp	FW
Dicentrarchus labrax	European seabass	MA
Engraulis encrasicolus	European anchovy	MA
Esox lucius	Northern pike	FW
Eutrigla gurnardus	Grey gurnard	MA
Gadus morhua	Atlantic cod	MA
Gasterosteus aculeatus	Three-spined stickleback	MI
Gobio gobio	Gudgeon	FW
Gymnocephalus cernua	Ruffe	FW
Hippoglossus hippoglossus	Atlantic halibut	MA
Lampetra fluviatilis	River lamprey	MI
Leuciscus leuciscus	Common dace	FW
Limanda limanda	Common dab	FW
Lota lota	Burbot	FW
Melanogrammus aeglefinus	Haddock	MA
Merlangius merlangus	Whiting	MA
Merluccius merluccius	European hake	MA
Molva molva	Ling	MA
Myoxocephalus scorpius	Shorthorn sculpin	MA
Oncorhynchus mykiss	Rainbow trout	FW
Osmerus eperlanus	European smelt	MI
Perca fluviatilis	European perch	FW

Phoxinus phoxinus	Eurasian minnow	FW
Platichthys flesus	European flounder	MI
Pleuronectes platessa	European plaice	MA
Pollachius pollachius	Pollack	MA
Raja clavate	Thornback ray	MA
Rutilus rutilus	Roach	FW
Salmo salar	Atlantic salmon	MI
Salmo trutta fario	Brown trout	FW
Salmo trutta trutta	Sea trout	MI
Sander lucioperca	Pikeperch	FW
Sardina pilchardus	European pilchard	MA
Savelinus alpinus	Arctic charr	FW
Scardinius erythrophthalmus	Rudd	FW
Scomber scombrus	Atlantic mackerel	MA
Scophtalmus maximus	Turbot	MA
Scopthalmus rhombus	Brill	MA
Solea solea	Common sole	MA
Spondyliosoma cantharus	Black seabream	MA
Sprattus sprattus	European sprat	MA
Squalius cephalus	Chub	FW
Thymallus thymallus	Grayling	FW
Tinca tinca	Tench	FW
Trachurus trachurus	Atlantic horse mackerel	MA
Trisopterus luscus	Pouting	MA
Trisopterus minutus	Poor cod	MA

Table 1.1: Nomenclature of fish species mentioned in this thesis. Fish habitats are labelled as follows: MA (marine), FW (freshwater), MI (migratory). Latin and common names follow Kottelat and Freyhof (2007), Camphuysen and Henderson (2017) and Froese and Pauly (2019).

1.3.1 Modern fish population distribution

Today’s fish distribution represents the result of a process that started at the end of the Ice Age, about 13-15,000 years ago, with the meltdown of the great ice that had covered most of the British Isles. The first freshwater fishes seem to have colonised the country via a terrestrial bridge connecting England from north of the river Humber to the river Thames with the rest of Europe; this became completely submerged about 7,500 BP (Wheeler 1977, 1; Locker 2018b, 3-4). Euryhaline fishes, with their high adaptability to different habitats, easily colonized the new land by swimming near the coastline, whereas the origin of stenohaline British fishes is still uncertain. One option is that they might have moved from the Continent to the south-east of England during previous interglacial events and survived until the complete retreat of the ice (Maitland & Campbell 1992, 46). Regardless of the means and ways of the colonisation, not many freshwater species reached Britain; this is testified by the fact that the present fauna comprises only around 56 freshwater species, while in the rest of Europe there are as many as 525 native species (Maitland & Lyle 1996, 9; Kottelat & Freyhof 2007, 26).

The frequency and distribution of Britain's freshwater fishes result from the combination of their independent movements and migrations, driven by environmental post-glacial changes, and human agency, either intentional or unintentional. As of today, the currently accepted native British stenohaline species are: brown trout, grayling, pike, barbel, gudgeon, tench, silver bream, freshwater bream, bleak, minnow, rudd, roach, chub, dace, spined loach, stone loach, burbot, perch, ruffe, bullhead (Maitland & Campbell 1992, 47; Locker 2018b, 3-4). New species, such as common carp, rainbow trout, goldfish and pikeperch, were imported and exploited for food, angling, and also for aesthetic reasons. Other species, such as baitfish (e.g. gudgeon, minnow, roach, dace), were transported around England following the increasing demand for sport fisheries (Maitland & Campbell 1992, 49). Changes in the autochthonous fauna may also occur through the practice of releasing captive exotic fish. This is what probably happened in the case of the goldfish, currently living in a feral state in many British lakes (Manchester & Bullock 2000). Often the introduction of exotic freshwater fishes has led to disruption to the local fauna and flora (Wheeler 1978, xviii). Introduction of non-native fauna may threaten biodiversity, and in terms of environmental damage is second only to habitat shrinkage (Kottelat & Freyhof 2007, 28). There are several other factors affecting the composition of the freshwater local fauna, but their full discussion goes beyond the purpose of this research; a selection of these has been usefully summarised by Maitland & Campbell (1992, 16) and is reported below (Table 1.2).

Danger	Effect
Industrial and domestic pollution	Elimination of stocks, blocking of migratory species
Land use (farming and forestry)	Eutrophication, acidification, sedimentation

River obstructions (dams)	Blocking of migratory species
Acid deposition	Elimination of fish stocks in poorly buffered waters
Drainage and canalisation	Loss of habitat, shelter and food supply
Industrial development (including roads)	Sedimentation, obstructions, transfer of species
Eutrophication	Alga blooms, de-oxygenation, changes in fish species
Fish farming	Eutrophication, introductions, diseases, genetic changes
Fishery management	Elimination by piscicides, introductions
Introduction of new species	Elimination of native species, diseases, parasites
Fluctuating water levels (reservoirs)	Loss of habitat, spawning and food supply
Warm water discharge	De-oxygenation, temperature gradients
Water abstraction	Loss of habitat and spawning grounds

Table 1.2: Factors affecting the composition of modern freshwater fish and freshwater habitats in the British Island (modified by Maitland & Campbell 1992, 16).

As consequence of these processes, the indigenous aquatic fauna has been heavily modified in the last century or so. Many native species are today considered endangered or completely extinct from British waters (Maitland & Lyle 1996, 9). Some of these species are anadromous, such as sturgeon, allis shad, twaite shad, smelt and hounting (the latter extinct from England since the 19th c.; Kottelat & Freyhof 2007, 382); others are primary freshwater, such as Arctic charr, and burbot, which was last recorded in England in 1969 and has been considered to be extinct since the 1980s (Worthington *et al*. 2011).

1.3.2 Species description

What follows is a brief description of a selection of freshwater and diadromous fish families and species frequently found on archaeological sites from England and with a specific research interest for this project. This section will eventually facilitate the interpretation of the archaeological data (Chapter 5), where a basic understanding of the biology, habitat and natural life cycle of the species will be necessary. Information on the conservation status of modern species follows the IUCN Red List of threatened species last checked on July 2020 (https://www.iucnredlist.org/, IUCN 2020) and specific reference to the list will be given for each species. The species size will be given as a standard or total length (Fig. 1.1), according to the source.

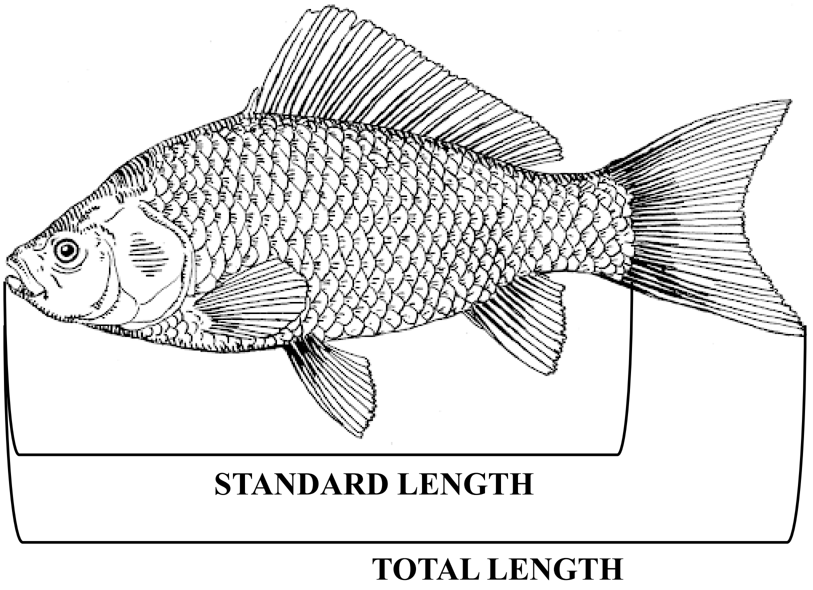

Fig. 1.1: Measurements used in taxon descriptions, following recommendations by Wheeler 1969 (modified free image from http://clipart-library.com).

The sturgeons (family Acipenseridae) are a family of about 25 species, well-known for being considered living fossils. In most sturgeon species, the ossified scutes and bony plates covering the head and the body give these animals a rather primitive aspect that has not changed significantly during the evolution of the family.

The Atlantic sturgeon (*Acipenser sturio*) is no longer present in British waters and it is considered to be critically endangered in the rest of Europe (Gesner *et al.* 2010). The sturgeon is an anadromous fish with slow growth that can reach a rather big size with females growing larger; the largest size ever recorded is of 600 cm of total length, weighing c.1000 kg, but modern-day fish rarely exceed 200 cm (Kottelat & Freyhof 2007, 57-58). During the spawning seasons (first peak in spring and second weaker peak in late summer/autumn), adult sturgeons normally swim from the sea to estuaries or large rivers; once the eggs are hatched, most juveniles will stay for 2-4 years in the estuarine area and eventually move to the sea (*ibid.*). The American Atlantic sturgeon (*Acipenser oxyrinchus*) is today occasionally recorded from Great Britain, the North Sea and the Baltic Sea; it is resident in North America on the Atlantic coast from Labrador to the Mississippi Delta (Kottelat & Freyhof 2007, 53-54); at the moment it is considered to be near threatened (St. Pierre & Parauka 2006). The American Atlantic sturgeon is also anadromous, as its spawn migration starts in the autumn in rivers and spawning happens in spring. Some juveniles migrate to estuaries during the first summer, while others leave freshwater habitats only after 2-4 years. The largest documented size for the American Atlantic sturgeon is 439 cm of total length, but today it rarely exceeds 200 cm (Kottelat & Freyhof 2007, 54). Flesh and eggs of sturgeons are considered to be a delicacy and can be quite expensive; the flesh can be eaten fresh, smoked and more rarely dried, while eggs in brine are consumed as caviar (Maitland & Campbell 1992, 15).

Eels are a small family of 15-20 species (Anguillidae), easily recognisable for their serpentine shape and the lack of pelvic fins. The most relevant representative of this family for this research is the European eel (*Anguilla anguilla*), with its typical elongated body; this fish has an average adult total length of 35-46 cm for males and 50-61 cm for females; males tend to reach a maximum of 54 cm (Tesch 2003, 168), while females can grow much larger; there are reports of female individuals up to 2 m long, with a maximum weight of 6.6 kg (Kottelat & Freyhof 2007, 61-62). The European eel is a catadromous species, but its life cycle has not been completely understood, as there are no precise data about spawning sites (possibly at a depth of 100-200 m). During late summer-autumn (September to early November), adult specimens (silver eels) swim downstream rivers to reach the sea and eventually the southern Sargasso Sea, where they lay their eggs and most likely die. Spawning peaks occur from the beginning of March until July. In the past, it was believed that eels would stop feeding during the migration, gradually causing the degeneration of their organ systems; however, recent studies suggest that they still feed on marine benthic micro-organisms during their journey. Other unsolved mysteries about eel life are represented by the mechanisms in which larvae (leptocephali) reach the European shore; there are indications that the old theory of the Gulf Stream drifting is no longer supported and larvae actively swim to the coast (*ibid.*). As leptocephali approach the continental shelf, up to 6-8 cm of total length, they metamorphose into glass-eels, named so for their transparent bodies, and move to the estuaries (Tesch 2003; Simon 2015). The arrival of glass eels on the southern North Sea coast has been reported for January-February (Tesch 2003, 121). Some of the glass eels will remain in the estuaries, some other will start the move upstream to colonise inland waters; during this migration, from an average of 7-8 cm of total length they mature into elvers and develop a skin pigmentation (Churchward 1996 in Tesch 2003, 137). During the next 5-8 years for male and about 12-20 years for females they feed and once they have reached around 30 cm of total length they mature into yellow eels, before full maturation stage, into silver eel (*ibid.*). Eventually, as silver eels, they start the spawning migration. There is broad size variation of sexually mature eels (silver eels), as it can take from 6 up to 57 years until maturation stage in Northern Europe, during which the animal will keep growing (*ibid.*). This species is considered critically endangered (Jacoby & Gollock 2014); eel has a high resistance to pollution and environmental changes, thus the biggest threat for the species is overfishing, in particular of glass-eels along the European coasts (Kottelat & Freyhof 2007, 62). The taste for eel is deeply connected with the cultural background of the consumers. In the United States eel is mostly avoided because of its slimy feel and snake-like appearance. In contrast, in most of Europe eels of every size are considered to be a delicacy. Each country has its peculiar way of eating this fish; it can be consumed smoked, pickled and also fresh, simmered with wine (Schweid 2002). Eel does not produce viable young in captivity, as without the depth of the Atlantic Ocean they do not naturally reproduce. They are usually captured as elvers and grown to a marketable size (*ibid.*).

The Clupeidae family includes mostly marine fishes, but there are 2 diadromous species that can be found in England. These are the allis shad (*Alosa alosa,*) and the twaite shad (*Alosa fallax*); they are very similar in shape and size and can be distinguished principally by the number of scales and gill rakers. Allis shad grows up to 70 cm of standard length, while twaite is smaller, growing up to 50 cm (Kottelat & Freyhof 2007, 67, 69). Both species are anadromous, spawning in rivers and swimming during the rest of their life in open sea (pelagic); juveniles tend to stay near the coast or in estuaries. These two species are very sensitive to environmental change, especially water pollution, and they are threatened by overfishing. The unfortunate consequence of this environmental stress was a decline of shad populations during the first decades of the 20th c. Nonetheless, these species are today not considered to be endangered (Kottelat & Freyhof 2008). The flesh of shads is very oily, tasty and rich in fat. They are consumed fresh, pickled or smoked and often processed to produce oil and other derivatives (Maitland & Campbell 1992, 93-97; Kottelat & Freyhof 2007, 63-69).

The Salmonidae are one of the best-known fish families, possibly because of their high commercial and industrial value. This group include both freshwater and anadromous fish, thus they all spawn in freshwater and tend to have similar physical features. Even experienced anglers may have difficulties in distinguishing between the various species, especially juveniles, also because species of this family can naturally hybridize. The taxonomy of Salmonidae is rather complicated, as there is no agreement on the actual number of species and genera; the main problem derives from modern stocking of alien populations for recreational and modern purposes, resulting in the genetic pollution of many native population (Kottelat & Freyhof 2007, 395). This research will adopt the taxonomic subdivision of the genus *Salmo* in Atlantic salmon (*Salmo salar*), sea trout (*Salmo trutta trutta*) and brown trout (*Salmo trutta* *fario*), as accepted by some literature (Charles *et al.* 2005; Keith *et al.* 2011; Guillaud *et al.* 2016), and discredited by other (e.g. Kottelat & Freyhof 2007, 401).

The Atlantic salmon (*Salmo salar*) is the largest species of the family, with a size that can be very variable; common total length is around 60-75 cm, with 2.7-4.5 kg of weight (Maitland & Campbell 1992, 101), but they can grow up to 150 cm (Camphuysen and Henderson 2017, 89-90). Salmons live predominantly in freshwater (1-8 years; Heland & Dumas 1994) and spend around 1-3 years in marine environments before returning to the natal river to reproduce (Guillaud *et al.* 2016). The duration of their migration varied through the centuries and between populations, according to climatic events and human activities (Turrero *et al.* 2012). Spawning typically takes place from October to early January, with peaks in November and some of the spawners survive and return once or twice to the sea (Guillaud *et al.* 2016). The survival of Atlantic salmon is jeopardised by water pollution, artificial barriers impeding the migration and a number of parasitic attacks; the populations of salmons have declined to the point that in some areas they have become locally extinct, like in the river Rhine (Camphuysen & Henderson 2017, 89-90). However, due to their economic values and consequent farming, the species is not endangered, but conservation measures are being taken to protect wild stocks (World Conservation Monitoring Centre 1996; Camphuysen & Henderson 2017, 90). Salmon flesh is consumed fresh, smoked, dried and salted but also tinned and frozen for mass production (Maitland & Campbell 1992, 101-111).

Like the Atlantic salmon, the sea trout (*Salmo trutta trutta*) migrates to freshwater to reproduce and spends from 6 months to 5 years in the sea feeding and growing (Rochard & Elie 1994); they do not go as far offshore as the Atlantic salmon, being mostly a costal species (Klemetsen *et al.* 2003). Conversely, the brown trout (*Salmo trutta fario*) does not migrate, exhibits a rather territorial behaviour and only moves upriver to spawn, rarely entering marine-brackish water for feeding (Adamson 1955; Guillaud *et al.* 2016). Therefore, while the sea trout is considered to be a migratory species, the brown trout is mostly confined to freshwater. Another difference between the two subspecies is that, while the sea trout can grow nearly as large as a salmon (with a range of 40-100 cm of total length; Russ 2011), the brown trout common length is around 20-30 cm of standard length; Kottelat & Freyhof 2007, 408). Both trout are threatened by water pollution and overfishing, and they appear to be particularly susceptible to attack by parasites and fungi. On an industrial level, they have been replaced through the years by the North American rainbow trout (*Oncorhynchus mykiss*), which is now widely distributed all over Europe. This is to the detriment of some lacustrine populations of *Salmo trutta* that are visibly declining (Freyhof 2011a). The flesh of trout is considered delicious and with a delicate taste, mostly consumed fresh or smoked (Maitland & Campbell 1992, 112).

Another migratory fish, taxonomically related to the salmons, is the European smelt (*Osmerus eperlanus*) of the Osmeridae family. This is a small fish, with a common total length around 10-20 cm; this species is anadromous and lives most of the time in the estuaries and coastal waters; smelt migrates upriver for the spawning season, which happens in March-April (Maitland & Campbell 1992, 163-166; Kottelat & Freyhof 2007, 348). Smelts have currently no major threats, except for water pollution on a local level and the construction of architectural barriers hindering their migration (Freyhof 2011b). This fish is regarded as being best eaten as fresh or smoked and it is often used for the production of fish oil or as baitfish (Froese & Pauly 2019; Muus & Nielson 1999).

Only one species of the pike family (Esocidae) can be found in British water, namely the Northern pike (*Esox lucius*). Pikes can grow to be one of the largest freshwater fishes in England, however there is large variability in their adult size, with females generally growing only slightly larger than males (Lorenzoni *et al.* 2002; Senay *et al.* 2017). Pike reaches sexual maturity at 17-40 cm of standard length, but they can grow up to 1300 cm of total length (Kottelat & Freyhof 2007, 342). Pikes' ideal habitats are shallow lacustrine waters or slow-flowing rivers. This species is potamodromous, meaning that it migrates upstream within the river, from the feeding ground to the spawning area; spawning season occurs generally from February to June. Older and larger pikes, because of their predatory (often cannibalistic) and aggressive behaviour, tend to be solitary and rare. Their presence in a river would act against the occurrence of smaller pike and in general smaller fish, so adult pikes deposit their faeces away from the foraging area, as they contain alarm pheromones which would warn other fish of their presence. This fish is rather resistant to pollution but sensitive to increases in water temperature above 29°C; however, it appears not to be an endangered species (NatureServe 2018). The taste for pike can be considered rather subjective; while some sources defines its flesh as '(..) considered unpalatable in most of the British Isles (..) but treated as a great delicacy elsewhere (..)' (Maitland & Campbell 1992, 175), others sources claim to be 'excellent food fish; utilized fresh and frozen (..)' (Frimodt 1995 in Froese & Pauly 2019). Pike is considered as a highly priced angling game, especially when large and feisty, and, despite numerous attempts, it has never been entirely domesticated (Maitland & Campbell 1992, 167-176).

Another fish well known to anglers for the painful stings caused by the spiky fins and sharp teeth is the European perch (*Perca fluviatilis*). This freshwater member of the Percidae family is easily recognisable by the lively colours of its skin. The size of an adult perch depends on the living environment, with female perches growing slower but ending up becoming larger than males (Ulićević *et al.* 2018). Perches typically range from 15 to 30 cm of total length, with a common standard length of 20 cm, but can grow up to 60 cm (Maitland & Campbell 1992, 280; Kottelat & Freyhof 2007, 530-531). This fish can easily adapt to a wide range of habitats, from lakes, streams, and rivers to estuarine lagoons. This species spawns generally in shallow waters during late spring and it can hybridise with the smallest member of the Percidae family, the ruffe (*Gymnocephalus cernua*). The ruffe grows up to 20 cm of standard length and co-exists peacefully with the perch by swimming at deeper levels (Maitland & Campbell 1992, 286). Both species are not endangered (Freyhof & Kottelat 2008a, 2008b); their flesh is regarded as very flavoursome, rich in fats and proteins and it is typically consumed fresh or smoked (Maitland & Campbell 1992, 280-288).

The only freshwater species of the Lotidae family (Gadiformes) is the burbot (*Lota lota*). The size of an adult burbot depends greatly on the geographical area where the animal lives; in England, the common total length was from 30 to 50 cm, but in other country it can grow up to 100 cm of standard length (Maitland & Campbell 1992, 262; Kottelat & Freyhof 2007, 462). Unfortunately, as mentioned above, this species became extinct in Britain about 45 years ago. Suitable habitats for burbots were the clean well-oxygenated flowing waters of lakes and rivers; spawning season generally occurred during winter-early spring in shallow waters. The flesh of this species is tasty if cooked and flavoured properly, but the liver is considered in some countries a delicacy when smoked or canned (Cohen *et al.* 1990; Maitland & Campbell 1992, 262-265).

The family of flat fishes (Pleuronectidae) consists mostly of marine members; the European plaice (*Pleuronectes platessa*) lives most of the time in muddy and sandy bottoms of sea and estuaries and very rarely enters freshwater (Kottelat & Freyhof 2007, 595). Conversely, the European flounder (*Platichthys flesus*) can be regularly found in freshwaters and estuaries. The common length of an adult flounder ranges from 20 to 30 cm of total length, but they can grow up to 50 cm of standard length, while plaice can reach up to 100 cm of standard length (Maitland & Campbell 1992, 308; Kottelat & Freyhof 2007, 593-595). As the name of the family implies, the flounder has a very flattened shape and generally lies on the left side, even though reverse flounders are not uncommon. The flounder, as a catadromous species, moves offshore to the warmer waters of the sea during the winter and lays its eggs in spring; the larvae slowly move back to the coast and enter the estuaries. Juvenile individuals, less than 3-4 years and measuring less than 20-25 cm of standard length, often swim deep inland upstream rivers to feed (Van Neer & Ervynvk 2016, 157). This fish is not highly valued by anglers, but it is known to have a palatable flesh when eaten fresh and smoked (Maitland & Campbell 1992, 308-311; Cooper & Chapleau 1998; Froese & Pauly 2019). Both flounder and plaice are not endangered (Munroe 2010; Freyhof 2014).

Carps, minnows and barbels belong to the Cyprinidae, one of the largest family of vertebrates. Currently this group includes about 2,100 species, whose intra-family phylogenetic relationships are not fully understood; subdivisions in subfamilies, tribes (etc.) within the Cyprinidae vary from author to author (Kottelat & Freyhof 2007, 78). Maitland and Campbell (1992, 177), identified 80 Cyprinidae species in Europe and 16 currently living in the British Isles (this last number also confirmed by Kottelat & Freyhof 2007). Another problem related to taxonomy is that some Cyprinidae species can easily hybridise; there are about 62 different natural hybrids within the European Cyprinidae. Hybrids between different species of the *Barbus* genus can be very common in some area, so as roach (*Rutilus rutilus*) with freshwater bream (*Abramis brama*) and *Squalius* spp. with *Alburnus* spp.; within some subfamily (e.g. Leuciscine) hybrids can also produce viable progeny (*ibid*., 247). Cyprinidae almost exclusively live in freshwater but some species can have a semi-anadromous life history, feeding in low salinity marine areas and migrating to the river to spawn (Kottelat & Freyhof 2007, 173). Cyprinidae occupy a wide range of habitats, showing different behaviours and a significant variety of body forms but because of the high number of members of this family, only two representative species will be described here. For other relevant species, a table is provided with information about their size (Table 1.3).

Roach (*Rutilus rutilus*) is one of the British Cyprinidae that can tolerate low salinity waters and can be found in brackish costal lagoons. The size of roach varies depending on the conditions of the living habitat; normally, it grows larger in waters with a low density of population and larger quantity of food available (especially molluscs). In normal conditions, the size of a roach ranges around 20-25 cm of total length but it can grow up to 50 cm of standard length (Maitland & Campbell 1992, 215; Kottelat & Freyhof 2007, 246). Roach is a shoaling[1] species, which often moves in schools and can adapt to a variety of environments, from large oxygenated lakes, to small streams and large lowland rivers. The spawning season occurs over a period of 5-10 days from April to May in different freshwater environments, while during winter the fish moves to deeper and cooler waters. Roach is a resistant fish that can tolerate temperature leaps, low oxygenation levels and some mild pollution. There are no

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[1] Fish forming a social group of over two individuals of the same species; shoaling is a pre-condition of schooling (groups of fish that swim together; Froese & Pauly 2019).

evident threats to roach apart from predators, most likely pike and humans (Freyhof & Kottelat 2008c). Roach flesh is eaten fresh but also dried and salted, though it tends to be considered of low value because it is rather tasteless and contains numerous bones; the angling value of this fish is more related to the skills required to catch it, rather than its commercial or nutritional quality (Maitland & Campbell 1992, 215-219; Kottelat & Freyhof 2007, 246-247).

The tench (*Tinca tinca*) is another Cyprinidae with an adult average total length of 25 to 35 cm, but they can grow up to 60 cm of standard length (Maitland & Campbell 1992, 194; Kottelat & Freyhof 2007, 295). This species favours hidden and quiet environments, such as muddy lowland lakes and slow-flowing rivers. It is a strong fish, resistant to high temperature and low oxygenated levels of water; for this reason, it can easily be transported and can survive out of water for quite long time. Reproduction occurs during May-October among low weeds. The worst threat for this fish is river engineering, though the species is not considered to be endangered (Freyhof & Kottelat 2008d). The flesh of the tench has a strong flavour, which it is not unanimously liked; nevertheless, the fish is still highly considered as a sport catch (Maitland & Campbell 1992, 194-197).

Latin name	**Common name**	**Common length (TL/cm)**	**Size up to (SL/cm)**
Abramis brama	Freshwater bream	30-50	70
Alburnus alburnus	Bleak	12-15	16
Barbus barbus	Barbel	40-60	90
Blicca bjoerkna	Silver bream	20-25	33
Cyprinus carpio	Common carp	40-50	110
Gobio gobio	Gudgeon	12-15	13
Leuciscus leuciscus	Common dace	20-25	25
Phoxinus phoxinus	Eurasian minnow	6-9	10
Rutilus rutilus	Roach	20-25	50
Scardinius erythrophthalmus	Rudd	20-30	35
Squalius cephalus	Chub	30-40	60
Tinca tinca	Tench	25-35	60

Table 1.3: Size of British Cyprinidae relevant to this research. Common total length (TL) in British waters follows Maitland and Campbell (1992); standard length (SL) in European waters follows Kottelat and Freyhof (2007; see also Fig. 1.1 for measurement description).

1.4 Ichthyoarchaeology

The study of fish remains from archaeological sites (ichthyoarchaeology) has slowly become a valuable branch of zooarchaeology, but only in the last few decades archaeologists have started fully recognising its importance. Early studies involving the analyses of fish remains date back to the mid-19th c., but they were almost exclusively undertaken by ichthyologists and palaeontologists, with little interest in past human life. During that period archaeology was still carrying the weight of an antiquarian tradition, thus bioarchaeological disciplines, such as zooarchaeology, were marginalised at least until the 1980s (Albarella *et al.* 2017, 5). Clear advances in the discipline can be backdated to the 1970s, with the work of researchers such as Jean Desse (e.g. Desse & Desse 1976) in France and Johannes Lepiksaar (e.g. Lepiksaar & Heinrich 1977) in Sweden; from this point onward, fish remains started being actively included in the archaeological process (Morales-Muñiz 2014, 3649). The second half of the 20th c. saw the publication of seminal methodological handbooks (e.g. Casteel 1976; Wheeler & Jones 1989), providing basic knowledge for the analysis of fish remains. The birth of the Fish Remains Working Group, part of the International Council for Archaeozoology (ICAZ), occurred in 1981. Meetings organised by the group gave ichthyoarchaeologists from all over the world the opportunity to get together every two years and discuss fish matters within an archaeological context. Hereafter, wet sieving became more frequent during archaeological excavations with the aim of recovering, amongst other small archaeological remains, fish bones. This provided the opportunity for a systematic study of archaeological fish remains to become a widespread practice. The taxonomic identification of fish became more accurate, and the name of the species slowly replaced the generic terminology of 'fish' or 'fish bones of cod size' appearing in site reports (Wheeler & Jones 2009, 2).

There are several reasons behind this earlier disregard of fish remains. Firstly, fish bones can be very small and fragile; they are often overlooked, especially when sieving is not carried out and, in some instances, they will preserve less well than mammal bones. Consequently, reconstructions of past human life tended to overlook fish consumption or were biased towards the consumption of larger fish (e.g. cod, ling), whose bones had better chances of being collected and identified. Conversely, bones of smaller species (e.g. herring, smelt) were mostly overlooked and therefore underestimated (Coy 1996, 56).

Another issue concerning ichthyoarchaeology is the general scarcity of fish specialists, possibly due to the relative novelty of the discipline. Morales-Muñiz (2014, 3649), in 2014 counted no more than 100 ichthyoarchaeologists in the whole world, representing 40 countries.

This number has definitively increased in the last few years, but it is still low when compared with the number of zooarchaeologists specialised in the study of mammal bones.

1.4.1 Embarking on a study of fish remains

Ichthyoarchaeology is defined as:

> “The analysis of fish remains from archaeological sites for the purposes of reconstructing the paleoecology of former aquatic environments and the paleoeconomy of past human populations”.
>
> (Morales-Muñiz 2014, 3648)

The analysis of fish recovered at a site can give precious information about the diet of the inhabitants and consequently the economy of the site; it is often possible to hypothesize about the sources exploited by ancient fishermen, whether freshwater or marine environments, and occasionally on the seasonality of the catch. Fish remains allow inferences about the fishing techniques used by a population, their level of technology and possibly about the presence of some trade activity. As stated by Morales-Muñiz, relative species frequencies and their diachronic modifications can reflect specific environments or changes in the environmental conditions, such as the rise or fall of water temperatures or the modification of the local hydrography, and they can also give information about past fish distribution (Wheeler & Jones 2009, 1-11). This initial definition can also be broadened, as particular species may yield important social value, as in the case of highly prized angling games or for some related habit or ritual, giving also an ideological potential to the study.

When approaching the study of fish remains, the first step is generally to make a list of species present within an assemblage, possibly contextualised by phases of occupation and areas within the site. At this stage, it is essential to associate these data with the recovery methods; hand-collected assemblages generally result in high percentages of large and robust bones (e.g. vertebrae, dentaries) from larger species (e.g. cod or pike) and a complete absence or only the occasional presence of the bones of smaller species (e.g. herring or small Cyprinidae). In order to have a more complete idea of the diversity of species and the distribution of anatomical elements present at a site, it is necessary to wet or dry sieve the sediment with a mesh size down to 3-1 mm (Zohar & Belmaker 2005; Morales-Muñiz 2014, 3649). In some cases, the use of a smaller mesh size (i.e. 0.6 mm), even if not always feasible, would be the only way to retrieve representative quantities of the smallest species, such as smelt or sprat (Enghoff 2005; Morales-Muñiz 2014, 3649).

There are countless other factors that can affect the task of identifying fish bones, such as the degree of details required for the final report, the working conditions, the experience of the researcher and the resources available (time, funding, lab equipment), and, in particular, the accessibility to a suitable reference collection. There are other tools that can help during the identification process, such as atlases, papers, online resources, but they can be far less precise than using direct comparison with bones of known species. This is particularly true for fish bones, as the size and physical features can substantially change with age; consequently, a good fish reference collection must include specimens of different age classes for each species.

Another crucial point to be taken into consideration is the choice of the recording protocol. About 95% of the bones of the fish skeleton are not diagnostic (Morales-Muñiz 2014, 3650) and the degree of preservation of different anatomical elements is extremely variable, depending on size, robustness and degree of ossification. During the recording process, accidental subjective biases may also occur (e.g. tiredness of the operator, the ability of seeing smaller bones, etc..), together with all the extrinsic factors related to each single specimen (e.g. taphonomic processes concealing morphological features). Eventually, the interpretation of the data must embrace the understanding that the zooarchaeological material represents a minimal part of the original assemblage, which, in return, is only a fraction of the fish that was actually consumed on site. Nowadays, there are various ways of partially avoiding biases intrinsic in archaeological assemblages; one of these is the recording of only selected diagnostic zones of the bone (e.g. Davis 1992; Albarella & Davis 1994).

The interpretation of this information can be processed at different levels, giving both qualitative and quantitative results. For instance, the simple determination of the presence or absence of taxa can entail reconstructions not only of human diet, but also provide information about the occurrence of a local exploitation of fish or the importation of fish from outside. For instance, variations in relative species frequencies may reflect socio-political and economic transitions, but also modifications in the environment and/or in the group of people living at the site (Wheeler & Jones 2009, 136).

The analysis of body part distribution can improve the understanding of butchery and preservation practices; for instance, an uneven element distribution can characterize a specific practice of carcass preparation. A typical example, showing the potential of this analysis, is the case of high recurrence of cleithra and vertebrae of large cod, accompanied by a general scarcity of skull bones; this pattern would be typical of stockfish, which was transported at the site in a beheaded form (e.g. Barrett 1997; Barrett *et al.* 2008; Wheeler & Jones 2009, 137).

When the remains are in a good preservation state, other evidence can be collected, such as appearance/preservation of the bone and presence of marks (e.g. butchery marks or gnawing marks); the interpretation of these can possibly clarify the agency responsible for the accumulations of the remains, which do not always have anthropogenic origins (e.g. marine bird leftovers, otter spraints, accumulations following natural death). From these observations, it is possible to collect information about the pre-depositional treatment of the carcass (butchery, cooking and preservation practices), the ways of disposal of the waste and post-depositional processes affecting the bone before recovery (Morales-Muñiz 2014, 3650).

In some cases, the seasonality of fishing can also be explored through species identification and size reconstruction. This can happen when specific migratory species are fished during recurrent periods of the year; these time spans will correspond to a defined moment during the life cycle of each species, reflecting the age and the size of the fish. This investigation is more reliable with species that migrate only for a short period of time, such as smelt (*ibid.*).

Furthermore, there are various studies on skeletochronology techniques that aim to reconstruct the age at death of the fish and the season of capture by reading incremental growth rings in specific anatomical elements (e.g. otoliths and scales). However, these techniques are still not standardised and suffer from problems of preservation and visibility of the outermost growth rings (Morales-Muñiz 2014, 3654; Wheeler & Jones 2009, 137-138).

Lastly, the spectrum of species, present at a site, together with their size may give information about fishing techniques. The catch of some fish requires more advanced navigation skills and technology, as in the case of large cods, which generally were fished offshore (Lough 1999). The presence of small fishes from the Cyprinidae and Clupeidae families may be an indicator of the use of the species as baitfish, therefore the practice of fishing with hooks (Wheeler & Jones 2009) or the use of fine mesh-nets to catch them (Wheeler 1979a, 22-23).

The methods and techniques involved in the study of fish remains are continuously developing, therefore there is no doubt about the importance of reviewing assemblages previously studied, in order to add new knowledge about past populations.

1.4.2 Biometrical approaches

Some of the earliest applications of fish size reconstruction date back to the 1960s when Boiko (1964) tried to estimate the natural mortality of pikeperch (*Sander lucioperca*) from natural and archaeological deposits by using its size and age (Wheeler & Jones 2009, 137). From that point onwards, new methods and techniques about fish size reconstruction were developed on bones, otoliths and sometimes also scales (Casteel 1976), with bones being the most reliable indicator (Thieren *et al.* 2012, 551). These techniques are grounded on the comparison of single anatomical elements with the same element belonging to a fish of known length (e.g. Van Neer 1986), thus requiring a very extended reference collection, or on the correlation between length of the bone and length of the fish (total length, standard length, fork length). In this last case, fish size can be reconstructed by using bivariate graphs plotting both given bone length and correlated fish length (e.g. Desse *et al.* 1987) or through the application of a regression equation (calculated on modern fish) which allows calculation of the fish size from the length of the bone and vice versa (e.g. for the specific case of eel see Thieren *et al.* 2012a; for the specific case of sturgeon see Thieren & Van Neer 2014). Another way to compare fish size is through the use of scaling index technique; this method allows to plot different measurements taken on archaeological material on the same scale, by comparing them to the same standard value; this method typically allows a substantial amplification of the sample size (Rizzetto & Albarella 2017, 766-767).

There are limitations and problem connected with all these methods; in general, problems with size reconstructions are connected with the fact that they overlook biological variations in the proportions of bone measurements of individual fish (Lernau & Ben-Horin 2016) and they are based on modern fish whose size have fluctuated through centuries as results of human introduced factors (e.g. fishing) and environmental changes (e.g. climate fluctuation; see for instance Yurtseva *et al.* 2014). However, this matter will be explored further in Chapter 4 in connection to the methodology chosen for biometrical analysis. What is important to highlight at this point is that biometry applied to the study of fish remains is an invaluable source of information, especially considering the fact that fish grows throughout its entire life (Morales-Muñiz 2014, 3652). For instance, the different classes of fish size distribution can indicate whether there was non-seasonal or seasonal fishing, but also whether the site was a subsistence site or a producer site. Morales-Muñiz (2014, 3655) summarised the parameters that can be potentially used in order to distinguish between the two in: relative species frequencies, anatomical element and size distribution. It is expected that in a commercial site the variety of species will be reduced, as there is a focus on those species the site is specialised in selling. In addition, in this type of site the size of fish would be more homogeneous, reflecting the standardisation of fishing practices and sources. Also, the processing techniques would be consistent (e.g. similar butchery marks and presence/absence of same anatomical portion), reflecting a highly standardised method of curing the fish and preparing the final product.

Biometry has often been used to differentiate between taxa that cannot be easily separated by the observation of their morphology (Albarella *et al.* 2017, 760), and this has also been the case for fish (e.g. for Cyprinidae family see Libois & Hallet-Libois 1988; for Salmonidae see Guillard *et al.* 2016). Additionally, fish size is age-related and often also sex-related (e.g. in the case of eel), thus can give information on the stage of life of the fish and consequently allow suppositions about fishing methods and sources. For instance, small glass eels were more likely fished with weirs and nets from estuaries, while big female silver eels were probably caught swimming downstream rivers through wooden traps or hooks (Wheeler & Jones 2009).

A later application of biometrical study on fish size is the estimation of human impact on fish population, where overfishing, for instance, can have a significant influence on fish size (Leach & Davidson 2001).

Finally, biometrical analysis can be particularly fruitful and give plenty of information, but there is a general dearth of published measurements and standardised methods, which makes comparisons among sites problematic.

Chapter 2. The medieval freshwater fish

This aim of this chapter is to contextualise the social and economic value, as well as the perception of different freshwater species, and more generically freshwater fish in medieval England. Many factors are involved, which need discussing, according to a number of different thematic issues.

2.1 Medieval fish populations

Like today, in medieval England aquatic environments were strongly affected by the interaction between anthropic and natural agents. The country, like the rest of Europe, experienced major climatic fluctuations, such as the 'Medieval warm period', from the 10th to the 12th c., and the 'Little Ice Age', from the 14th to the 19th c. (Hoffmann 2008, 49). Moreover, other two long-term phenomena should be mentioned in this context: the postglacial shifts of water levels and the faunal recolonization of northern Europe (*ibid.*). Clearly the species most affected by these climate fluctuations were those with more limited adaptability and restricted ecological niches.

Increasing pressure on the freshwater ecosystems occurred during the Middle Ages, as a consequence of human activities. The overexploitation of fish caused the reduction of fish density and species variability but also a modification of fish size (*ibid.*, 48). A demographic increase of the European population occurred from the 8th to the 13th c., concurrently to agricultural improvements, which saw a major expansion of arable farming, the intensification of farming practices and the enclosure of most of England's open fields; this process also sustained the growth of towns (FeedSax 2020). This trend is reflected in an increased eutrophication (nutrient enrichment) of the waters, mainly due to the spread of fertilizers in the fields, as well as domestic waste, toxic pollution of the freshwater bodies and the sealing and drainage of rivers due to accelerated erosion/siltation activities. The clearance of woodlands with the aim of creating arable fields and the construction of artificial barriers (dams, water mills) altered the natural course of rivers and therefore the original migration routes of fish (Hoffmann 2005, 2008).

This massive modification of aquatic ecosystems had different effects on freshwater species, both with positive and negative outcomes. Hoffman (Hoffmann 2008, 50-53) retraces the history of some European species considered to be representative of their environments and paradigmatic of the adaptive response to this human impact.

The Atlantic salmon (*Salmo salar*), which was very abundant prior the 11th c., became gradually rarer in European waters as a consequence of overfishing and of the construction of artificial barriers, which obstructed or completely impeded spawning migrations. The outcome of these human actions was a northward retreat and the shrinkage of salmon habitats from the early 13th c. onwards (Hoffmann 2008, 50-51). Representation of salmon (and trout) in archaeological assemblages is generally biased by the poor survival rate of the bones, but the importance of the species is attested by several legislations and royal decrees for protecting the fries (young fish) and their habitats (regular clearing of spawning rivers and regulation in the use of dams and other obstructions to fish migration).

As mentioned in the previous chapter, nowadays spawning populations of Atlantic sturgeon (*Acipenser sturio*) are present only in the river Garonne, in France, and they are protected by European law as the species is regarded to be critically endangered (Gesner *et al.* 2010). Conversely, prior the 11th c. this species was widespread and consumed all over Europe. It was by the 12th c. that sturgeon frequency started to decline as a result of overfishing and later on due to its low tolerance of the spawning conditions in the northern cold climates of the Little Ice Age (Hoffmann 2008, 51). Furthermore, sturgeons are large and slow swimmers, characteristics that make them easy to catch, which could have accelerated their decline and disappearance in most of Europe. With the gradual disappearance of the sturgeon, another species colonised European waters and eventually prevailed: the Atlantic sturgeon of North America (*Acipenser oxyrinchus*), a considerably stronger and more climatically adaptable fish (Ludwig *et al*. 2002).

The European eel (*Anguilla anguilla*) is known to have an excellent physiological adaptability to different environments. In fact, this species managed to occupy new environments within European waters as a consequence of human activities. At latest the 1200s saw an explosion in eel fishing in the area of the Rhine and Po delta (Hoffmann 2008, 52). The increase of lagoons and estuary areas due to siltation, together with the eutrophication of rivers and streams, created perfect living conditions for this fish (*ibid.*, 51-52). However, focussing on England, a different pattern appears, as the archaeological evidence shows a visible decline of eel frequencies from the Saxon period to the 11th c. with few exceptions, which remains constant but is less evident in the following centuries, at least until the 15th c. (Barrett *at al.* 2004a; Albarella 2019).

Until the 7th c., European evidence of the occurrence of the common carp (*Cyprinus carpio*) is limited to the Balkan Peninsula, in Black Sea drainages. From this moment onward, the fish was imported to western Europe from the Danube for breeding and to please the taste of the wealthier end of the market. This fast-growing species rapidly replaced the cold-tolerant but slow-growing native freshwater bream (*Abramis brama*). Some carps escaped and became perfectly adapted to a water heated and made siltier by human pollution (Hoffmann 1994, 2008, 52-53).

As already mentioned, human impact on aquatic ecosystems had a major effect on fish frequencies, but also on size distribution of some species. For instance, a detailed study by Harland *et al.* (2016) of the fish assemblages from the sites of Coppergate and Blue Bridge, medieval York, shows how the largest eels were fished from the 10th -11th c. contexts at Coppergate and, from that point onwards, eel size decreased at both sites. Pike was also identified in abundance; pikes of 50-80 cm of total length were recorded until the mid-11th c. but they are rarer and no larger than 50 cm from later periods. A decrease in the maximum length of the two species was correlated with fishing pressure, where a high rate of fishing activities would have prevented the fish to reach a large size. In the case of the pike, a shift in fishing sources, from river to fishponds, was also hypothesised. This would have additionally contributed to a size reduction, as large pikes are unsuited to artificial fishponds.

2.2 The price and value of freshwater fish

Despite the ecological problems affecting aquatic habitats, medieval England was still rich in freshwater bodies and aquatic fauna. Potentially, the large availability of freshwater resources could have provided freshwater fish for all social classes, but this was not the case. From the 11th c. onwards, there was not easy accessibility to freshwater fish, which was generally more expensive than sea fish. A document that exemplifies the different economic value of freshwater and sea fish is an account, dated 1461, reporting the purchase of fish for the residence of the bishop of Coventry and Lichfield, in south Staffordshire (Dyer 1994, 106):

Sea fish	
Salt-fish	8d.
Stockfish	3d.
Herring	1/4d.
Plaice/flounder	1/2d.
Freshwater fish	
Pike	12d.
Pickerel	8d.

Bream	5d.
Tench	6d.
Perch	2d.
Chubb	4 1/2d.
Eel	1 1/2d.

When comparing prices, it is important to consider the weight and size of the fish, which is often not indicated in these documents; for instance, stockfish would be larger and lighter (dried) than most of other fish. Nevertheless, it is clear how pike was the most expensive fish on the list.

The reasons behind the higher price and higher social value of freshwater fish are various. Historical sources indicate that during the Saxon period the newly arisen class of self-made middle-upper lords, called ‘thegns’, used to demonstrate their wealth through possessions and an expensive lifestyle. Symbolic of their affluence were activities such as hunting, fowling and fishing, performed in parks and ponds, within their private estates (Sykes 2007). With the arrival of the Normans in 1066 and their new aristocracy, there was an exponential escalation of this process aiming to enhanced visibility and power, which initiated a chain of consequences. An increase in the privatisation of the land, incorporated into estates, occurred, and there was also a growth in private fisheries. More money was also invested in the construction of private ponds connected with high status estates. These ponds were firstly a symbol of royal status, later being adopted by the rest of the aristocracy; by the 12th c. pond systems were also built within monastic sites (Locker 2018b, 47). Hunting and fowling rights were reinforced, together with riparian rights (allocation of water bodies) in land ownerships; there was a strict regulation on fishing from private ponds and rivers and poaching was severely punished by law (Dyer 1994).

All these limitations and regulations of freshwater aquatic sources and the exclusivity of fishing rights on river, estuaries and natural/artificial ponds dramatically diminished the accessibility to freshwater sources, consequently increasing the value of freshwater fish (Serjeantson & Woolgar 2006).

While freshwater fish became rarer and less accessible, it also reduced its contribution to the diet. Prior the 10th c. rivers and estuaries were still the most exploited sources of fish; freshwater fish was commonly consumed on dining tables, while marine fish rarely appeared, especially in inland settlements (*ibid.*). From the 7th to the 10th c. freshwater and migratory species dominate English archaeological assemblages. However, from around 1000 AD, at the time of the so-called 'fish event horizon' (Barrett *et al.* 2004a), a substantial increase in the frequency of marine fish, followed by a decrease in freshwater fish (Orton *et al.* 2017), is evident in archaeological assemblages. This phenomenon was the result of the combination of different environmental and socio-cultural factors, partially mentioned above. From the 11th c. onwards, the most common species consumed became cured herring and cod (together with other Gadiformes). The growing trade of these two species in preserved form led to the transport of large quantities of marine fish towards inland locations; this significantly increased their commercialisation. The shrinkage of the freshwater ecosystems (Section 2.1) was another factor involved in this phenomenon. The movement and concentration of people in towns during the 10th c. increased the levels of water pollution but also the demand for fish, which was no longer supported by the freshwater supply. Religion also played its part in this growing demand. Following religious precepts, fish was regularly consumed on fast days, while meat was forbidden to all social classes (Dyer 1994). The English Benedictine Reform of the 10th c. represented an attempt to give new vigour to the application of religious rules and, within this, dietary regulations were included (see Section 2.5). The adoption of floating driftnets seems to have also a role in the increase of the consumption of marine fish (Barrett *et al.* 2004b).

The result of these processes was that freshwater fish became not only a less significant part of the diet, but, for some species, it raised to symbol of social privilege (Dyer 1994).

2.2.1 The value of different species

Historical sources for the 11th-15th c. (e.g. Domesday Book, household accounts, statutes regulating fishing activities, and recipe books) indicate that species such as freshwater bream, perch and northern pike became more expensive and mainly associated with moated sites, castles and monasteries. However, following the surge of the town markets of the 15th c., some riverine species (e.g. eel, small Cyprinidae) were sold cheaply, and could thus also be afforded by the lower classes (Dyer 1994, Woolgar 2000). Clearly, not all freshwater species had the same cost, but to establish which ones could be regarded as luxury items is complex. To attempt so, information about the socio-cultural context in which the fish was consumed needs to be merged with an understanding of the biology and living habits of the species. Nevertheless, the perception of what represents luxury is inevitably multifaceted and associated with the relevant society and historical period. Ervynck *et al.* (2003, 429) define luxury as 'the consumption, beyond the level of affluence, of goods that are special, limited in supply, difficult to procure or very expensive for other reasons'. Recognising luxury within the zooarchaeological record it is often challenging (Ashby 2002, Ervynck *et al.* 2003). Factors that need to be considered include the socio-cultural context of the site, the geographic area and availability of species. Taphonomic, particularly recovery, biases could hamper the presence of smaller species or smaller/fragile anatomical elements and must therefore not be ignored.

Rarity and exoticism would have added value to the fish (Ashby 2002, 40); a typical example is represented by the carp, whose initial appearances in England (13th c.) is due to precious gifts for rich folks (Bond 2016b, 181). A large variability of species in an assemblage could also be representative of status, as a varied and diversified diet was mostly related to rich tables (Reitz & Wing 1999). Accessibility to a species would have defined its value; this could be related to the effort put in catching the fish, but also the restrictions limiting the access to freshwater sources (e.g. fishing rights on fisheries, private fishponds; Dyer 1994). Element distribution and anthropogenic modification of the bones can also be indicative of the wealth of the people living at the site (Albarella & Davis 1996). For instance, patterns indicating the importation of preserved fish (e.g. beheaded stockfish) could held some status information. Freshwater fish was traditionally caught locally and consumed fresh while, after the 'fish event horizon', some marine species, typically herring and cod, were commonly preserved as a form of cheap staple food, with the potential of being transported all over the country (Barrett *et al.* 2004a). The quality, nutritional value and gastronomic level of fresh fish would have been higher than preserved fish, and this would have also been also reflected in its price (Van Neer & Ervynck 2004, 203).

Fish size needs to be considered in this picture. Historical sources tell us that larger and selected specimens were likely destined to a restricted high class: a large pike or a large eel would have been a typical table centrepiece, displayed as sign of wealth from an aristocratic host. At the elite table, the meal was not only embodying the experience of the food, but it was attentively designed to honour and enhance the greatness of the lord (Woolgar 2016, 172). There are various reasons why a larger size freshwater fish would have been more expensive, but, in the case of farmed fish, the high price would reflect the labour and time put into growing fish in habitats with low productivity such as fishponds (Dyer 1994; Section 2.3). Using the example of the marine halibut, Locker (2018a, 17) observed that the gastronomic value of a fish would diminish with increasing size and age, as the flesh would progressively coarsen. However, the importance of the symbol was higher than its culinary value. Woolgar (2016, 114) underlined that while there was a sentiment that it was better to eat the flesh of young animals, mature fish was to be preferred. In the Chaucer's 'Merchant's tale' (1418-1420) a knight looking for a young wife will proclaim: 'I would rather have old fish and young flesh.

It is better to have a pike than a pickerel, and tender veal is better than old beef'. To complicate the matter, an interesting synopsis of heraldic symbols of English aristocratic families made by Locker (2018b, 63-65) shows how fish is often present, but the size of the species seems not to be relevant, as pike, bream, chub roach were represented together with the smallest minnow and loach.

In a nutshell, some freshwater species were prized more than others. From a zooarchaeological point of view, it could be argued that these high valued species are indicative of high status sites, when they are abundant and/or large size.

For example, the sturgeon was considered a royal fish in medieval England. The accessibility to sturgeon was extremely restricted as the crown and a few or designated lords had exclusive fishing rights for this species (Moore & Moore 1903). In addition to its rarity (Section 2.1), quality and nutritional value, the large size and peculiar appearance of this fish would have enhanced its importance.

For similar reasons, the Atlantic salmon was considered good eating; the flesh of this species is fatty, and therefore very calorific and nutritious. The accessibility of this species, when fished in rivers, was regimented; additionally, this fish was localised in some periods and areas (Section 2.1; also, specifically for the Thames river, see Wheeler 1979a, 22).

The pike was also a highly prised game in medieval England; in the previous section (2.2) we have seen how pike was the most expensive fish in the list of purchases for the bishop of Coventry and Lichfield; we also know that, during the 13th c., the price fixed for the species by Edward I was at least double the cost of salmon and ten times the cost of cod (Hamilton-Dyer 2007, 184). By the 15th c., an adult pike would have costed the equivalent of a week wage of a skilled craftsman (Dyer 1994). Because of their cannibalistic and aggressive behaviour, large pikes tend to be rare and not easy to fish. Today, anglers speak about fishing for pike as an exciting challenge, as this strong fish can be dangerous but also an escape artist. The skills and bravery put into fishing a large pike, the limitation on its accessibility and the quality of the meat would all be factors contributing to the high value of this species. Pike became so highly esteemed that by the 16th c., together with salmon and trout, it was protected by law. Fishing for juvenile individuals was forbidden, in particular for young spawn below 10 inches for pike, 16 inches for salmon and 8 inches for trout (Moore & Moore 1903, 177).

Freshwater bream was also considered a prestigious pond fish. The cost of bream during the period investigated was has high as three-four times a craftsman daily wage (Bond 2016b, 160). The reason for this high price can be found in the slow growth of this species. It would have taken a minimum of five years for this fish to reach the size of a ‘matrices brama’, i.e. to be appropriate as a classy gift, suitable for a rich table (Currie 1988).

Woolgar (2016, 114) observes how the common perception of different value attributed to different fish species was reflected also in proverbs about fishing or about individual fish.

Hake, red herring (smoked, as opposed to ‘white’, which indicate herring preserved in brine) and oysters were often used in expressions referencing things of lesser value. Trout, pike and pickerel were often appearing in proverbs (‘to be as hale as a trout’) related to the healing power of fish, considered health food in medieval England (*ibid.*)

2.3 Freshwater fish exploitation

2.3.1 Freshwater fish management

Together with the decrease of freshwater fish consumption after the AD 1000, a clear attempt to securing the access to freshwater supply occurred; this was achieved by increasing the regulations on small-scale freshwater fishing and by an improvement and expansion of the freshwater fisheries (Barrett *et al.* 2004a, 628). These fisheries were controlled by the elites (Hoffmann 1996, 653), and a number of traps were built during the 11th - 12th c., to catch migratory river species, such as eel and salmon (Barrett *et al.* 2004a, 628). By the 12th c. many of the larger rivers supported fisheries privately owned; a substantial documentation indicates this regimentation, as many legal cases connected with the overuse of these sources and litigations for abusing the fishing rights are reported (Hoffmann 1996). Furthermore, there were statutes regulating where and when people could fish, what type of fish could be caught, the mesh size of nets and weirs to be used, the number of structures allowed in a particular stretch of the river, etc...

Store ponds for growing fish had been in use in England at least since Saxon times (Locker 2018b, 55), but is in the 11th - 12th c. that the introduction of the first formal pisciculture done in fishponds can be traced back. The first ponds were associated with royal possessions, and later they were introduced to manorial and religious sites. The landscape evidence for ponds has also been recorded in villages, but these cases are very few compared to elite contexts (*ibid.*, 54-55). One of these few examples is represented by the parish of Tanworth, Forest of Aden, Warwickshire, were 19 fishponds were recorded from the 11th to the 14th c., belonging to freemen and wealthy tenants; bream, roach and tench were grown in the ponds and consumed locally or sold (Roberts 1966, in Locker 2018b, 58). Fishponds were built for various purposes:

to supply the subsistence needs, for commercial sales, to provide a status symbol for the propriety owner, to provide an ornamental feature for the garden or as a place where to enjoy angling as a pastime (even though there is no evidence of sport angling from ponds for the period studied; Locker 2018b, 55). Fishponds as ornamental features are documented from the 12th-13th c., but they became more common and elaborate in the late 14th c., reflecting the status of the household (Taylor 2000, 14; Locker 2018b, 57).

Fishponds were far insufficient from supplying the yearly demand of fish for an estate, and this low yield was caused by letting fish to forage on natural resources, which resulted in a slow growth (Currie 1988; Bond 1992). Therefore, even after fishponds became popular, the main source of freshwater fish remained riverine and lacustrine fisheries (Bond 2016b, 162), which relied on species availability and were highly productive in specific seasons. With the arrival of the Normans, common fishery rights were taken over by major landowners. Fisheries were mostly focused on eel and, in some areas, salmon; famous salmon fisheries were located in the River Severn, where, in the Shropshire stretch, at least 41 weirs have been recorded (Locker 2018b, 58). Weirs were laid in the rivers either blocking it completely, or, in some cases, providing a gutter for letting boats and migrating fish pass. Most of the weirs were privately owned, but occasionally they belonged to town councils (*ibid.*).

The first pond built during the reign of William the Conqueror in 1086-1089 was a large pool, covering more than 50 hectares of arable land, stocked with bream and pike (Bond 2016b). In the 13th c., the number of royal ponds increased considerably, as attested by a multiplication of records reporting fishpond management activities. The Close Rolls and Liberate Rolls are important examples of documents explaining how fishponds were run; they include information about the work of specialist fishermen, travelling across the country in order to manage the royal ponds and supervise the netting and carriage of the fish; furthermore, these documents also name the various royal fishponds spread around England (e.g. Marlborough Castle, Woodstock Palace, Havering Manor and the hunting-lodges of Brigstock, Clipstone, Feckenham, Kingscliffe, Silverstone and Woolmer). These ponds provided fish as required by the royal cohort during seasonal and religious festivities, or they were used as sources for royal gifts (*ibid.*). For instance, in 1231 the Dean of St Martin’s in London was given a batch of 1,000 breams from the royal ponds of Havering Manor (Close R. 1231-4: 11 in Bond 2016b, 164).

Fish was often carried around from different royal ponds in order to restock those cleared out; sometimes ponds were also restocked through purchase of fish, for which we have a detailed documentation. There is a record of the sheriff of Cambridgeshire buying 3,000 pikes in 1250 for the king's ponds in Havering Manor (Liberate R, 1245-51: 273 in Bond 2016b, 164), while, in 1247-51, 400 bream sourced from the same manor were divided among the royal ponds of Kennington and Windsor (Close R. 1247-51: 399 in Bond 2016b, 164). Live fish was transported in barrels or wrapped in wet grass and rushed in the new ponds (Locker 2018b, 55); the best season to transport the fish was winter, whilst moving fish in warmer conditions was harmful for the animals (Taverner 1600, 6).

From the 12th c. onwards, fishponds featured in baronial and manor-houses and they were comparable to deer-parks and rabbit-warrens in terms of privilege and limited accessibility. By the 13th c., among all social classes, fishponds became an enviable status symbol to aspire to. Typically, these estates were surrounded by moats, which were also used to keep fish, such as Cyprinidae, eel and pike (McDonnell 1981; 14).

The surge of episcopal fish ponds could also be dated to the mid-12th c. and is probably related to the bishop of Winchester, King's brother, and his fashion flair for high status food; the ponds of the bishop were stocked with pike, bream, perch and roach, which were treasured as a personal luxury and consumed fresh (Bond 2016b, 165). More typically, fishponds within religious sites were used to source fish to be consumed during feasts by the bishops, local religious authorities, and their entourage; as in the case of secular ponds, an improvement of the fish yield was not a priority.

Documentary records attest to a wide variety of freshwater fish kept in medieval ponds.

Among Cyprinidae, the most renowned and first fish to be documented (Locker 2018b, 55) was the noble freshwater bream; tench and, later, carp were other two favourites. These three species can tolerate slow moving muddy waters and a low level of oxygen; thus they are well-adapted to be transported and live in artificial ponds. Other Cyprinidae typically kept in ponds were roach and dace.

In particular, carp was an excellent pond fish often used by commercial producers, not only because of its resilience but also for its low maintenance and fast growth. Despite becoming the most popular fish to be kept in ponds in the 15th c., it was still relatively expensive and typically reserved for the aristocracy (Currie 1991: 102-103). As mentioned above, there are early records of carp in England dated to the 13th c., which possibly represent gifts from abroad, but the first certain evidence for carp stocked in ponds is dated 1462-1472; an account reports that Sir John Howard, the Duke of Norfolk, introduced 800 carps in his seven fishponds (Bond 2016b, 181).

Pike was another typical pond fish that adapted well to artificial habitats but required expert management. A document from 1289, with instructions for manorial bailiffs, recommended to stock ponds with bream and perch, but avoid pike as they tend to eat any other smaller fish in their habitat (Bond 2016b, 161). Perch was also habitually kept in ponds, as a fish relatively tolerant of low oxygen levels (Chambers and Gray 1988: 119-20), like also eel, which is extremely resilient and, in nature, can survive for long periods of times in mud puddles (Fort 2002).

Ponds were elaborated water system with specific and not easily achievable environmental and ecological requirements (Locker 2018b, 56). Silt accumulation, algae and plants were disrupting agents for the delicate pond environment; if not treated properly, these would reduce the space and quantity of oxygen available and consequently slow down the growth of the fish. For this reason, ponds were periodically emptied, cleaned and restocked (in a good management, at least every five years). The maintenance of the ponds was costly and complex and, as mentioned above, well paid professional fishermen were needed in order to maintain the ponds (Bond 2016b). There were different typologies of fishponds and different terminologies referred to them (Roberts 1986). For instance, a *vivarium* was a large pond, where fish was reared and fattened up. A *servatorium* or *cervorium* was a small square/rectangular pond, where fish was stored when the *vivaria* were emptied or when it was ready to be eaten (in this last case the *servatorium* would have been built near the main house). *Vivarium piscum* was probably referred to ponds temporarily used to store fish caught from the river. Another way of stocking fish was through the use of ponds adjacent to water mills. These water systems appeared in England during the 7th c. and by the 11th c. there were over 6,000 water mills recorded on the Domesday Survey (1086). A typical fish sourced by mills was eel, caught with special traps attached to the sluice of the waterwheels (Wheeler 1979a, 22) and this activity was captured in a beautiful image of the Luttrell Psalter manuscript; but other species were suited to the millpond waters, like Cyprinidae, trout and grayling.

It appears that initially fish were not bred in ponds, but the fish supply was supported by the introduction of wild fry (young fish) and by movement of different breeding-stocks from the *vivaria* and *servitoria* (Bond 2016b, 171). However, Steane (1988, 46) observed that the purchase of large quantities of fish (e.g. 300 pikes to stock royal ponds in the mid-13th c.) could suggest the existence of fish nurseries. Fish at different stages of life were kept in separate ponds to prevent larger predators, most typically pike, to eat smaller individuals. Fish were also protected from poaching and terrestrial predators through enclosures; inside these enclosures, it was also possible to find buildings, such as fishermen residences, fish-smoking structures, storages for nets and equipment, and shelters for watchmen (Bond 2016b).

The start of the 14th c. witnessed a high and rising level of mortality, caused by overpopulation and recurrent famines; this was the result of the inability of agricultural production and animal exploitation to meet an ever increasing demand for food (Postan 1972). The level of mortality was further aggravated by the Black Death, which killed as much as 40% of the population. In addition, historians believe that, following the recurrence of the plague in the early 1360s and mid-1370s, the population decrease could have exceeded the 50 % (*ibid.*). The plague was such an unprecedented disaster that, in England, it took nearly two centuries and several generations to fully recover. During this period economic activities were severely damaged, with a subsequent decline of land value (*ibid.*). In this context, the 14th c. century also saw a significant decline in the use of royal fishponds and in their seigneurial monopoly, as many royal and aristocratic houses fell into neglect. Lords were initially reluctant to renounce their fishing rights and to lease out the ponds, because of the prestige attached to it, but in most cases they had no choice; at the same time, aspiring middle class folks were enriching by selling off the leased ponds and fisheries (Bond 2016b, 180). Rents of river fisheries were higher than those of ponds, possibly because of the lowest maintenance, as naturally restocked, and as consequence the lesser capital invested (Dyer 1994, 107; Locker 2018b, 56). During the same period, there was an increased demand for freshwater fish on the open market, which increased the commercial production. Large part of this demand during the early 14th c. was covered by manorial lessees. In the meantime, large fish markets started to grow in big towns, first of all London; royal provisioners started to rely on these commercial poles as well, rather than on the royal ponds scattered around the territory. The production of freshwater fish became more efficient, maximising the yield of ponds throughout the use of food supplements, and the introductions of fast-growing species, such as carp (Bond 2016b, 181-182).

2.3.2 Monastic fishponds

The history, typology and management of medieval monastic fishponds in England varies little from royal and manorial ponds; nevertheless, this section will briefly discuss some evidence specifically connected with ponds located within religious sites.

There are some 11th c., possibly 10th c., examples of fishponds connected with monastic sites, mostly representing donations of lay benefactors; furthermore, there are at least two Benedictine abbeys mentioned in the Domesday Book (1086) owning fishponds. A significant number of records of monastic fishponds starts to appear after the mid-12th c. and kept increasing during the 13th c., when a number of abbots decided to invest in upgrading their lands (Bond 2016a, 33-34). Some religious houses were also benefitting from fishing privileges on private fishponds and river fisheries, granted from their patrons.

As in the case of secular estates, the 14th c. witnessed a decline in the use of monastic fishponds, which were often leased to obviate economic difficulties. However, there are cases in which fishponds within the richest religious residences were kept or even built brand new (e.g. see the ponds built at Eynsham Abbey during the 14th c., Chapter 5).

Once again, fishponds were not intended for subsistence and very rarely produced surplus for sale; in this sense river fisheries were much more productive. A rare case of the sale of fish surplus was recorded by Kirk (1892, 52, 74 in Bond 2016a, 46) from the accounts of Abingdon Abbey. The low productivity of fishponds is attested to by the case of the Augustinian canons of Waltham and the Cistercian monks of Beaulieu, which, in the 1340s, were extremely indebted with the London fishmongers, despite owning extensive fishponds (Close R., 1343-1345: 229, 474; Currie 1989, 157). The function of fishponds was, yet again, exclusivity; fishponds provided prestigious meals for special occasions, such as feasts or death commemorations of members of the patronal family, and entertainment for the abbot’s guests as garden amenity. Similarly, lords often granted fishing rights to monastic communities on their private ponds, but reserving the best catch for themselves to be consumed during important family occasions (Bond 2016a, 31-32).

Fishponds were located both inside and outside the precincts of religious establishments and, in some cases, they had a considerable size. For instance, at Winchester Priory boats were needed to fish from the two extensive fishponds (Bond 2016a, 40). Ponds were stocked through purchases, gifts, or transfers of fish from different monastic establishments. There is documentary evidence that Henry III donated live fish to restock the ponds of several abbots, such as when he donated 60 bream to Fountains Abbey in 1229 and of 10 prime female bream to Byland Abbey in 1245 (Close R. 1227-31: 278; 1242-7: 328). Bond (2016a, 35-36) observed that the number and size of ponds within monastic precincts cannot be used as evidence of the wealth and status of a monastery. To exemplify this, he made the example of the Canterbury Cathedral priory, a large Benedictine house, which possessed only one fishpond; at the opposite end of the spectrum, the small rural Augustinian priory in Maxstoke owned ten ponds and a moated enclosure. Furthermore, in Lincolnshire, a number of different religious communities appear to have been equipped with complex pond systems (Everson *et al.* 1991), like the Cistercians (e.g. nunnery of Heynings) and the Benedictines (e.g. the nunnery of Stainfield).

2.3.3 Fishing for freshwater fish

Fishing from ponds was carried out with various methods and tools, applicable also to fishing from river and estuarine fisheries. Spears and harpoons, wickerwork traps, rods and lines were standard tools to catch freshwater fish, but the most common was the use of nets. In larger ponds, boats were also used for fishing in the deeper areas and professional fishermen were hired (Woolgar 2016, 117). Another technique was to reduce the volume of the water by breaching dams, so the fish could be more easily caught with nets and in larger quantities. A less efficient method was the use of rod, line and baited hooked, typically utilized for larger fish, but definitively more time consuming and less fruitful (Bond 2016b, 177-178). Fishing from rivers was an activity for professional fishermen and for boys, typically less desirable during winter months and Lent (Woolgar 2016, 116).

Salmon was not suited to the pond environment, so was largely fished from rivers; hooks, lines and nets were used, as well as wicker traps built on weirs and mills located on salmon upriver migration paths (Wheeler 1979a, 22-23). Eel fishing was done with methods suited to the age and dimension of the fish. The small glass eels were caught in abundancy with weirs and nets from estuaries and coastal areas; larger individuals were typically fished from mills with traps attached to the sluice of waterwheels or from rivers through the use of funnel shaped wicker baskets; the older specimens were caught while migrating downstream. Once again, a less effective method, but still used, was the catching of eels with hooks and lines (Wheeler 1979a, 22-23).

Obligatory freshwater species, such as Cyprinidae, pike, burbot, and perch, were fished with traps, nets and hooks. Juvenile or small Cyprinidae (e.g. bleak, minnow) and other small species (e.g. stickleback) were generally not targeted and they were caught in abundance when fine-mesh nets or fine-woven wicker traps were used (*ibid*.). Large species such as pike and sturgeon, required specifically designed hooks and nets. A study on fishing for sturgeon from the Danube area (Bartosiewicz *et al.* 2008) shows that to catch these large and strong animals required specific and resistant tools, but also targeted skills, together with a knowledge of the habitat and behaviour of the fish.

It was general knowledge that the best time for catching fish was during the night or at early dawn or dusk, ‘biting time’ being between 4 and 8 p.m. from May to September, on a dark day during winter and from 4 and 8 a.m. for the rest of the year (Woolgar 2016, 118). Some species though, were best caught in the middle of the day, as the case of trout (*ibid.*).

Documentary evidence for angling as sport in medieval England is scanty. One of the earliest documents on fishing for sport is the well-known 'The Treatyse of Fysshinge with an Angle', dated 1496 and written by an anonymous author. This written work was inserted in the second printing of 'The Book of St. Albans', a manual conceived for gentlemen instructing on the art of hawking, hunting and heraldry. The treatise was an angling compendium, including suggestions on fishing seasons, species distribution, bait selection and instructions on how to make and use rods, lines and hooks (Bond 2016b, 177-178). There are some rare references to angling dated to the 14th c. and Hoffman (1985; 1997, 345) suggests that angling skills were probably transmitted orally at first, so this pastime may be older than the documentary evidence shows. Typical 'game fish' would be sought from rivers (e.g. pike, grayling, salmon, trout) and represented a greater challenge than fishing for roach, rudd, tench (the so-called 'coarse fish') (Maitland & Campbell 1992). In angling too, the larger the fish, the greater the challenge and the value. Unlike bloody and violent activities such as hunting, the contemplative side of angling may have made this hobby better suited for monks (Locker 2018b, 61).

2.4 The medieval table

Many authors describe how typology, variety and quantity of food consumed created socio-cultural identities in present and past societies (for instance Dietler 2006; Van der Veen 2010; Twiss 2012). Zooarchaeologists have several times attempted to associate meals of past populations with cultural identity, religion and social rank, conferring to food the value of material culture (Crabtree 1990; Thomas 1999; Ashby 2002; Ervynck *et al.* 2003; Grau Sologestoa 2017; Albarella *et al.* 2017).

This is particularly true when studying the exploitation and consumption of fish, a food resource which, still today, has many religious and socio-cultural connotations; these connotations were even stronger in the past, when the implied meanings associated with a meal were countless, especially in a society impregnated with traditions, rituals and religion as that of Medieval times.

In medieval society, a good meal was highly regarded, and the levels of refinement and quality, according to contemporary standards, were proportional to the social rank of the household. Among all classes, everyday eating and drinking followed seasonal harvests, the dictates of the Church and the medical science of the time (Dyer 1994). During special occasions, such as religious festivities or political meetings, wealthy house owners would have glorified their wealth among friends and allies by offering luxurious and opulent banquets (Van der Veer 2003; Klemettilä 2012, 8-14). During festivities, also the middle-class would have stretched their budgets, mimicking the rituals and dishes of the upper class (Woolgar 2016). In the poorest houses, the rare piece of meat or fresh fish would have been treasured for these rare occasions. However, it was on the everyday meal that the social distance from wealthy and not would be clearly showed, both in terms of quality and quantity of food (Van der Veer 2003, 415).

In this setting, freshwater fish played different roles according to species, size, and origin; the same freshwater species could both be considered a luxury item and a peasant dish (Dyer 1994, 108). This concept can easily be exemplified by the contemporary perception of eel. This species was not particularly regarded when small or consumed in small quantities, but it would acquire value when in large size or when consumed in large quantities within one meal (Locker 2018b, 48). Eel was enjoyed at all levels of the society and distinguished by size and colour (e.g. grey, black, red; Woolgar 2016, 117). Eel appeared on menus of medieval banquets either in large quantities (possibly for the lower tables) or as ‘grete’ eel, large female silver eels, used as centre piece for the more important tables (*ibid.*). Furthermore, fresh eel was often used as a fish gift among wealthy people, and, once again, in the form of a large eel, or in large quantity, and as currency for paying rent (Nicholson 2018). At the same time, following the bishop of Coventry and Lichfield account (Section 2.2 but for convenience copied again below; Dyer 1994, 106), eel by the mid-15th c. was clearly among the cheapest fish.

Freshwater fish	
Pike	12d.
Pickerel	8d.
Bream	5d.
Tench	6d.
Perch	2d.
Chubb	4 1/2d.
Eel	1 1/2d.

Looking at the account it is clear how a large pike had an higher price than a small one; ‘pickerel’ was a term used to define juvenile small pikes that were still edible (the smallest pikes tend to be too bony and have too little flesh to be considered worth eating), while fish over 50-60 cm of total length and 3 lbs (around 1.36 Kg) would be regarded to be proper ‘pike’ (Locker 1997, 7). The largest specimens of all would be known as ‘luce’, and their price was exponentially higher (Bond 2016b, 160). Compared to other species, pickerel was still expensive and therefore to be considered good eating, but it was much more affordable that a larger pike.

Among Cyprinidae, tench appear to be the most expensive fish; however, we have seen how documentary sources suggest that bream was the most valued Cyprinidae, and, together with pike, the favourite fish to be kept in ponds (Locker 2018b). Possibly, the price for tench indicated in the account is referred to a much larger individual than bream, or, as often happen in medieval documents, nomenclature of the species is not exact. Identification of species from medieval records can be complicated by the interchangeability of fish names in local dialects or the different terms referred to different stages of life of the fish.

2.4.1 The medieval taste for fish

Medieval recipes and cookbooks tell us which fish was served and how the fish was cooked for wealthy tables. It appears that the upper class was particularly fond of sturgeon, salmon, pike, bream and lampreys.

The Calendar of Liberate Rolls testify that for the feast of St. Edward’s Day (13 October 1257), Henry III served 250 bream, 300 pikes and 15,000 eels (possibly this last for the lower tables; Dyer 1994, 110; Locker 2018b, 47). In 1403, the wedding banquet for Henry IV of England and Joan of Navarre, hold in London, included (Klemettilä 2012, 81):

> ‘*First Course*:
> Salted fish, strongly seasoned river lamprey, pike, bream and baked salmon.
> *Second Course*:
> Harbour porpoise, fish in aspic, bream, salmon, sea eel, sculpin, plaice and river lamprey pies.
> *Third course*:
> Tench, trout, fried flounder, perch, baked river lamprey, loach, sturgeon and crabs.’

An example of a typical meal of fast days is provided by the household of Henry Percy, Earl of Northumberland (1341-1408). The host couple had oven-baked herring or sprat dishes for breakfast, close relatives had sprat and salted fish, while the lowest-ranking members of the household only had salted fish (Klemettilä 2012, 83).

We have already seen how, with the ‘fish event horizon’ (Barrett *et al.* 2004a), marine fish became more common, to the point that preserved herring and cod were considered a staple food. Marine fish started to be transported inland, sold in bulk and stored. In order to prevent spoiling and to allow stocks to last throughout the year, the fish was preserved in a variety of ways. It could be dried, salted, pickled, smoked; smoking did not guarantee long-lasting preservation and was a method introduced later in the centuries (e.g. the practice of smoking herring did not start before the late 13th c.; Locker 2000). There are only a few mentions of salted fish in medieval cookbooks, as this was reserved for the poorest tables or for humble meals, such as during fast days. Another type of references give us an inside of the somewhat negative perception of preserved fish (Woolgar 2016, 114-115); for instance a poem of the monk Lydgate (c.1370- c.1451) quotes: ‘All is not gold that shines out, a stockfish bone in darkness gives off light’ (MacCracken (ed.) 1934, in Woolgar 2016, 115), probably referring to the phosphorous content of the bone and clearly discrediting the value of preserved fish. Stockfish, featherbeds and women were also appearing in a number of riddles and puzzles as things that might be beaten. Soaking and successively beating with hammers preserved fish was part of its preparation (*ibid.*).

Conversely, freshwater fish was traditionally consumed fresh, locally sourced and cooked in a number of different ways. The fish was served whole or chopped into pieces when cooked in soups, pies and pastries; the internal organs and the fish roes were also consumed. Fresh fish could be poached in wine, vinegar or beer, fried in a cast iron or copper, pan-grilled on a grid, as well as baked inside a pie or pastry with a wide variety of herbs and spices sprinkled on the top or rolled into the dish (Klemettilä 2012, 81). In 1483, during Richard III coronation feast the menu included ‘gret carp and breme in foile’, possibly in a thin pastry. A typical recipe for cooking pike was called ‘glazed pilgrim’; it consisted of a pike cooked in three ways as the head was boiled, the middle body fried and the end and tail roasted (Hammond 1993, 136; Locker 2018b, 48). Lots of exotic spices were used to flavour the fish; these included ginger, cloves, nutmeg, cinnamon, and saffron, which was the most expensive of all. The spices were so expensive that there were specific locked spice ‘offices’ (spicery), where other precious ingredient were also kept (e.g. special wines, dried fruit; Klemettilä 2012, 92). The use of spices would have been another way to increase social distance at the table; poor people dishes would have been dressed with garlic and onion mixtures, or aromatic herbs, such as parsley, which were undoubtedly more affordable. Another practice favoured by the elite was the use of a variety of sauces to accompany the fish; sauces were so highly regarded that, within high status households, there were designated members of the staff (carvers) whose job was to select and combine appropriate sauces with the dish; furthermore, there was a separate area of the kitchen intended for sauce making (saucery) (*ibid.*). A typical example of medieval sauce served with fish was the ‘galentyne’, made with bread soaked in vinegar, seasoned with cinnamon, ginger and ginger root; when served with eel and pike it was flavoured with garlic (Klemettilä 2012, 90). The 14th c. manuscripts collated as ‘Curye on Inglysh’ (Hieatt & Butler 1985; in Locker 2018b, 47) refer to sturgeon, lampreys, eels, bream, roach, tench and pike cooked and served in ‘bruet’ (broth) and ‘galentyne’ and with other sauces made with bread, ale and wine. Mustard was another usual sauce used to accompany fish, as the typical taste of the medieval English person, among all social classes, was the combination of sweet and savoury flavours. For this reason, sauces were used also by the lower class, but they were made by mixing cheaper ingredients (Klemettilä 2012).

Woolgar (2016, 113-114) observes that within elite households fish was not only upscaled with spiced flavours, but great importance was given also to the look of a dish, in particular to the colours. So there were dishes such as ‘chisanne’ where chopped roach, tench, plaice (and in later period carp) where fried in oil with raisins and red wine; ‘gin-gaudre’, a stew made with fish heads and entrails spiced with green powders; or ‘eels in sore’, a dish characterised by a red sauce, cooked with wine, minced onions, ginger, cinnamon and coloured with red sanders.

2.4.2 The diet of the invisible people

Information about the value and way of eating freshwater fishes can be tracked down in details from written sources, such as household accounts from aristocratic houses and monasteries; this evidence is typically scanty or completely missing for the lowest classes, which tend to be historically and archaeologically ‘invisible’. The diet of the lower classes was mostly based on vegetables, pulses, grains and some dairy products, but in particular cereals, especially the poorer grains (rye, barley, oats) in form of bread and pottage (Woolgar 2016). Meat or fish were not eaten regularly. There were rare occasions and festivities in which meat and fish would be consumed, in some case as leftovers from the tables of the gentry, gifted both outside and inside the household (in areas specifically constructed for the poor) as a sign of Christian virtue. Peasant food represented a simple diet but inherited with moral virtue, in a world where excess and luxurious foods were condemned as a religious sin (*ibid.*). Everyday eating was determined by seasonal harvest and the religious requirements for every specific period. Also, within lower social levels dietary rules were enforced by the Church; thus, meat was forbidden during religious festivities and fast days. This would have not greatly changed the typical meal of a modest villager, which did not contemplate meat for most of the year (Klemettilä 2012).

The quantity of meat consumed in the countryside slightly increased after the mid-14th c., with the amelioration of the diet and in general of the economy after the Black Death (Woolgar 2016). Before the privatisation of the freshwater sources, local freshwater and estuarine sources would have provided fish (e.g. Cyprinidae) also for lower classes (Reynolds 2015). With restricted access to water sources and the decrease of the availability of freshwater fish, the cheapest option for town people or lower classes was to buy whatever available fish was unregulated or cheap. As discussed, the cheaper choice would be represented by preserved herring and cod, and sometimes small eel. Poaching would have been the cheapest possible option, but it was severely punished by law (Dyer 1994).

2.5 Fish and religion

Around AD 530, St. Benedict outlined a set of conventions, detailing moral frameworks about diet and lifestyle of the monks. The Rule of St. Benedict was followed by the main coenobitic orders, such as Benedictines, Cluniacs and Cistercians. The Cistercians and Cluniac were formed in England at least by the 11th c. (Patrick 2016, 29), while the Benedictines were already long established, the first Benedictine monastery being founded in Canterbury in 597. Canonical orders such as the Augustinians, followed different conventions, but were still largely based on the Rule. The Augustinian order only reached England in the early 12th c. (Hicks and Hicks 2001). The guidelines of the Rule of St. Benedict were centred around the idea of a life conducted humbly and in relative poverty. In relation to diet, the Rule stated that monks should not drink alcohol and they should not be heavy eaters; gluttony was considered immoral (Patrick 2016). Monks could eat a daily meal on a time varying with the season and consisting in two cooked dishes (*pulmentaria*): mainly cereals and vegetables, diversified at times with small quantities of eggs, cheese but also fish (Harvey 2006, 215). A third dish was represented by fresh fruit and seasonal vegetables (*ibid.*). The consumption of 'quadrupeds' meat' was forbidden, except for the sick, old men and children (Patrick 2016). A strict observance of the Rule in England was not universal before the 12th c. (Bond 2016a) but even after then it was open to interpretations and at times very relaxed; abbots were allowed to make changes or give certain concessions about quantity and quality of food and drinks (Patrick 2016, 31). Historians note that monks found progressively more astute ways of interpreting the rule, so that they could eat 'irregular food' without breaking it (Harvey 1997). A typical example of this is the appearance of rooms called 'misericords' near refectories in 1336, authorised by Pope Benedict XII; while the consumption of meat was generally forbidden in the refectory, in the ‘misericord’ monks could eat, on a rota basis, food not prescribed in the Rule (Harvey 2006). So, the observance of customary fish-days was limited to the six weeks of Lents, on the vigils of important religious festivities such as Christmas Eve, but also every Fridays and Saturdays (Dyer 1994). Another typical way of adding extra food in the diet was through ‘pittances’; these were special dishes introduced at the start of the 13th c. to be consumed on festive days of Saints, anniversaries and other special occasions, for instance connected with the founders (Harvey 1997, 616; Patrick 2016, 32). Pittances were also an opportunity for lay patrons to publicly display their wealth and pity (*ibid.*). The result of this process is that by the 13th c. monastic diet was comparable to upper-class diet, both in terms of quality and quantity of food consumed (Harvey 1993, 34; Woolgar 2016). While on an average 12th -13th c. aristocratic household meals were made of four/five courses, meals on feast days at the wealthiest Benedictine monasteries were characterised by 13-16 courses (Bynum 1987, 41). This rich nature of monastic diet was not only resulting from the numerous gifts of food from the elite, but also from the own wealth of religious establishments; often monasteries possessed extensive amounts of land, including hunting parks, fishponds and livestock, which were providing a constant flow of income. However, not all orders were equally tolerant of this loose lifestyle and relaxed application of the Rule. The Cistercians, for instance, encouraged a return to the strictest interpretations of the Rule; conversely, the Benedictines, especially after the 8th c., were one of the most liberal orders. In England it seems that the distance from the Mother churches, which were all based on the Continent (i.e. France and Italy), played a role in the greater relaxation of the dietary rules (Patrick 2016, 31). An early, and partially unsuccessful, redirection of this lavish lifestyle was attempted through the English Benedictine Reform of the 10th c., which was mostly focussed on restoring the original monastic tradition and creating a better-defined separation between secular clergy and monasticism.

The variety of food consumed within religious establishments is reported in monastery records, including kitchen accounts on food purchases and charters on secular elite food endowments. There was some variation in the diet of different orders. The Augustinians had more freedom, both in lifestyle and diet; they ate more meat than the Cistercians, having a diet more similar to that of high status secular tables (Woolgar 2006, 195). The quality and quantity of food consumed in monasteries would of course depend on the prosperity and status of a particular establishment. Regardless on religious prohibitions, meat was expensive and could not be afforded by all monasteries. However, documentary sources report a large variety of different types of food, including red meat, poultry, eggs, milk, cheese, fruits spices, conserves and confections, and of course a variety of fish, in particular marine species (Bond 2016a, 31).

In a religious context, fish was associated with repentance, protecting humans from excess (Klemettilä 2012, 77) and, as mentioned above, it was used as substitute for meat during fast days. It may seem strange to modern readers, but what was defined as 'fish' in medieval times was far from been biologically accurate. Monastic accounts under the entry 'fish purchase' included: whale, dolphin, porpoise, beaver, seal, goose (..), and, in some cases, even poultry and rabbit (Bynum 1987, 41; Patrick 2016, 32-33).

Chapter 3. Zooarchaeological overview

This chapter briefly summarises relevant zooarchaeological research on fish assemblages from medieval England, partially mentioned in the previous chapter and further explored here. This chapter was not written with the intention of creating an exhaustive review of all ichthyoarchaeological work for the period of interest, but rather to produce a comparative framework for the discussion (Chapter 6). This short review will not focus solely on freshwater species as, in order to have an understanding of the role of freshwater fish in medieval England, we also need an understanding of the role of marine fish.

3.1 General trends in fish frequency and occurrence

A good starting point to explore medieval fish consumption is the work of Serjeantson and Woolgar (2006); the authors combined archaeological and documentary evidence related to fish consumption in medieval England and eventually highlighted the complementarity of the two sources. As part of that review, they compared around 120 assemblages, most of them from sieved samples, collected from 50 sites, represented by settlements of different typology (castles, towns, religious establishments and fishing villages).

The results show a major change in fish exploitation from the late 10th c. It is possible to record a transition from a narrow range of species from local sources (particularly Cyprinidae and eel), which were predominant from the 7th-10th c. deposits, to a prevalence of marine fish (particularly herring and/or Gadiformes; Fig. 3.1), which became well established in the 11th c. and 12th c. (*ibid.*; Barrett *et al.* 2004a).

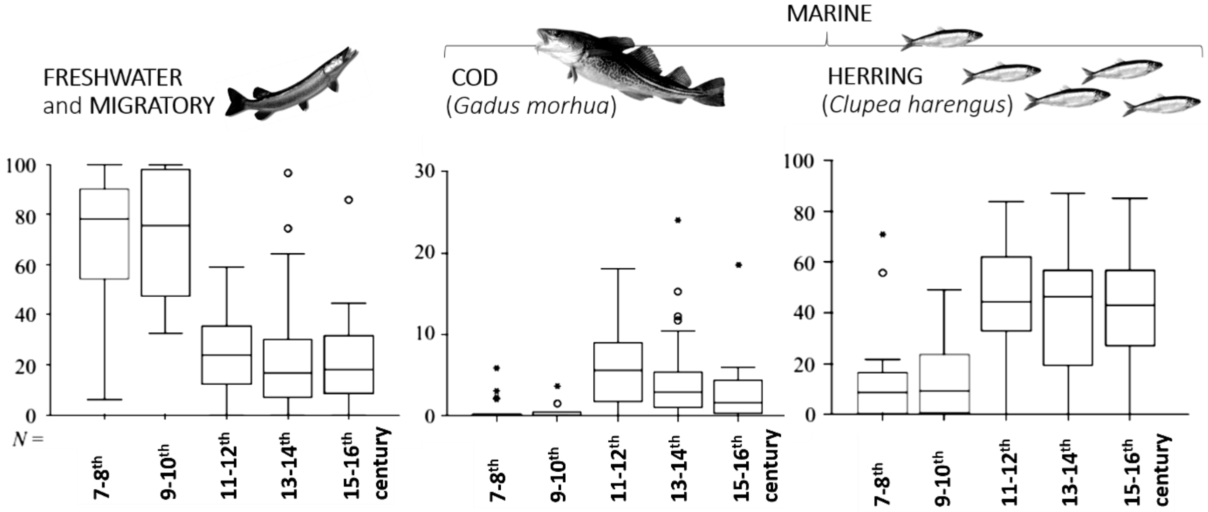

Fig. 3.1: Boxplots showing the percentages (NISP) of freshwater and migratory species, and marine species (cod and herring) from English fish bone assemblages from AD 600 to 1600. Freshwater and migratory percentages are based on the presence of Cyprinidae, pike, perch, eel, smelt, Salmonidae and Pleuronectiformes, including flounder (modified from Barrett *et al.* 2004a).

In central England, from mid-Saxon period towards the 12th-13th c. an increase of marine fish, from 50% to about 80% of the total fish identified, has been reported (Albarella 2019; Fig. 3.2). This pattern appears slightly delayed in inland areas compared to coastal sites as the consumption of freshwater fish, as expected, is higher at inland sites (*ibid.*).

Cod was mostly unexploited until the 11th. However, around the 1000 AD, the trade in preserved cod took off and the fish is found in archaeological sites of this period in higher percentages, before declining again in favour of other species, such as haddock, ling, saithe and hake (Serjeantson & Woolgar 2006; Barrett *et al.* 2004a). In the early medieval period, cod is the most frequent species in the towns of eastern England (York, Norwich, London),

A regional variation in the distribution of marine species has been identified, following also the natural geographical distribution of the species: in the south-west (Ilchester, Exeter, Launceston Castle, Taunton and Bristol) hake was more abundant than cod and in the south (Exeter, Portchester Castle, suburbs of Winchester) conger also appeared among the larger marine fish. Ling started to occur relatively late, from the 14th c. onwards, and that is also the case for haddock, which is found mostly in deposits dated from the 13th to the early 16th c. (Serjeantson & Woolgar 2006). A number of assemblages, dated 13th-16th c., were dominated by Gadiformes (Barrett *et al.* 2004a), but this pattern was not apparent in central England (Albarella 2019).

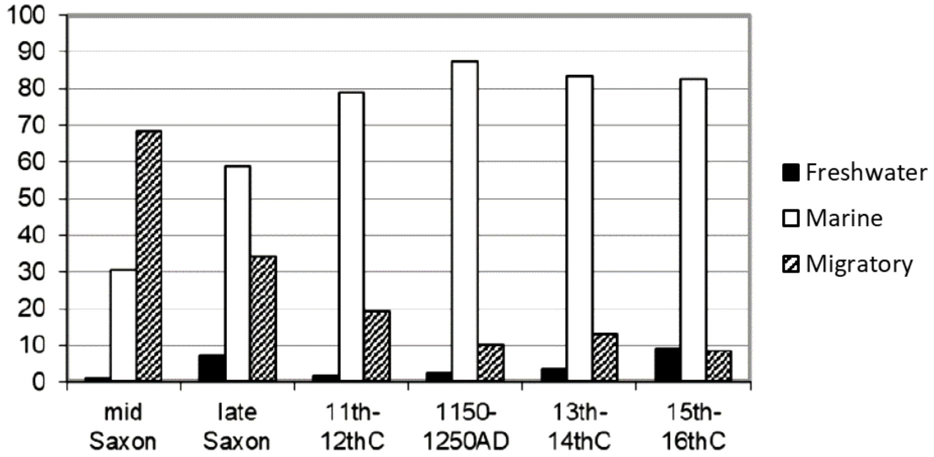

Fig. 3.2: NISP percentages for freshwater, marine and migratory taxa from Saxon and medieval sites across central England (modified from Albarella 2019).

Herring was firstly found in early medieval deposits from 8th-10th c. (e.g. York, London), probably caught locally; in the 10th c. a large-scale fishery of this species appeared and by the 11th c. herring was by far the most common species found at inland sites and sites within close reach of the coast and remained the most common fish in many sites also up to the 15th-16th c. It is important to consider that, in terms of proportion of flesh provided, cod and other large marine fish were as, if not more, important than herring, especially in towns and other secular households (Serjeantson & Woolgar 2006).

Whiting is a small Gadiformes also often recovered, especially from London sites, where it was one of the four most common species pre-10th c. and is in some instances even more frequent than herring in the 13th-14th c. (Serjeantson & Woolgar 2006). In central England it shows a clear increase in abundance after the 12th c. (Albarella 2019).

Pleuronectiformes (mostly plaice and flounder) were also often present from an early date. Collectively, these fish outnumbered herring in 13th-14th c. deposits from the wealthier suburb of Winchester and in two London ecclesiastical sites (St. Mary Spital and St. John's Priory) (Serjeantson & Woolgar 2006).

Eel is on average the dominant species pre-Conquest, before being replaced by herring in the 11th c. Biometrical data show that two different sizes of eel were typically consumed, approximately around 30-40 cm and over 50 cm. This latter size probably represented large females consumed as luxury food (*ibid.*). Within central England, a comparison of eel versus herring shows the latter to be predominant since late Saxon times, with some minor fluctuations of its presence between early and late medieval times. Similarly, in the south of England (Holmes 2017), it appears that, from the late Saxon to early medieval period, the presence of eel kept declining with the increase in use of marine fish. From the 12th c. a greater proportion of eel was recorded from high-status sites from southern England, while in ecclesiastical sites marine fish (particularly herring and cod) was more frequent. Within the same area, large eels are recorded in ecclesiastical sites from the 14th to the 16th c. (*ibid.*); documentary evidence indicates that some of the largest specimens were imported from France (Serjeantson & Woolgar 2006, 123). From the 14th c. the consumption of migratory fish (mostly eel) increases in urban sites, where the mean proportion is 21% on the total fish, compared to 13% during 12th -14th c. and 11% during 11th -12th c.

From the context outlined above, it is clear that from the 11th c. onwards the incidence of freshwater fish decreased substantially. In her review on medieval freshwater fish exploitation, Locker (2018b, 54, 127) also emphasized this scarcity of freshwater fish remains, which in most of the cases (independently from the site status or location) represented a small minority of remains, with marine fish being more commonly eaten. Based on this evidence, Locker suggested that the lower class was typically consuming cheap fish, such as herring; this type of fish was being consumed in large quantities also by the elite, together with cod and other marine taxa. Freshwater fish was consumed on a much reduced scale and mostly as luxury food (thus rare by definition) (*ibid.*). At the same time, Locker observed how the location of sites was a key variable affecting freshwater fish consumption; she (*ibid*., 49) proposed it to be even more relevant than status and chronology. Sites near the coast tend to have fewer obligate freshwater species, compared to the hinterland. Assemblages from Lincolnshire, eastern England and London had a relatively high proportion of pike, Cyprinidae and eel, sourced from fisheries from the Fens and the Thames. Conversely, the area around Canterbury, despite its vicinity to the Stour river, produced assemblages with relatively fewer obligate freshwater fish, but a clear predominance of eel and Pleuronectiformes, together with marine fish.

Focussing on taxa that are particularly relevant to this research, pike was one of the most frequent species from pre-11th c. deposits. After this date, it appears more rarely in archaeological assemblages, both as small ‘pickerels’ and larger-sized fish, the latter representing a luxury dish (Serjeantson & Woolgar 2006; Chapter 2). In Serjeantson and Woolgar’s (2006) review, pike was among the most common species from deposits dated to the 11th-14th c. in two high status sites, Eynsham Abbey (also studied for this research) and Launceston Castle (see next section), as well as in a 13th-14th c. deposit in the urban site of Stert Street (again part of this research). Pike, therefore, seems to be present in different site types, and a critical review of its frequency and size might highlight a connection between this species and high-status sites, as suggested by documentary sources (e.g. Dyer 1994).

Cyprinidae were recovered from deposits from early periods, particularly from 'wics' (medieval trading centres) from 8th to 9th c. contexts, hence well before the spread of the fishponds after the Norman Conquest (1066). Despite this upsurge in fishpond construction, Cyprinidae remained only moderately common until the 13th c. and again have been recovered from different site types (Serjeantson & Woolgar 2006). Locker (2018b) noticed how the presence of ponds does not always result in a higher consumption of freshwater fish. For instance, at Winchester, Hampshire, documentary sources mention the regular purchase of marine fish from Southampton, despite the presence of many large ponds owned by the bishop of the city (Bunyard 1941; Stevens & Olding 1985 in Locker 2018b, 49). This phenomenon raises an interesting question related to the frequency of typical pond species (Cyprinidae, perch, pike) and the actual archaeological or documentary evidence of fishponds at a site. Does the presence of fishponds effect the composition of a fish assemblage? If this is not the case, why is the role of fishponds so marginal?

A comparative analysis of fish frequencies by type of site can be found again in Serjeantson and Woolgar's (2006) work. It appears that the archaeological evidence for fish consumption at inland rural low-status settlements is scanty, while from costal settlements more fish bone was recovered, mostly belonging to costal species. The authors ruled out recovery and preservation biases for this fish scarcity at inland sites, as equally small and fragile bones of amphibians and rodents are regularly recovered from such rural settlements. Additionally, lack of sieving can explain the lack of small fish bones but not those of the larger species. It therefore seems genuine that large marine species were probably rarely eaten at rural inland sites as confirmed also by stable isotopic analysis undertaken on human bones (Müldner & Richards 2006).

Whereas in rural communities the selection of species would have been mostly dictated by local availability, within towns the existence of urban markets would have increased the accessibility to species from more remote areas and from a greater diversity of habitats (O'Connor 1989, 19). Consequently, limitations to what could be bought were largely determined by the economic means of buyers (*ibid.*), as well as by the legal accessibility to specific species (e.g. sturgeon was reserved by law to the crown during certain periods; Moore & Moore 1903). Following the trend of the period, also in towns herring and eel were regularly consumed from the 9th c. and, by the 11th-12th c., large marine fish started to appear in bulk (Barrett *et al.* 2004a). Archetypical of this situation could be the case of York, where the focus moved from the river-based fishing of small Cyprinidae and eel of the 7th to 10th c., to the exploitation of herring from the mid-10th c., and to an organised trade of North Sea fish in the

11th -12th c., especially involving cod and later haddock and ling (O'Connor 1989; Harland *et al.* 2016; see also next section).

Again from Serjeantson and Woolgar's (2006) work, high status site (castles, palaces, manors and some religious houses) assemblages present a range of 20-25 species and, within these, herring and Gadiformes tend to be the most common taxa from the 11th to the 15th c. Within higher status sites, the accessibility to specific species was potentially limitless, as lords could satisfy their food desires by purchasing almost anything they wanted, as well as by exploiting their lands and water resources. A later but still relevant example of this wide accessibility to fish species is the 15th-16th c. assemblage from the rural high status manor of Little Pickle (Bletchingly, Surrey), possibly connected with Anne of Cleves, queen consort of Henry VIII (Bullock 1994, 270). Fish remains were sieved through a 6 mm mesh, hence small species such as herring and eel are inevitably underrepresented. Despite this bias, a very large variety of freshwater taxa were recovered, such as pike, carp, freshwater bream, and tench, together with the highly priced sturgeon. Alongside these highly regarded fish species, also ling and other large Gadiformes were identified; the distribution of anatomical elements indicated that these were probably purchased as preserved fish, ensuring the availability of fish in the longer term (Locker 2018b, 25). The very high status diet of the inhabitants of the manor was also evident from bird remains, which similarly showed the consumption of a wide range of species obtained from different sources, as both wild (anatids) and domestic (large chicken) (Grau-Sologestoa *et al.* 2018). At some high-status sites, personal tastes may have impacted on the nature of the fish assemblage; this is the case, for example, of Carisbrooke Castle (Isle of Wight), Middleton Stoney (Oxfordshire) and Faccombe Netherton (a manor belonging to the Bishop of Winchester, Hampshire), where fish was rare and unpopular compared to birds (Serjeantson & Woolgar 2006).

Generally, it is difficult to demonstrate from an archaeological point of view whether the consumption of fish was more frequent in religious establishments (as suggested by religious diet requirements) than in secular households; however, isotope studies for the period, shows how monks tent to have high nitrogen isotopes in their bones meaning that they were consuming large quantities of fish (Müldner & Richards 2006, 236). In a multidisciplinary study of monks in medieval England, Patrick (2016, 38-39) produced a list of fish taxa archaeologically identified from 19 British medieval monastic establishments. Specific chronology or recovery methods of the assemblages are not specified, but this work provides a good overview of species occurrence. The most common species is cod, present in nearly all sites (17 sites), followed by plaice/flounder and conger (13 sites), and eel, herring and whiting

(12 sites). Other marine taxa are rarer, but, among the freshwater fish, Cyprinidae are the most common taxon, appearing at 11 sites, followed by pike. Other freshwater taxa, such as perch, burbot, grayling, trout (*Salmo trutta*?) and stickleback are present but rare. Among migratory species Salmonidae and sturgeon (*Acipenser* sp.) were recovered from eight sites. Despite marine fish clearly appearing more frequently and with a larger variety of species, the common presence of freshwater species is noticeable within ecclesiastic sites, particularly Cyprinidae, but also of highly regarded species, such as sturgeon, pike and Salmonidae.

A good example of a fish bones assemblage from an ecclesiastic site is the one collected from the dorter undercroft of Westminster Abbey (Locker 1995). Fish remains were mostly recovered from a mid-11th century ditch (238), being both hand-collected and sieved (down to 1 mm of mesh size). A large variety of taxa were recovered, sourced from different habitats; among these sturgeon, Salmonidae, pike and a variety of Cyprinidae (tench, freshwater bream, barbel, dace, chub, roach) were identified, the smallest specimens of the latter group possibly representing the stomach content of a larger predator. These taxa, together with the presence of other highly regarded species, such as turbot and brill, suggest a high status diet, both in terms of variety of species and quality. The Abbey owned fishing rights on the river Colne during the 15th c., and Locker suggested this may have been also the case for earlier periods. Other migratory (e.g. eel) and marine taxa (e.g. herring, whiting, cod) were present, but the assemblage seems to be represented mostly by taxa from coastal or estuarine areas and freshwater habitats (*ibid.*). In terms of frequency of species, the larger sample collected from ditch (238) is dominated by herring (31%), followed by smelt (17%), plaice/flounder (15%), Cyprinidae (8%), whiting (8%), Rajidae (7%), eel (6%) and pike (2%). A comparison with later fish assemblages (from the 12th-13th c. and 16th c.), recovered from the area of the sub-vault of the 'misericord' (Jones 1976), reveals the presence of a similar range of taxa but with a major focus on offshore catch with species such as cod and haddock (Locker 1995), reflecting the trend noticed in other assemblages (Barrett *et al*. 2004a).

3.2 Individual sites

This section is dedicated to a brief discussion of specific sites, which are used to give a general overview of the composition of fish assemblages illustrative of the period examined (11th - 15th c.). The assemblages are roughly grouped by typology (i.e. castles, religious, urban, rural), but this categorization was not always possible and, where appropriate, geographical vicinity of sites has been preferred.

An informative fish assemblage was recovered from Norwich Castle (Locker 2009) and associated with the developing city of Norwich. The Castle, with Norman foundation, was the administrative centre for the wealthy area of Norwich; deposits from the site were dated from Saxon to post-medieval times. Fish bones derive from hand-collected and sieved contexts dated from the 11th to the 16th c. (NISP: c. 5,000) and mostly representing contexts associated with the urban environment. The assemblage clearly showed a reliance on marine fish, in particular herring and cod, with the presence of eel increasing in later periods but not substantially. Freshwater species are scarce, with pike, perch and Cyprinidae representing 3% (mostly pike) of the total assemblage for the 11th-12th c., 0.2% (only Cyprinidae) for the late 12th-mid-14th c. and 3% (mostly Cyprinidae) for the mid-14th -mid-16th c. (Locker 2018b, 51-52). Within Cyprinidae, Locker identified tench, chub-dace and roach, all probably caught in local rivers.

Other sites from Norwich gave similar results; an example is represented by the fish assemblage from St. Martin-at-Palace Plain (site Magistrates Court; Locker 1987). In sieved remains (NISP: c. 3,650) from late 10th c. to the mid-15th c. deposits, herring was the predominant species, followed by Gadiformes (mostly cod) and eel (with some fluctuations in frequency). The contribution of freshwater fish is again low; excluding the migratory taxa such as eel and Salmonidae, only seven bones of Cyprinidae (including roach and dace) were recovered from the earlier deposits and, because of their small size, they were interpreted as a possible bycatch.

Locker (2018b, 52) argued that the vicinity of Norwich to the river Yare, at the time entirely navigable until the port of Great Yarmouth (one of the most famous herring fishery in medieval England), would have facilitated the supply of marine fish. Consequently, this easy accessibility to marine resources would be reflected in fish assemblages recovered from the area. This trend is also confirmed by fish remains recovered from the site of Dragon Hall, studied by Nicholson (2005), situated in the St. Julian Parish in Norwich. The assemblage was represented by sieved and hand-collected remains (NISP: 3,466) recovered from a number of proprieties dated from the 10th to the early 15th c., including the 15th c. merchant’s hall. Eel is the predominant species in the late 10th - late 11th c., while from the late 11th c. herring became the most common species, with Gadiformes (in particular cod) having equal importance in terms of meat proportions. These results reflect the importance of the East Anglian fisheries, in particular the local herring fishery of the Great Yarmouth, flourishing at least since the 7th c. From the earlier period (late 10th - late 11th c.) smelt and Cyprinidae are also frequent, but these latter were interpreted by Nicholson as waste because of their small size and the lack of taphonomic evidence which would suggest consumption. In all periods Salmonidae and perch are rare, flounder (tentatively identified) is slightly better represented, and pike is missing. Fish consumption at the site of Dragon Hall was centred around the exploitation of marine resources (i.e. herring and cod), but there was also a significant contribution of costal and estuarine/riverine fisheries.

On the opposite coast, in Cornwall, the site of Launceston Castle, of Norman foundation, also produced a relevant fish assemblage (Smith 1995). The archaeological evidence shows that from the mid-13th c. until the 15th c. the castle was occupied intermittently as a high status residence; starting from the 14th c., however, the castle saw the declining status of the residential constable and a more sporadic occupation; in the 15th-16th c. the residential keeper of the castle was probably of low status (Albarella & Davis 1996). The faunal assemblage from the castle reflects this decreasing status of the people living at the castle from the late 13th c. onwards, and the increased use of the precincts of the castle as a town rubbish tip. The faunal remains gradually transitioned from an high-status assemblage represented by relatively high percentages of pig, deer, wild birds, to a typical urban assemblage throughout the 15th and 16th c., with the narrowing of the species spectrum (now focussed on sheep and cattle) and a decrease in frequency of bird and fish bones compared to mammal bones. Albarella & Davis (1996) described this transition as the representation of the decline of the site, whose animal bone assemblage gradually moved from the typical characteristics of a castle to those of an urban dump. Unfortunately, no clear information about recovery is available; it appears that all faunal material was collected consistently for most of the periods: mostly hand-retrieved with some sieving performed. Sieved samples were not ‘whole earth’, therefore there was not a clear idea regarding which proportion of smaller elements and small species were lost (*ibid.*). Furthermore, no mesh size was known. Most fish bones derive from the late 13th c. (NISP: 1864) and 15th c. phases (NISP: 672). No major change in fish exploitation was revealed by the study of the two periods, as in both the assemblages are dominated by hake, followed by conger, whiting and cod. A large variety of species was recovered from the Castle, mostly marine (e.g. haddock, ling, horse mackerel, Sparidae, Labridae, Rajide etc.) and including various species belonging to Pleuronectiformes (turbot, plaice, halibut). Taxonomic variety decreases in the later period, matching the decrease in mammal diversity, which is a consequence of the decline of the status of the castle. It is interesting to notice the low percentage of herring bones, represented only by a few vertebrae from the later 13th c.; this scarcity could partially be associated with a recovery bias but could also be representative of a fishery mostly relying on hake, in contrast with those from the east coast, mostly based on herring. The castle had a good connection with the coast (around 14 miles away) as testified by the high percentage of other marine fish, but also the presence of cetaceans and marine birds, such as gannets and shearwaters (*ibid*.). The presence of freshwater and migratory species is scanty; only nine fragments belonging to eel and Salmonidae were retrieved from the late 13th c. sample and two fragments of sturgeon were recovered from the 15th c. sample. Smith (1995) highlighted that this high emphasis on hake and other marine species (e.g. Sparidae) reflects an exploitation of the local fishing ground (mostly concentrated around the port of Exeter), rather than international trade. She also noticed that only a few species, such as the large Pleuronectiformes (e.g. halibut, turbot, large plaice), suggested the high status of the site. Nonetheless, it is worth mentioning that sturgeon and salmon would have represented special treats. Possibly the vicinity and connections of the castle with the coast was reflected in the abundance of fresh marine fish, which would have limited the need of a supply on freshwater sources (thus the scarcity of freshwater fish). Furthermore, the fact that the predominant species were hake (possibly partially preserved, as suggested by Smith) and conger, rather than the more typical herring and cod, could also reflect a specific food choice of the inhabitants of the castle, based on higher regarded/more expensive fish.

Excavations at St. Mary Spital (London), an Augustinian house running one of the most important hospitals of medieval England, revealed fish remains covering a long chronological period (Locker 1992a). The largest group (NISP: c. 1,050) is from the 13th - late 14th c. It is not clear if this religious house owned fishponds, but it is known that it relied for food on possessions outside London (Thomas *et al.* 1997). The fish bone assemblage was largely represented by herring and estuarine fish (mostly plaice/flounder): a small number of Cyprinidae was retrieved from a few contexts (with chub and roach identified) and two remains of pike were recovered from 14th c. deposits; eel was present but in low percentages.

Moving towards the north of England, Harland *et al.* (2016) produced a review of sieved fish assemblages recovered from York; consistently with the rest of England, they observed a decline in the relative frequency of freshwater and migratory species (eel, Cyprinidae and pike) in the mid-10th-mid-11th c., but also later in the 14th c., associated with the increase in the relative frequency of marine taxa, specifically herring and Gadiformes. The early shift was concomitant with a brief increase in size of eel and pike (50-80 cm of total length) followed by a steady decrease. This clear decrease of freshwater and migratory species was attributed to an increased demand of fish, following the 10th c., which would have put strain on freshwater fisheries, leading also to a decrease of the size of the catch. The following further decline of freshwater fish of the 14th c. was attributed to continuing fishing pressure and/or in the increasing monopolisation of freshwater resources by the elite. As mentioned, the decrease in size of eel and pike after the mid-11th c. was probably the result of fishing pressure and, in the specific case of pike, also of a shift from natural watercourses to fishponds (where large pike was unmanageable).

During the excavations of the sites of St. Peter’s Lane and Little Lane in Leicester, a large number of fish remains was recovered thanks to an extensive wet-sieving program (Nicholson 1988). Contexts from the two sites were mostly represented by a series of pits, quarries and wells excavated over a Roman street and over the site of what was presumed to be the medieval church of St. Peter. Fish bones were hand-collected and wet-sieved from early to late medieval contexts from both Little Lane (NISP: c. 380, scales and dermal denticles excluded) and St. Peter’s Lane (NISP: c. 510, scales and dermal denticles excluded). The sites provided a similar range of taxa; the assemblage from Little Lane was dominated by herring, followed by eel and the rest being mostly Gadiformes (including cod, haddock and ling). Salmonidae and smelt were represented by just a few fragments and, among freshwater species, only 12 bones were identified as Cyprinidae (tench and chub), pike and grayling; perch was identified through its scales. At St. Peters Lane, the assemblage was again dominated by herring, but in lower percentages, and with a greater presence of Gadiformes and eel. A total of 25 bones were attributed to Cyprinidae (with tench and possibly roach and dace identified), possible pike and perch, Salmonidae and smelt. From both sites the size of freshwater fish was relatively small, in the range of 15-30 cm of total length. Nicholson suggested that the few freshwater species present in both assemblages may represent luxury items. An increase in the frequency of Gadiformes, Pleuronectiformes and Rajidae in the later medieval period was interpreted as an indication of a better organised fishing industry, which produced an increased trade of fish from mid-deep waters from the North Sea.

Another relevant fish assemblage was recovered from Huntingdon (Locker 1996; Locker 2018b, 52), one of the most important medieval towns in Cambridgeshire. The town, located about 40 miles from the coast and the main port of Kings Lynn, had ups and down in prosperity. The assemblage is associated with the 13th -14th c. town market; about 2,000 remains from sieved deposits were identified, largely attributed to herring. Eel and freshwater species, mostly Cyprinidae, as well as a few remains of perch and pike were also found. Other estuarine species were poorly represented.

A small assemblage (NISP: 142) from the urban site of Franklyn House, in Canterbury, showed a lack of freshwater fish from the 12th to 14th c. deposits, being mostly represented by herring, whiting and Pleuronectiformes (Locker 2014); only one bone each of pike and ruffe, and two of perch were recovered from later periods. It appears that other fish bone assemblages from Canterbury, excavated by the Canterbury Archaeological Trust, have similar patterns (Locker 2018b, 52-53). Despite many sites being associated with religious establishments, home farms and hospitals with private fishponds, the presence of freshwater fish was always low. It appears that, rather than exploiting freshwater resources, these sites where relying on coastal supplies, composed mostly of herring, whiting, plaice/flounder and large Gadiformes, such as cod.

Locker and Jones (1985) reviewed ten Ipswich sites ranging in date from the mid-Saxon to the post-medieval period. Ipswich, Suffolk, is set on the river Orwell, at about 10 miles from the mouth of the river and the open coast of the North Sea. Most of the fish remains were recovered from pits, through sieving. From the late Saxon (NISP: 2,453) to the medieval period (11th to the 14th c.; NISP: 1,437) we witness a dramatic drop in the presence of eel, together with an increase in the consumption of herring and Gadiformes, especially cod. These changes in the later period have been interpreted as a swap from an exploitation of riverine/estuarine fisheries (eel) to an expansion of the herring industry (especially from Great Yarmouth) and the exploitation of more offshore and deep habitats (Gadiformes). Other species well represented for the medieval period are Rajidae and Pleuronectiformes. Other species, such as salmon and smelt, were identified as accidental catches. The only freshwater species is a perch-like fish, represented by just a few remains. It appears that in one of the ten sites analysed, Turret Lane, and in possibly two other contexts from two other sites (Foundation Street/Star Lane and Bridge Street), the importance of eel continued also during the medieval period in contrast with the increase of herring and Gadiformes at the other sites. This difference was interpreted as probably reflecting status, with the food deposits accumulated by different social classes.

During excavations at different tenements at The Brooks site, in Winchester, Hampshire, fish bones dated to the 13th-14th c. were collected (Locker 1997b). Around 1,200 remains were identified and the presence of freshwater taxa (below 1%) and eel (about 2%) was minimal. Most of the assemblage was represented by herring, whiting, cod, haddock and Pleuronectiformes. Documentary sources testify how marine fish was regularly bought and imported from the port of Southampton.

Excavations at Ivy Street and Brown Street in the centre of Salisbury, Wiltshire, revealed a number of medieval buildings aligned to the street frontage, with extensions to the rear, in one case containing also a cess pit (Rawlings 2000). A total of 654 (NISP) bulk sieved fish bones were recovered almost entirely from the cess pit, dated late medieval period (Hamilton-Dyer 2000); a few bones belonging to conger, cod and Pleuronectiformes were hand-collected

(NISP: 13). Most of the bones recovered from the pit were attributed to eel (67%), while herring is only represented by 8% of the identified specimens, and is outnumbered by Cyprinidae (12%, where dace was identified). Other fish, such as stickleback and bullhead and a very small quantity of other marine taxa (Rajidae, conger, cod, plaice) were all small. Documentary sources testify that marine fish came through the port of Southampton, some probably preserved (cod and herring), other smoked (conger) (Coy 1996). Eel remains all belonged to small eels (nothing in the range of silver eel was found). Dace, bullhead and stickleback, because of their small size, were interpreted as incidental catches but most likely eaten, as evidence of crushing connected with human digestion was observed. The combined evidence of fish and mammal bones led to the suggestion that the faunal assemblage may have originated from a low status site: wild resources were poorly represented and domestic animals were represented either by remains interpreted as possible craft waste (sheep), or low value parts of the carcass (cattle).

Back to the north of England, specifically in North Yorkshire, there is the site of Wharram Percy, one of the few rural villages that was excavated and where fish bones were recovered. Unfortunately, chronology for this site is very broad and material was mostly hand-collected, but some relevant information can still be gained from its study (Barrett 2004). The assemblage was represented by around 250 identified fish remains recovered from sites 9, 12 (peasant houses with a broad medieval chronology) and 71 (a fishpond area with deposits dated from the 13th to the 15th-16th c.). The assemblage was mostly represented by a high diversity of large marine species: herring, cod (possibly also imported preserved, e.g. stockfish), haddock, ling, hake, whiting, plaice, conger eel, halibut, ray and shark. Despite the presence of the fishpond, the only freshwater species is represented by a pike vertebra; seven eel bones were also identified. This lack of freshwater species can partially be explained with a recovery bias affecting smaller species, but the abundance of small herring bones suggests that the predominance of marine species could be genuine, following the general trend for the rest of England from the 11th c. onwards but also what suggested by documentary sources (Chapter 2), with lower proportions of freshwater fish from lower status sites.

At the rural medieval manor and hamlet of West Cotton, Raunds Northamptonshire, fish remains were extremely rare (Albarella & Davis 1994, 2010). Among the species recovered from both hand-collected and sieved samples from 11th-15th c. contexts, a handful of bones of freshwater catch (NISP: 8) were identified as perch, Cyprinidae and eel; while the rest of the bones were represented by marine catch in the form of ling (NISP: 1) and herring (NISP: 31). Despite the proximity of the river it appears that at the medieval village fishing was a subsidiary activity and the little fish that was consumed was rather imported (herring, ling) than sourced locally.

Overall, what could be gained from this brief summary is a general scarcity of freshwater fish independently from the site type and location. Many assemblages are affected by differential preservation and recovery bias, but where there is good survival of the small and fragile herring bones it is reasonable to think that there would be at least as good reasons for the sturdier Cyprinidae bones to survive. Therefore, in most cases, the paucity of freshwater species appears to be a genuine phenomenon. The apparent low variety of Cyprinidae must, however, be interpreted cautiously because the identification of these species can be challenging.

Although fishponds may look like the most logical place where to look for information related to freshwater fish, excavations of these structures are not particularly informative for several reasons. Firstly, they were regularly cleaned and dead fish was removed, thus any recovered remains would represent the last occupants of a neglected pond, i.e. species typically able to survive in stagnant, silted waters (Chambers & Gray 1988, 126). Ponds were cyclically dried and let to be grazed by sheep and cattle so that the exposure to the sun and the manure would restore the acidity and fertility of the soil and create a prosperous habitat for insects, which later would provide food for the fish (Bond 2016b, 170). Accumulations of fish bones in ponds are rare and generally represented by isolated teeth and scales (Jones 1989). A rare example of a fish assemblage recovered from ponds is represented by the Augustinian Owston Abbey, in Leicestershire (Shackley *et al.* 1988, 306). One of the four ponds belonging to this abbey of modest status was excavated, and fish samples, representing probably the last few years prior dissolution (1536), were analysed. A total of 27 bones were recovered from bulk-sieved samples and attributed to rudd, freshwater bream, chub, roach, pike and perch.

Chapter 4. Methods

The methods adopted for this study are described below. These were established before the beginning of data collection, but then further adapted to suit the specific characteristics of the assemblages and also in order to match the evolution of the research questions. Some of the methods reflect standard practices in zooarchaeological research, while others have been tailored to this specific study.

4.1 Recording

4.1.1 Recording protocol

The assemblages were recorded on electronic sheets using the database program Microsoft Access. I am currently identifying a platform were to upload the database with the data collected to guarantee open accessibility. The recording protocol derives from that developed by Davis (1992) and Albarella and Davis (1994); the latter was specifically designed for mammal, bird, amphibian and reptile remains. However, the protocol could be adapted to the study of fish remains, as it relied on a set of methodological principles which can be applied to any faunal assemblage (Jones 2017). The protocol was integrated with the suggestions contained in Wheeler and Jones (2009) and the York recording system (Barrett 2000; Harland *et al.* 2003).

The recording protocol relies on a selection of anatomical elements, which are highly diagnostic at taxonomic level (Table 4.1). Anatomical element nomenclature follows the guidelines of Wheeler and Jones (2009) and Thieren *et al.* (2012a), for the specific case of the eel. This selection includes ‘countable’ elements, which are used in quantification analyses. Other elements, which are not part of this selection, are ‘non-countable’, and were recorded at a lower level of detail; non-countable elements are excluded from quantification analyses, but used to highlight the presence of specific taxa (which would otherwise be invisible) and, in some cases, in biometrical analyses. Typical examples of non-countable elements used to detect the presence of a species otherwise unrepresented by countable elements are pharyngeal bones of the Cyprinidae family. The morphology of pharyngeal dentition in Cyprinidae (Plate 4.1) reflects feeding habits, habitat, and body size of the animal, and therefore is highly species-specific; the observation of features such as overall bone shape, individual tooth shape, tooth row arrangement, and number of teeth for each row can very often provide indication of the species (Maitland 1972; Winfield 1991 & Nelson, 398-399; Pasco-Viel *et al.* 2010).

Plate 4.1: Examples of identified pharyngeal bones belonging to tench (left), chub (middle), roach (right) compared with reference specimen (n 0900), Sheffield ref. collection.

Interhaemal spines (*os anale*) are also non-countable elements that can be used for species identification in the case of Pleuronectidae (to distinguish flounder/plaice/dab; Wouters *et al.* 2007, 61). In sturgeons (*Acipenser* sp.), head plates and scutes are the most likely elements to be found in the archaeological record, as the rest of the skeleton is not well ossified and does not usually survive; these elements, at times, can also be diagnostic of the species (Thieren *et al.* 2012b; Thieren *et al.* 2015; Thieren & Van Neer 2016) but, in the recording protocol adopted for this study, they do not represent countable elements. The same applies to dermal denticles for thornback ray (Van Neer 2002), scales for perch (Libois *et al.* 1987) and scutes for Atlantic horse mackerel (Camphuysen & Henderson 2017, 241-243), which can all be easily identified to species level by macroscopic observation; these and other examples of non-countable elements used for species identification are highlighted with a '*' in the tables of the Number of Identified Specimens (NISP).

Whenever the remains could not be identified at least to order-level, these were classified as 'unidentified'. Fragments of fin rays, ribs, brachial arches and scales were treated separately from other unidentified non-countable fragments and their number was estimated. Accumulation or absence of these elements can contribute to the analysis of body part distribution, providing useful information on the distinction of preparation and consumption areas (e.g. Smith 2001), carcass processing practices (e.g. Barrett 1997) and on-site cleaning of the fish (e.g. Bond & O'Connor 1999).

Countable anatomical elements were selected on the basis of their taxonomic identifiability and recurrence in the skeleton of different species, as well as their robustness and, consequently, higher chance of preservation in the archaeological record (Table 4.1). The aim of this selective approach is to minimise the biases related to taphonomic processes, anatomical differences between taxa, and species identifiability. For example, the remains of different species are affected differently by taphonomic processes, depending on the composition of their bones (Wheeler & Jones 2009, 62). In bony fishes (class Osteichthyes), some species have more robust bones than others. Gadiformes, Cyprinidae, pike and perch, for instance, have mineralised, strong bones, which will endure relatively well taphonomic processes. Other species such as salmon, herring, and the Atlantic mackerel, on the other hand, tend to be under-represented in archaeological assemblages (Enghoff 1986, 68; Wheeler & Jones 2009, 62). These species have a bone composition richer in lipids, consequently their remains tend to break and decay more easily; furthermore, their oily bones tend to produce a strong smell, which is a lure to scavengers. The bone structure of salmons becomes more porous and very low in calcium during the spawning season, so their remains are even less likely to survive (Hamilton-Dyer 2007, 181). The exclusion of the most fragile elements from the recording protocol should reduce such bias against the representation of species with a compromising bone composition; however, a less pronounced but inevitable underestimation of these and similar species should still be taken into account.

The selection of countable elements focussed on those commonly found in the skeleton of most species; this approach aimed to minimise the bias related to the fact that not all species have the same type and number of bones, and/or in some cases some elements are less developed (Wheeler & Jones 2009), thus not easily identifiable. In particular, eel has a relatively high number of vertebrae (114 on average) but no ventral fin or pelvic girdle, while the skull shows a number of reductions (Tesch 2003, 1). These features are not comparable to other species and could not be integrated into the standard protocol; therefore, a different and shorter list of elements had to be created and used for the recording of eel remains. All these adjustments need to be borne in mind while comparing taxonomic frequencies.

Code element	Description
A	articular
AAV	anterior-abdominal vertebra
B	basioccipital
BAP	basipterygium
CE	ceratohyal

CL	cleithrum
CO	coracoid
CV	caudal vertebra
D	dentary
ECT	ectopterygoid
EHY	epihyal
ENT	entopterygoid
HYO	hyomandibular
INT	interopercular
LC	last caudal vertebra
MAX	maxilla
OP	opercular
OT	otolith
PA	palatine
PAR	parasphenoid
PAV	posterior-abdominal vertebra
PCV	generic pre-caudal vertebra
PCV1	1st pre-caudal vertebra
PCV2*	2nd pre-caudal vertebra
PCV3*	3rd pre-caudal vertebra
PCV4*	4th to 9-10th pre-caudal vertebrae
PCV5*	following 18-19 pre-caudal vertebrae
PCV6*	following 17 pre-caudal vertebrae
PRE	preopercular
PSC	postcleithrum
PST	posttemporal
PX	premaxilla
Q	quadrate
S	scapula
SUB	subopercular

SUP	supracleithrum
URO	urohyal
VC	vertebral body
VOM	vomer

Table 4.1: Countable anatomical elements recorded during this study. The nomenclature follows Wheeler and Jones 2009. Underlined countable anatomical elements are those found also in the eel skeleton; '*' indicates anatomical elements exclusively recorded for eel (the distinction of vertebrae in this species follows Thieren *et al.* 2012a).

For each specimen, context, recovery method, completeness, preservation of the surface, anatomical element, taxon (order/genus/species), taphonomic modifications and measurements were recorded in detail whenever possible.

4.1.2 Taxonomic identification

Identification of fish skeletal remains relied primarily on comparisons with the modern specimens of the zooarchaeological reference collection held at the University of Sheffield[2] (UK) and the Royal Belgian Institute of Natural Sciences[3], Brussels (Belgium). The support and supervision of Wim Wouters (Royal Belgian Institute of Natural Sciences) was essential for the identification of several specimens. Atlases (Cannon 1987; Lepiksaar 1994; Watt *et al.* 1997; Conroy *et al*. 2005; Radu 2005; Camphuysen & Henderson 2017), manuals (Casteel 1976; Wheeler & Jones 2009) and various digital identification guides were consulted, including Archaeological Fish Resource (2011). Published papers were also useful, particularly for specific groups of species such as Pleuronectidae (Wouters *et al.* 2007) and sturgeons (Thieren *et al.* 2015). The series of "Fiches d'Osteologie Animale pour l' Archaeologie" was also consulted.

The identification of Salmonidae was particularly challenging, due to morphological similarities as well as the lack of personal experience of the author. Therefore, the distinction of Atlantic salmon (*Salmo salar*) from the trout (*Salmo trutta trutta/Salmo trutta fario*) has been attempted only on the ceratohyal, when diagnostic features were clearly evident (Lepiksaar & Heinrich 1977; Heinrich 1987). Although many other criteria have been used in

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[2] https://www.sheffield.ac.uk/archaeology/about/research-facilities

[3] https://www.naturalsciences.be/en/science/collections/overview/539

zooarchaeology to distinguish these species (e.g. Desse & Desse 1976; Feltham & Marquiss 1989; Guillaud *et al.* 2016), they were not adopted in this study. In addition, when bones belonged to individuals visibly larger than 20-30 cm of standard length (i.e. beyond the common size range of the brown trout), they were assigned to either of the two anadromous species, i.e. Atlantic salmon (size range 60-150 cm of total length) and sea trout (size range 40-100 cm of total length) (Chapter 1).

Cyprinidae bones tend to be difficult to identify beyond the family as, with the exception of the pharyngeal bones, anatomical elements can be very similar between different species. Species-level identification of Cyprinidae remains mostly relied on pharyngeal teeth (see above) but other elements, such as basioccipital, parasphenoid, cleithrum, dentary, and maxilla have also been used (Wouters personal communication). Among the plethora of other elements, some were carefully used, as they can be diagnostic in certain species (e.g. tench, freshwater bream, gudgeon, carp) but, at the same time, not so much in others (e.g. roach, rudd, silver bream). This is the case, for example, for premaxilla, articular, opercular, hyomandibular and quadrate.

4.2 Quantification

The frequency of species, namely the relative proportions of taxa, was calculated using the number of identified specimens (NISP) and, where possible, the minimum number of individuals (MNI). The minimum number of anatomical units (MAU), obtained from the minimum number of elements (MNE), was used for the analysis of the distribution of anatomical elements. Within each assemblage, the records were organised by chronology and recovery method, and quantification analyses were performed separately on these sub-groups. In a few cases, a spatial analysis of taxonomic frequencies was performed (e.g. Windsor Castle).

4.2.1 Number of Identified Specimens (NISP)

This quantification method consists of the raw count of every countable element in the dataset, regardless of the level of completeness. This method comes with a number of limitations (Rizzetto & Albarella 2017, 764), which need to be considered during the interpretation of the data. Typically, NISP calculations tend to overestimate taxa whose skeletons are composed by a larger number of bones and by larger bones as, once they break, they tend to produce more abundant and larger (i.e. more easily recovered and identified) fragments. Furthermore, NISP counts are biased by the problem of interdependence, whereby fragments originating from the same animal are all counted (Grayson 1984; Lyman 2008). To some extent, these problems are mitigated by the recording protocol adopted in this study; however, comparisons with the results of other quantification methods, such as the MNI (see below), can contribute to assess such biases. A consistency of results between the NISP and the MNI, for example, would suggest a marginal interference of taphonomic processes on the assemblage and confirm the reliability of the results from the NISP method itself.

The frequencies of the eight most common taxa, when available in this number, was calculated only when the total NISP by phase was ≥ 100. Species were grouped by genus, family, or order when the higher classification was larger in number; when species of Gadiformes were grouped, the freshwater burbot was excluded. Eight taxa were graphically represented for each site-period, following the previous work by Barrett *et al.* (2004a, 621), which identifies eight major taxa as dominating English fish assemblages from the 7th to the 16th century: herring, Gadiformes (burbot excluded), Cyprinidae, pike, eel, Salmonidae, smelt and Pleuronectiformes (mostly flounder and plaice). Species-level identification of Cyprinidae remains, based on pharyngeal bones (non-countable elements), has been excluded from the general analysis of species frequencies, but specific NISP tables and bar charts (Cyprinidae NISP by phase ≥ 25) were produced using all identified elements (both countable and non-countable).

NIPS counts were used also for the analysis of habitat distribution, distinguishing between freshwater, marine, and migratory taxa. The habitat of each species encountered in this study is specified in Table 1.1 (Chapter 1). The same sample size threshold has been used, with habitat distribution being analysed only when total NISP by phase was ≥ 100. Remains belonging to unidentified Gadiformes have been included in the ‘marine’ group only when the attribution to the freshwater burbot could be excluded; when this was not possible, the remains were included in the category ‘other’. Unidentified Pleuronectiformes and Pleuronectidae (including the category plaice/flounder) have been excluded from habitat analyses because of the high variability of habitats occupied (both marine and freshwater) and rather included in the ‘other’ category in the habitat distribution tables. In general, ‘other’ is intended to include all those remains for which the identification to family/order level implied the potential presence of species with different ecological requirements (e.g. herring and shads for Clupeidae).

4.2.2 Minimum Number of Elements (MNE) and Minimum number of Animal Units (MAU)

The MNE is the minimum number of each anatomical element represented by the remains recorded for each taxon (Rizzetto & Albarella 2017, 763). Calculations of the MNE will vary depending on the minimum level of completeness of specimens adopted to represent the unit of analysis (Lyman 2008). For this analysis, only countable remains with at least 50% level of completeness were included, in order to limit the over-counting of fragments from the same bone. The MAU is calculated adjusting MNE counts according to the frequency of each element in the skeleton of each taxon (*ibid.*). For example, the presence of 13 eel dentary would give an MNE of 13 and a MAU of 7 for eel dentary. The MAU was used to investigate anatomical element distribution and, in particular, the frequencies of head bones versus vertebrae. Tables and graphs presenting the results of anatomical element distribution analyses were organised by specific anatomical groups (Table 4.2). **Group I** includes part of the head elements (minus II): neurocranium, jaws, gill arches, gill covers; **Group II** includes the other head elements: outer branchial skeleton; **Group III** includes the pectoral and pelvic skeleton; **Group IV** includes precaudal vertebrae; **Group V** includes caudal vertebrae; **Group VI** includes anatomically unidentified vertebrae. In the specific case of eel, when an anatomical element is not present in that species or is undeveloped/reduced, this was simply not considered (/). A specific note is required on the use of fish vertebrae in MAU calculations. This is more problematic than the use of skull elements, and results in less reliable estimations when distinctive vertebrae (i.e. first pre-caudal, first caudal, penultimate caudal; Wheeler & Jones 2009, 149-153) are not present. The reason for this is that the number of vertebrae is variable in the fish vertebral column. Clupeiformes, for instance, can have from 45 to 65 vertebrae, Gadiformes from 55 to 75, Anguilliformes from 100 to 119. Even within the same species, the number of vertebrae is not constant but is related to age (*ibid.*). As vertebrae were by far the most common anatomical element recorded in this study, it was decided to include them in the MAU quantification analyses; some expedients were put in place in order to minimise the associated biases.

Group	**Element**	
I	**A**	Articular
	B	Basioccipital
	D	Dentary

	ECT	Ectopterygoid
	ENT	Entopterygoid
	HYO	Hyomandibular
	INT	Interopercular
	MAX	Maxilla
	OP	Opercular
	OT	Otolith
	PA	Palatine
	PAR	Parasphenoid
	PRE	Preopercular
	PX	Premaxilla
	Q	Quadrate
	SUB	Subopercular
	VOM	Vomer
II	**CE**	Ceratohyal
	EHY	Epihyal
	URO	Urohyal
III	**BAP**	Basipterygium
	CL	Cleithrum
	CO	Coracoid
	PSC	Postcleithrum
	PST	Posttemporal
	S	Scapula
	SUP	Supracleithrum
IV	**PCV1 (PCV2)**	1st (2nd) pre-caudal vertebra
	AAV	Anterior-abdominal vertebra
	PAV	Posterior-abdominal vertebra
V	**CV**	Caudal vertebra
	LC	Last caudal vertebra
VI	**VC**	Vertebral body (centrum)

Table 4.2: Countable elements organised by the anatomical groups used in anatomical element distribution analysis. Underlined countable anatomical elements are those also found in the eel skeleton.

Group IV, which includes the precaudal vertebrae, was the most complicated to standardise for MAU calculations because of the high variability among different taxa. PCV1 (PCV2) refers to the first pre-caudal vertebra but it also includes the second vertebra when this is fused to the first one (in this case, the two vertebrae have been considered as one element); this is typically found in Cyprinidae and occasionally also in herring. The other precaudal vertebrae were divided into two main subgroups, 'anterior-' and 'posterior-abdominal', following the guidelines on vertebral morphotypes suggested in the literature (for Gadiformes: Cannon 1987; Wheeler & Jones 2009; for Pleuronectidae: Wouters e*t al.* 2007; for eel: Thieren *et al.* 2012a). In the specific case of eel, because of the higher number of subgroups in the pre-caudal vertebrae category (five, excluding the first vertebra), the MAU for the subgroup anterior-abdominal vertebrae was considered the highest among type 2-4 pre-caudal vertebrae, while the MAU for the subgroup posterior-abdominal vertebrae was the highest among type 5-6 pre-caudal vertebrae. In those cases (e.g. herring) when no references were found in literature on how to divide pre-caudal vertebrae into the two main subgroups, this has been achieved by looking at modern material from the Sheffield reference collection: the precaudal vertebrae of modern specimens were divided into two subgroups and counted, providing the standard number, which was then kept consistent for the species among all sites.

The numbers used for MAU calculations, corresponding to the frequency of each element in the skeleton of each taxon for the three groups of vertebrae are listed in Tables 4.3-4.4. When higher taxonomic groups (e.g. family, order) were used, a standard species was chosen as representative; typically, this was the one most commonly found in the assemblages. Despite the potential bias introduced by this strategy, the consistent use of a standard species allowed to reliably compare the results from different sites.

Taxa	**Common name**	**TL (cm)**	**SL (cm)**	**PCV1**	**AAV**	**PAV**	**CV**	**LC**	**Total**
Clupea harengus	Atlantic herring	26.5	23.5	1	20	14	22	1	58
Clupeiformes/Clupeidae*	-	26.5	23.5	1	20	14	22	1	58
Merlangius merlangus	Whiting	40	36.5	1	4	14	33	1	53
Large Gadiformes*	-	78.8	68.3	1	3	14	33	1	52
Solea solea	Common sole	26	22	1	1	11	32	1	46
Pleuronectiformes*	-	68	50	1	1	11	28	1	42
Esox lucius	Northern pike	71.5	65	1	40		20	1	62

Cyprinidae*	-	19	15	1	19	1	18	1	40
Perca fluviatilis	European perch	27.5	24	1	3	17	20	1	42

Table 4.3: Numbers used for MAU calculations based on vertebrae. '*' herring was chosen as the standard species for Clupeiformes and Clupeidae; cod was chosen as the standard species for Gadiformes; plaice was chosen as the standard species for Pleuronectiformes; roach was chosen as the standard species for Cyprinidae. TL: total length, SL: standard length.

Taxa	*Anguilla anguilla*
Common name	European eel
Total length (cm)	96
Standard length (cm)	94
PCV1	1
PCV2	1
PCV3	1
PCV4	4
PCV5	22
PCV6	16
CV	69
Total	114

Table 4.4: Numbers used for MAU calculations based on vertebrae for eel, following the morphotypes described in Thieren *et al.* (2012a).

As a general rule for all the taxa, anterior-abdominal vertebrae were those characterised by a central body and neural spine; in posterior-abdominal vertebrae, lateral processes appear on the body; caudal vertebrae are those with both neural spine and haemal spine (Wheeler & Jones 2009; Fig. 4.1). These three groups cannot be distinguished in the vertebral columns of pike and Salmonidae species (for the morphotypes of Salmonidae vertebrae see also Morales 1984, Morales *et al.* 1994), which were divided into two anatomical groups: pre-caudal and caudal vertebrae.

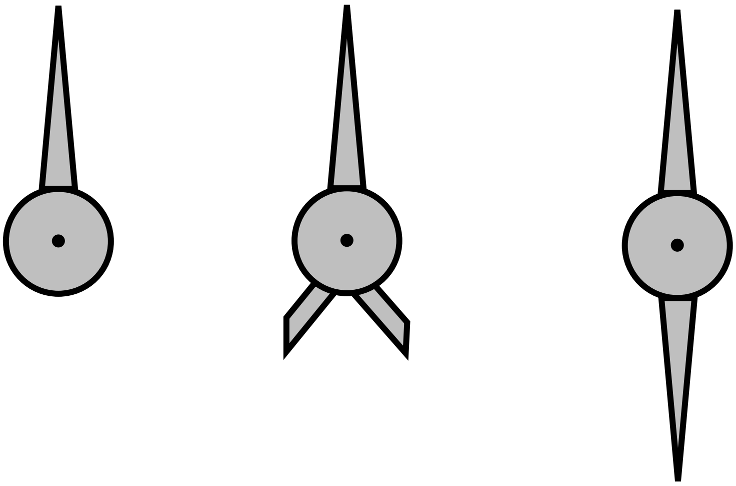


Fig. 4.1: Schematic representation of the three vertebral morphotypes; from left: anterior-abdominal, posterior-abdominal, and caudal vertebrae.

The MAU was only calculated only for taxa with NISP by phase ≥ 100. Species were grouped by genus, family, or order when the higher classification was larger in number. When species of Gadiformes were grouped, large Gadiformes (e.g. cod, ling, haddock) were analysed separately from small Gadiformes (e.g. burbot, whiting, poor cod). The MAU was calculated disregarding side, differences in age/size, and, in most of the cases, spatial distribution, in order to minimise aggregation biases (i.e. the MAU will increase when applying the same calculations to smaller clusters of contemporary contexts, or even separate contexts, compared to calculations for the whole site-period). Furthermore, in this way the MAU was quicker to calculate and it was possible to use a consistent approach across different taxa. For the analysis of anatomical element distribution, percentages are calculated out of the element with the highest MAU; for the analysis of frequencies of head bones versus vertebrae, the highest MAU from Group I and the highest MAU from Group IV-VI were selected and percentages calculated out on the highest of the two. This latter analysis aims to assess whether the fish was consumed and disposed as whole or headless. For this reason, the other anatomical groups were excluded; these could have biased the results, since the fins and/or gills were removed in some medieval butchery practices.

4.2.3 Minimum Number of Individuals (MNI)

Another quantification method used in this research is the MNI, which corresponds to the highest MAU of each taxon.

The MNI calculates the minimum number of animals represented for each taxon, on the basis of the most frequent anatomical element (Rizzetto & Albarella 2017, 764). With this method, anatomical differences among taxa are overcome, as the unit of analysis is the whole animal rather than individual elements. In addition, recovery and other taphonomic biases are mitigated, as the anatomical elements more frequently recovered (and therefore used in MNI estimations) are usually those which preserve better in the archaeological record. However, the MNI also presents some limitations: rare species are often overestimated, especially in small assemblages, as a single countable anatomical element will correspond to one individual; in addition, as mentioned for MAU, MNI estimations change with different aggregation strategies, namely the way the material from different contexts is merged or analysed separately (Grayson 1984; Lyman 2008). Furthermore, the method assumes that whole carcasses were transported to the site (Binford 1978), while there are many examples of animals, including fish, being imported in portions (e.g. beheaded as stockfish).

For the specific case of vertebrae, the calculation of MNI differed from MAU, as is based on the total number of vertebrae in the vertebral column, rather than the three different sub-groups. While MAU was used to explore anatomical element distribution within a species, MNI is used to compare proportions between different taxa, therefore a level of comparability was necessary even among species with highly differentiated vertebrae. In this way, 200 vertebrae of eel, despite the typology of vertebrae, will represent 2 individuals (MNI), while the same number of vertebrae for herring will represent 4 individuals (MNI). The calculation will not provide information about the specific portions of vertebral column present for eel and herring, but it will give the possibility of comparing the MNI frequencies between different taxa.

The first pre-caudal vertebra, which can be easily identified in most taxa, was independently used in MAU/MNI calculations. The numbers used to calculate MNI of all the other vertebrae corresponded to the number of vertebrae (minus the first pre-caudal vertebra) of modern standard specimens from the Sheffield reference collection (Table 4.5).

Taxa	**Common name**	**Divisor**
Clupea harengus	Atlantic herring	57
Clupeidae	-	57*
Anguilla anguilla	European eel	113
Merlangius merlangus	Whiting	52
Solea solea	Common sole	45

Table 4.5: Divisors used for MNI calculation based on vertebrae. Each divisor corresponds to the total number of vertebrae minus one (the first pre-caudal vertebra). '*' the herring specimen was used as the standard for Clupeidae.

When a different approach was adopted, this has been clarified in the relative site chapter (e.g. the site of St. Gregory's Priory).

4.3 Taphonomy

Taphonomic evidence, both that originating from natural degradation after discard (diagenesis) and modifications caused by human agency before discard (biostratinomy) and during recovery (e.g. Lyman 2010), were observed and recorded. This evidence can provide information on the environmental factors influencing bone survival, hence on the representativeness of the material collected, as well as on the treatment of carcasses during preparation/cooking, consumption and waste disposal. Taphonomic alteration was consistently recorded only on countable elements and analysed using raw counts (NISP).

4.3.1 Surface preservation and bone completeness

The degree of surface preservation of each fragment was recorded using the five categories described below (Table 4.6), created by Albarella and Davis (1994) and described by Rizzetto (2014).

Category	Definition of surface preservation
E (excellent)	the surface of the bone is perfectly visible and mostly intact, no signs of erosion nor surface penetration are visible
G (good)	clearly visible surface morphology, localised surface erosion with only slight surface penetration
M (medium)	part of the surface eroded and some details masked by erosion, but general bone profile maintained
B (bad)	large part of the surface eroded, hiding morphological features but general bone profile maintained
A (awful)	entire surface eroded, heavy penetrating erosions, modified morphology (identification compromised or incomplete as a consequence)

Table 4.6: Categories of surface preservation used for this research (adapted from Rizzetto 2014).

The degree of bone completeness was recorded using the stages described in Table 4.7; for stages 2 to 4, the anatomical portions present were also indicated (**P**roximal, **M**edial, **D**istal).

Stage	Completeness
1	> 75%
2 P/M/D	75-50%
3 P/M/D	50-25%
4 P/M/D	< 25%

Table 4.7: Stages of bone completeness used for this research.

4.3.2 Butchery and burning

Butchery marks were recorded as cut (Plate 4.2) or chop marks, or the combination of the two. Location and frequency of butchery marks can provide an indication of butchery practices and occasionally could support the evidence for the importation of preserved fish at the site (e.g. Barrett 1997; Enghoff 1997).

Plate 4.2: Example of cut marks on a cleithrum of pike of approximately 42.5 cm of total length (from undated contexts, Eynsham Abbey).

Evidence of burning was recorded using three stages: singed (the bone appears red-brown in colour or black in some areas), burnt (the bone appears almost entirely black-carbonised), and calcined (the bone has a white or light grey/blue colouration). Burning marks could provide information on cooking and waste disposal practices. The exposure of the bone to high temperatures results in breakages, shrinkage and bone deformation; therefore, burned and calcined bones were excluded from biometrical analyses.

4.3.3 Gnawing

Gnawing marks were extremely rare; these were recorded as present/absent and categorised as produced by carnivores or rodents. This type of evidence can add information on waste disposal practices, by suggesting the exposure of food waste at the site.

4.3.4 Crushing

Crushing, defined as mechanical damage and/or chemical bone deformation, was also recorded. In the case of smaller species, this type of bone deformation could be the result of damage from human consumption and digestion (Jones 1984; 1986; Wheeler & Jones 2009, 69-76). In larger species, the causes of this deformation could be many, although most typically it would have been produced by trampling. Crushing marks on bones from large species, however, have also been linked to human agency; indeed, various cooking techniques could leave this type of marks on bones, such as the practice of compressing the body of the fish with a weight during preparation (e.g. Davidson 2012), or that of pounding the dried carcass in order to release flavours from the flesh or to break the fibres of the stockfish before preparation (e.g. Wubs-Mrozewicz 2009). Crushed and deformed bones were excluded from biometrical analyses.

4.3.5 Recovery method

The composition of any fish assemblage is significantly affected by the recovery methods used during excavation. Hand-recovered material is biased towards larger elements and bones from larger animals; therefore, in order to reconstruct a more reliable view of fish exploitation, sieving must be carried out, as species diversity increase significantly with the use of fine meshes (Wheeler & Jones 2009, 40; Morales-Muñiz 2014;). Recovery methods have been categorised as follows:

H-C: hand-collected material
S: sieved material, with no indication of mesh size
CS: coarse-sieved material, with mesh > 2 mm
FS: fine-sieved material with mesh ≤ 2 mm
MIX: sieved material and hand-collected material mixed after collection
ND: no information about recovery methods is available

4.4 Biometry

Biometric data were analysed in order to explore variations in the size of freshwater fish among different sites and periods; this allowed to investigate patterns of fish culture and commercial fish exploitation, as well as to identify the consumption of ‘luxury’ fish or other expensive products. For this reason, measurements were only taken on a selected range of taxa: strictly freshwater fish (pike, perch, Cyprinidae) and eel. Measurements (Table 4.8) were taken according to Morales and Rosenlund (1979); for the specific case of eel, additional and alternative measurements were taken following Thieren *et al.* (2012a). Measurements were taken using electronic callipers and approximated to the tenth of millimetre. As mentioned above, bones with breakages or deformations were not measured. When broken unmeasurable bones were unusually large, the fish size was estimated by comparison with bones from modern specimens of known size and their presence was mentioned in the results but excluded from the analysis.

Element	Measure	Description
Vomer	**1**	Greatest oro-aboral length
	2	Greatest medio-lateral breadth
Parietal	**1**	Greatest oro-aboral length
	2	Greatest medio-lateral breadth
Frontal	**1**	Greatest oro-aboral length
	2	Greatest medio-lateral breadth
Basioccipital	**1**	Greatest dorso-ventral height of proatlas
	2	Greatest medio-lateral breadth of proatlas
Premaxilla	**1**	Greatest length
	2	Greatest height
	3	Chord length
Maxilla	**1**	Greatest length
	2	Greatest height
Palatine	**1**	Greatest length
	2	Greatest height
Dentary	**1**	Greatest length
	2	Greatest height
	3	Inside length
	4	Anterior height
Articular	**1**	Greatest length
	2	Greatest height
	3	Greatest medio-lateral breadth of the articular surface
Quadrate	**1**	Greatest length
	2	Greatest height
	3	Greatest medio-lateral breadth of the articular surface
Hyomandibular	**1**	Greatest length
	2	Greatest height
	6**	Greatest antero-posterior distance
Ectopterygoid	**1**	Greatest length
	2	Greatest height
	3	Chord length
Metapterygoid	**1**	Greatest length
	2	Greatest height
Entopterygoid	**1**	Greatest length
Ceratohyal	**1**	Greatest length
	2	Greatest height
Epihyal	**1**	Greatest length
	2	Greatest height
Urohyal	**1**	Greatest length
	2	Greatest height

Opercular	**1**	Greatest length
	2	Greatest height
	3	Greatest medio-lateral breadth of the articular surface
	4	Greatest dorso-ventral height of the articular surface
Subopercular	**1**	Greatest length
	2	Greatest height
	3	Chord length
Interopercular	**1**	Greatest length
	2	Greatest height
Preopercular	**1**	Greatest dorso-ventral height, measured on a three-contact points system
	2	Greatest height
Cleithrum	**1**	Chord length
	2	Height measured on a three-contact points system
	9**	Antero-posterior distance in the middle of the cleithrum
Posttemporal	**1**	Greatest length
	2	Greatest height
Supracleithrum	**1**	Greatest length
	2	Greatest height
Postcleithrum	**1**	Greatest height
Scapula	**1**	Greatest length
	2	Greatest height
Coracoid	**1**	Greatest length
	2	Greatest height
Basipterygium	**1**	Greatest length
Pharyngeal bones * Os pharyngeum inferious (Ceratobrachiale V)	**1**	Height measured on a three-contact points system
	2	Chord length
Vertebrae	**A1**	Greatest dorso-ventral height of the centrum
	A2	Greatest medio-lateral breadth of the centrum
	B2	Greatest cranio-caudal length of the centrum

Table 4.8: Set of measurements recorded on pike, perch and Cyprinidae remains during this study, following Morales and Rosenlund (1979). '*' pharyngeal bone measurements were only used in scatter plots. Underlined measurements were also recorded on eel remains; '**' indicates measurements exclusively recorded on eel remains (following Thieren *et al.* 2012a).

For the specific case of cod, seven categories were created based on the size of specimens available from the Sheffield reference collection (>3, =3, 3< and >2, =2, 2< and >1, =1, <1; Table 4.9). This approach was aimed to provide a rough estimation of cod size. Despite being a marine fish, code size is relevant to this research in terms of investigating the potential import of large preserved stockfish at the sites; this evidence, coupled with the presence of fresh freshwater fish, could be a possible indicator of status (see Chapter 2). The size of cod was not analysed in detail but, when relevant to the core research questions, it was in mentioned in the 'Results' chapter.

Reference sizes	Total length (cm)	Standard length (cm)
1	32.0	29.0
2	53.7	48.5
3	75.8	63.8

Table 4.9: The three reference sizes used for the creation of the cod size categories adopted in this study.

Furthermore, the material from the site of Eynsham Abbey was mostly recorded at the Royal Belgian Institute of Natural Science in Brussels, using the local reference collection. Many pike bones from this assemblage were too damaged to be measured, so they were visually compared to the wide selection of modern pike specimens which was part of the reference collection. A similar approach could not be adopted for the material recorded in Sheffield, due to the small number of modern specimens available. Pike sizes estimated in this way were mentioned in the Results but excluded from the analysis.

All identified and measurable bones were used in biometric analyses (including non-countable elements), apart from the exceptions mentioned below. The selection of biometrical data, therefore, entirely depended on the preservation and integrity of the analysed specimens, as well as their identifiability. Anterior-abdominal, posterior-abdominal and first and last caudal vertebrae were also included in the biometrical analyses. Caudal vertebrae were not used, because of their high size variability along the vertebral column; however, when caudal vertebrae were noticeably large for a specific taxon, an estimation of the minimum fish size was attempted by comparison with a modern fish reference specimen of known size: if the archaeological caudal vertebra was larger than the first caudal vertebra of the modern specimen, it was possible to suggest that it belonged to an individual as large as or larger than the modern specimen. Again, this information was only used in the discussion of the results and not for the analysis. For the specific case of pike, some caudal vertebrae were selected and used in biometrical analyses, as the size variability of the first 10-12 caudal vertebrae is minimal in modern reference specimens. The presence and inclination of neural and haemal spines were used as indicators of the rough position of the caudal vertebrae, in order to identify those first 10-12 vertebrae to be included in biometric analyses.

Measurements from different elements were combined by use of a size index scaling technique, which allows plotting different measurements on the same scale. This is achieved by dividing each archaeological value to a standard value, hence producing comparable relative values (Meadow 1999, 285-289; Rizzetto & Albarella 2017, 766-767). The use of a scaling technique bears the advantage of increasing the sample size, allowing the analysis of small and otherwise unserviceable faunal assemblages. For biometric analyses, different type of recovery was not considered and available measures for each species were grouped only by periods. Furthermore, a sample size threshold by phase of ≥ 40 measurements was chosen; however, the presence of particularly large specimens was reported and discussed independently from the overall sample size.

The scaling technique adopted in this study is the log ratio, which calculates the decimal logarithm of the ratio between each measurement and its standard (Simpson *et al.* 1960; Meadow 1999, 288). This technique was chosen as it is easy to use and widely used in zooarchaeological analyses (Meadow 1999; Albarella & Payne 2005), therefore allowing for comparisons with other and future studies. The standards used in this study were modern specimens from the reference collections of the Universities of Sheffield and York (Table 4.10). A modern roach was used as the standard for the Cyprinidae family. This strategy relies on the fact that log ratio histograms aim to compare relative measurements, rather than calculating fish sizes, and allow to interpret the results by acknowledging the biases and advantages of such analyses. Due to the biological and ecological differences of Cyprinidae species, fish size and speed of growth vary, thus within the resulting log ratio histograms, the distribution of size values from Cyprinidae remains would represent both size and taxonomic variability, and any interpretation must take this into account. Because of the higher degree of morphological variability of Cyprinidae pharyngeal bones, these were excluded from log ratio histograms.

Three standard values (A1, A2, B2; Fig. 4.2) were used for vertebrae; these represent the means of all the measurements taken for each section of the vertebral column of the reference specimens.

ID n	2036	F486	1963	2051	1987	1704
Ref. collection	Sheffield	York	Sheffield	Sheffield	Sheffield	Sheffield
Species	*Esox lucius*	*Esox lucius*	*Perca fluviatilis*	*Rutilus rutilus*	*Anguilla anguilla*	*Anguilla anguilla*
Common name	Northern pike	Northern pike	European perch	Roach	European eel	European eel
Origin	France	unknown	Northern Italy	Northern Italy	Northern Italy	unknown
Total length (cm)	71.5	34.0	27.5	19.0	96.0	49.0
Standard length (cm)	65.0	30.0	24.0	15.0	94.0	46.5

Table 4.10: Modern standard specimens used in biometric analyses for this research.

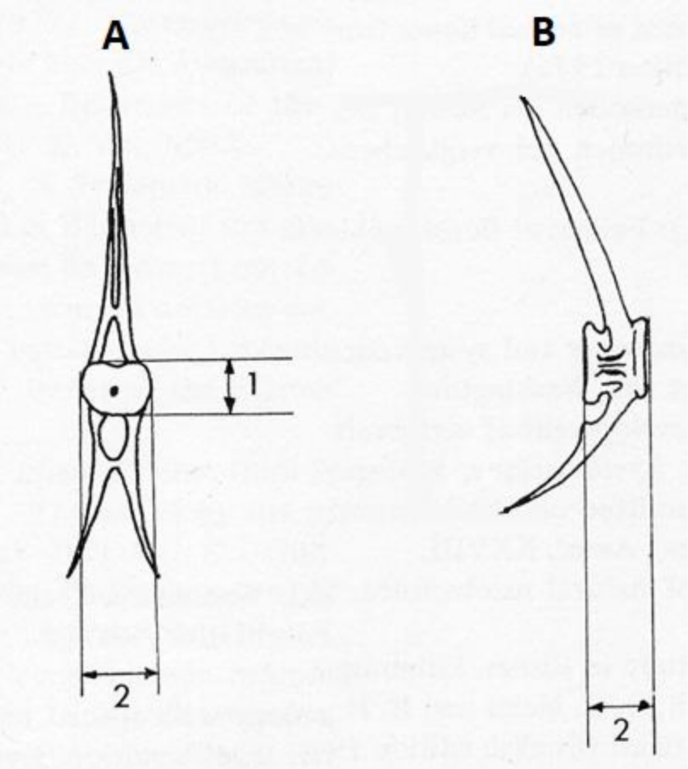


Fig. 4.2: Measurements recorded and used in biometric analyses (adapted from Morales & Rosenlund 1979, 44-45). A1: Greatest dorso-ventral height of the centrum, A2: Greatest dorso-ventral breadth of the centrum, B2: Greatest cranio-caudal length of the centrum.

There are some limitations to the use of scaling index techniques (Meadow 1999, 291-296; Albarella 2002, 54-55). Many factors can affect size/shape characters in animal remains, such as environmental conditions, age, sex and hybridisation (Payne & Bull 1988, 29-30). Such factors can impact differently on different measurements; when all values are merged into log ratio histograms, therefore, size patterns produced by different measurements and potentially deriving from different factors may be blurred, compromising a reliable interpretation of biometrical data. Measurements from the same axis (i.e. length, width or depth) are better correlated and should ideally be analysed separately (Davis 1996); however, in this study it was preferred to merge all measurements, in order increase the sample size. A trial test was performed using data from Stafford Castle, comparing the results from analyses including only one measurement per element and including all measurements; as the outputs were similar, it was decided to use multiple measurements per element, in order to increase sample size. This, however, means that the significance of the differences of the means between groups cannot be statistically tested as the variables are not independent of each other, therefore failing to meet one of the criteria for a correct application of statistical testing.

Regression equations for fish size reconstruction were sporadically used for Cyprinidae pharyngeal bones (Libois & Libois 1988); a potential problem related to the use of regression equations is that the degree of accuracy in determining fish length decreases with the size of the species. Modern specimens, on which regression equations are calculated, tend to be smaller in size than archaeological specimens (Jones 1991; Orchard 2003; Reynolds 2015), as fish size has changed through time as a result of human interventions and environmental changes (e.g. Yurtseva *et al.* 2014). Regression models, which rely on mathematical manipulations of modern and ancient data, overlook changes in the individual proportions between bone size and fish size; therefore, estimations of fish size based on regression equations tend to be rough approximations of actual fish size, not being very accurate (Lernau & Ben-Horin 2016). Furthermore, some anatomical elements provide less accurate body length estimations than others (e.g. for eel, vertebrae generate more reliable size estimations than cranial elements; Thieren *et al.* 2012a); a selection of the most suitable elements, however, would drastically reduce the sample sizes, and therefore the reliability of biometrical analyses. The use of a size index scaling technique, as opposed to regression models for fish size estimations, was therefore preferred in this study, in order to minimise biases and work on larger sample sizes.

Measurements from the pharyngeal bones (Morales & Rosenlund 1979, 43) of identified Cyprinidae remains were directly plotted on scatter plots. The aim of this analysis was to determine the overall value distribution of different Cyprinidae species from different assemblages, as well as to detect any potential clusters, which may reflect the presence of different species.

4.5 Pathologies and other conditions

Fish bone pathologies are rarely discussed in zooarchaeology; however, a recently published paper by Harland and Van Neer (2018) provides a first categorization of fish pathologies, which has been included in the recording protocol.

However, very few pathologies were observed in this study, so the data have not been analysed further. The only recurrent bone tissue alteration was a 'hyperostosis' on haddock bones. This is a condition characterising specific elements and species, manifested by the swelling and proliferation of the bone tissue; hyperostosis appears not to be injurious to the fish and is associated with sexual maturity and growth (von den Driesch 1994; Wheeler & Jones 2009, 21).

Chapter 5. Results

The selection of sites included in this research has been determined by both theoretical and practical factors (Table 5.1; Fig. 5.1).

Site type and chronology were the main criteria adopted to make an initial selection. It was important to include sites that were of both high status and low status, secular and religious, inland and coastal and were dated to the period of interest of this research (11th-15th c.). Unfortunately, not all fish assemblages could be precisely dated but more details are provided in the discussion of individual sites. The assemblages of some of the sites that had originally been selected unfortunately proved to be inaccessible, but enough alternative material was eventually found.

It was also important to have a good geographic spread, to avoid drawing results that would only characterise a specific region. This was achieved, with some limitations, as the availability of the relevant evidence is biased towards the South and East of the country (Fig. 5.1).

Another important variable affecting site selection was the size of the assemblages; a threshold of NISP $\geq$ 100 was implemented, and, for the smaller assemblages (e.g. Orchard Lane with NISP: 196), interpretations and generalisations were limited. For some large assemblages, time constraints meant that their recording was selective, giving priority to those contexts that had the potential to provide the most relevant information for my research questions.

All assemblages discussed in this thesis had previously been studied, but they were fully reanalysed by the author, in order to provide consistency of recording and approach.

In order to facilitate the reading of the chapter, graphs and tables described in the text will be found at the end of each section related to each site.

Map ref. n	**Site**	**Site code**	**Useful chronology**	**Type**	**County**
1	Stafford Castle	SC87B SC90B	11th-15th c.	secular castle	Staffordshire
2	Windsor Castle	Windsor 431/485	11th-14th c.	secular castle	Berkshire
3	Eynsham Abbey	EEA90-92	11th-15th c.	religious establishment	Oxfordshire
4	St. Mary Graces	MIN86	15th c.	religious establishment	London
5	St. Gregory's Priory	NGB89	14th-15th c.	religious establishment	Kent
6	Stert Street (38, 40, 42, 44)	AB SS/75	13th-15th c.	urban site	Oxfordshire
7	Orchard Lane	HUNOL94	11th-12th c.	urban site	Cambridgeshire
8	Fleet Valley	VAL88	12th-15th c.	urban site	London
9	Trig Lane	TL74	13th-15th c.	urban site	London
10	Billingsgate	BIG82	11th-15th c.	urban site	London
11	Milk Street	MLK76	11th-14th c.	urban site	London

Table 5.1: List of sites discussed in this research.

Fig. 5.1: Geographic location of sites discussed in this research. For site names see reference number (Map ref. n) in Table 5.1.

5.1 Stafford Castle

The excavation of Stafford Castle was part of a project endorsed by the Stafford Borough Council in order to stop the deterioration of the structure and to promote its historical and educational value. The Stafford Castle Project started in the 1970s and culminated with the publication of two volumes on survey, excavation and research carried out at the site from 1978 to 1998. The first volume, edited by Darlington (2001), covers the historical, landscape and geophysical surveys; the second volume, edited by Soden (2007), focusses on the excavations and post-excavation research. The following information, unless otherwise stated, is extracted from these two volumes.

5.1.1 The site: the castle

Stafford is in the county town of Staffordshire, in the West Midlands, and Stafford Castle is located two miles south-west from the city centre, on a prominent knoll. The castle lies on the eastern side of a valley, which is today crossed by a small stream, joining north-east with the river Sow, via the Doxey Brook. The area associated with the castle is large, covering as many as 26 acres. The remains of the rectangular keep of the castle are surrounded by a circular motte and an inner and outer bailey on the north-east. On the west side of the motte there are earthworks for what has been interpreted as gardens, while on the south-east of the outer bailey there are the remains of a settlement. Other archaeological sites in the area associated with the castle are the nearby St Mary's Church, three parks, two moats and a medieval road.

The medieval city of Stafford possessed two castles, a honorial castle, the so-called Stafford Castle, and a royal castle, this last located in the centre of the town. The presence of two castles created a potential ambiguity at times, making it difficult to discern which of the two was mentioned in documentary sources; therefore, there are still some grey areas in the reconstruction of the origins of Stafford Castle (i.e. the honorial castle). This was probably built between 1071 and 1088 by Robert I of Stafford, which was granted the land by the king, and remained in use for more than 550 years. There is documentary evidence for a substantial renovation of the castle carried out in 1348, but there is a gap of information from the foundation to this point. It appears that by the early 14th c., the Stafford family had lost some of their political power, which is reflected in a decline of their economic fortune; it is possible that they moved out of the castle before 1348. The family wealth was restored by Ralph

Stafford, as result of a political marriage and a close friendship with king Edward III, of which Ralph was soldier-administrator. After Ralph, the castle remained part of the family fortune for several generations with exception of brief periods, during which it was seized by the Crown (1521-1531 and early 17th c.). In 1531, Stafford Castle was returned to Henry of Stafford and underwent another renovation, most significantly the extension of the keep, the lodgings and service buildings probably located in the inner bailey; however, the castle never regained the wealth or the status of the previous years. During the Civil War, the castle was partially demolished and used as source for building stone and a few years later the Stafford title definitively ended.

The documentation about the settlement nearby the castle is scant; there are references about rents due "in front of the castle entrances" for the 14th and 15th c.; it is also known the number of taxpayers during the 13th c., which amounts to eight, and drops down to 6 by the 14th c., reflecting the gradual decline of the castle and abandonments of the tenements. Maps and documentary evidence testify the presence of at least three main parks reverted to the direct control of Stafford Castle by the 15th c.: Great Park, Little Park and Hyde Par. First mention of Stafford parkland is in 1284, but almost certainly the parks are older, possibly from the 11th c. The parks purpose was to keep the lord's deer and to host private hunts. At Hyde Park, in 1372, documentary evidence suggests the presence of 2 ponds with associated fishery; at least 2 fishponds were also associated with Great Park. By the 15th c. pools in the park were leased out, so as the lands surrounding the castle for farming of cattle, pigs and rabbits. The estate features (parks, pools, farms, herbage) were protected by robust fences with palings and internal ditches and strictly reserved to the lord: no person was allowed to hunt, fish or foul without permission. Another significant income for the Stafford family was the lease of the fisheries and mills owned in the town, such as the major fishery of the King's Pool (1350) and the fishery at Broadeye on the river Sow (1287).

Animals belonging to the lord, however, were not only object of renting agreements but were also consumed at the castle during rich banquets, as many household accounts testify. In a document from 1556-1567, meat featured as main dish and a variety of fish was mentioned, including salmon and cod. The rich meals were cooked with a mixture of spices (e.g. liquorice, ginger, nutmeg, cloves, pepper), some of them particularly expensive and sought after (e.g. saffron), and accompanied by dried fruits (figs, almonds) and comfits, biscuits, sugar and candy.

5.1.1.1 Excavations and zooarchaeological studies

Extensive and regular excavation and research at Stafford Castle started in 1978 with a small-scale evaluation of the area, led by Philip Barker. This survey revealed that the site was larger than previously believed, thus the following year the project was further expanded under the direction of Charles Hill and the support of a group of volunteers from Manpower Services Commission. From 1989 the excavations were overseen by the combined direction of Vivienne Metcalf, Philip Barker and David Wilkinson; after 1990 John Darlington became the director of the project. The main excavation comprised of four main areas (Fig. 5.1.1): **Site A** (the keep and the motte), **Site B** (the inner bailey), **Site D** (middle settlement site, east of the outer bailey) and **Site E** (south-west settlement site).

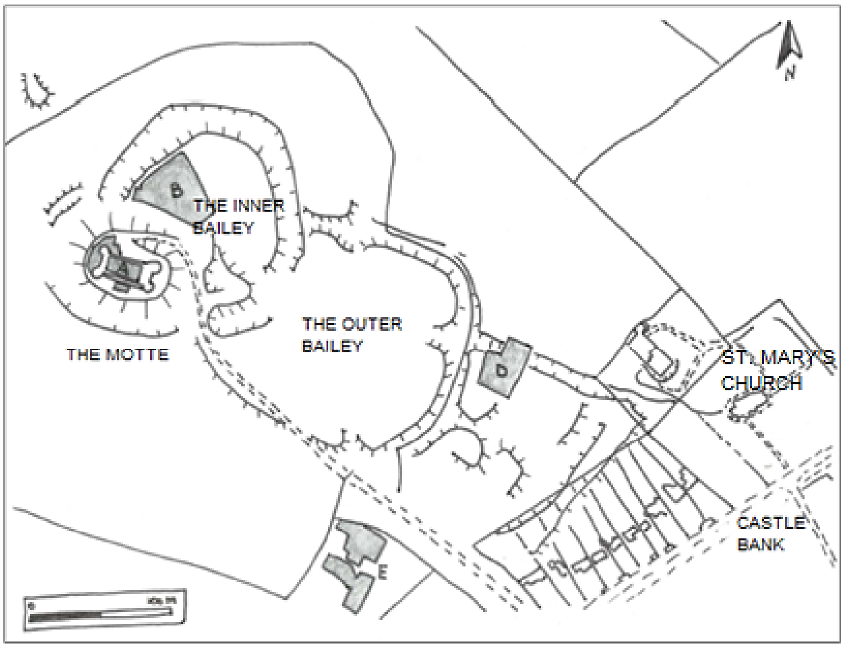


Fig. 5.1.1: Location of Stafford Castle excavations and principal earthworks (modified by Soden 2007, 4).

All areas share the same phases and, for **Site A** and **Site B,** the excavations revealed a detailed stratigraphic sequence, which allowed to define sub-phases. Here is a summary of the chronology and construction phases (for a more detailed discussion of the phases and sub-phases, see Soden 2007: 1-8):

Phase 1: Pre-Castle deposits (up to c. 1070)
Phase 2: The Norman Castle (c. 1070-1348)
Phase 3: The 1348 new keep construction and occupation of the inner bailey (1348-c. 1425)

Phase 4: Later medieval occupation, new structures and oven construction within the inner bailey (c. 1425-1500)
Phase 5: New stone and timber framed buildings within the inner bailey (c. 1500-1600)
Phase 6: The demise of the castle and Civil War destruction (c. 1600-1650)
Phase 7-9: Post-Civil War (c. 1650-present)

Site recording followed the 1980s guidelines of the Museum of London site manual (1980) and generic animal bones were bulk-recorded. Sampling was carried out through the years in an inconsistent manner and this absence of standardisation caused complications in the comparability of material. Furthermore, Darlington in 1996 observed that a challenge to the post-excavation process was the lack, during the excavation, of a plan for the creation of an archive and post-excavation reports. This, together with the frequent turnover of project managers and the sad loss of Philip Barker, delayed the completion of the study of the archaeological evidence and the publication of the two volumes.

Despite such delays, the zooarchaeological evidence has been studied and published. The mammal bones from **Phase 1-6** were studied by Peta Sadler and Gillian Jones (2007, 161-172); mammal bones from later phases were studied by Richard Thomas (2011); the birds remains were studied by Peta Sadler (2007, 172-179) and the fish remains by Sheila Hamilton-Dyer (2007, 179-184).

5.1.2 Material and recording method

Fish remains were collected during two different yeas of excavation (1987, 1990) of the inner bailey area (Site B) from **Phases 1** to **5**. However, for the purpose of this research, only **Phases 2**, **3** and **4** have been studied in detail and are reported here. The main contexts of provenience are 7118 (fill of pit 7116, beneath the rampart fighting platform) from the earlier levels of **Phase 2** (c. 1070-1120) and fills of the **Phase 3** ditch. Fish remains were mostly recovered through sieving and, in a small proportion, through hand-collection. Around 92% of the sieved material originates from context 7118, which was fully sampled. No information was available about the sieve mesh size, but it was possible to make some relevant observations during the recording of the material. It was clear that context 7118 had been sampled using different mesh sizes. Bags of material were clearly grouped and packed by mesh size and two categories of sieving have been reconstructed: fine-sieved material (1 mm and 2 mm mesh) and coarse-sieved material (4 mm mesh).

Fish bones from hand-collected and coarse-sieved bags were already sorted from other bone remains, while for the rest of the sieved material they were not. Considering the large size of the unsorted sample, it was decided to rapidly scan the fine-sieved bags, with the aid of an optical microscope. Only 10% of the finer sieved material was checked, but not recorded. The aim of this approach was to detect the potential occurrence of very small species (e.g. smelt, sprat) without investing an excessive amount of time. However, the range of taxa (mostly herring bones, pike teeth, perch scales) was not different from that of the coarse-sieved sample fraction, which is why it was not recorded.

5.1.3 Results

A grand total of 36,042 fish elements were present in the assemblage. Of these, 5,855 were identified taxonomically (with various degrees of precision) and 5,171 were recorded as countable elements, following the recording protocol.

Such a high number of unidentified bones is the consequence of a high degree of recovery from context 7118 (pit 7116), which was mostly represented by undiagnostic fin rays, ribs and bone fragments. The sieved sample produced also over 7,000 scales, 93% of which are from context 7118; around 100 scales were attributed to perch but not included in the analysis, following the recording protocol.

In general, completeness of the bones was good, with most of the elements more than 50% intact; there was also a medium/good level of preservation of the bone surface (Tables 5.1.1-2, Fig. 5.1.2-3).

5.1.3.1 Taxonomic frequencies

Sieved material

NISP calculation for the coarse-sieved sample shows three main taxa dominating the **Phase 2** assemblage (Table 5.1.3, Fig. 5.1.4): herring (29%), eel (25%) and pike (21%) (Plate 5.1.1). These are followed by an important presence of other freshwater fish, such as perch (10%) and the Cyprinidae family (9%). Cyprinidae remains are mostly unidentified vertebrae; tench represents approximately 70% of the species identified and roach 20%; a small number of remains were also attributed to chub, gudgeon and bleak (Table 5.1.4, Fig. 5.1.5). Salmonidae represent little over 1% of the identified taxa, with five ceratohyals attributed to species, one to salmon (*Salmo salar*) and four to sea trout/brown trout (*Salmo trutta trutta/Salmo trutta fario*). Pleuronectiformes (1%) are mostly unidentified Pleuronectidae vertebrae, but six specimens were matched with flounder, four with plaice and two with common sole. Gadiformes are uncommon, the most frequent being the freshwater burbot (0.4%). The occurrence of other taxa has little value, but it is worth noticing the presence of other freshwater species such as bullhead (*Cottus perifretum*) with four remains and stone loach (*Barbatula barbatula*) with two remains.

Plate 5.1.1: Pike cleithra (left) and eel bones (right) from context 7118.

The MNI for **Phase 2** largely reflects NISP frequencies, though, with this quantification method, eel is shown to be more abundant than herring (Table 5.1.5, Fig. 5.1.6). These are followed by pike, perch and Cyprinidae.

Overall, for **Phase 2** (Table 5.1.6, Fig. 5.1.7) freshwater taxa (43%) represent the larger part of the assemblage, with the rest split between marine (30%) and migratory (28%) fish.

NIPS frequencies for **Phase 3** (Table 5.1.3, Fig. 5.1.4) show the same combination and rank of taxa than the previous phase, but with different proportions. Herring dominate the assemblage (43%), followed by eel (19%), pike (14%) and perch (10%). Again Cyprinidae (4%) are represented mostly by unidentified remains, with the exception of four remains of tench, three of roach and one of gudgeon (Table 5.1.4). Salmonidae are present in small quantities (1%) and none were identified to species in this phase; only flounder was detected among the Pleuronectiformes (1%), which were mostly represented by vertebrae. As in the previous phase, there is a dearth of Gadiformes, the most common being burbot (1%). The only other recorded freshwater species is again the bullhead (*Cottus perifretum*), with one remain.

Only herring reaches the threshold for MNI calculation and the species is represented by nine individuals (Table 5.1.5).

In **Phase 3** marine taxa (44%) become most common, followed by freshwater (32%) and migratory fish (24%) (Table 5.1.6, Fig. 5.1.8). The difference in sample size between the two periods makes the interpretation of chronological trends difficult. However, an increase in the frequencies of marine taxa is clearly perceivable in the later phase of the castle, to the detriment of migratory and in particular freshwater fish.

No sieved material was recovered from for **Phase 4**.

Hand-collected material

Only 66 remains were hand-collected from **Phase 2** (Table 5.1.3), most of these being pike; very few remains of other species were retrieved. Again, Gadiformes are barely represented, with three remains of cod. Most of the remains are from freshwater, due to the dominance of the pike (Table 5.1.7).

A larger number of remains were hand-recovered for **Phase 3** (Table 5.1.3, Fig. 5.1.9), again pike being by far the most common species (68%). Perch (11%) and unidentified Cyprinidae (5%) are the next most common taxa, with some specimens attributed to tench and chub (Table 5.1.8). Similar frequencies (4%) are shown by cod and Salmonidae, with one ceratohyal belonging to salmon (*Salmo salar*). Few remains of eel (3%) are present and for the marine counterpart herring (1%) and haddock (1%) are present. The only haddock cleithrum recorded showed the characteristic swelling, evidence of hyperostosis, which is very common in the species (von den Driesch 1994). As typical with this type of recovery, smaller species are underrepresented or completely absent. Another freshwater species recorded is burbot with only one specimen.

Despite the small size of the sample, it is clear that the relative percentage of freshwater fish is definitively higher (85%) than for marine and migratory taxa (Table 5.1.7, Fig. 5.1.10), which is in contrast with the results from the sieved material.

Only three remains of pike and seven of cod were retrieved from the hand-collected sample of **Phase 4** (Tables 5.1.3, 5.1.7).

5.1.3.2 Anatomical element distribution

The analysis of anatomical element distribution was performed only for the five more frequent taxa identified in sieved samples (Table 5.1.9).

The MAU for herring in **both phases** shows how the species is primarily represented by vertebrae, with the most common anatomical element being the first vertebra followed by anterior-abdominal vertebrae (Fig. 5.1.11-12); the head is much less represented (Fig. 5.1.13).

In **Phase 2**, pike is mostly represented by head bones (Group I) with the most common anatomical element been the ectopterygoid, followed by the supracleithrum (Fig. 5.1.14); a clear disproportion is visible in the presence of bones from the head versus the vertebral column, with the former being unequivocally more common (Fig. 5.1.15).

In **Phase 2**, eel is also mostly represented by head elements (Group I), with the most common element being the dentary, followed by the cleithrum (Fig. 5.1.16); the predominance of head elements is only slightly less pronounced than for pike (Fig. 5.1.17).

The most common anatomical elements for perch belong to the pectoral girdle (cleithrum and supracleithrum) (Fig. 5.1.18), while, overall, the species is mostly represented by head elements (Group I) (Fig. 5.1.19).

The MAU for Cyprinidae shows, as most common element, the preopercular, followed by posterior abdominal vertebrae (Fig. 5.1.20); the MAU comparison of frequencies for head skeleton and vertebrae resulted in almost equal percentages (Fig. 5.1.21).

5.1.3.3 Taphonomic alterations

Taphonomic evidence is summarised in Table 5.1.10 and was predominantly recorded on material recovered from context 7118, early levels of **Phase 2** (c. 1070-1120). Overall, visible taphonomic alteration is uncommon, with only 1% of the identified material showing burning marks, 2% showing crushing (mechanical and/or chemical bone deformation, Chapter 4) or gnawing marks and only 0.4% showing butchery marks. The frequency of taxa displaying taphonomic alteration reflects the taxonomic frequency for **Phase 2**, with herring most commonly affected, followed by eel, pike, perch, Cyprinidae and Salmonidae. Most of the taphonomic evidence was recorded on vertebrae; some exceptions are: a cut marks visible on the cleithrum of an eel of over 96 cm of total length (context 2843, **Phase 2**; Plate 5.1.2), a crushed pike dentary and a dentary displaying a chop on the symphysis and gnawing marks, in form of punctures similar to carnivore gnawing, both belonging to adult individuals (context 7118, early Phase 2).

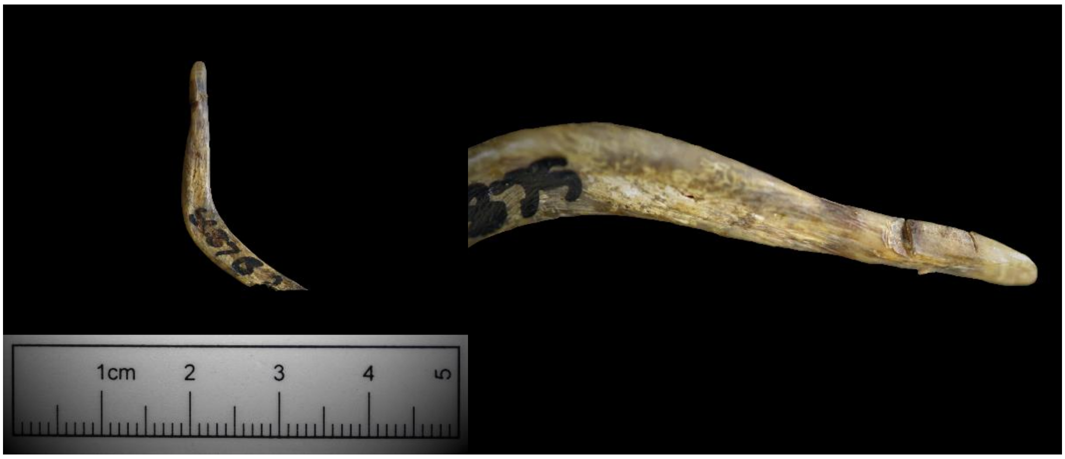


Plate 5.1.2: Cut marks on large eel cleithrum.

5.1.3.4 Biometrical analysis

The Log ratio histogram for pike, **Phase 2** (Fig. 5.1.22), shows that most of the measurements fall in the range of adult fish as they plot over the red line marker of 34 cm in total length (standard length 30 cm) and most modern pikes reach sexual maturity at 17-40 cm of standard length (Kottelat & Freyhof 2007, 342). Measurements for younger pikes appear to be heterogeneously distributed, while the spread for the adult catch is more uniform. The sizes of two operculars, one pre-caudal vertebra and one premaxilla were larger than the standard (dotted line), representing individual over 70 cm of total length. The size of a broken ectopterygoid was matched by visual comparison to a modern pike with over 1 m of total length. It appears that modern pike total length does not change significantly between sexes, with female been only slightly larger than male (Senay *et al.* 2017). It is, therefore, not surprising that in the pike of Stafford Castle there is no clear indication of sexual dimorphism in the distribution of the measurements.

The sample size for **Phase 3** is small, but it is possible to notice a slightly higher mean value then in the previous phase (Fig. 5.1.23). Juvenile pikes are scarcely represented, though a few more were noted among specimens that could not be measured. The single largest measurement is represented by an opercular probably belonging to a pike of around 80 cm in length. Another broken ectopterygoid was matched by visual comparison and resulted larger than a modern specimen with a total length of 1 m.

For perch, **Phase 2**, the log ratio histogram shows a wide range of measurements (Fig. 5.1.24), representing various stages of life of the fish; there is a concentration of individuals, slightly smaller than the standard (standard length: 24 cm), and comparable to the size of modern adult unsexed perch (standard length: 20 cm, Kottelat & Freyhof 2007). Female perches tend to grow more slowly but end up becoming larger than males (*ibid.*, 530-531). However, no clear separation of the sexes can be detected, but it is likely that most of the larger specimens over the standard measure belong to females.

Perch **Phase 3** measurements are represented by a small sample and show an increase of the mean value and an apparent reduction of smaller/younger individuals (Fig. 5.1.25).

As mentioned in the Methodology (Chapter 4), measurements for Cyprinidae were grouped without considering species identification. This means that, due to the biological and ecological differences between species, fish size and speed of growth will vary, limiting the possibility of interpretation. The standard used for comparing measurements is a modern roach of 19 cm of total length and 15 cm of standard length. Cyprinidae for **Phase 2** are represented by an unsurprising wide range of measurements, including some very small individuals, distributed in an approximately bimodal manner (Fig. 5.1.26). Two larger caudal vertebrae, excluded from the ratio by recording protocol (Chapter 4), were recovered from this phase with measurements doubling those of the standard.

Only a few measurements could be taken for Cyprinidae in **Phase 3**, which mostly resulted to be larger than the standard value.

Overall, it was possible to measure 18 pharyngeal bones for Cyprinidae, identified as roach, gudgeon, bleak, tench (Fig. 5.1.27); 15 of these belonged to **Phase 2**, with the larger species being roach, without any particular outlier, and the smallest one being bleak; for **Phase 3** only 3 pharyngeal bones were measured, one of these is a tench belonging to a large individual with a total length possibly around 45 cm (Libois & Hallet-Libois 1988), modern tench common length being 25-35 cm (Maitland & Campbell 1992, 194).

A good sample size represents eel for **Phase 2**, which shows a largely unimodal distribution (Fig. 5.1.28). The mean value plots in the range of yellow/silver eel (over 30 cm of total length; Tesch 2003, 150), near the marker of 49 cm of total length (red line), while there is a minor representation of smaller eels. Considering the large size of the standard (0), over 35 cm the common length of modern female silver eel (*ibid.*, 168), the presence of very large specimens is noteworthy, possibly belonging to female silver eel over 1 metre of total length.

For **Phase 3**, eel sample size is much smaller and the mean similar (Fig. 5.1.29). The distribution is more skewed towards smaller individual, but a few large outliers keep the mean within close range with the previous phase.

5.1.4 Discussion

Diachronical changes are difficult to establish with certainty as **Phase 2** only has a substantial sample size, but there is wealth of other valuable information to be gathered from the evidence presented above.

Herring and eel were the most commonly fish consumed at the site, which indicates that recovery bias was limited and the preservation of the material is probably good. Pike consumption was also very prominent, especially when one considers the much larger size of this fish. Perch and, to a lesser extent, representatives of the Cyprinidae family also had a significant role in the diet, while the contribution of other taxa such as Salmonidae and Pleuronectiformes was negligible. It is important to remember, however, that salmon/trout has bones with a porous structure that can be very low in calcium during the spawning season, which makes them less likely to survive (Hamilton-Dyer 2007, 181). The limited consumption of large Gadiformes (cods etc.), though possibly increasing in later periods, is noteworthy. With the exception of the herring, there is a clear focus on the exploitation of freshwater environments and the use of local resources, such as streams and rivers. As mentioned above, literary sources indicate that in the 13th c., Stafford Castle owned several fishponds and rights to sections of the river Sow. This is well reflected in the abundance of freshwater fish consumed at the site. The river Sow and other streams were exploited for pike, eel, perch, salmon/trout, burbot. It cannot be excluded that adult Atlantic salmon/sea trout was a sea catch, as these taxa spend part of their life in marine water, before to return to the river of their birth (see species overview in Chapter 1). The ponds would have provided more pike, perch and the larger Cyprinidae, such as tench and roach, which are well-adapted to be bred in this type of environment. Non-predatory fish, such as tench, rarely manage to live and grow for many years in a natural environment, especially when predators, such as pike, are part of their ecosystem. The large tench retrieved in the assemblage is therefore likely to have been kept captive. The spectrum of the species eaten at the castle shows that there was a limited exploitation of fish from estuaries; the limited presence of estuarine fish such as plaice and flounder is likely to represent imported fish, considering the upriver position of the site. For this reason, eel was probably also sourced elsewhere. Most eels live only part of their lives (glass eel stage) within coasts and estuaries and start to colonise inland freshwaters at the stage of elvers (from roughly 7-8 cm of total length; Churchward 1996 in Tesch 2003, 137). Most individuals found at Stafford Castle tend to be around the size range of yellow/silver eel (over 30 cm of total length; Tesch 2003, 150), a maturation stage in which, typically, individuals live and can be fished in rivers. European eels, when sexually mature (silver eel), from September to early November, start a seaward migration towards the spawning ground, the Sargasso Sea (see species overview Chapter 1). There is a very broad variation in the size and age of sexually mature eels (Simon 2015), but the predominance of large eels in an assemblage suggests a fishery using traps placed in river or streams in order to catch eels on their migration journey (Wheeler & Jones 2009, 164). Furthermore, considering the high sexual dimorphism in eels, with females being larger and males rarely growing beyond 54 cm of total length (Tesch 2003, 168), it is likely that most individuals over the marker of 49 cm of total length were females. It is also possible that eels were caught in nature at a juvenile stage and then grown in ponds until they reached their optimal size; this practice of eel ponds stocking during medieval times is well attested by historical sources (e.g. Bonow *et al.* 2016; Chapter 2).

The low percentage of small Cyprinidae (below 15 cm total length) and small perch could reflect a managed exploitation of the ponds, where the animals were caught at an optimal weight/size, with the smaller fish representing perhaps an accidental catch. Hamilton-Dyer (2007, 184) in her earlier report on the assemblage, suggests that small fish could also constitute the gut content of larger predators, such as pike. Therefore, the scarcity of these small specimens could indicate that pikes were generally gutted elsewhere, perhaps on the riverbank. However, the breeding of Cyprinidae in ponds could also be suggested by the bimodal distribution of their measurements, where the two peaks could represent two different sources of fishing: the larger group being bred individuals and the smaller group wild ones. In this perspective, the smaller specimens would be juveniles or smaller species (e.g. gudgeon, bleak). The two peaks could also represent different populations of the main larger species (tench, roach) or two age groups of a combination of the larger species (tench, roach, chub). Furthermore, as in most teleost fishes, also in Cyprinidae males tend to be smaller than females, which grow faster (Winfield & Nelson, 1991, 470-471), therefore the two peaks could correspond to two different sexes of the most common species (tench).

The unimodal distribution of pike measurements suggests a managed catch focused on larger specimens, but the presence of a few smaller individuals still indicates the availability of the fish all year round; conversely, different frequencies of fishes of specific sizes (sinusoidal distribution) would have suggested seasonal fishing (Morales-Muñiz 2014; Chapter 1).

Pike was mostly fished at its optimal size in terms of quantity of meat and manageability in the ponds, since large pikes can predate on smaller ones. The larger pikes were probably sourced from natural environments and represent a targeted catch: because of their predatory and aggressive behaviour, large pikes in nature tend to be solitary and rare; their presence in a river would probably also act against the occurrence of smaller pike and in general smaller fish in that environment. At the same time, the lack of juvenile pikes could again indicate the advantage of a controlled fishponds, where no fish was killed before growing into a convenient size.

Overall, most of the species have sizes comparable to adult stages. Fish growth typically proceeds unevenly by bursts, mostly regulated by environmental factors, but it slows down after reaching a certain age (Wheeler & Jones 2009). Furthermore, large size fish in a confined environment, such as fishponds, would create management problems (pollution due to overcrowding, cannibalism towards smaller individuals, spread of diseases etc.). For this reason, in the case of captive fish, there would be a size limit in which it would no longer be convenient to keep a fish alive. At the same time, both captive and wild fish (e.g. from river fisheries) would not be caught at a juvenile stage; fishermen would have rather favoured individuals which had reached their growth peak to favour the survival of fish populations but also because often fish size limits were established by law (Chapter 2; e.g. Hoffmann 1996). At Stafford Castle, this would be reflected in the lack of very young specimens. Therefore, in general, most of the freshwater-migratory species were only fished once they had reached their optimum weight; which could be evidence of controlled management and targeted fishing, where the abundance of fish allowed to spare smaller individuals. It is important to emphasize that fishponds can rarely give sustainment for a whole year (Chapter 2; Bonow *et al.* 2016) and even if at Stafford these were supported by river fisheries, these had to be supplemented with imported preserved herring.

The anatomical element distribution for herring shows a prevalence of vertebrae, but this is likely to be the result of taphonomic bias, considering the fragility of herring head bones. It is likely that small fish, such as herring, was consumed whole in a preserved form (e.g. pickled), with gutting being the only preparatory action. For pike, eel and perch the relative small number of vertebrae could suggest that the fish was served without head in most of the cases and then the heads were disposed separately from the rest of the body (Hamilton-Dyer 2007, 182). Cyprinidae bones indicate that the whole fish was prepared, possibly in the form of fish soups or preserved pickles. The presence of scales has been used as evidence of on-site cleaning (e.g. Bond & O’Connor 1999), which is the case at Stafford too, at least for perch.

The evidence of burned bones from context 7118 is not species-specific. Singed bones could be the result of cooking, while most of the burned and calcined bones are more likely to represent the disposal of kitchen and/or meal waste into a fire.

Evidence of crushing and deformation was recorded on several bones. In the case of the smaller species, in particular eel and herring, bone deformation could be interpreted as sign of damage typical of human consumption and digestion (Jones 1984, 1986). In larger species, such as pike and Salmonidae, the causes for the deformation of the vertebral bodies could be several, most typically trampling. However, crushing of bones in large species has been also connected with human agency; various cooking techniques could leave this type of marks on bones, such as compressing the body of the fish with a weight in the preparation of pressed fish (Davidson 2012) or as resulting from hammering of the dried carcass in order to release the flavour from the flesh or soften it, before preparation (Wubs-Mrozewicz 2009).

Chop marks on smaller species such as herring and cyprinids could be associated with consumption. Chops were also found on vertebrae of eel and pike, probably indicating the splitting of the carcasses into pieces. A chop on an eel cleithrum could represent the decapitation of the fish and confirms what suggested by the anatomical element distribution, namely that the fish was served without its head. The chop on the pike dentary could represent an attempt to get rid of a stuck hook or tongue removal (Barrett *et al.* 1997, 13; Wheeler & Jones 2009, 66). The single cut on a Salmonidae vertebra could be associated with the splitting of the body along the vertebral column. A chop on a large cod vertebra from **Period 4**, together with an overall scarcity of bones from the head in all periods, could suggest preserved fish (e.g. stockfish), which may have been imported, alongside herring, from the near ports of the Dee and Mersey coast or the Hull-Yarmouth coast (Hamilton-Dyer 2007, 183). The consumption of stockfish at the castle was clearly not an important part of the fish diet, possibly because the fish supply was already covered by freshwater fish, with herring as a backup.

From all this evidence, it appears that the assemblage is the likely result of the combination of kitchen refuse, table waste and, at least in the case of context 7118, cesspit refuse.

Completeness	PHASE 2 (c.1070-1348)	PHASE 3 (1348-c. 1425)	PHASE 4 (1425-c. 1475)
> 75% present	1691	239	1
75-50% present	1572	235	3
50-25% present	795	133	4
< 25% present	429	67	2

Table 5.1.1: Bone completeness by phase, all recovery methods.

Preservation	PHASE 2 (c.1070-1348)	PHASE 3 (1348-c. 1425)	PHASE 4 (1425-c. 1475)
Excellent	13	2	0
Good	857	249	2
Medium	3363	346	7
Bad	254	77	1
Awful	0	0	0

Table 5.1.2: Bone preservation by phase, all recovery methods.

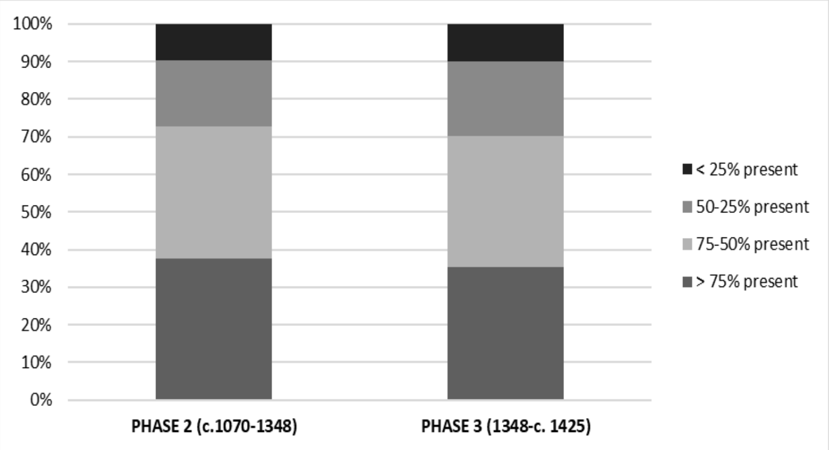


Fig. 5.1.2: Percentage of bone completeness by phase (**Phase 2**, NISP: 4487; **Phase 3**, NISP: 674), all recovery methods.

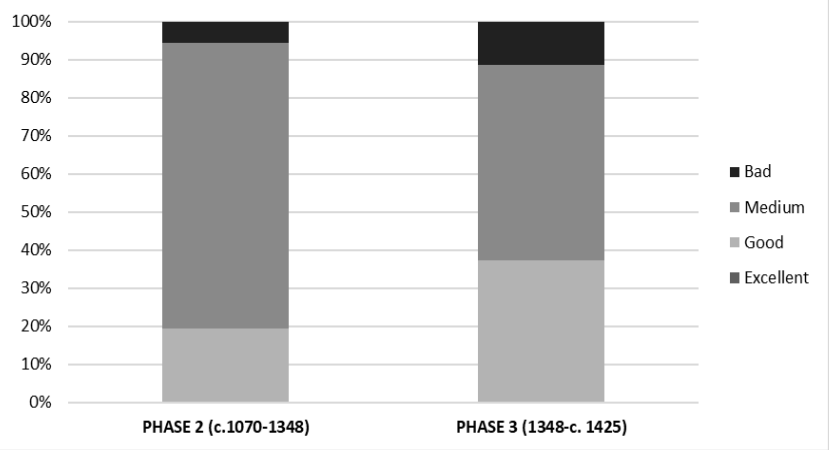


Fig. 5.1.3: Percentage of bone preservation by phase (**Phase 2**, NISP: 4487; **Phase 3**, NISP: 674), all recovery methods.

TAXA		PHASE 2		PHASE 3		PHASE 4	TOT
Latin name	**Common name**	**S**	**H-C**	**S**	**H-C**	**H-C**	
Clupea harengus	Atlantic herring	1285	1	188	4	0	1478
Esox lucius	Northern pike	949	36	64	165	3	1217
Anguilla anguilla	European eel	1103	8	84	8	0	1203
Perca fluviatilis	European perch	457	9	45	27	0	538
Cyprinidae	-	347	1	18	7	0	373
Salmonidae	-	80	2	15	9	0	106
Tinca tinca	Tench	75	6	1	7	0	89
Pleuronectiformes	-	36	0	3	0	0	39
Lota lota	Burbot	20	0	6	1	0	27
Gadus morhua	Atlantic cod	1	3	0	11	7	22
Osmerus eperlanus	European smelt	17	0	0	0	0	17
Gadiformes	-	8	0	1	0	0	9
Platichthys flesus	European flounder	6	0	3	0	0	9
Rutilus rutilus	Roach	6	0	1	0	0	7
Squalius cephalus	Chub	6	0	0	0	0	6
Cottus perifretum	Bullhead	4	0	1	0	0	5
Pleuronectes platessa	European plaice	4	0	0	0	0	4
Salmo trutta trutta/Salmo trutta fario	sea trout/brown trout	4	0	0	0	0	4
Gobio gobio	Gudgeon	3	0	0	0	0	3
Melanogrammus aeglefinus	Haddock	0	0	0	3	0	3
Barbatula barbatula	Stone loach	2	0	0	0	0	2
Pleuronectes platessa/Platichtys flesus	European plaice/flounder	2	0	0	0	0	2
Solea solea	Common sole	2	0	0	0	0	2
Salmo salar	Atlantic salmon	1	0	0	1	0	2
Alosa sp.	-	1	0	0	0	0	1
Clupeidae	-	1	0	0	0	0	1
Merlangius merlangus	Whiting	0	0	1	0	0	1
Chelidonichthys cuculus	Red gurnard	1	0	0	0	0	1
Alburnus alburnus*	Bleak	*	0	0	0	0	0
	TOTAL	4487		674		10	5171

Table 5.1.3: NISP of taxa by phase based on diagnostic elements (other records noted as *) for sieved (S) and hand-collected material (H-C). _Alburnus alburnus* is_ represented by pharyngeal plate.

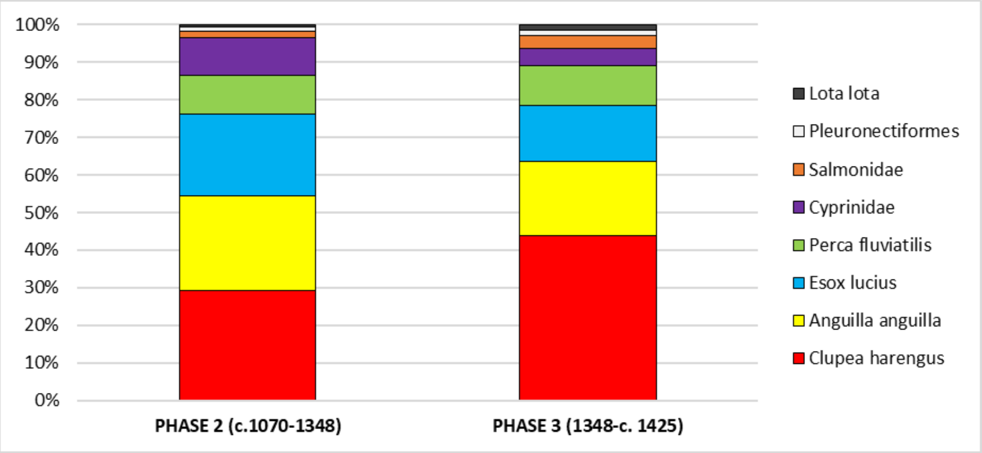


Fig. 5.1.4: Frequencies for the 8 most common taxa by phase (**Phase 2**, NISP: 4386; **Phase 3**, NISP: 428), for sieved (S) material. Threshold by phase: tot NISP ≥ 100.

TAXA	PHASE 2 (c.1070-1348)	PHASE 3 (1348-c. 1425)
Tinca tinca	79	4
Rutilus rutilus	21	3
Squalius cephalus	7	0
Gobio gobio	6	1
Alburnus alburnus	5	0
Cyprinidae unid.	422	23

Table 5.1.4: NISP for the Cyprinidae family by phase for sieved (S) material based on all counted specimens and pharyngeal bones; although regarded as not countable, pharyngeal bones will be represented in this table because they have been consistently recorded for all Cyprinidae.

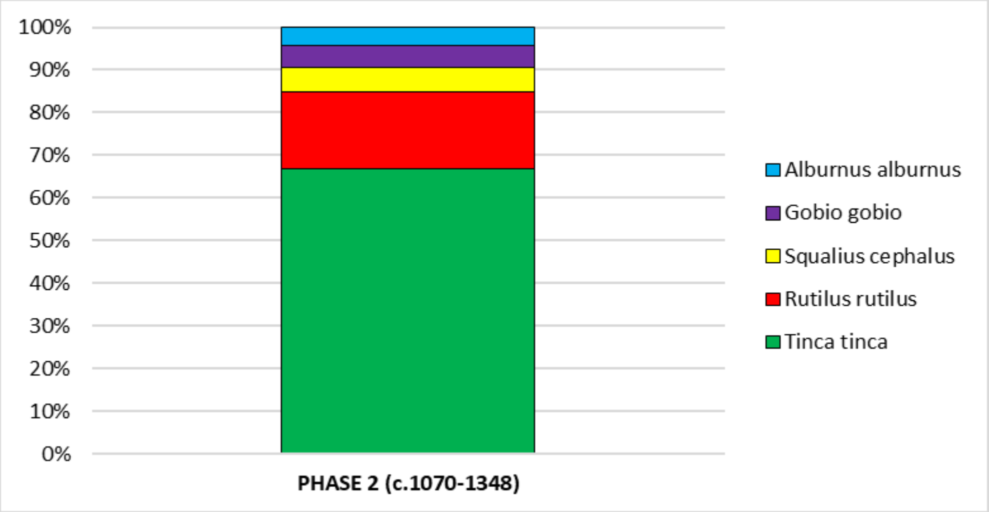


Fig. 5.1.5: Frequencies for the Cyprinidae family for **Phase 2** (NISP: 118), for sieved (S) material. Threshold by phase: tot NISP ≥ 25.

TAXA	PHASE 2 (c.1070-1348)	An.E.	PHASE 3 (1348-c. 1425)	An.E.
Anguilla anguilla	39	D	/	
Clupea harengus	34	PCV1	9	PCV1
Esox lucius	21	ENT	/	
Perca fluviatilis	13	SUP	/	
Cyprinidae	12	PRE	/	

Table 5.1.5: MNI by phase for main taxa, for sieved (S) material. Threshold by phase: taxa NISP > 100. **An.E.** is the anatomical element used for MNI calculation. D: dentary, ENT: entopterygoid, PCV1: first precaudal vertebra, PRE: preopercular, SUP: supracleithrum, /: threshold requirement no fulfilled.

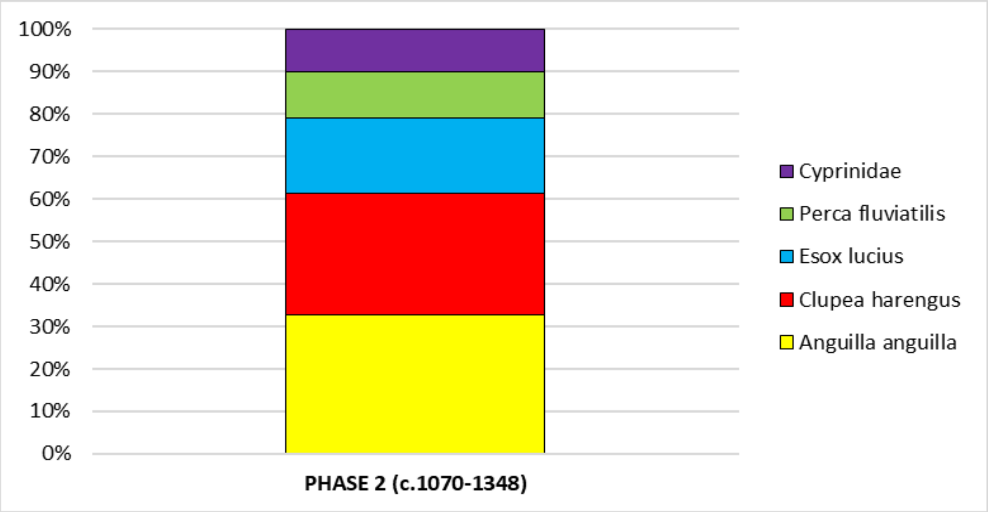


Fig. 5.1.6: MNI total n (119) for main taxa for **Phase 2**, for sieved (S) material. Threshold by phase: taxa NISP ≥ 100.

HABITAT	PHASE 2 (c.1070-1348)	PHASE 3 (1348-c. 1425)
Freshwater	1877	137
Marine	1291	190
Migratory	1208	101
Other	45	3

Table 5.1.6: Taxa habitat distribution by phase, for sieved (S) material.

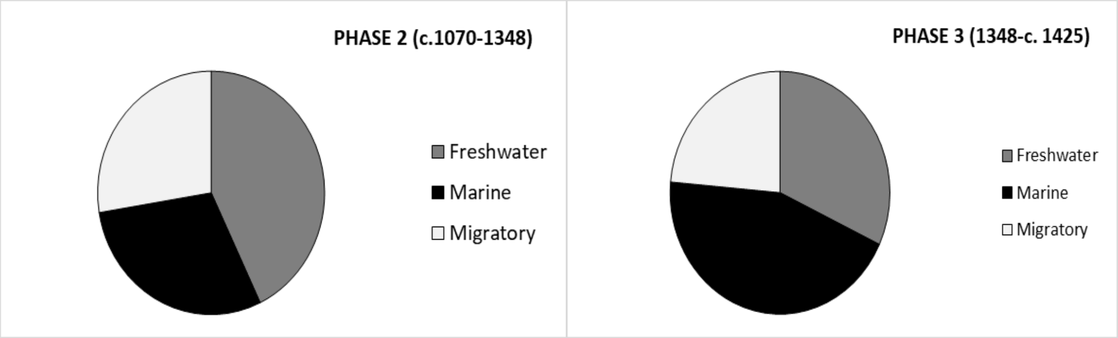


Fig. 5.1.7-8: Frequencies of habitat distribution for **Phase 2** (NISP: 4376) and **Phase 3** (NISP: 428) for sieved (S) material. "Other" excluded. Threshold by phase: tot NISP ≥ 100.

HABITAT	PHASE 2 (c.1070-1348)	PHASE 3 (1348-c. 1425)	PHASE 4 (1425-c. 1475)
Freshwater	52	207	3
Marine	4	18	7
Migratory	10	18	0
Other	0	0	0

Table 5.1.7: Taxa habitat distribution by phase, for hand-collected (H-C) material.

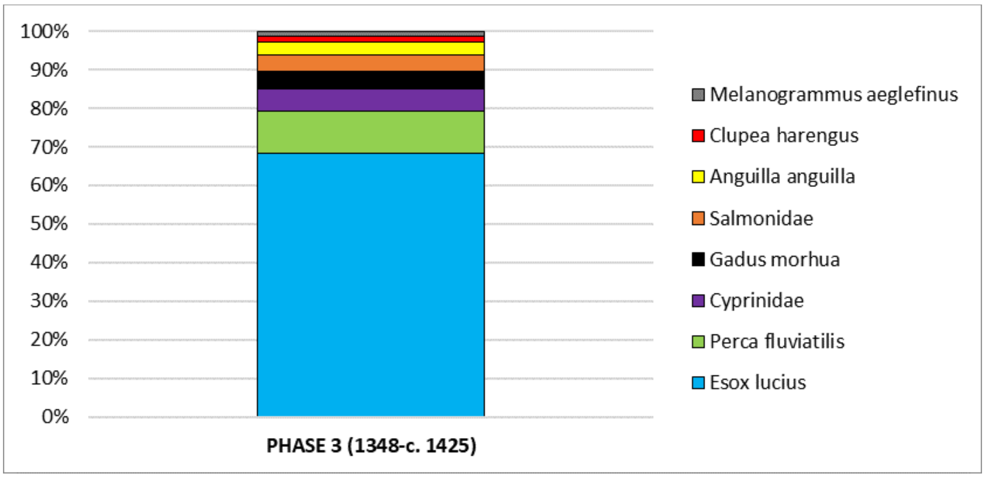


Fig. 5.1.9: Frequencies for the 8 most common taxa for **Phase 3** (NISP: 242), for hand-collected (H-C) material. Threshold by phase: tot NISP ≥ 100.

TAXA	PHASE 2 (c.1070-1348)	PHASE 3 (1348-c. 1425)
Tinca tinca	6	10
Squalius cephalus	0	3
Cyprinidae unid.	1	13

Table 5.1.8: NISP for the Cyprinidae family by phase for hand-collected (H-C) material based on all counted specimens and pharyngeal bones; although regarded as not countable, pharyngeal bones will be represented in this table because they have been consistently recorded for all Cyprinidae.

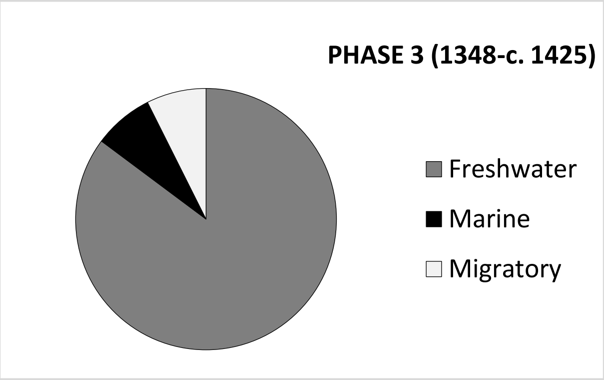


Fig. 5.1.10: Frequencies of habitat distribution for **Phase 3** (NISP: 243) for hand-collected (H-C) material. "Other" excluded. Threshold by phase: tot NISP > 100.

GROUP	Element		*Clupea harengus*		*Esox lucius*	*Anguilla ang.*	*Perca fluviat.*	Cyprinidae
			PHASE 2	**PHASE 3**	**PHASE 2**	**PHASE 2**	**PHASE 2**	**PHASE 2**
I	**A**	Articular	10	0	9	24	10	2
	B	Basioccipital	1	1	3	6	2	8
	D	Dentary	3	1	7	39	6	4
	ECT	Ectopterygoid	0	0	9	0	3	0
	ENT	Entopterygoid	0	0	21	\	2	0
	HYO	Hyomandibular	10	0	2	29	4	7
	INT	Interopercular	0	0	0	11	0	3
	MAX	Maxilla	16	3	9	22	5	2
	OP	Opercular	7	1	2	23	6	4
	OT	Otolith	0	0	0	0	0	0
	PA	Palatine	0	0	2	\	0	0
	PAR	Parasphenoid	3	0	0	31	1	0
	PRE	Preopercular	0	0	2	5	9	12
	PX	Premaxilla	4	1	12	\	8	0
	Q	Quadrate	5	0	8	9	8	0
	SUB	Subopercular	2	1	0	9	3	5
	VOM	Vomer	3	0	0	33	2	0
II	**CE**	Ceratohyal	12	1	5	27	7	5
	EHY	Epihyal	12	2	6	18	4	2
	URO	Urohyal	0	1	0	\	0	0
III	**BAP**	Basipterygium	6	0	6	\	5	10
	CL	Cleithrum	14	0	11	34	4	8
	CO	Coracoid	2	0	14	\	0	0
	PSC	Postcleithrum	0	0	8	\	10	1
	PST	Posttemporal	13	1	18	\	7	8
	S	Scapula	2	1	1	\	6	6
	SUP	Supracleithrum	16	0	20	1	13	8
IV	**PCV1 (PCV2)**	1st (2nd) precaudal vertebra	34	9	0	0	5	6
	AAV	Anterior abdominal vertebra	28	6	2	10	4	3
	PAV	Posterior abdominal vertebra	6	1		6	2	11
V	**CV**	Caudal vertebra	7	1	2	3	3	5
	LC	Last caudal vertebra	11	0	0	\	0	2
VI	**VC**	Vertebral body (centrum)	0	0	0	1	1	0

Table 5.1.9: Anatomical element distribution (MAU) by phase for main taxa, for sieved (S) material. **Group I =** Head elements (Minus II): Neurocranium, jaws, gill arches, gill covers; **Group II =** Head elements: Outer branchial skeleton; **Group III =** Pectoral and pelvic skeleton; **Group IV =** Precaudal vertebra; **Group V =** Caudal vertebrae; **Group VI =** undefined vertebrae. \ = missing/undeveloped or unidentified anatomical elements for eel (Methods, Chapter 4).

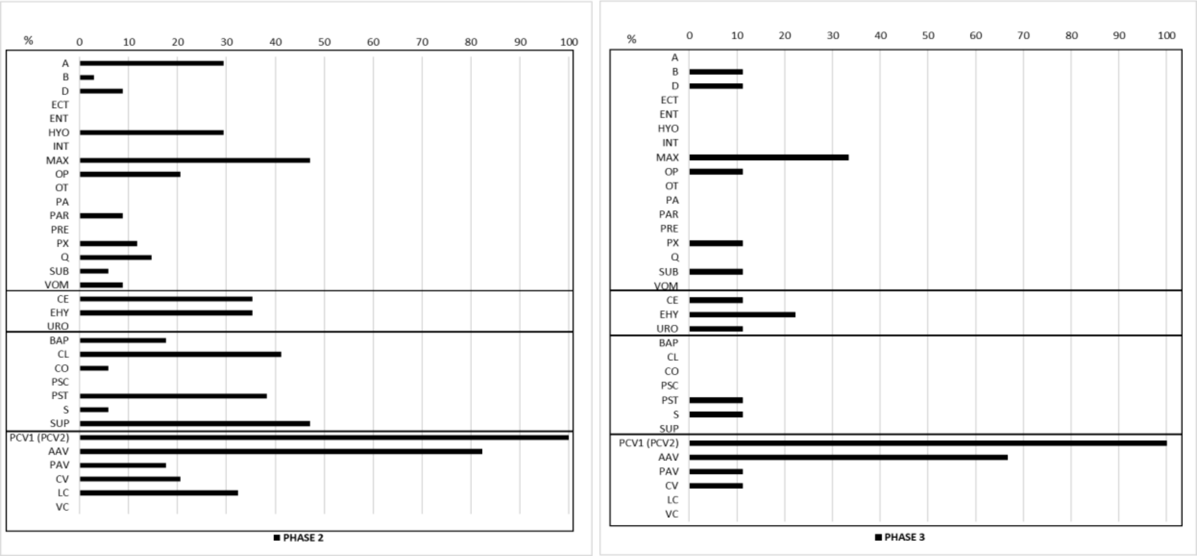


Fig. 5.1.11-12: Frequencies of anatomical element distribution (MAU) for *Clupea harengus*, **Phase 2** and **Phase 3**, for sieved (S) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

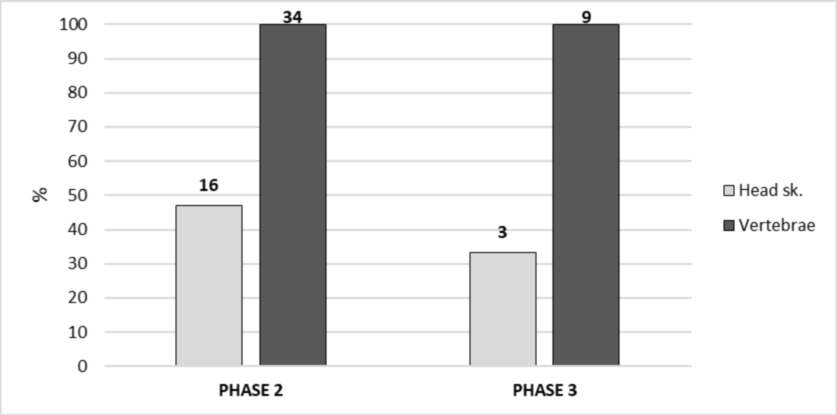


Fig. 5.1.13: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Clupea harengus* by phase, for sieved (S) material.

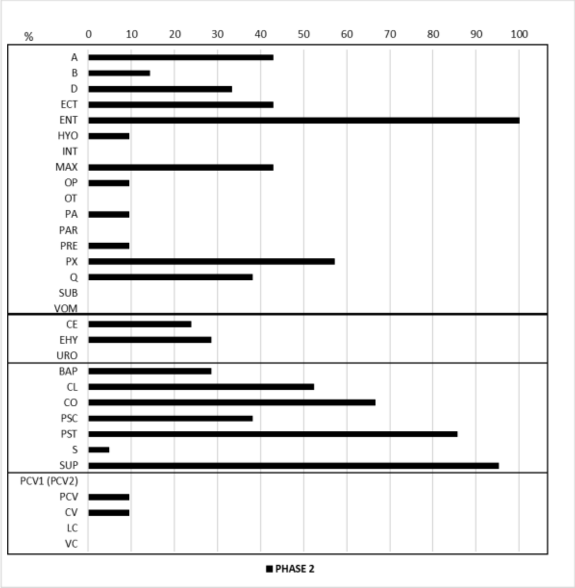


Fig. 5.1.14: Frequencies of anatomical element distribution (MAU) by phase for *Esox lucius for* **Phase 2**, for sieved (S) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens. NB: PCV (precaudal vertebra) corresponds to AAV (anterior abdominal vertebra) + PAV (posterior abdominal vertebra) for other species.

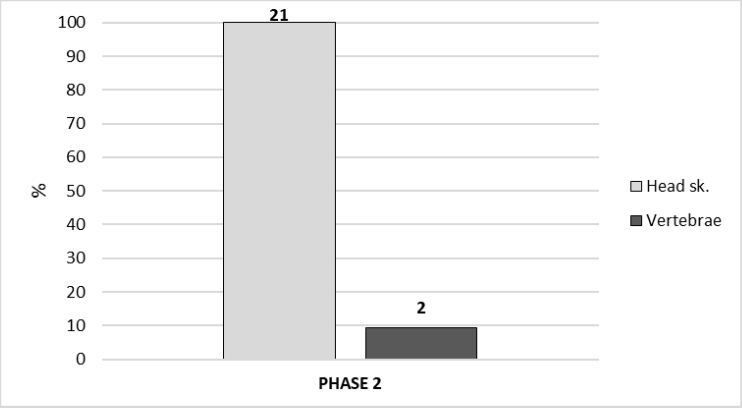


Fig. 5.1.15: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Esox lucius* for **Phase 2**, for sieved (S) material.

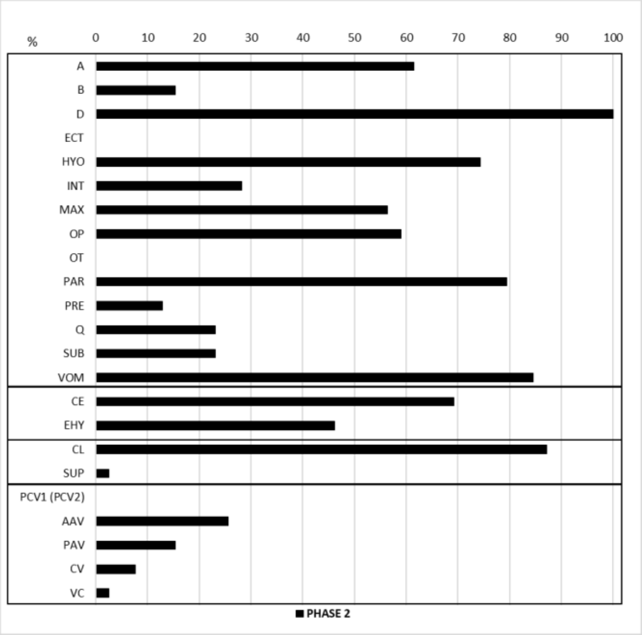


Fig. 5.1.16: Frequencies of anatomical element distribution (MAU) for *Anguilla anguilla*, **Phase 2**, for sieved (S) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

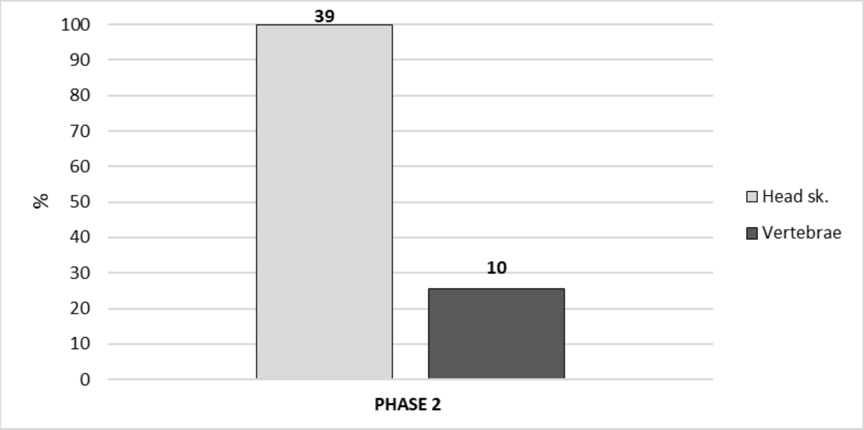


Fig. 5.1.17: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Anguilla anguilla* for **Phase 2**, for sieved (S) material.

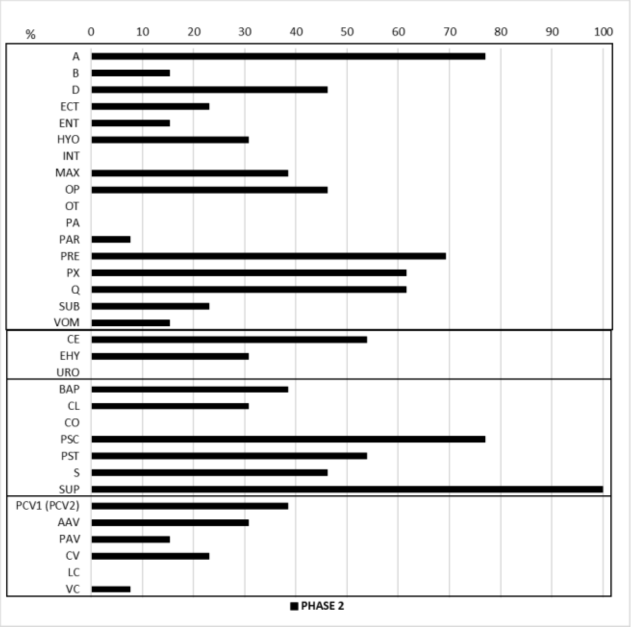


Fig. 5.1.18: Frequencies of anatomical element distribution (MAU) for *Perca fluviatilis*, **Phase 2**, for sieved (S) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

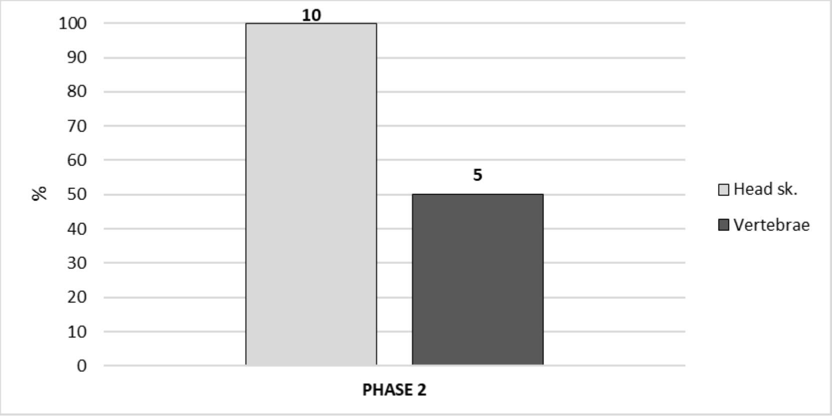


Fig. 5.1.19: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Perca fluviatilis* for **Phase 2**, for sieved (S) material.

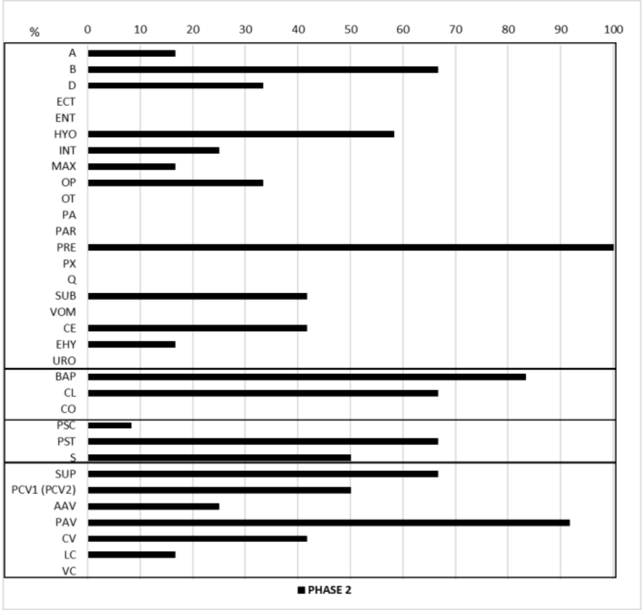


Fig. 5.1.20: Frequencies of anatomical element distribution (MAU) for Cyprinidae family, **Phase 2**, for sieved (S) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

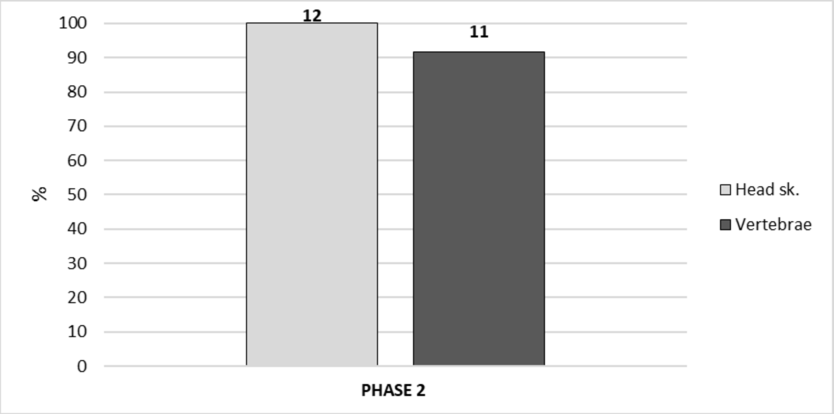


Fig. 5.1.21: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in Cyprinidae family for **Phase 2**, for sieved (S) material.

TAXA **Burning**	*Clupea harengus*	*Anguilla anguilla*	*Esox lucius*	*Perca fluviatilis*	Cyprinidae	Salmonidae	**TOT**
Singed	0	1	0	0	0	0	1
Burned	15	7	13	10	2	0	47
Calcined	2	0	1	0	1	1	5
Tot burned	17	8	14	10	3	1	53
Other modifications							
Crushed*	36	37	11	4	3	4	95
Gnawing	0	0	1	0	0	0	1
Tot modified	36	37	12	4	3	4	96
Butchery marks							
Chop**	2	6	6	0	2	0	16
Cut	0	0	0	0	0	1	1
Tot butchered	2	6	6	0	2	1	17

Table 5.1.10: Taphonomic modifications for context by taxa for 7118 (pit 7116), early levels of **Phase 2 (c. 1070-1120)**, NISP 4456, all recovery methods. * 8 crushed vertebrae of Anguilla anguilla from other contexts of Phase 3: 1 from 2837, 1 from 2905, 2 from 2909, 1 from 2916, 3 from 2906. ** 1 chop mark on vertebra of Gadus morhua from context 2718, Phase 4. ** 1 cut mark on cleithrum of Anguilla anguilla from context 2834, Phase 2.

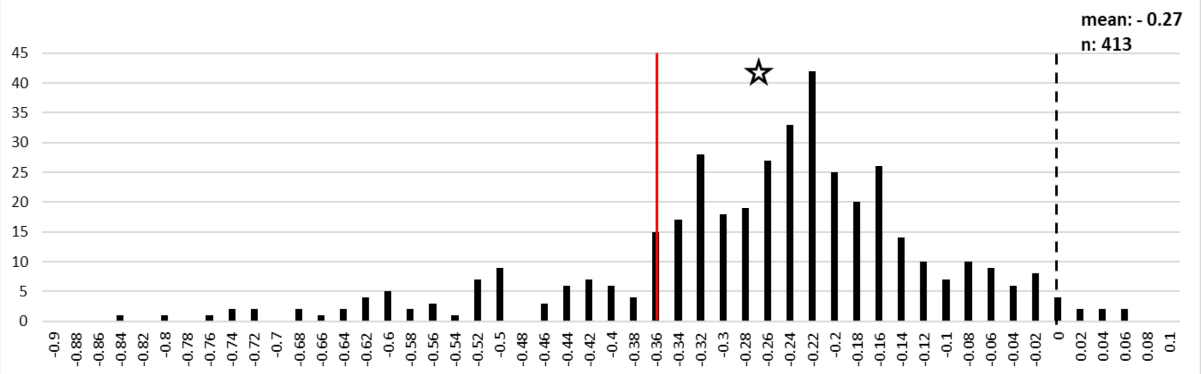


Fig. 5.1.22: Size distribution for all anatomical elements for *Esox lucius*, **Phase 2**. The star indicates the mean (-0.27), the red line marker represents a modern pike (origin: unknown) with TL of 340 mm and SL of 300 mm (mean: -0.36). The standard set of values is represented by the value 0 (TL: 715 mm, SL: 650 mm; modern individual, origin: France). Bones measured: 186; n measures: 413.

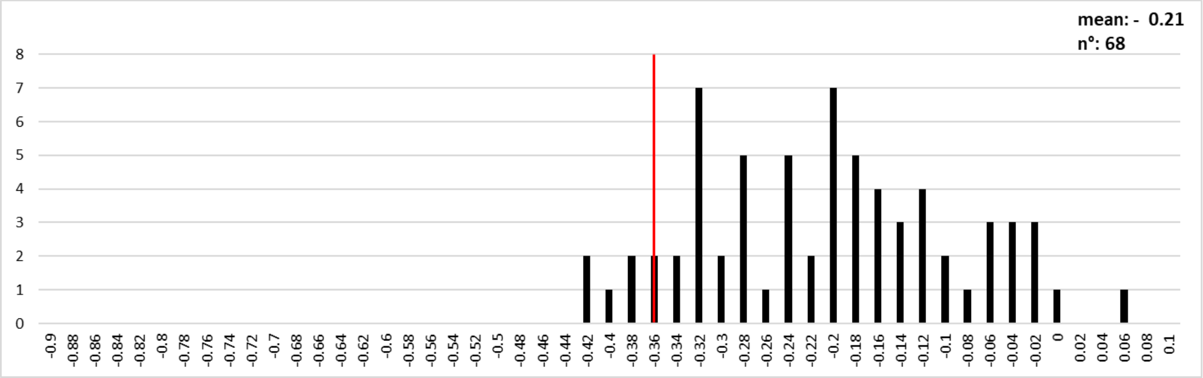


Fig. 5.1.23: Size distribution for all anatomical elements for *Esox lucius*, **Phase 3**. The star indicates the mean (-0.21), the red line marker represents a modern pike (origin: unknown) with TL of 340 mm and SL of 300 mm (mean: -0.36). The standard set of values is represented by the value 0 (TL: 715 mm, SL: 650 mm; modern individual, origin: France). Bones measured: 26; n measures: 68.

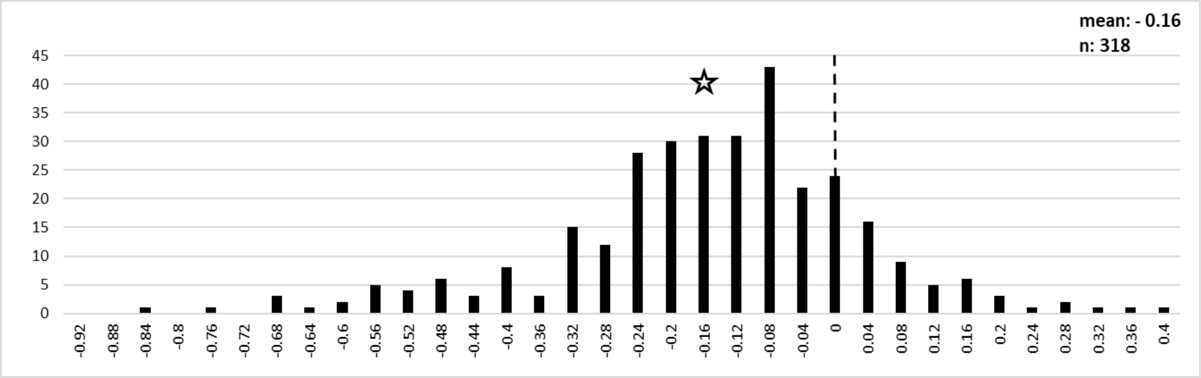


Fig. 5.1.24: Size distribution for all anatomical elements for *Perca fluviatilis*, **Phase 2**. The star indicates the mean (-0.16). The standard set of values is represented by the value 0 (TL: 275 mm, SL: 240 mm; modern individual, origin: Italy). Bones measured: 164; n measures: 318.

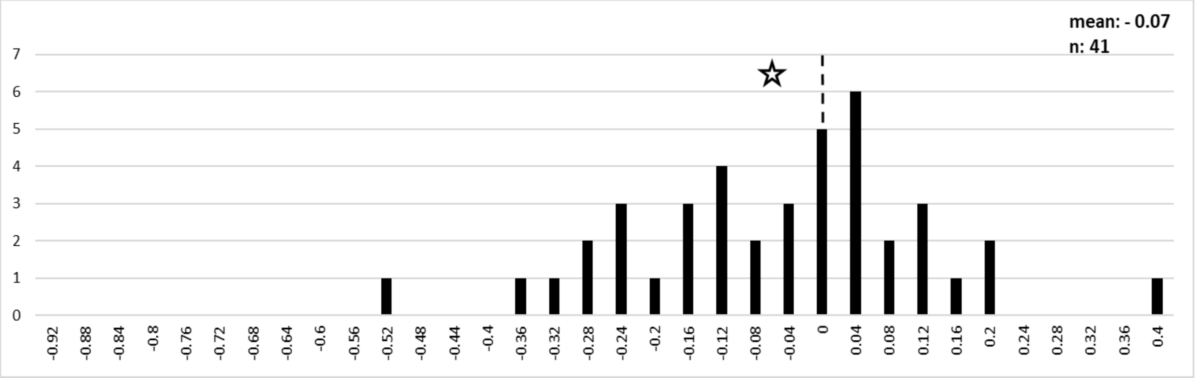


Fig. 5.1.25: Size distribution for all anatomical elements for *Perca fluviatilis*, **Phase 3**. The star indicates the mean (-0.07). The standard set of values is represented by the value 0 (TL: 275 mm, SL: 240 mm; modern individual, origin: Italy). Bones measured: 20; n measures: 41.

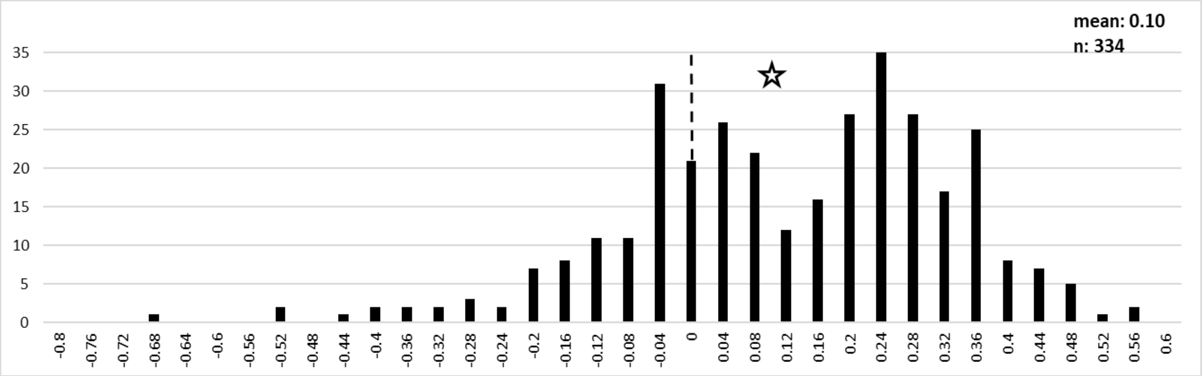


Fig. 5.1.26: Size distribution for all anatomical elements for Cyprinidae family, **Phase 2**. The star indicates the mean (0.10). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 150; n measures: 334.

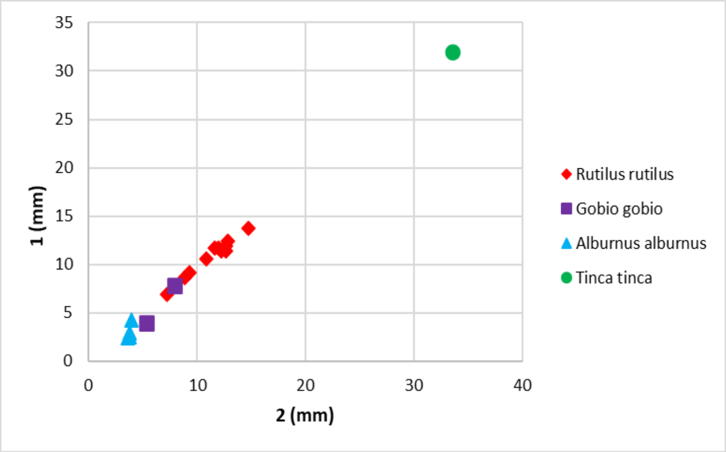


Fig. 5.1.27: Distribution of measurements (n 18) for Cyprinidae pharyngeal bones, **Phase 2-3**, all recovery methods; measure **1** (height), measure **2** (cord length).

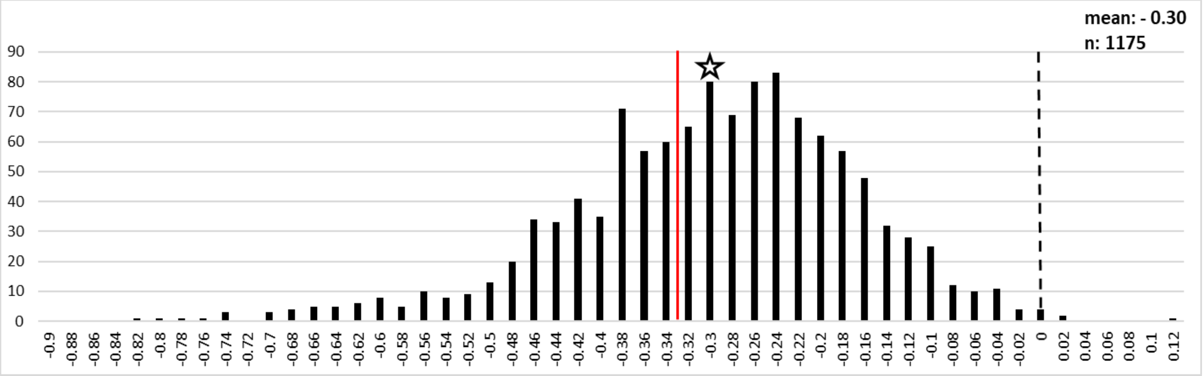


Fig. 5.1.28: Size distribution for all anatomical elements for *Anguilla anguilla*, **Phase 2**. The star indicates the mean (-0.30). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 581; n measures: 1175.

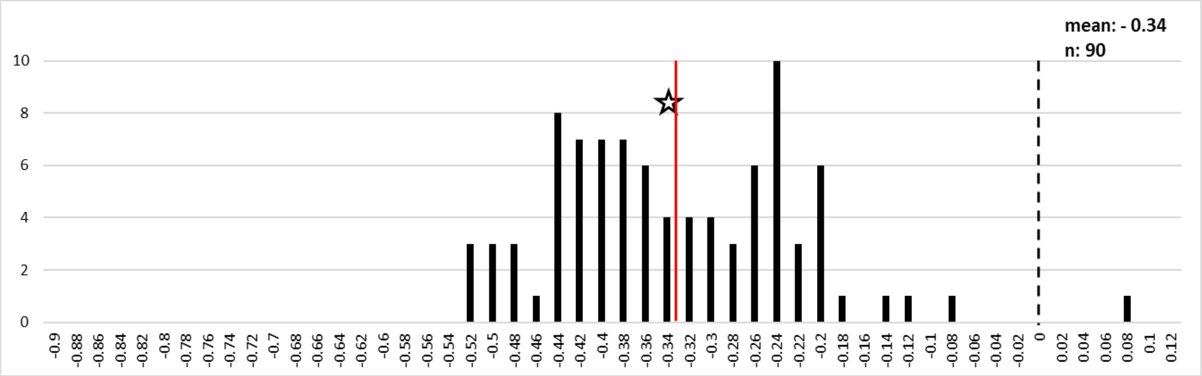


Fig. 5.1.29: Size distribution for all anatomical elements for *Anguilla anguilla*, **Phase 3**. The star indicates the mean (-0.34). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 33; n measures: 90.

5.2 Windsor Castle

Despite its fame, archaeological interest for Windsor Castle only began in relatively recent times. The most important excavation started at the end of the 1980s, prior to a restructuration project of the Round Tower's motte. The excavation was carried out by the Central Excavation Unit of English Heritage, today Historic England. A complete publication of the excavation results has not emerged, but some specialist reports are available.

5.2.1 The site: the castle

Windsor Castle is located at a distance of about 20 miles from the city centre of London, in the county of Berkshire. The castle lies within a meander south-west of the river Thames, occupying around 13 acres (including a fortification, the royal palace and a small town; Fig. 5.2.1).

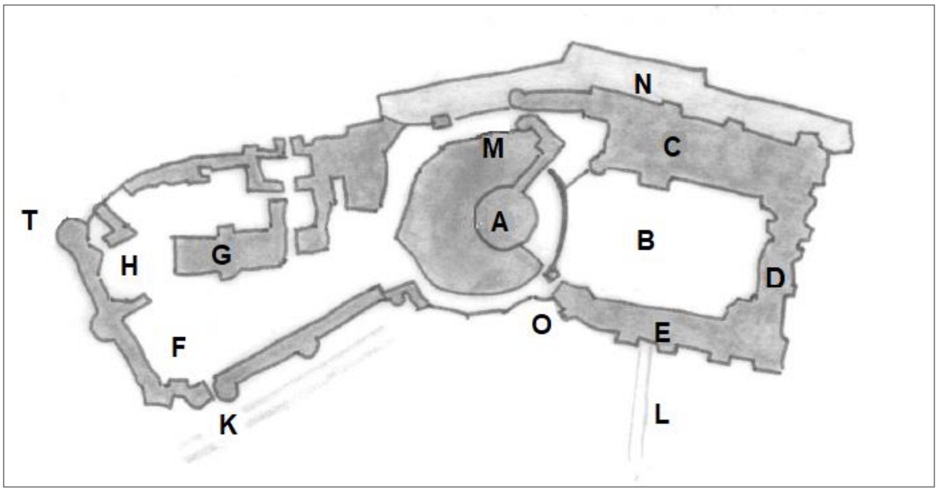


Fig. 5.2.1: Plan of Windsor Castle, **A:** The Round Tower, **B:** The Upper Ward, The Quadrangle, **C:** The State Apartments, **D:** Private Apartments, **E:** South Wing, **F:** Lower Ward, **G:** St George's Chapel, **H:** Horseshoe Cloister, **K:** King Henry VIII Gate, **L:** The Long Walk, **M:** Norman Gate, **N:** North Terrace, **O:** Edward III Tower, **T:** The Curfew Tower (modified by https://en.wikipedia.org/wiki/File:Windsorcastleplan.png).

The castle was built in the 1070s-1080s after the Norman invasion of England, at a request of William the Conqueror; the construction represented a defensive feature to protect London and strategically oversee part of the river Thames and the Windsor Forest. The original castle comprised of a round timber keep (later known as the Round Tower) on an artificial 15 m high motte, surrounded by a small bailey (the Middle Ward); its building also coincided with the foundation of the medieval town of Windsor (Brindle & Kerr, 1997). An east bailey (the Upper

Ward) was constructed subsequently and by the end of the 11th c. also a west bailey (the Lower Ward) was added. William's son, Henry I, was the first king to use the castle as royal residence and Henry II, between 1165-1179, commissioned a series of modifications of the castle, the most important of which was the rebuilding of the stone keep, the replacement of the wooden wall with a stone one and the renovation of the royal accommodation within the keep (Mulville 1998). Archaeological investigations have demonstrated that the construction of the stone Round Tower happened later, in 1224-1225 (Locker 2018a). In the early 13th c., after a prolonged siege during the First Barons' War, Henry III invested a conspicuous amount of money in repairing the consequent damage and strengthening the defences; he commissioned the building of a sumptuous royal palace for his wife and children and a number of representative buildings in the Lower Ward. Edward III pushed the renovations and expenditures for the castle even further, rebuilding the rooms of the keep with a luxurious design and embracing the massive project of the Upper Ward (most notably the building of the State Apartment and of the quarter dedicated to the Order of the Garter). During the 15th c., the castle was still in use and, in 1417, Henry V hosted a massive diplomatic event during the visit of the Holy Roman Emperor. During the Wars of the Roses (1455-85), the castle did not play an important role. Many monarchs succeed after those wars, some enjoying fully the castle and its amenities, other using the castle only briefly. The castle was further renovated and expanded throughout the centuries but the main architectural styles (French Rococo, Gothic and Baroque), still visible today, date back to George III and IV (18th-19th c.). The integrity of the fortification was undermined in a number of occasions, such as the looting and destruction during the Civil War (1642-1651), the bombing of World War II but also a 15 hour-long fire in the Upper Ward area in 1992. From 1952, the current monarch, Elizabeth II, uses Windsor Castle as her favourite weekend retreat and the site remains one of Britain's major touristic attractions.

Windsor Castle is surrounded by an extensive park, adorned by gardens and water features, some of the most renowned being Windsor Great Park, Home Park, the Royal Gardens, Virginia Water (etc..). With the arrival of the Normans, free forest land was gradually confiscated, becoming the object of exclusive royal rights (Chapter 2). Windsor forest was converted into a royal deer hunting park and became a source of wood, game (deer and boar) and fish for the castle. By 1129, the first keeper of the park was hired and in 1240 Henry III defined the borders of the Great Park (which, today, covers 5,000 acres) by the use of ditches, palisades and other defensive structures. In 1368, also Little Park (today known as Home Park) was converted by Edward III into a deer park, whose boundaries kept expanding for centuries.

The Windsor parks were used in many different ways through the years; they were sets of joust and tournaments, were used for keeping horses during the Hundred Years' War (1337-1453), for hosting cruel entertainments such as bear baiting, and later in the years they also became pasture- and farm-land.

In the 13th c., there was a general increase in fishpond construction in royal proprieties (Chapter 2) and this was also the case at Windsor Castle, during the time of Henry III. He spent most of his reign (1216-1272) in England and he invested much money and resources implementing the home supply. The main fishponds at Windsor were probably located within the Great Park (Roberts 1997: 246-247) and they were used primarily as *servatoria*, i.e. stoking mature fish ready to be eaten (Bonow *et al.* 2016, 159-160). During this period, specialist fishermen were travelling around England upkeeping the royal ponds and supervising the transport and stocking of fish. A small number of royal ponds supplied the ponds at Windsor regularly; this is the case for Marlborough, in Wiltshire, located about 50 miles from the castle, which is documented to be one of the main suppliers of the Windsor ponds between 1240 and 1272 (Bonow *et al.* 2016, 164). Bream and pike were habitually used to stock royal ponds as documented by a number of records; in 1247-1251, for instance, 200 breams were transferred from the ponds at Havering, London East, to the Windsor ponds and there is also a record of 500 small pikes introduced to the king's ponds during the same period (Close R. 1247-51: 399 in Bonow *et al.* 2016, 164). Occasionally, royal ponds were also repopulated through purchases; in 1265, the constable at Windsor was commissioned to buy 300 pikes and 300 daces and roach for the Windsor Park ponds (Liberate R. 1245-51: 273; 1260-7: 190 in Bonow *et al.* 2016, 164). New stock for royal ponds was also acquired by taking in temporary custody fish from episcopal vacancies or wardship of aristocratic residences. In 1281, 60 breams, 40 pikes and around 400 individuals of other species were transported from the Bishop of Winchester's pond at Frensham, in Surrey, to the Windsor Castle ponds (Close R. 1253-4: 18; 1279- 88: 79). Fishponds were periodically emptied, cleaned and restocked, while fish was separated in "ready to be eaten" and "still in growing process" and consequently transported to other ponds (Bonow *et al.* 2016, 175). In 1270, the royal pond at Marlborough was emptied and all the eels kept there were culled, preserved in salt and transported to Windsor Castle (Liberate R. 1267-72: 115 in Bonow *et al.* 2016, 176). Through the centuries, documentary sources show how ponds and parks continued to be sources of supply for the estate, but it appears that part of the fish was also bought in bulk from major ports, such as London, Bristol and Southampton; lamprey, for instance, was a favourite of Henry III and it was sourced from the royal weirs in Gloucestershire (Priestley 2000b). Locker (2018a, 21) underlines the lack of household information from the Windsor kitchen regarding food, for the 11th to the 14th c. One of the rare mentions of fish, during this period, refers to 1210-1211 Pipe Roll, related to the organisation of the Christmas festivities at Windsor, where 10,000 herring, 1,900 whiting, 900 haddock and 3,000 lampreys were bought (Priestley 2000b). Again, in the 1238-1270 Close and Liberate Rolls royal records, some fish species are mentioned: i.e. lampreys, small pike ('pickerel' or 'luccettos'), shad, bream, mackerel, salted herring and salted eel (Priestley 2000a).

5.2.1.1 Excavations and zooarchaeological studies

Not much archaeological investigation was done at the castle, apart from the above-mentioned 1980s excavation. However, it is worth mentioning the excavation of the Great Hall in the Lower Ward in 1895, the excavation of St. George Chapel in 1970, and the earthworks opened at three sites in 2006 by Oxford Archaeology as part of a television programme for Channel 4 called "Time Team".

As mentioned, the most important and extensive archaeological investigation started in 1988, prior to a maintenance renovation of the motte beneath the Round Tower (Site 431), which was at risk of collapse. A second site, Upper Ward (Site 485), was opened following the 1992 fire prior to the laying of new foundations and drains. The excavation was completed within that the same year (Locker 2018a).

Mammal bones from different areas of the site were studied by Mulville (1998), Baker (2001) and White (2005), the molluscs by Light (2001) and the eggshell by Sidell (2001); their research is at the moment only available as unpublished reports. The bird bones where studied and published by Baker (2010) and the fish bones by Locker (2018a).

5.2.2 Material and recording methods

The material here analysed originates from both 1988 excavations: the larger sample from the Round Tower (Site 431) and a smallest sample from the Upper Ward area (Site 485). The Round Tower has been interpreted as the living area of the Constable, one of the highest official, responsible for managing the castle, including food provision. The Upper Ward housed the king palace (*Domus Regis*) including the king and queen quarter. Therefore, both areas housed people of very high status (Baker 2010, 57-58).

The information about recovery and phasing (Table 5.2.1) reported below derives from Locker (2018a, 1-4).

Fish bones were collected from different rooms within the Round Tower (Site 431); however, most of the fish, and in general faunal remains, were recovered from the Kitchen (SS661) used by the staff. Fish bones originated from a range of different contexts, predominantly construction and floor layers, dating up to the 19th c. The current study focuses on four phases (2-5) associated with construction episodes, which will briefly be summarised here. **Phase 2** is dated to the **11th c.**, when the motte was built and initially occupied. **Phase 3** (**12th c.**) is associated with the reconstruction of the motte; the earliest kitchen deposit possibly also belongs to this phase. **Phase 4** (**13th c. - mid-14th c**.) has a rather problematic chronology and, for the purpose of this research, has been divided into a **13th c.** sub-phase, for which the chronology is more precise, and a **late 12th -14th c.** sub-phase, for which it is less clear. The material assigned to this phase will be briefly discussed but excluded from diachronic interpretations due to uncertain phasing. **Phase 5** (**mid 14th c.**), corresponds to the rebuilding carried out by Eduard III.

Fish bones were found from different deposits of the Upper Ward area (Site 485), but because of time restrictions only the larger sample from the Guard Chamber (SSD597) was analysed. This area was identified as the ground floor room within the turret of the Kitchen Gate. The analysed fish remains belong to **Phase 2-3**, (**12th-13th c.**); this phase is associated with the building campaigns affecting all parts of the castle and pre-dates the construction of the Kitchen Gate.

Phasing	Round Tower (Site 431)	Upper Ward (Site 485)
Phase 1	pre-castle activity, mostly Roman	pre-late 12th c.
Phase 2	late 11th c.	late 12th c.
Phase 3	12th c.	13th c.
Phase 4	late 12th-14th	late 14th c.
Phase 5	mid 14th c.	15th and 16th c.
Phase 6	1670	late 17th c.
Phase 7	c. 1830	19th-20th c.

Table 5.2.1: Summary of the whole phasing for the two excavated areas at Windsor Castle (after Locker 2018a, 1-3).

Fish remains were retrieved through both sieving and hand-collection. Baker (2010, 61) states that during the early stages of excavation of the Round Tower Kitchen, hand-collected and sieved materials were, at some stage, bagged together. This needs to be considered while investigating the assemblage. A substantial part of the fish bone assemblage derives from wet-sieved sampling through the use of three mesh sizes: 4 mm, 2 mm, and 1 mm. Other remains were recovered by flotation; in the Round Tower a 0.25/0.5 mm mesh was used to collect the flots and a 0.5/1 mm mesh to collect the residues; for the Upper Ward a 0.5 mm mesh was used to collect the flots and a 0.5/1 mm mesh for the residues. Residues and flots were sorted using different strategies during different seasons of excavation. In general, all the material from the 4 mm fraction was sorted, while for the smaller fractions the quantity of material sorted varied from a minimum of 10% to a maximum of 100%.

Considering the very large size of the assemblage, it was necessary to sample for the purpose of this research. The 1 mm fraction was rapidly scanned with an optical microscope but not recorded as the range of taxa observed did not differ from other studied samples.

Some bags of material from the 2 and 4 mm fractions were not studied but the context number was recorded and compared with Locker (2018a)'s results. The comparison showed that the range of taxa present in the non-recorded larger fraction did not differ from the recorded material, with the exception of freshwater bream (*Abramis brama*) and brill (*Scopthalmus rhombus*). Furthermore, a comparison of the unstudied material for the smallest fractions (1, 2 mm) showed that three species were missing: shorthorn sculpin or bull-rout (*Myoxocephalus scorpius*), smelt (*Osmerus eperlanus*) and sprat (*Sprattus sprattus*). Smelt is a migratory species while the other two live in marine habitats, therefore no relevant data for freshwater species was missed with this recording approach.

Because of the above-mentioned phasing issues and to allow comparability with other sites, construction phases were ignored and the material was arranged in chronological groups, from the 11th to the mid-14th c. Spatial distribution and context type were also not considered for the purpose of this analysis, with the exception of the division between the two main sites the Round Tower and the Upper Ward. A further subdivision would have drastically diminished the sample size. Possible biases resulting from this choice will be considered during the discussions. Three recovery categories were created following the recording protocol: fine-sieved material (1 mm and 2 mm mesh), coarse-sieved material (4 mm mesh) and hand-collected material. Materials from flots and residues were grouped together as very light elements that could be overrepresented in flot samples (e.g. scales) are, in any case, not used for quantitative analysis, according to the adopted recording protocol.

5.2.3 Results

Within the selected samples, 45,261 fish remains were counted for the Round Tower (Site 431); 13,652 of these were identified taxonomically (with various degrees of precision) and 12,681 represented countable specimens. The high number of unidentified bones, represented mostly by undiagnostic fin rays, ribs and bone fragments, is likely to be a consequence of the high degree of recovery from the larger context 2586 (a Kitchen layer).

For the Upper Ward area (Site 485), 3,899 bones were counted, 1,478 identified at various taxonomic levels and 1,382 recorded as countable specimens.

The Round Tower site produced a number of scales from various areas, some of which were identified as belonging to perch and around 16 as scutes of Triglidae. From the Upper Ward area (Site 485) only few scales were recorded. As mentioned above, these elements are typically recovered through flotation and they have not been included in the analysis.

In all periods, the Round Tower material had a good level of completeness, as most elements represented by more than 50-75% (Table 5.2.2, Fig. 5.2.2). The preservation of the bone surface varied among periods, appearing good in material from the **11th** and **12th-14th c.** and medium for the **12th**, **13th**, **14th c.** material (Table 5.2.3, Fig. 5.2.3).

For the Upper Ward area, most bones were represented by more than 50%, with a medium level of preservation of the surface (Tables 5.2.4-5, Fig. 5.2.4-5).

5.2.3.1 Taxonomic frequencies

5.2.3.1.1 The Round Tower (Site 431)

Fine-sieved material (2 mm)

Only few remains were collected from the from the **11th**, **12th**, and **13th c**. 2 mm fraction. These belong to eel, herring, Cyprinidae and small Gadiformes (Table 5.2.6). The only substantial sample for this fraction is from the **14th c.** (Table 5.2.6, Fig. 5.2.6), where the total NISP is represented by herring for more than 70% of the identified material, followed by eel (15%) and Cyprinidae (8%). Cyprinidae remains are mostly unidentified vertebrae, while five bones were attributed to gudgeon and one respectively to dace, chub, dace/chub, barbel, and bleak (Table 5.2.7). Slightly more than 1% of the identified taxa are represented by Pleuronectiformes, with four specimens consistent with plaice and two with Pleuronectidae vertebrae. Other freshwater species are represented by bullhead (*Cottus perifretum*), with four remains.

The MNI for the **14th c.** material is consistent with NISP frequencies, with the most abundant species being herring (with 35 individuals) and eel (with four individuals) (Table 5.2.8).

Overall, for the **14th c.** (Table 5.2.9, Fig. 5.2.7), marine taxa dominate the assemblage (75%), while migratory (16%) and freshwater (8%) fish are much less frequent.

Coarse-sieved material (4 mm)

NISP calculation for the coarse-sieved sample shows two major taxa dominating in all periods: herring and eel (Table 5.2.6). The **11th c.** sample was too small to be used for comparison; also, the **12th-14th c.** sample was not used due to its uncertain chronology. A cursory evaluation, however, suggests that both samples are similar to other periods in the range of represented taxa.

The **12th c.** sample (Table 5.2.6, Fig. 5.2.8) shows nearly equal percentages of herring (38%) and eel (33%). Cyprinidae are represented (16%) by mostly unidentified remains, with dace and chub covering nearly 70% of the identified specimens, followed by roach (17%), and small quantities of gudgeon, barbel and bleak (Table 5.2.10, Fig. 5.2.9). Other taxa recovered in small proportions are the freshwater pike (3%) and perch (2%). Pleuronectiformes represent just over 1% of the identified taxa, with six remains belonging to plaice and three to Pleuronectidae vertebrae. For the Salmonidae family (1%) no specimen was identified to species. There is a dearth of Gadiformes, the most common being haddock (0.4 %); just a few other gadid bones were found: seven belonging to cod, four to the freshwater burbot, four to whiting and two to unidentified Gadiformes. One cleithrum of haddock showed hyperostosis, with the typical swelling and enlarged porosity of the bone tissue (von den Driesch 1994). The occurrence of other taxa is of marginal importance and no other freshwater species was recorded.

The MNI for the **12th c.** sample (Table 5.2.11), reflects mostly NISP frequencies but, with this quantification method, eel (14 individuals) is more frequent than herring (13 individuals); Cyprinidae follow with 11 individuals.

Overall, the **12th c.** sample is mostly represented by marine taxa (41%), but migratory (35%) and freshwater (24%) fish are still well represented (Table 5.2.12, Fig. 5.2.10).

For the **13th c.** sample (Table 5.2.6, Fig. 5.2.11) the rank of taxa largely differs from the previous period, with the exception of herring, which is still the most common taxa (45%). The second most abundant taxa are whiting (15 %), followed by eel (11%). Pleuronectiformes (10%) are represented mostly by unidentified specimens, with the exception of 11 remains belonging to plaice, 11 to plaice/flounder, two to sole and one to flounder. Cyprinidae (7%) are predominantly unidentified, but four remains were matched to dace, four to roach, one to chub and one to dace/chub (Table 5.2.10). Pike represents just over 3% of the identified material, while Triglidae and Gadiformes 2%. Apart from whiting, other Gadiformes presents are cod with five bones and haddock with four bones, one of which showing hyperostosis. Other taxa are sparsely represented; however, it is worth mentioning the presence of Salmonidae (nine bones) and perch (one bone).

Only herring reaches the threshold for MNI calculation and is represented by six individuals (Table 5.2.11).

Despite the small size of the sample, in the **13th c.** an increase in the proportion of marine taxa (74%) is apparent, while the occurrence of both migratory and freshwater fish dropped to 13% of the identified material (Table 5.2.12, Fig. 5.2.12).

The **14th c.** sample is by far the largest among all the periods (Table 5.2.6, Fig. 5.2.13). Herring (59%) shows an increase from previous periods and is in line with its frequency in the fine-sieved sample. Eel (13%) is the second most abundant species, followed by Cyprinidae (7%), again in percentages comparable to the fine-sieved sample. 85% of the Cyprinidae are unidentified bones and among the identified specimens more than 60% is represented by dace and chub, 22% by roach and small percentages by barbel, gudgeon, bleak and tench (Table 5.2.10, Fig. 5.2.9). Among Pleuronectiformes (7%), 141 remains were attributed to plaice, 98 to plaice/flounder, ten to flounder and nine to sole. Whiting is represented by 6% of the material, while other Gadiformes (3%) are present in small quantities; other species identified are cod (129 remains) and haddock (23 remains). One cleithrum and one supracleithrum of haddock showed hyperostosis. Pike and perch are poorly represented (about 1%). 53 specimens were attributed to Salmonidae and one to sturgeon (Acipenseridae), but too fragmented to be assigned to species (*Acipenser sturio*/*Acipenser oxyrinchus*).

The MNI for the **14th c.** material (Table 5.2.11, Fig. 5.2.14) reflects largely NISP taxa representation, with herring (76 individuals) been the most abundant species, while the gap between eel (33 individuals) and Cyprinidae (30 individuals) is smaller.

Habitat distribution for this period (Table 5.2.12, Fig. 5.2.15) varies little from the 13th c. sample, with marine taxa (75%) dominating the assemblage; there is a slightly higher incidence of migratory fish (15%) to the detriment of freshwater fish (11%).

Hand-collected material

The hand-collected sample provides a view of some of the larger species consumed at the site, which inevitably are undervalued in the sieved samples, especially from the 2 mm fraction. Hand-collected material was only recovered for 13th and 14th c. layers in small quantities.

Only 16 remains were retrieved from **13th c.** contexts, nine belonging to herring and the rest to mostly marine taxa (Table 5.2.6).

The **14th c.** sample (Table 5.2.6, Fig. 5.2.16) is visibly skewed towards larger species, as is typical for this type of recovery. Pleuronectiformes (33%) and Gadiformes (32%) have similar percentages, while herring (18%) has much less represented. Other 18 remains were attributed to pike, Salmonidae, Cyprinidae, Sparidae, eel and perch. Little information can be gained from this sample, dominated by marine taxa (Table 5.2.13).

5.2.3.1.2 The Upper Ward area (Site 485)

Fine-sieved material (2 mm)

NISP calculation for the Upper Ward sample (Table 5.2.14, Fig. 5.2.17), for the **late 12th-13th c**., shows a range of taxa largely similar to the sieved sample of the Round Tower, with herring (40%), eel (22%) and Cyprinidae (14%) being the most common species. More than 90% of the Cyprinidae remains could not be identified (Table 5.2.15); a small number of remains were attributed to dace, chub, roach and gudgeon. The occurrence of pike (6%) is slightly larger than in the Round Tower, and so is perch (4%). Pleuronectiformes (4%) are slightly more abundant than perch and again were mostly unidentified, but 21 specimens were matched with plaice, eight with plaice/flounder and one with flounder. Whiting represents slightly over 3% of the material and, within other Gadiformes (3%), nine bones were matched with cod and four with haddock. The presence of 13 Salmonidae remains is worth noticing.

The MNI provides similar results to NISP, with herring (26 individuals) as the most common species; according to the MNI, however, Cyprinidae (eight individuals) are more abundant than eel (seven individuals; Table 5.2.16).

Overall, this is the sample were the occurrence of marine taxa (50%) is the lowest, as a result of the higher presence of freshwater (26%) and migratory fish (24%) (Table 5.2.17, Fig. 5.2.18). This result is unlikely be biased by the fine sieving recovery method, as the higher proportion of marine remains in the other samples could mainly be explained through the abundance of the very small herring bones.

5.2.3.2 Anatomical element distribution

5.2.3.2.1 The Round Tower (Site 431)

The analysis of anatomical element distribution was performed for the seven more frequent taxa recovered from all sieved samples (Table 5.2.18).

For the **12th** and **13th c**. coarse-sieved material, herring is primarily represented by head bones (Group I). The most common anatomical elements for the **12th c.** are dentary, epihyal and caudal vertebrae (Fig. 5.2.19), with head and vertebrae equally represented (Fig. 5.2.20); for the **13th c.**, the most common element are caudal vertebrae, followed by opercular and preopercular (Fig. 5.2.21); head elements are slightly less well represented than vertebrae (Fig. 5.2.20).

For the **14th c.** fine-sieved material, herring is primarily represented by vertebrae, with the most common anatomical element being the first vertebra followed by anterior-abdominal vertebrae (Fig. 5.2.22); the head is by far less represented (Fig. 5.2.23). For the **14th c.** coarse-sieved sample, the species is mostly represented caudal vertebrae and ceratohyal (Fig. 5.2.24); vertebrae are little more abundant than head elements (Fig. 5.2.20).

The MAU for Cyprinidae, from the coarse-sieved sample, shows similar distribution for both **12th** and **14th c.**, where the taxon is mostly represented by vertebrae, with first vertebra and pre-abdominal vertebrae being the most common element (in reverse order for the **14th c.**; Fig 5.2.25-26); head elements are less abundant than vertebrae and the gap slightly increases in the **14th c.** (Fig. 5.2.27).

Likewise, eel MAU for coarse-sieved material shows similar results for the **12th** and **14th c.** (Fig. 5.2.28-29). The species is primarily represented by head bones (Group I), particularly in the **14th c.** (Fig. 5.2.30). The most common anatomical elements are dentary and parasphenoid for the **12th c.** and vomer and parasphenoid for the **14th c.**

Even eel recovered from **14th c.** fine-sieved samples is mostly represented by Group I head elements (Fig. 5.2.31), with dentary and ceratohyal as the most common anatomical elements. The percentage of vertebrae is higher than in coarse-sieved samples but still less abundant than the head (Fig 5.2.32).

For the **14th c.** coarse-sieved material, quadrate is the most common anatomical element for Pleuronectiformes, which is mostly represented by head elements (Group I) (Fig. 5.2.33), though only marginally so (Fig. 5.2.34).

The MAU for withing, **14th c.**, shows premaxilla and posterior-abdominal vertebrae being the most common anatomical elements (Fig. 5.2.35); MAU comparison for head skeleton versus vertebrae resulted in an identical percentage (Fig. 5.2.36).

For other large Gadiformes the most common anatomical area represented is head Group I (Fig. 5.2.37) as confirmed by MAU comparison where head elements double vertebrae (Fig. 5.2.38).

Finally, a small sample shows pike largely represented by head bones (Group I), with the most common anatomical element being basipterygium (Fig. 5.2.39); head elements double the MAU for vertebrae (Fig. 5.2.40).

5.2.3.2.2 The Upper Ward area (Site 485)

The analysis of the anatomical element distribution for the **late 12th-13th c.** fine sieved sample from the Upper Ward area was performed only for the three most frequent taxa (Table 5.2.19).

Herring is primarily represented by vertebrae, in particular first/second and anterior abdominal vertebrae (Fig. 5.2.41), with head unequivocally less represented (Fig. 5.2.42).

The most common anatomical elements for eel belong to the head Group I (vomer, basioccipital, Fig. 5.2.43), while, overall, vertebrae are much less represented (Fig. 5.2.44).

The MAU for Cyprinidae shows how the taxa is mostly represented by vertebrae, mainly posterior-abdominal and first vertebrae (Fig. 5.2.45); vertebrae double the MAU for elements from the head skeleton (Fig. 5.2.46).

5.2.3.3 Taphonomic alterations

5.2.3.3.1 The Round Tower (Site 431)

For the **12th c.** (Table 5.2.20) and **13th c.** (Table 5.2.21) taphonomic evidence is scanty, possibly reflecting the small size of the samples. Few bones appeared to be burned; one eel vertebra (13th c.) was crushed (mechanical and/or chemical bone deformation, Chapter 4) and a few butchery marks were recorded exclusively on vertebrae, with the exception of a cut on an eel cleithrum and a chop on Cyprinidae dentary (around 20-25 cm of total length), both from the 12th c. sample.

Plate 5.2.1: Chop mark on pike basipterygium (above) and chop on a vertebra of Salmonidae (below).

Even in the larger **14th c.** sample (Table 5.2.22), taphonomic alteration was not common; around 8% of the identified bones showed burning and less than 1% showed crushing and butchery marks. A variety of species was affected, the most relevant being herring, reflecting taxonomic frequencies. Eel shows the highest frequency of crushing evidence, while most butchery marks were recorded on vertebrae and bones from the cod pectoral skeleton (cleithrum, supracleithrum and posttemporal), four specimens belonging to individuals of more than 75 cm of total length. A cut mark and six chops were visible on eel vertebrae; two of these were precaudal vertebrae matching with a modern individual of 96 cm of total length. Other modifications worth mentioning are: one chop on an adult pike basipterygium (Plate 5.2.1) and one chop and some cuts on a pike dentary, with only the area of the symphysis preserved; one chop on a posterior-abdominal vertebra of Cyprinidae, possibly belonging to an individual of over 50 cm of total length; for Salmonidae, one chop on a vertebra (Plate 5.2.1) and one chop and cut on a vomer.

No taphonomic alteration was observed on material from **11th c.** or **12th-14th c.**, with the exception of crushing on a pike caudal vertebra, from the earlier period, and a burned eel vertebra, from the latter one.

5.2.3.3.2 The Upper Ward area (Site 485)

The taphonomic evidence recorded on the Upper Ward material (**12th-13th c.**) is summarised in Table 5.2.23. There is a significant incidence of burned bones, represented by 37% of the identified material and largely belonging to herring. Few bones showed crushing (less than 1%) and butchery marks were observed on only two remains: two cuts on the proximal end of a pike cleithrum and a chop on a perch anterior-abdominal vertebra (total length of around 30 cm).

5.2.3.4 Biometrical analysis

Within the Round Tower, a number of pike measurements were recorded for the **12th c.** (Fig. 5.2.47). The log ratio histogram shows the occurrence of a few scattered small/juvenile pike, while the bulk of measurements are distributed roughly in an unimodal manner around the red line marker of 34 cm in total length; the size here represented would be within the range of adult fish (for modern pike more than 17-40 cm of standard length; Kottelat & Freyhof 2007, 342). A few larger pikes are present, but none reaching 70 cm of total length (standard value 0).

For the **13th c.**, measurable bones for pike were scanty (Fig. 5.2.48), but it is possible to see how pike tends to be larger than in the previous phase. Juvenile pikes are not represented.

The sample for **14th c.** (Fig. 5.2.49) is by far the largest and most pike measurements fall within the range of adult fish, with a mean value slightly larger than in the 12th c. sample, but smaller than in the 13th c. sample. Small younger pikes are infrequent and the distribution for the larger catch peaks around the red line (34 cm of total length) and is, on average, well below the standard value (0). Only ten bones were equal or larger than the standard (0), some even approaching one meter in length; one broken dentary was matched by visual comparison with a modern specimen with a total length of 1 m.

Only a few measurements were available for pike for **11th c.** and **12th-14th c.**, where the species mostly resulted to be slightly larger than the red line marker of 34 cm in total length.

Measurements for pike from the **late 12th-13th c.** Upper Ward Site (Fig. 5.2.50), show the smallest mean value registered, slightly lower than the red line (34 cm of total length); no large pike was recovered. The measurements plot heterogeneously around the mean, equally split between juvenile and adult individuals.

Measurements for perch recovered within the Round Tower are more limited. For the **11th c.** century only three bones were measured, two of these belonging to individuals larger than the standard value (total length over 27.5 cm).

The log ratio histogram for the **12th c**. perch (Fig. 5.2.51) shows a roughly bimodal distribution of the measurements and a concentration of individuals of a size slightly smaller than the standard (standard length: 24 cm) and comparable to a modern adult perch (standard length: 20 cm, Kottelat & Freyhof 2007). The few larger perch could represent female individuals, as female perches tend to grow larger than males (*ibid.*, 530-531).

For the **13th c.** perch, the only bone measured were smaller than the standard.

Similarly to the 12th c., the distribution of measurements for perch for the **14th c.** (Fig. 5.2.52) seems approximately bimodal. The main concentration probably represents the smallest adult individuals, while the second peak includes larger perch, probably females.

The Log ratio histogram for perch recovered from the Upper Ward Site, **late 12th-13th c.** (Fig. 5.2.53), shows a size distribution largely similar to the 14th c. sample; with a rough bimodal distribution around the standard value and a predominance of smaller individuals.

In order to increase the sample size, measurements for Cyprinidae are here grouped by family, which means that different taxa are likely to contribute to the variability (Chapter 4). The standard used to produce log ratio histograms is a modern roach of 19 cm of total length and 15 cm of standard length.

Very few measurements were available for Cyprinidae from the Round Tower for the **11th c.** and **12th-14th c.** and they tend to be larger than the standard value, so with a total length of over 19 cm.

From the **12th c.** sample, there is a greater number of measurements (Fig. 5.2.54) and they plot in an approximately unimodal manner around the mean value, slightly larger than the standard; some bones are clearly larger than the standard and possibly belonging to individuals that could reach 50 cm of standard length (the largest Cyprinidae species from the assemblage can grow up to 50-90 of standard length cm in modern individuals, Kottelat & Freyhof 2007). Six larger caudal vertebrae, which by recording protocol were excluded from the ratio (Chapter 4), were recovered from this phase with measurements three times those of the first caudal vertebra of the standard and one vertebra resulted four times larger.

In the **13th c.**, the size of the Cyprinidae (Fig. 5.2.55) is larger than in the previous period, but the sample size is much smaller. Small Cyprinidae are largely absent and most of the bones tend to be slightly larger than the standard - over 19 cm of total length. The larger outliers could possibly reach 50 cm of standard length. Three caudal vertebrae, excluded from the ratio, had measurements doubling those of the first caudal vertebra of the standard and other two caudal vertebrae were three times as large.

Cyprinidae measurements for the **14th c.** (Fig. 5.2.56) represent once again the largest sample for the taxa. There is a wide range of measurements, which is not surprising as different species are represented, mostly concentrated around the standard value. Overall, the Cyprinidae appear to be smaller than in previous periods, but very small Cyprinidae are scarce. A few bones could possibly match individuals reaching 50 cm of standard length. Among the numerous caudal vertebrae recovered, 18 were double the size of the first caudal of the standard, five were about three time its size and two, four times the size.

A good number of bones were measured for Cyprinidae recovered in the Upper Ward Site, from the late **12th-13th c.** (Fig. 5.2.57). The average size is slightly smaller than in previous periods and most measurements plot over a limited range in a unimodal manner. Again, recovery method could have biased the sample towards smaller values. A few specimens are especially large, more than any found in the Round Tower material, so likely to be larger than 50 cm of standard length. Two caudal vertebrae were recovered from this area with measurements doubling those of the first caudal vertebra of the standard and one caudal vertebra was three times as large.

Plate 5.2.2: Broken pharyngeal bone belonging to barbel.

Overall, 81 pharyngeal bones for Cyprinidae were measured for all the phases (Fig. 5.2.58). Only two of these were recovered from the Upper Ward Site and belonged to dace; the remaining 79 were recovered from Round Tower from **12th c.** to **14th c**. The scatter plot shows how the smallest species are gudgeon and bleak; a group of bones of similar size belong to dace, chub, and roach, with roach been the largest of the group; barbel is within this range of measurements but, because of the different shape of the bone, it does not fall into this cluster. The largest specimen is represented by a chub outlier. A broken pharyngeal bone belonging to barbel (Plate 5.2.2) was recovered from the 14th c. sample. This was too large to be visually compared with the modern barbels of the reference collection, but it was larger than a tench of 37 cm of total length.

Eel measurements from the Round Tower for the **11th c.** (Fig. 5.2.59) are represented by a small sample and are generally smaller than the marker of 49 cm of total length (red line), although some larger outliers are present.

The **12th c.** eel is represented by a good sample size (Fig. 5.2.60) distributed unimodally over a wide range of measurements; the mean value is larger than in the previous phase but still smaller than the red line marker and most of the measurements plot within the stage of yellow/silver eel (over 30 cm of total length; Tesch 2003, 150). Some smaller individuals are present, and a few very large outliers could possibly represent female silver eel over 1 meter of total length (considering that males rarely grow beyond 54 cm of total length; Tesch 2003, 168). A caudal vertebra was recovered from this period with measurements nearly equal to the first caudal vertebra of the standard (0).

For the **13th c.,** a small sample of measurements appears to plot between the two standards, representing yellow/silver eel (Fig. 5.2.61). The presence of smaller eel is scanty, which corresponds to an increase of the mean value and again very large individuals are present.


Plate 5.2.3: Epihyal belonging to large eel.

The largest sample of eel measurements is from the **14th c.** (Fig. 5.2.62). The log ratio histogram for this period shows a wide range of measurements, representing various stages of life of the fish; there is a concentration of individuals slightly smaller than the marker of 49 cm of total length (red line), while larger eel seem to distribute sinusoidally up to the standard value (0) of 96 cm of total length. Some of the largest eels from this period must have been more than 1 meter in total length, and almost certainly female silver eels (Plate 5.2.3). Some broken bones (one caudal vertebra, one hyomandibular, two vomers) could not be measured but were larger than the standard (0), therefore more than 96 cm in total length.

The mean value for the **12th-14th c.** sample (Fig. 5.2.63) does not differ from those of the 12th c. and 14th c.

A reasonable sample of eel measurements could be obtained from the Upper Ward Site, **late 12th-13th c.** (Fig. 5.2.64). As observed for other taxa, eel from this site has one of the smallest means (only the 11th c. eels are, on average, smaller), which could again reflect the recovery method. The measurements are distributed in a sinusoidal manner, with the main peak being smaller than the red line marker and probably still within the range of yellow/silver eel. Larger eels are infrequent but some very large female eels, comparable with the large 14th c. individuals, are present, likely over 1 meter of total length.

5.2.4 Discussion

As mentioned above, when comparing data from different periods it is fundamental to consider sample size differences and comparability of recovery methods; in this regard, the largest sample with better recovery is from the 14th c. As consequence of different sample size among periods and the uncertainty of some phasing, the discussion will focus on diachronic changes between the 12th c. and 14th c.

In all periods, herring is the most common species. Considering the small size of this fish, this is indicative of efficient recovery. The frequency rank of herring, eel, and Cyprinidae is constant throughout the chronological sequence, with the exception of the less reliable 13th c. sample, where whiting is the second most common species. The relative frequency of herring in comparison to other species increases through centuries. This is probably related to the more general phenomenon of increased reliance on marine resources from the 11th c. onwards (Barrett 2004a, 2004b; Chapter 2).

Pike seems to have had a significant role in the diet in the earlier phases and especially in the Upper Ward, but, from the 13th c. onwards, it declines, mainly at the expenses of Pleuronectiformes, particularly plaice. Perch seems to have been subjected to a similar decline. Whiting was commonly consumed from the 13th c. onwards, possibly following the trend seen for herring, while other large Gadiformes (cods etc.) are rarer, though present in each period. Locker (2018a) suggests that the poor representation of larger taxa could result from the practice of clearing larger debris from the floor, which favoured smaller specimens to be recovered from floor levels. However, the hand-collected sample provides a view of the largest species consumed at the site, the most important of which are plaice, cod, haddock and ling. We must also consider the larger amount of flesh provided by larger species (e.g. cod, pike, silver eel) compared to the smallest herring, in order to evaluate their contribution to human diet properly. Salmonidae seems to have had a very minor role, but we must consider that their bones do not tend to preserve well (Hamilton-Dyer 2007, 181). The contribution of other taxa (e.g. Sparidae, Triglidae) was negligible.

The single sturgeon specimen from the 14th c. is important as this species had an high social/economic value in medieval England, especially after the 12th c., when it became rarer due to fishing pressure and human modification of its habitat (Hoffmann 2005, 2008; Chapter 2)

Overall, it seems that from the 12th to the 14th c. there is an increased focus on marine taxa. Additionally, as mentioned above, a high degree of control of freshwater resources from the royal court is documented, mentioning several fishponds, fisheries and fishing rights on the river Thames. This is well reflected in the variety of freshwater catch (eel included) consumed at the site. The fishponds would have provided the larger Cyprinidae (roach, chub, barbel, tench and the bream identified by Locker, 2018a) and dace, pike, perch and eel. Conversely, Salmonidae, some of the perch, eel and the larger pikes would have been fished from the river

Thames and its streams. The Thames estuary would have been the source of plaice and flounder (which can also swim several kilometres upriver) and possibly also the smallest eel, which at the stage of glass eel/elver can be found in estuaries, while they start their inland movement from roughly 7-8 cm of total length (Churchward 1996 in Tesch 2003, 137). When sexually mature, silver eels swim downstream rivers to the spawning ground (the Sargasso Sea), so the larger female silver eels found at Windsor could have been caught during their autumn migration (Chapter 1).

The distribution of pike measurements for the earlier periods tend to be diverse, but with a focus on adult individuals. Approaching the 14th c., the distribution of pike sizes, with the exception of some outliers, seems to become bimodal. Modern pike total length does not change significantly between sexes (Senay *et al.* 2017), therefore it is unlikely that the two peaks could represent the two sexes. This bimodal distribution of pike sizes could represent a seasonal exploitation or different fishing sources (i.e. fisheries and ponds). The largest pikes would have been sourced from the natural environment as too aggressive to be grown in ponds, and they could represent a targeted catch.

The relative low proportion of small Cyprinidae (below 15 cm total length) and small perch could suggest a managed exploitation of the ponds, where the animals would be grown up to an optimal weight/size before being culled. The smallest individuals could represent an accidental catch or the stomach content of a larger predator (pike, perch). Small freshwater fish tend to be tasteless and bony, but in the Middle Ages it was consumed both fresh and preserved (Locker 2018a). The similar bimodal distribution for perch and Cyprinidae for the 14th c. could represent again seasonal exploitation of the ponds. In the case of Cyprinidae, the clusters could represent different age groups of a combination of the larger species (tench, roach, chub), while the smallest values would represent the youngest individual and/or the smallest species (bleak, gudgeon).

As mentioned above, eel size shows how the fish was caught at a variety of life stages. In the Upper Ward sample, the sinusoidal distribution could be representative of periodical supply.

Overall, most taxa have sizes comparable to adult age, possibly showing how a controlled management that spared smaller individuals, but also reflecting the use of fishponds as *servitoria*, as described by historical sources.

The anatomical element distribution for herring shows how the fish was probably eaten whole. A clear prevalence of vertebrae is visible from the fine-sieved samples, but this is likely to be the result of a taphonomic bias, considering that head bones tend to be particularly fragile and difficult to be identified when highly fragmented. However, it cannot be excluded that the fish was purchased beheaded in some case. Herring was likely to be consumed in a preserved form (e.g. pickled, dried or salted), with gutting being the only preparatory action, but there is evidence of some preservation techniques where the fish was beheaded and for instance sprinkled in salt (Van Neer & Ervynck 2004, 210). Considering the relative short distance of the site from the coast, there could have been occasions when the fish would have been consumed fresh, especially during seasonal spawning migrations when schools of herring swam near the shore (Camphuysen & Henderson 2017, 75).

Small Cyprinidae would have also been eaten whole, either fresh in pies, pastries and soup or preserved (e.g. pickled; Locker 2018a). The prevalence of vertebrae in the fine-sieved sample, as in the case of herring, could be due to taphonomic bias against the more fragile Cyprinidae head elements.

For eel and pike, the relatively small number of vertebrae could indicate that the fish was served without heads and these were disposed of elsewhere (Hamilton-Dyer 2007, 182). However, in the fine-sieved sample from the 14th c., eel is represented by similar percentages of vertebrae and head elements. There is the possibility that the smallest individuals were eaten whole, whilst the largest eels were prepared differently; however, there could also be a bias in the coarse-sieve sample, where the smallest caudal vertebrae where not retrieved. Considering the availability of fish in the ponds, it is very likely that eel was consumed both fresh and preserved (e.g. smoked, salted).

Plaice and flounder were probably served whole, fresh or salted. The same is the case for whiting, a small Gadidae that could have been caught in the Thames estuary, and then eaten in both fresh, salted and preserved forms. Body parts distribution for larger Gadiformes does not suggest curation techniques by removal of the head (e.g. stockfish); however, specifically for the case of cod, a prevalence of elements from the body and the presence of butchery marks on vertebrae and near the gills area could suggest decapitation and possibly preservation. The presence of scales or scutes can indicate on-site cleaning (e.g. Bond & O’Connor 1999) and this seems to be the case for perch and Triglidae. The very few remains of Salmonidae could represent some relatively rare river catch, which would imply that they were consumed fresh. However, the medieval tradition for salmon to be stored, dry-salted and smoked is documented, therefore this type of preparation cannot be excluded (Locker 2018a, 18).

Evidence of burning is visible on the bones of different species, but in particular on herring from the Upper Ward area; burning evidence generally indicates the disposal of kitchen and/or meal waste into a fire and it is typical of kitchen deposits. There is a higher concentration of herring burned bones, which could possibly reflect the consumption of cooked fresh fish.

Some small specimens (herring, eel, Cyprinidae) show evidence of bone deformation and erosion which generally is characteristic of human consumption and digestion (Jones 1984, 1986). The bones of other larger species (pike, Pleuronectiformes, Cyprinidae) appeared mechanically crushed which is typically associated with trampling; however, certain cooking preparations required the pressing and pounding of the fresh or dried fish and could leave this type of marks on bones (e.g. Wubs-Mrozewicz 2009; Davidson 2012); therefore, human agency cannot be excluded.

Butchery marks on small species (e.g. herring, small Cyprinidae) is associated with consumption. Chops on the vertebrae of larger species (eel, pike, Salmonidae) could suggest the splitting of the carcasses into pieces. A cut on an eel cleithrum could represent the decapitation of the fish. A chop on a pike and Cyprinidae dentary, and a cut and chop on a Salmonidae vomer could result from an attempt to extract the hook or tongue removal (Barrett 1997, 13; Wheeler & Jones 2009, 66). A chop on a pike basipterygium could represent the cutting of the pelvic fin or degutting of the fish.

In conclusion, the bulk of the fish diet was covered by marine fish, which would have been eaten as preserved or fresh, in the latter case possibly brought directly to the castle via fishmonger (as the costumers could have afforded the cost of transport). Herring appears to have been a staple food at the site. When the court was at the castle, a valuable quantity of fish for the royal table would have been guaranteed by the royal ponds and fisheries on the Thames, from which the supply could have been seasonal during certain periods.

Considering the contexts and the above evidence, the assemblages from the two sites seem to represent mostly kitchen refuse and table waste; however, the presence of digested bones also suggests the occurrence of cesspit refuse.

Completeness	late 11th c.	12th c.	13th c.	14th c.	late 12th-14th c.
> 75% present	30	538	109	2532	40
75-50% present	52	1114	512	5727	173
50-25% present	20	179	78	1075	13
< 25% present	3	22	14	329	9

Table 5.2.2: Bone completeness by chronology in the Round Tower (Site 431), all recovery methods.

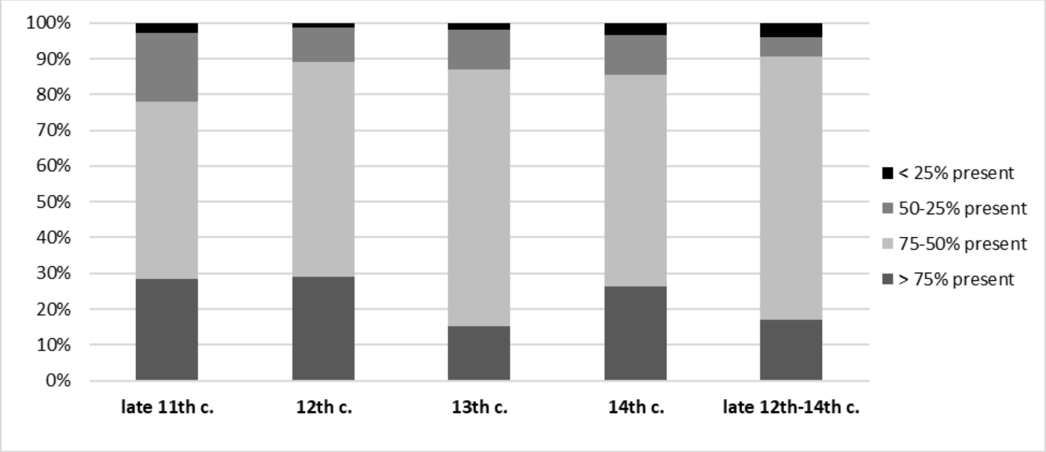


Fig. 5.2.2: Percentage of bone completeness by chronology (**late 11th c.**, NISP: 105; **12th c.**, NISP: 1853; **13th c.**, NISP: 713; **14th c.**, NISP: 9663; **late 12th-14th c.**, NISP: 235) in the Round Tower (Site 431), all recovery methods.

Preservation	late 11th c.	12th c.	13th c.	14th c.	late 12th-14th c.
Excellent	0	7	0	81	0
Good	79	555	195	2509	128
Medium	26	1275	510	7042	107
Bad	0	16	8	31	0
Awful	0	0	0	0	0

Table 5.2.3: Bone preservation by chronology in the Round Tower (Site 431), all recovery methods.

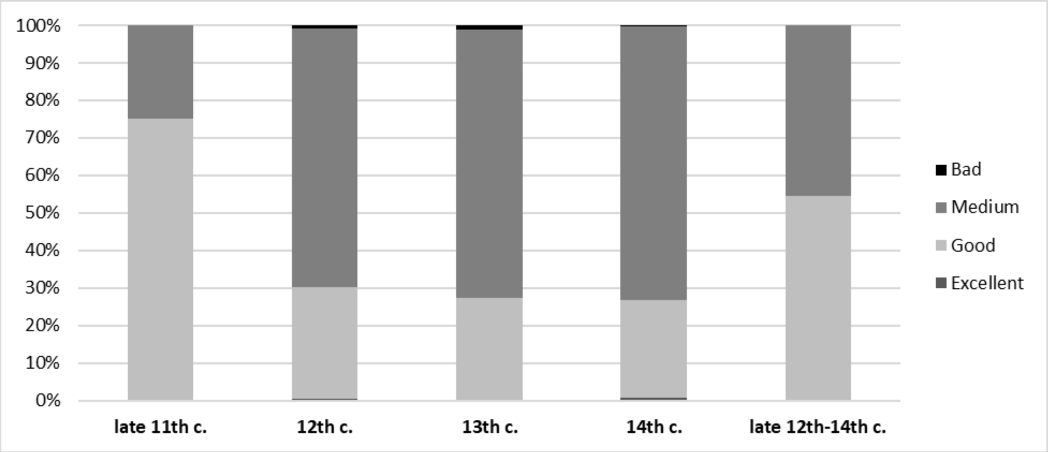


Fig. 5.2.3: Percentage of bone preservation by chronology (**late 11th c.**, NISP: 105; **12th c.**, NISP: 1853; **13th c.**, NISP: 713; **14th c.**, NISP: 9663; **late 12th-14th c.**, NISP: 235) in the Round Tower (Site 431), all recovery methods.

Completeness	late 12th-13th c.
> 75% present	524
75-50% present	655
50-25% present	157
< 25% present	46

Table 5.2.4: Bone completeness by chronology from the Upper Ward excavation (Site 485), all recovery methods.

Preservation	late 12th-13th c.
Excellent	13
Good	366
Medium	999
Bad	4
Awful	0

Table 5.2.5: Bone preservation by chronology from the Upper Ward excavation (Site 485), all recovery methods.

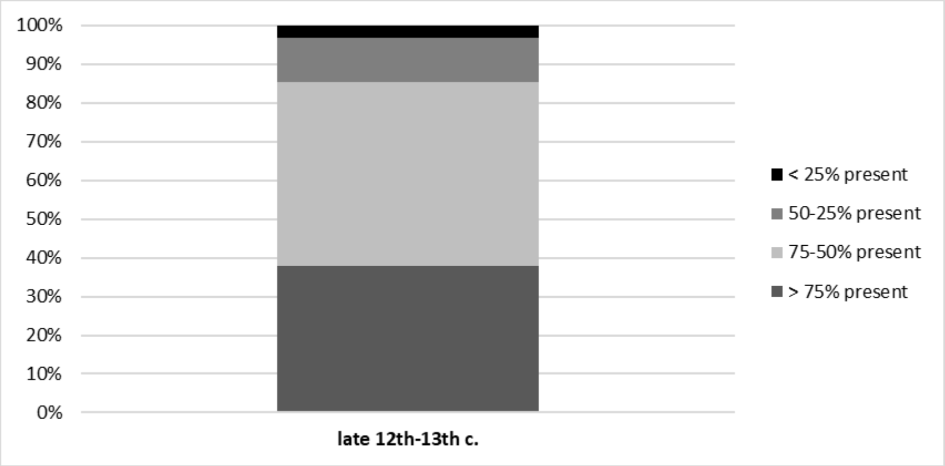


Fig. 5.2.4: Percentage of bone completeness by chronology (**late 12th-13th c.**, NISP: 1382) from the Upper Ward excavation (Site 485), all recovery methods.

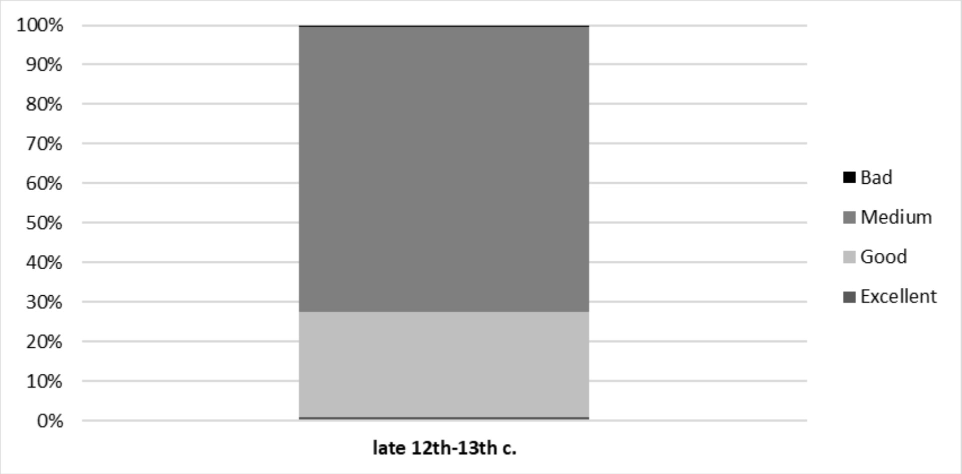


Fig. 5.2.5: Percentage of bone preservation by chronology (**late 12th-13th c.**, NISP: 1382) from the Upper Ward excavation (Site 485), all recovery methods.

TAXA		late 11th c.		12th c.		13th c.			14th c.			late 12th-14th c.	TOT
Latin name	**Common name**	**FS**	**CS**	**FS**	**CS**	**FS**	**CS**	**H-C**	**FS**	**CS**	**H-C**	**CS**	
Clupea harengus	Atlantic herring	0	14	1	709	3	301	9	777	4996	21	56	6866
Anguilla anguilla	European eel	9	47	0	613	0	76	0	167	1108	1	71	2091
Cyprinidae	-	1	9	0	289	1	53	0	80	635	4	24	1092
Merlangius merlangus	Whiting	0	0	0	4	0	105	2	3	510	8	22	646
Pleuronectiformes	-	0	7	0	28	0	46	1	8	364	16	17	471
Esox lucius	Northern pike	0	10	0	72	0	26	0	0	127	5	18	253
Gadiformes	-	0	0	0	2	1	8	0	7	174	14	1	193
Pleuronectes platessa	European plaice	0	0	0	6	0	11	0	4	141	10	0	162
Perca fluviatilis	European perch	1	5	0	50	0	1	0	0	81	1	8	146
Gadus morhua	Atlantic cod	0	0	0	7	0	5	0	0	129	10	1	142
Pleuronectes platessa/Platichtys flesus	European plaice/flounder	0	0	0	3	0	11	0	2	98	11	2	116
Salmonidae	-	0	1	0	27	0	9	0	0	53	5	5	95
Triglidae	-	0	0	0	0	0	18	2	0	36	0	7	63
Scomber scombrus	Atlantic mackerel	0	1	0	8	0	0	0	0	39	0	1	49
Melanogrammus aeglefinus	Haddock	0	0	0	10	0	4	0	0	23	2	0	37
Leuciscus Leuciscus/Squalius cephalus	Common dace/Chub	0	0	0	8	0	0	0	1	12	0	0	21
Rajidae	-	0	0	0	0	0	5	0	0	12	0	1	18
Leuciscus Leuciscus	Common dace	0	0	0	5	0	0	0	1	9	0	1	16
Conger conger	European conger	0	0	0	0	0	9	0	0	5	0	0	14
Solea solea	Common sole	0	0	0	0	0	2	1	0	9	0	0	12
Rutilus rutilus	Roach	0	0	0	3	0	0	0	0	9	0	0	12
Platichthys flesus	European flounder	0	0	0	0	0	1	0	0	10	0	0	11
Barbus barbus	Barbel	0	0	0	1	0	0	0	0	6	0	0	7

TAXA		late 11th c.		12th c.		13th c.			14th c.			late 12th-14th c.	TOT
Latin name	**Common name**	**FS**	**CS**	**FS**	**CS**	**FS**	**CS**	**H-C**	**FS**	**CS**	**H-C**	**CS**	
Clupeidae	-	0	0	0	0	0	0	0	1	4	0	0	5
Sparidae	-	0	0	0	0	0	0	1	0	4	2	0	5
Lota lota	Burbot	0	0	0	4	0	0	0	0	0	0	0	4
Cottus perifretum	Bullhead	0	0	0	0	0	0	0	4	0	0	0	4
Gasterosteus aculeatus	Three-spined stickleback	0	0	0	0	0	0	0	1	2	0	0	3
Spondyliosoma cantharus	Black seabream	0	0	0	1	0	1	0	0	1	0	0	3
Molva molva	Ling	0	0	0	0	0	0	0	0	2	2	0	2
Gobio gobio	Gudgeon	0	0	0	0	0	0	0	1	1	0	0	2
Squalius cephalus	Chub	0	0	0	1	0	0	0	0	1	0	0	2
Chelidonichthys lucerna	Tub gurnard	0	0	0	0	0	0	0	0	2	0	0	2
Belone belone	Garfish	0	0	0	1	0	0	0	0	0	0	0	1
Alosa sp.	-	0	0	0	0	0	0	0	1	0	0	0	1
Trachurus trachurus	Atlantic horse mackerel	0	0	0	0	0	0	0	0	1	0	0	1
Tinca tinca	Tench	0	0	0	0	0	0	0	0	1	0	0	1
*Alburnus alburnus**	Bleak	0	0	0	*	0	0	0	*	*	0	0	0
Acipenseridae*	-	0	0	0	0	0	0	0	0	*	0	0	0
*Raja clavata**	Thornback ray	0	0	0	*	0	*	0	0	*	0	0	0
	TOTAL	105		1853		713			9775			235	12681

Table 5.2.6: NISP of taxa by chronology based on diagnostic elements (other records noted as *) for fine-sieved (FS: mesh 2 mm), coarse-sieved (CS: mesh 4 mm) and hand-collected material (H-C) for the Round Tower material (Site 431). Acipenseridae* is represented by fragment of the cranium, Alburnus alburnus* is represented by pharyngeal plate, Raja clavata* is represented by dermal denticle.

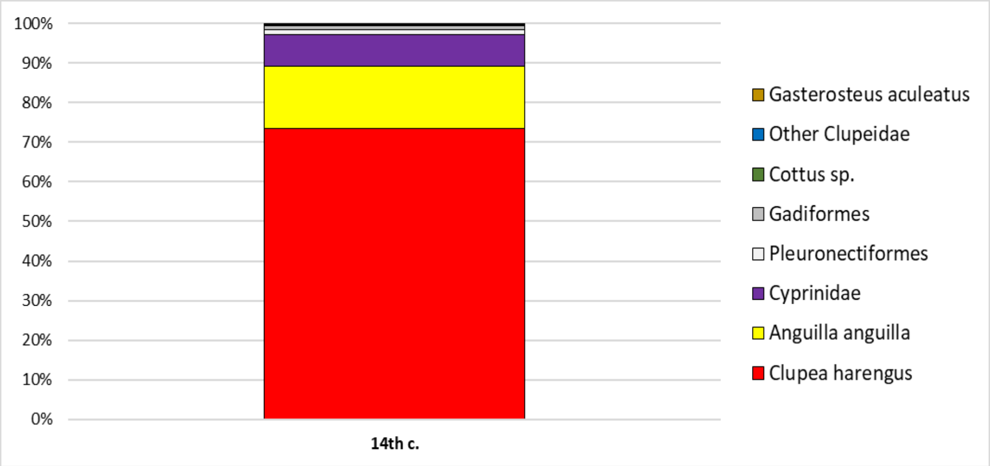


Fig. 5.2.6: Frequencies for the 8 most common taxa for **14th c.** (NISP: 1058), for fine-sieved material (mesh 2mm) from the Round Tower (Site 431). Threshold by phase: tot NISP ≥ 100.

TAXA	late 11th c.	13th c.	14th c.
Gobio gobio	0	0	5
Leuciscus leuciscus	0	0	1
Squalius cephalus	0	0	1
Leuciscus leuciscus/Squalius cephalus	0	0	1
Barbus barbus	0	0	1
Alburnus alburnus	0	0	1
Cyprinidae unid.	1	3	91

Table 5.2.7: NISP for the Cyprinidae family by chronology for the Round Tower material (Site 431) for fine-sieved (mesh 2 mm) material based on all counted specimens and pharyngeal bones; although regarded as not countable, pharyngeal bones will be represented in this table because they have been consistently recorded for all Cyprinidae.

TAXA	14th c.	An.E.
Clupea harengus	35	PCV1
Anguilla anguilla	4	CE/B

Table 5.2.8: MNI for **14th c.** for main taxa for fine-sieved material (mesh 2 mm) from the Round Tower (Site 431). Threshold by phase: taxa NISP > 100. **An.E.** is the anatomical element used for MNI calculation. B: basioccipital, CE: ceratohyal, PCV1: first precaudal vertebra.

HABITAT	11th c.	12th c.	13th c.	14th c.
Freshwater	2	0	1	87
Marine	0	1	3	785
Migratory	9	0	0	169
Other	0	0	1	17

Table 5.2.9: Taxa habitat distribution by chronology, for fine-sieved (mesh 2 mm) material from the Round Tower (Site 431).

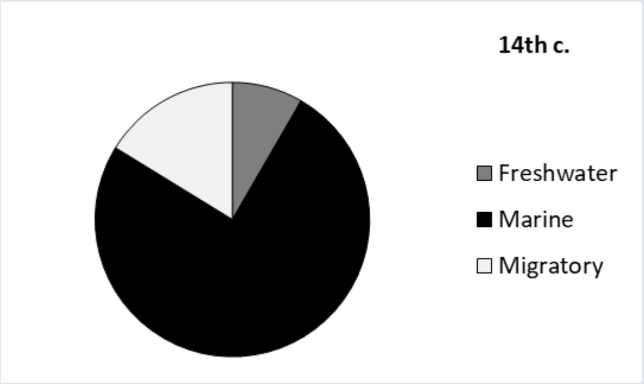


Fig. 5.2.7: Frequencies of habitat distribution for **14th c.** (NISP: 1041) for fine-sieved (mesh 2 mm) material from the Round Tower (Site 431). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

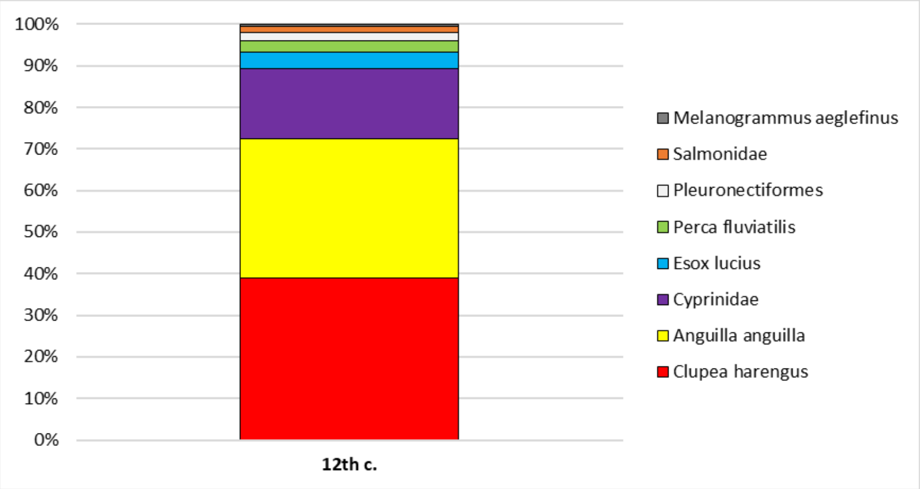


Fig. 5.2.8: Frequencies for the 8 most common taxa for **12th c.** (NISP: 1825) for coarse-sieved material (mesh 4 mm) from the Round Tower (Site 431). Threshold by phase: tot NISP ≥ 100.

TAXA	late 11th c.	12th c.	13th c.	14th c.	late 12th-14th c.
Leuciscus leuciscus	0	16	4	36	2
Rutilus rutilus	0	8	4	26	0
Squalius cephalus	1	6	1	19	0
Leuciscus leuciscus/Squalius cephalus	0	9	1	15	0
Barbus barbus	0	2	0	11	0
Gobio gobio	0	3	0	5	0
Alburnus alburnus	0	1	0	1	0
Tinca tinca	0	0	0	2	0
Cyprinidae unid.	5	265	56	665	20

Table 5.2.10: NISP for the Cyprinidae family by chronology for the Round Tower material (Site 431) for coarse-sieved (mesh 4 mm) material based on all counted specimens and pharyngeal bones; although regarded as not countable, pharyngeal bones will be represented in this table because they have been consistently recorded for all Cyprinidae.

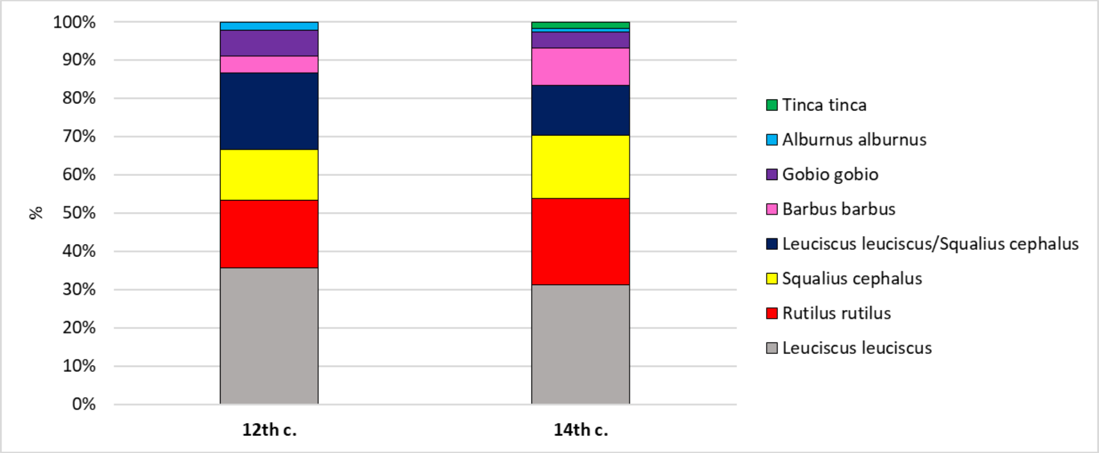


Fig. 5.2.9: Frequencies of species for the *Cyprinidae* family for **12th c.** (NISP: 45) and **14th c.** (NISP: 115) for coarse-sieved (> 4 mm) material. Threshold by phase: tot NISP ≥ 25.

TAXA	12th c.	An.E.	13th c.	An.E.	14th c.	An.E.
Clupea harengus	13	various	6	MAX/PRE	76	CE
Anguilla anguilla	14	D	/	/	33	VOM
Cyprinidae	11	B	/	/	30	PCV1
Pleuronectiformes	/	/	/	/	15	Q
Merlangius merlangus	/	/	/	/	11	PX
Large Gadiformes	/	/	/	/	4	various
Esox lucius	/	/	/	/	3	BAP

Table 5.2.11: MNI by chronology for main taxa for coarse-sieved material (mesh 4 mm) from the Round Tower (Site 431). Within Large Gadiformes, *Lota lota* is excluded. Threshold by phase: taxa NISP > 100. **An.E.** is the anatomical element used for MNI calculation. B: basioccipital, BAP: basipterygium, CE: ceratohyal, D: dentary, PCV1: first precaudal vertebra, PX: premaxilla, Q: quadrate, VOM: vomer, /: threshold requirement no fulfilled.

HABITAT	11th c.	12th c.	13th c.	14th c.	late 12th-14th c.
Freshwater	24	433	80	882	51
Marine	15	748	467	6015	88
Migratory	48	640	85	1173	76
Other	7	31	60	535	20

Table 5.2.12: Species habitat distribution by chronology, for coarse-sieved (mesh 4 mm) material from the Round Tower (Site 431).

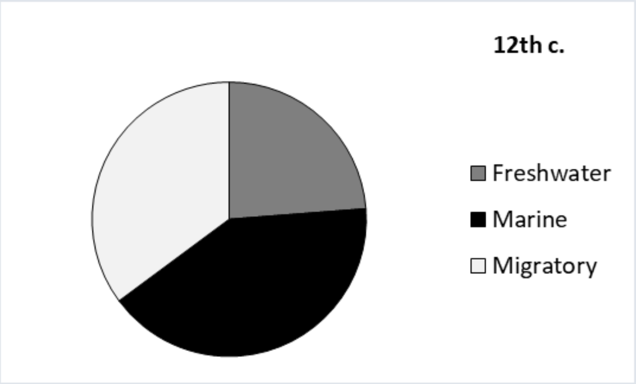


Fig. 5.2.10: Frequencies of habitat distribution for **12th c.** (NISP: 1821) for coarse-sieved (mesh 4 mm) material from the Round Tower (Site 431). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

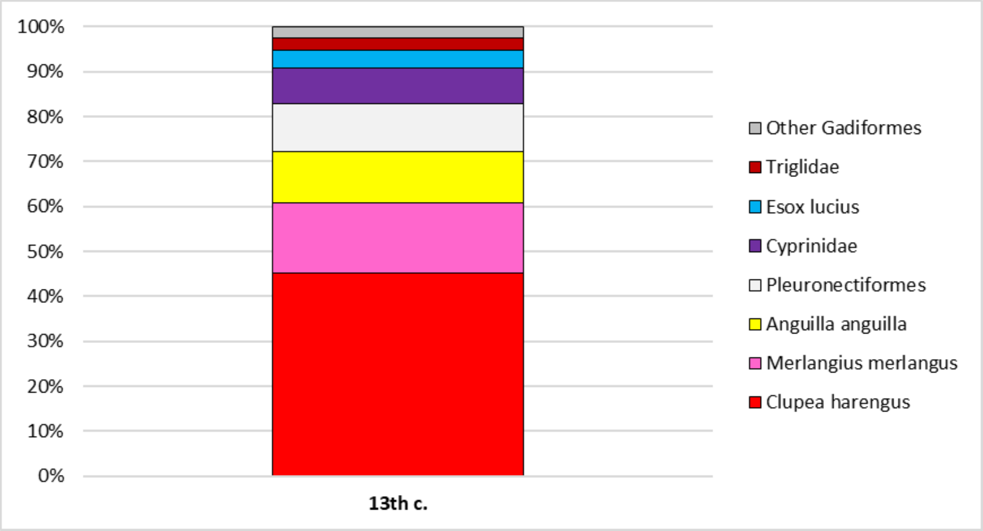


Fig. 5.2.11: Frequencies for the 8 most common taxa for **13th c.** (NISP: 667) for coarse-sieved material (mesh 4 mm) from the Round Tower (Site 431). Threshold by phase: tot NISP ≥ 100.

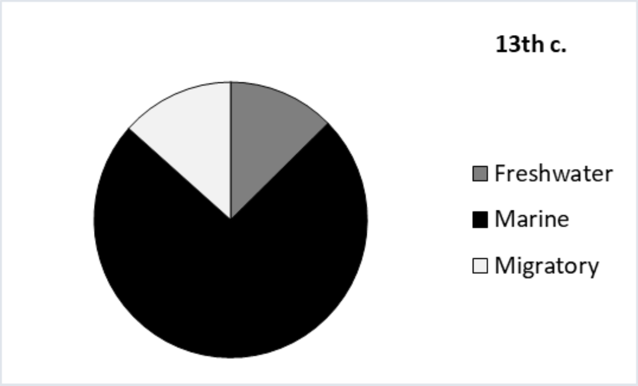


Fig. 5.2.12: Frequencies of habitat distribution for **13th c.** (NISP: 632) for coarse-sieved (mesh 4 mm) material from the Round Tower (Site 431). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

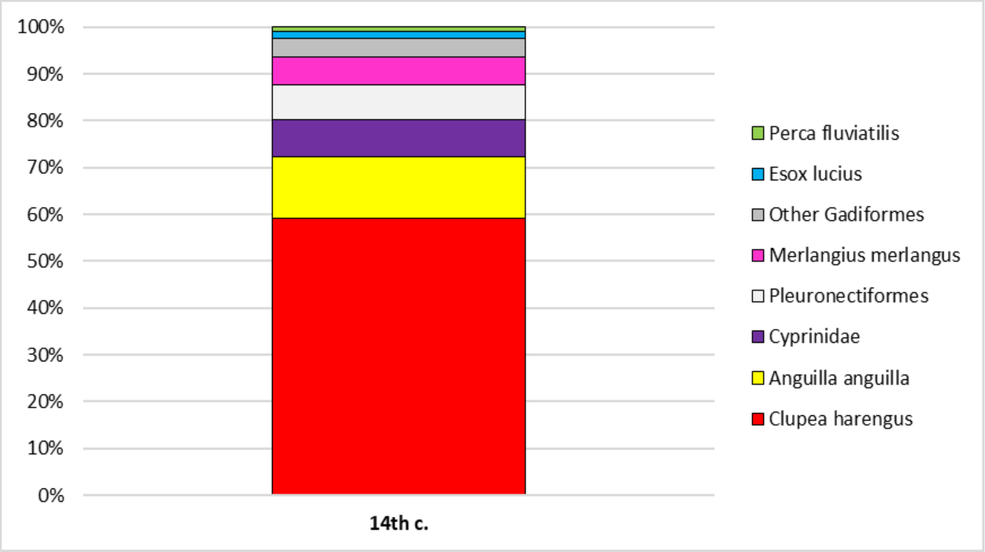


Fig. 5.2.13: Frequencies for the 8 most common taxa for **14th c.** (NISP: 8445) for coarse-sieved material (mesh 4 mm) from the Round Tower (Site 431). Threshold by phase: tot NISP ≥ 100.

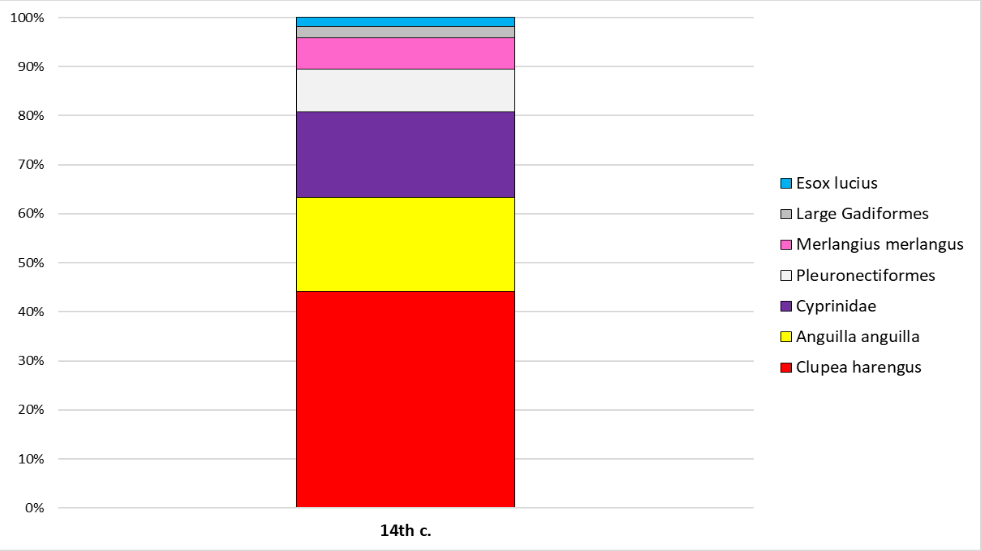


Fig. 5.2.14: MNI total n (172) for main taxa for **14th c.**, coarse-sieved (mesh 4 mm) material, from the Round Tower (Site 431). Threshold by phase: taxa NISP ≥ 100.

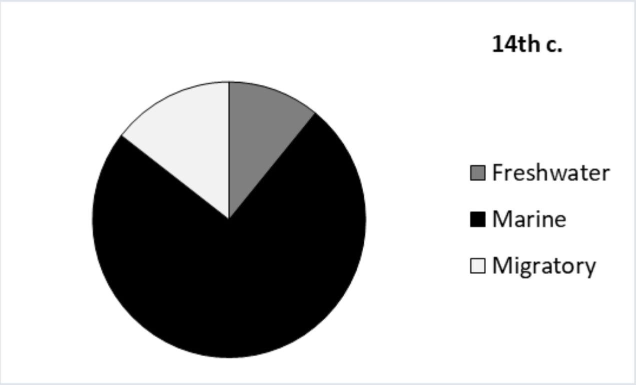


Fig. 5.2.15: Frequencies of habitat distribution for **14th c.** (NISP: 8070) for coarse-sieved (mesh 4 mm) material from the Round Tower (Site 431). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

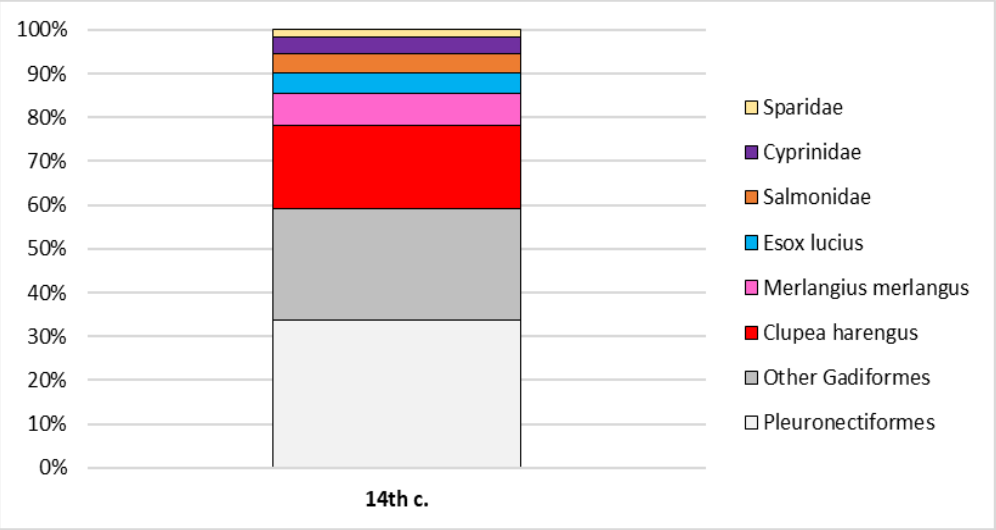


Fig. 5.2.16: Frequencies for the 8 most common taxa for **14th c.** (NISP: 111) for hand-collected material from the Round Tower (Site 431). Threshold by phase: tot NISP ≥ 100.

HABITAT	13th c.	14th c.
Freshwater	0	10
Marine	15	69
Migratory	0	6
Other	1	27

Table 5.2.13: Species habitat distribution by chronology, for hand-collected material from the Round Tower (Site 431).

TAXA		late 12th-13th c.
Latin name	**Common name**	**FS**
Clupea harengus	Atlantic herring	546
Anguilla anguilla	European eel	302
Cyprinidae	-	186
Esox lucius	Northern pike	92
Perca fluviatilis	European perch	61
Merlangius merlangus	Whiting	50
Pleuronectiformes	-	34
Gadiformes	-	33
Pleuronectes platessa	European plaice	21
Salmonidae	-	13
Scomber scombrus	Atlantic mackerel	10
Gadus morhua	Atlantic cod	9
Pleuronectes platessa/Platichtys flesus	European plaice/flounder	8
Triglidae	-	4
Melanogrammus aeglefinus	Haddock	4
Rajidae	-	2
Conger conger	European conger	2
Rutilus rutilus	Roach	2
Squalius cephalus	Chub	2
Platichthys flesus	European flounder	1
*Leuciscus Leuciscus**	Common dace	*
*Leuciscus Leuciscus/Squalius cephalus**	Common dace/Chub	*
*Gobio gobio**	Gudgeon	*
*Raja clavata**	Thornback ray	*
	TOTAL	1382

Table 5.2.14: NISP of taxa for **late 12th-13th c.** based on diagnostic elements (other records noted as *) for fine-sieved material (mesh 2 mm) from the Upper Ward excavation (Site 485). Cyprinidae* are represented by pharyngeal plate, *Raja clavata** is represented by dermal denticle.

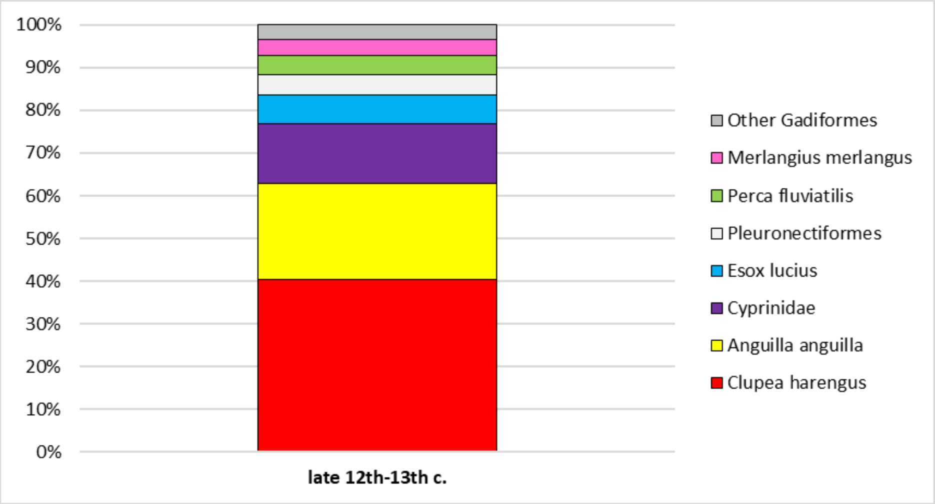


Fig. 5.2.17: Frequencies for the 8 most common taxa for late **12th-13th c.** (NISP: 1351), for fine-sieved material (mesh 2mm) from the Upper Ward excavation (Site 485). Threshold by phase: tot NISP ≥ 100.

TAXA	late 12th-13th c.
Leuciscus leuciscus	7
Squalius cephalus	5
Rutilus rutilus	3
Gobio gobio	1
Cyprinidae unid.	208

Table 5.2.15: NISP for the Cyprinidae family for late **12th-13th c.** from the Upper Ward excavation (Site 485) for fine-sieved (mesh 2 mm) material based on all counted specimens and pharyngeal bones; although regarded as not countable, pharyngeal bones will be represented in this table because they have been consistently recorded for all Cyprinidae.

TAXA	late 12th-13th c.	An.E.
Clupea harengus	26	PCV1
Cyprinidae	8	PCV1
Anguilla anguilla	7	VOM

Table 5.2.16: MNI for late **12th-13th c.** for main taxa for fine-sieved material (mesh 2 mm) from the Upper Ward excavation (Site 485). Threshold by phase: taxa NISP > 100. **An.E.** is the anatomical element used for MNI calculation. PCV1: first precaudal vertebra, VOM: vomer.

HABITAT	late 12th-13th c.
Freshwater	343
Marine	666
Migratory	316
Other	57

Table 5.2.17: Species habitat distribution by chronology, for fine-sieved (mesh 2 mm) material from the Upper Ward excavation (Site 485).

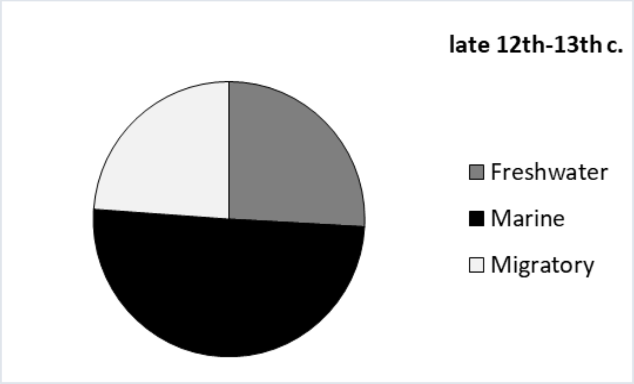


Fig. 5.2.18: Frequencies of habitat distribution for late **12th-13th c.** (NISP: 1325), for fine-sieved (mesh 2 mm) material from the Upper Ward excavation (Site 485). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

GROUP	**Element**		*Clupea harengus*				Cyprinidae		*Anguilla anguilla*		
			12th c.	**13th c.**	**14th c.**		**12th c.**	**14th c.**	**12th c.**	**14th c.**	
			CS	**CS**	**FS**	**CS**	**CS**	**CS**	**CS**	**FS**	**CS**
I	**A**	Articular	7	4	2	75	2	1	1	2	5
	B	Basioccipital	5	0	0	30	11	21	1	4	6
	D	Dentary	13	2	1	45	1	9	14	2	20
	ECT	Ectopterygoid	1	0	2	5	0	0	0	0	0
	ENT	Entopterygoid	0	0	0	1	0	0	\	\	\
	HYO	Hyomandibular	3	2	1	38	1	4	3	2	15
	INT	Interopercular	8	4	0	34	2	4	1	0	2
	MAX	Maxilla	10	3	1	47	2	2	1	1	8
	OP	Opercular	10	6	0	65	3	12	2	2	5
	OT	Otolith	0	0	0	1	0	0	0	0	0
	PA	Palatine	0	0	0	0	0	0	\	\	\
	PAR	Parasphenoid	1	1	7	42	0	5	13	3	23
	PRE	Preopercular	5	6	3	58	2	8	0	0	0
	PX	Premaxilla	0	0	2	0	1	2	\	\	\
	Q	Quadrate	5	1	4	44	1	4	1	1	5
	SUB	Subopercular	10	4	1	62	1	3	1	0	1
	VOM	Vomer	0	0	4	3	0	0	7	2	33
II	**CE**	Ceratohyal	11	5	0	76	0	4	4	4	7
	EHY	Epihyal	13	1	4	45	0	0	1	1	1
	URO	Urohyal	5	3	9	47	5	8	\	\	\
III	**BAP**	Basipterygium	2	0	0	3	1	6	\	\	\
	CL	Cleithrum	6	2	2	43	3	14	5	2	5
	CO	Coracoid	3	1	0	35	0	0	\	\	\

	PSC	Postcleithrum	0	0	1	0	1	1	\	\	\
	PST	Posttemporal	4	0	3	29	0	0	\	\	\
	S	Scapula	0	1	1	3	1	3	\	\	\
	SUP	Supracleithrum	3	0	4	15	1	1	0	0	0
IV	**PCV1 (PCV2)**	1st (2nd) precaudal vertebra	1	0	35	9	15	30	0	1	2
	AAV	Anterior abdominal vertebra	3	1	19	19	4	7	1	3	3
	PAV	Posterior abdominal vertebra	5	2	4	25	14	32	7	1	12
V	**CV**	Caudal vertebra	13	8	3	92	8	17	4	2	6
	LC	Last caudal vertebra	12	3	10	24	4	9	\	\	\
VI	**VC**	Vertebral body (centrum)	0	0	0	0	0	0	0	1	0

Table 5.2.18 (PART 1).

GROUP	**Element**		Pleuronectiformes	*Merlangius merlangus*	Large Gadiformes	*Esox lucius*
			14th c.	**14th c.**	**14th c.**	**14th c.**
			CS	**CS**	**CS**	**CS**
I	**A**	Articular	13	7	3	1
	B	Basioccipital	4	4	1	0
	D	Dentary	12	2	1	2
	ECT	Ectopterygoid	7	2	4	2
	ENT	Entopterygoid	0	0	0	1
	HYO	Hyomandibular	13	1	1	0
	INT	Interopercular	4	1	4	1
	MAX	Maxilla	10	7	3	1
	OP	Opercular	2	0	2	0
	OT	Otolith	1	1	2	0
	PA	Palatine	10	8	4	1
	PAR	Parasphenoid	2	1	1	1

	PRE	Preopercular	10	0	0	1
	PX	Premaxilla	10	11	2	0
	Q	Quadrate	15	4	2	1
	SUB	Subopercular	1	0	1	0
	VOM	Vomer	4	3	1	0
II	**CE**	Ceratohyal	1	3	1	0
	EHY	Epihyal	2	0	2	0
	URO	Urohyal	8	0	2	2
III	**BAP**	Basipterygium	4	0	0	3
	CL	Cleithrum	3	1	4	2
	CO	Coracoid	0	0	1	0
	PSC	Postcleithrum	0	0	3	0
	PST	Posttemporal	8	7	2	2
	S	Scapula	0	1	3	1
	SUP	Supracleithrum	9	6	4	1
IV	**PCV1 (PCV2)**	1st (2nd) precaudal vertebra	1	1	0	0
	AAV	Anterior abdominal vertebra	13	4	2	2
	PAV	Posterior abdominal vertebra	5	11	1	0
V	**CV**	Caudal vertebra	8	6	2	1
	LC	Last caudal vertebra	4	0	0	0
VI	**VC**	Vertebral body (centrum)	0	0	1	0

Table 5.2.18 (PART 2): Anatomical element distribution (MAU) for main taxa by chronology, for fine-sieved (FS: mesh 2 mm) and coarse-sieved (CS: mesh 4 mm) material, from the Round Tower (Site 431). **Group I** = Head elements (Minus II): Neurocranium, jaws, gill arches, gill covers; **Group II** = Head elements: Outer branchial skeleton; **Group III** = Pectoral and pelvic skeleton; **Group IV** = Precaudal vertebra; **Group V** = Caudal vertebrae; **Group VI** = undefined vertebrae. \ = missing/undeveloped or unidentified anatomical elements for eel (Methods, Chapter 4).

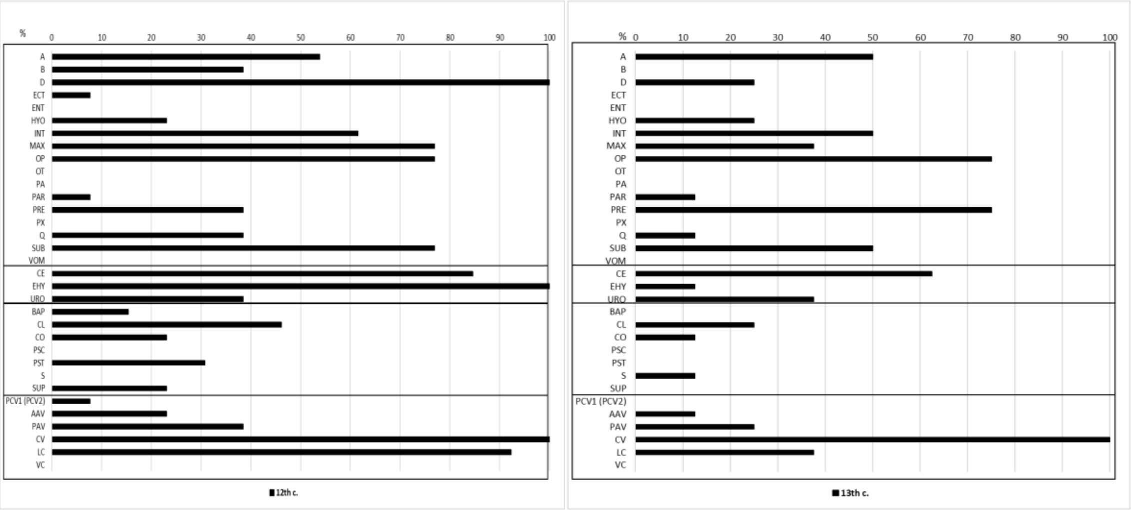


Fig. 5.2.19, 21: Frequencies of element distribution (MAU) for *Clupea harengus*, **12th, 13th c.,** for coarse-sieved material (mesh 4 mm) from the Round Tower (Site 431). Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

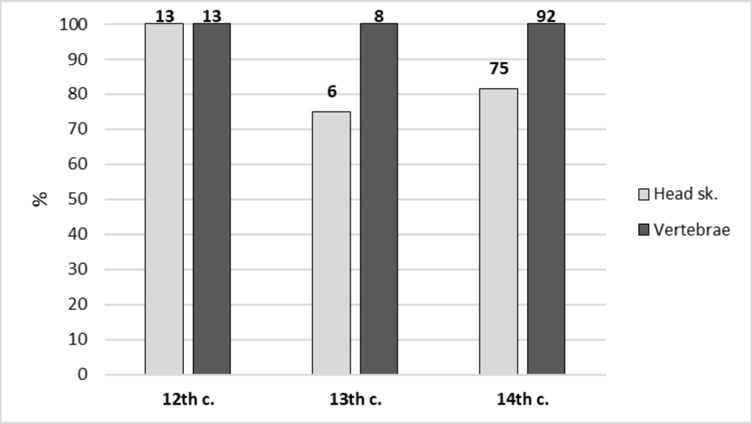


Fig. 5.2.20: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Clupea harengus* by chronology, for coarse-sieved (mesh 4 mm) material from the Round Tower (Site 431).

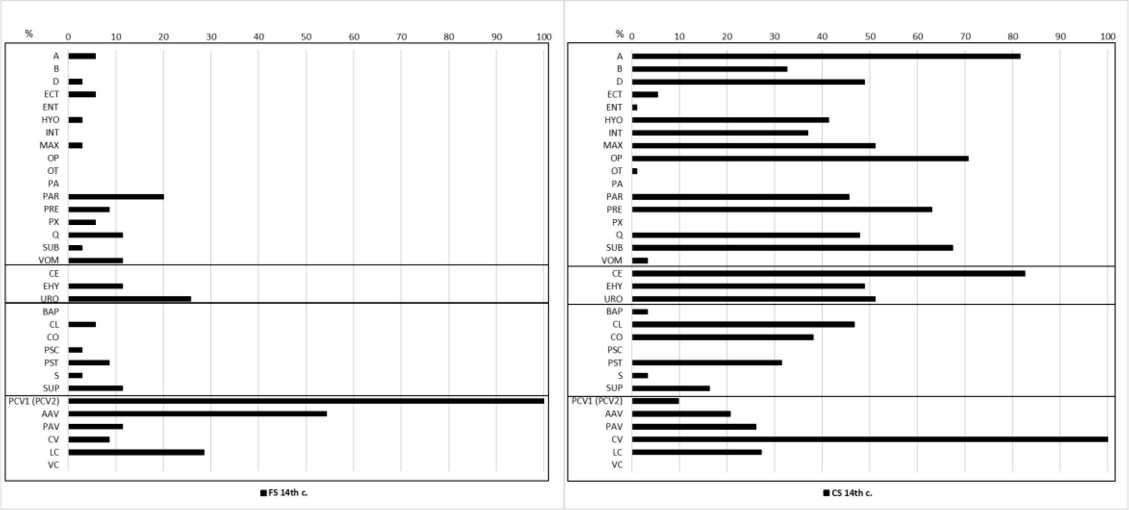


Fig. 5.2.22, 24: Frequencies of element distribution (MAU) for *Clupea harengus*, **14th c.,** for fine-sieved material (mesh 2 mm) and coarse-sieved material (mesh 4 mm) from the Round Tower (Site 431). Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

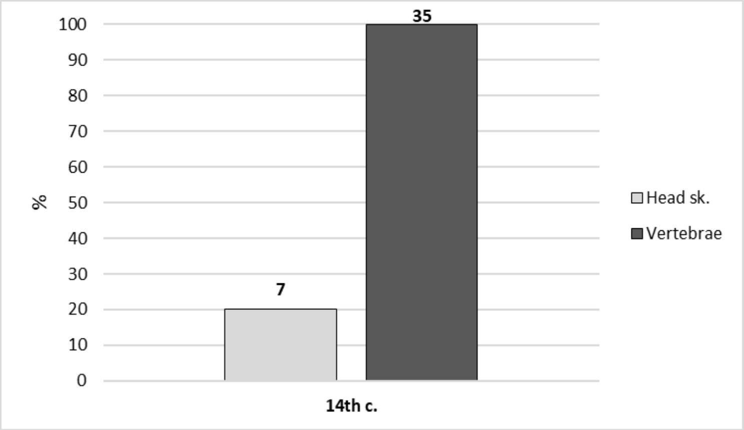


Fig. 5.2.23: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Clupea harengus* for **14th c.**, for fine-sieved (mesh 2 mm) material from the Round Tower (Site 431).

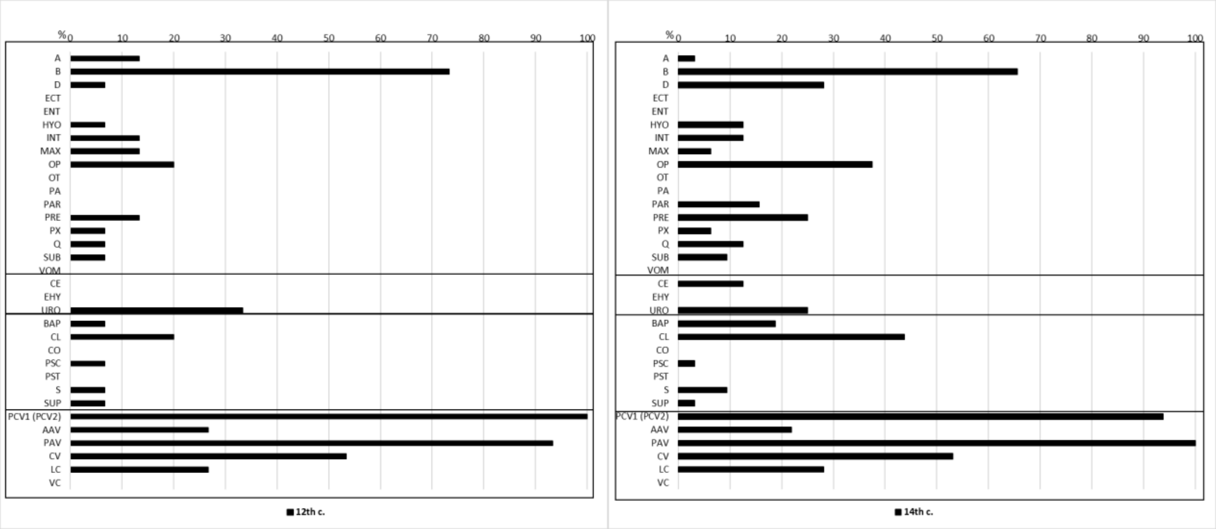


Fig. 5.2.25-26: Frequencies of element distribution (MAU) for Cyprinidae family, **12th**, **14th c.**, for coarse-sieved material (mesh 4 mm) from the Round Tower (Site 431). Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

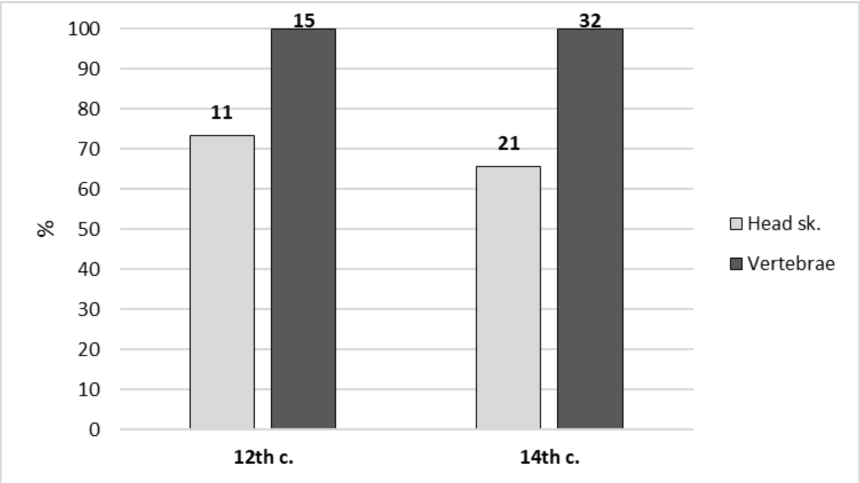


Fig. 5.2.27: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae for Cyprinidae family by chronology, for coarse-sieved (mesh 4 mm) material from the Round Tower (Site 431).

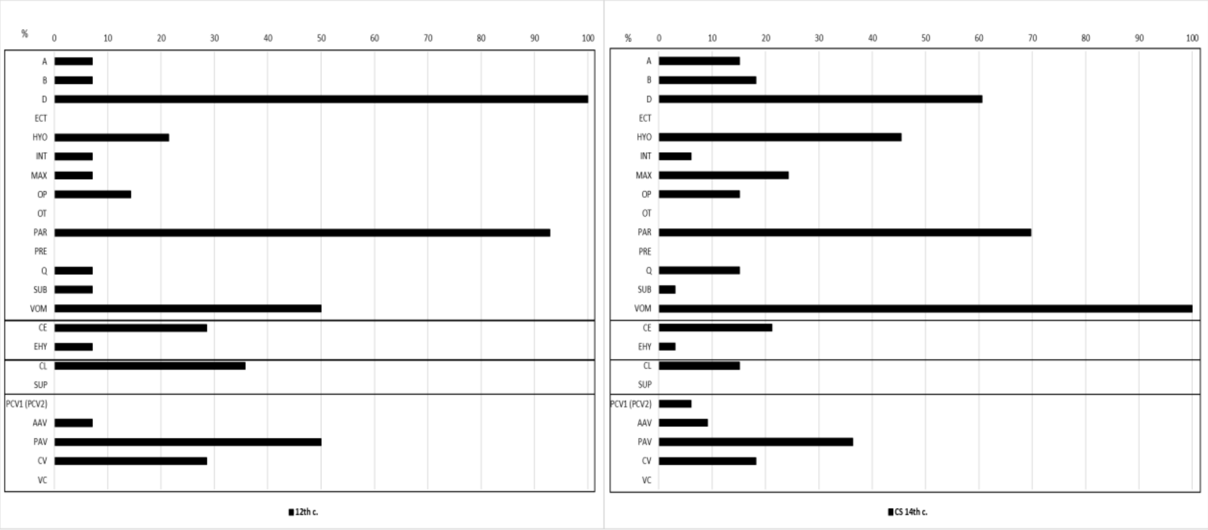


Fig. 5.2.28-29: Frequencies of element distribution (MAU) for *Anguilla anguilla*, **12th c. and 14th c.,** for coarse-sieved material (mesh 4 mm) from the Round Tower (Site 431). Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

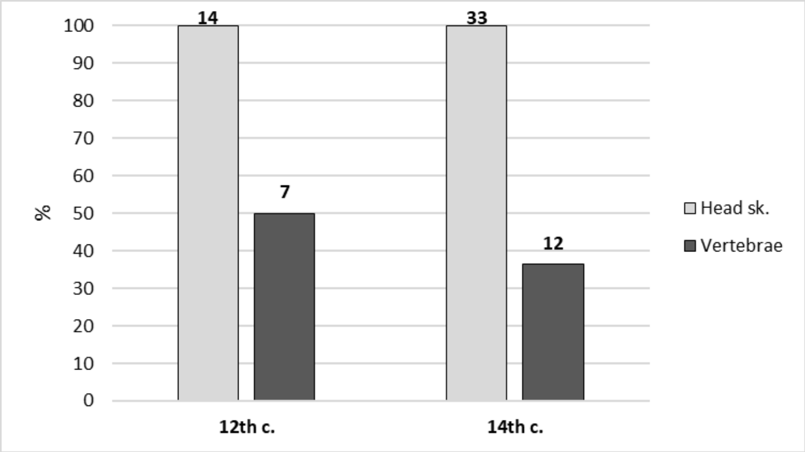


Fig. 5.2.30: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Anguilla anguilla* by chronology, for coarse-sieved (mesh 4 mm) material from the Round Tower (Site 431).

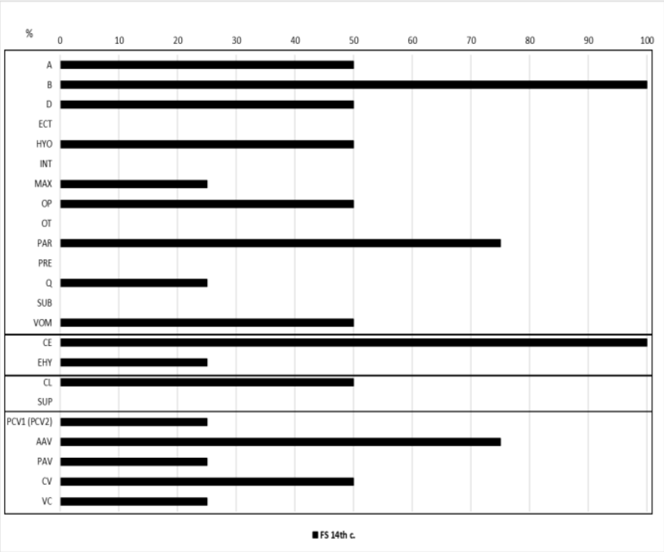


Fig. 5.2.31: Frequencies of element distribution (MAU) for *Anguilla anguilla*, **14th c.**, for fine-sieved (mesh 2 mm) from the Round Tower (Site 431). Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

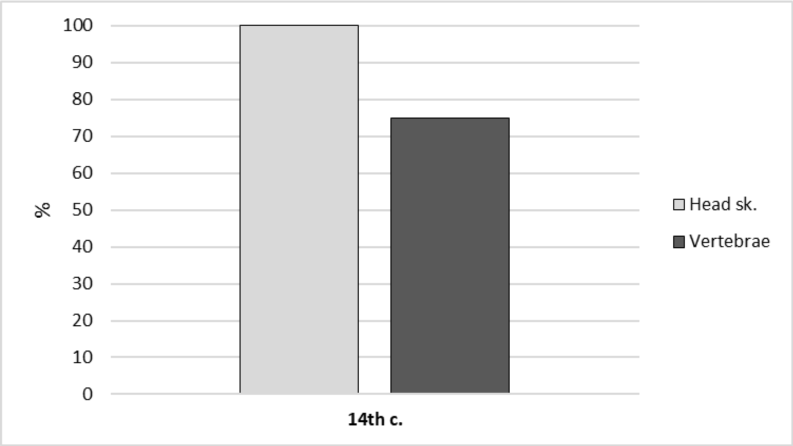


Fig. 5.2.32: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Anguilla anguilla* from **14th c.**, for fine-sieved (mesh 2 mm) material from the Round Tower (Site 431).

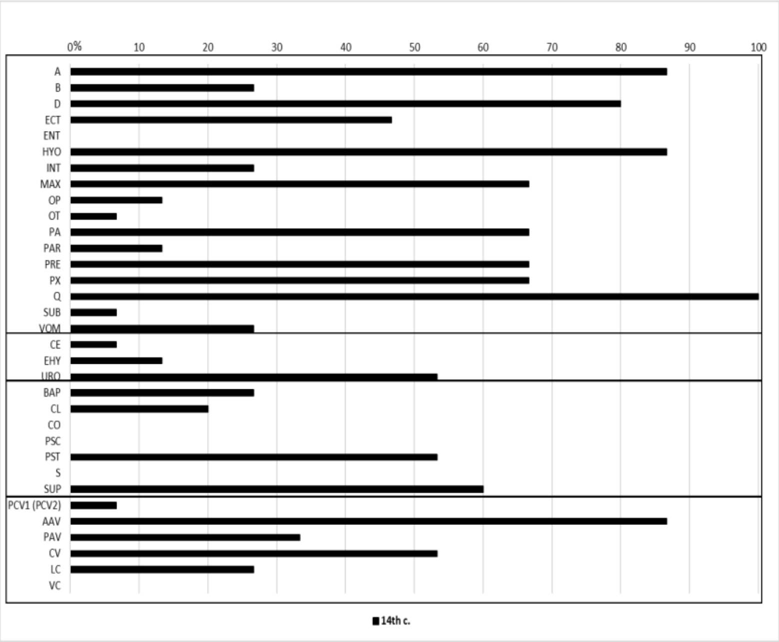


Fig. 5.2.33: Frequencies of element distribution (MAU) for Pleuronectiformes from **14th c.**, for coarse-sieved material (mesh 4 mm) from the Round Tower (Site 431). Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

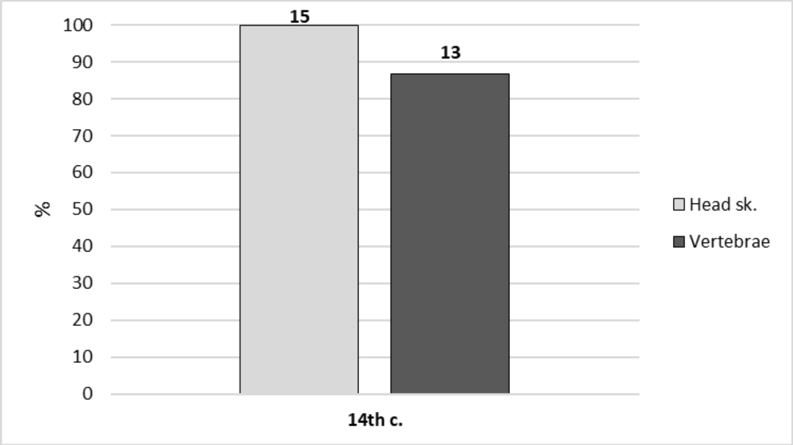


Fig. 5.2.34: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in Pleuronectiformes from **14th c.**, for coarse-sieved (mesh 4 mm) material from the Round Tower (Site 431).

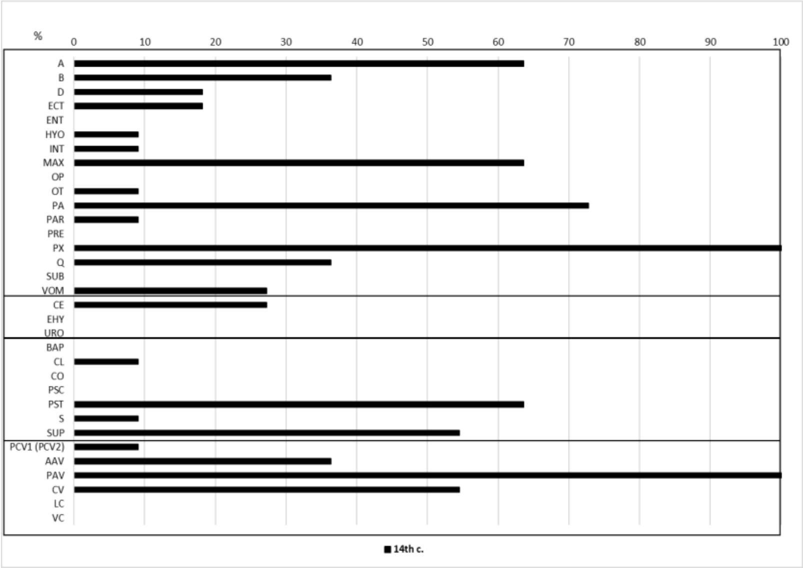


Fig. 5.2.35: Frequencies of element distribution (MAU) for *Merlangius merlangus* from **14th c.,** for coarse-sieved material (mesh 4 mm) from the Round Tower (Site 431). Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

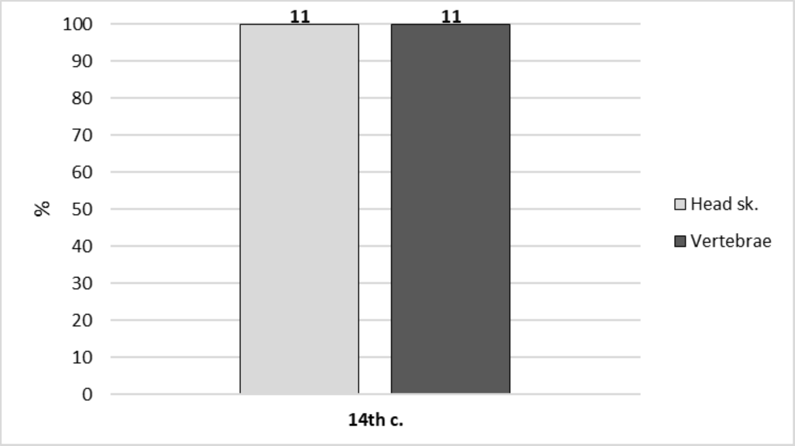


Fig. 5.2.36: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Merlangius merlangus* from **14th c.**, for coarse-sieved (mesh 4 mm) material from the Round Tower (Site 431).

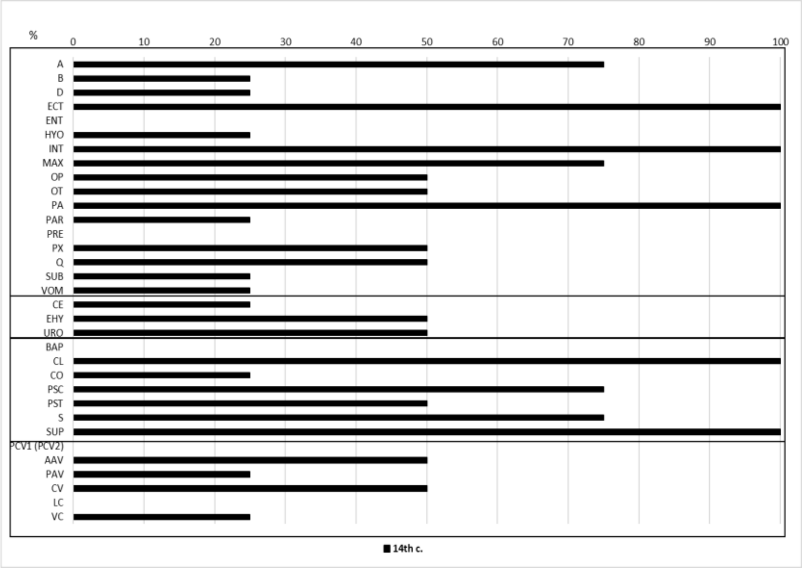


Fig. 5.2.37: Frequencies of element distribution (MAU) for large Gadiformes (*Lota lota* excluded) from **14th c.**, for coarse-sieved material (mesh 4 mm) from the Round Tower (Site 431). Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

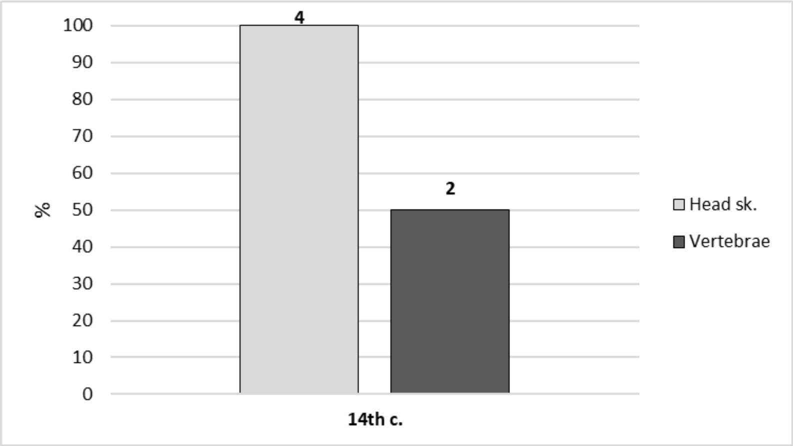


Fig. 5.2.38: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in Large Gadiformes (*Lota lota* excluded) from **14th c.**, for coarse-sieved (mesh 4 mm) material from the Round Tower (Site 431).

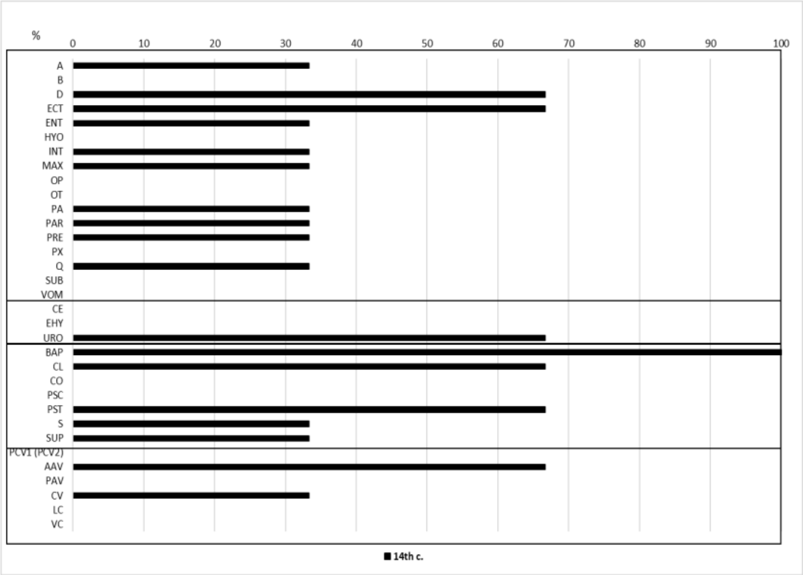


Fig. 5.2.39: Frequencies of element distribution (MAU) for *Esox lucius* from **14th c.**, for coarse-sieved material (mesh 4 mm) from the Round Tower (Site 431). Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens. NB: PCV (precaudal vertebra) corresponds to AAV (anterior abdominal vertebra) + PAV (posterior abdominal vertebra) for other species.

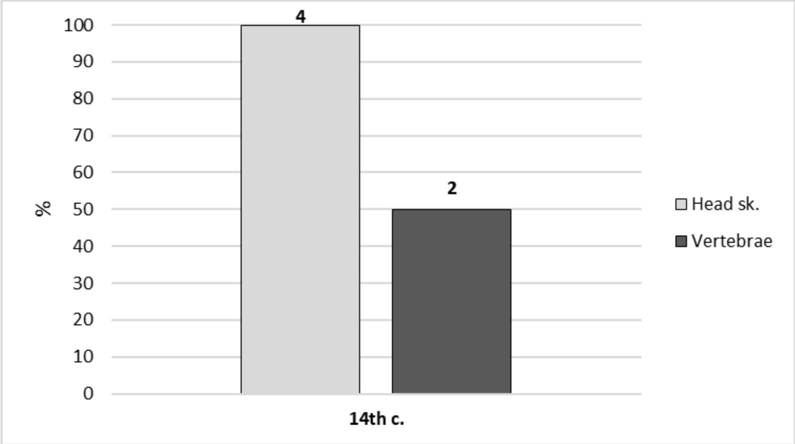


Fig. 5.2.40: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Esox lucius* from **14th c.**, for coarse-sieved (mesh 4 mm) material from the Round Tower (Site 431).

GROUP	**Element**		*Clupea harengus*	*Anguilla anguilla*	Cyprinidae
			late 12th-13th c.		
			FS	**FS**	**FS**
I	**A**	Articular	2	2	0
	B	Basioccipital	1	6	4
	D	Dentary	1	4	0
	ECT	Ectopterygoid	0	0	0
	ENT	Entopterygoid	0	\	0
	HYO	Hyomandibular	0	1	0
	INT	Interopercular	0	0	0
	MAX	Maxilla	2	1	0
	OP	Opercular	0	2	0
	OT	Otolith	0	0	0
	PA	Palatine	0	\	0
	PAR	Parasphenoid	2	5	0
	PRE	Preopercular	0	0	0
	PX	Premaxilla	0	\	0
	Q	Quadrate	0	2	1
	SUB	Subopercular	0	0	0
	VOM	Vomer	0	7	0
II	**CE**	Ceratohyal	1	3	1
	EHY	Epihyal	0	1	0
	URO	Urohyal	0	\	1
III	**BAP**	Basipterygium	0	\	0
	CL	Cleithrum	1	5	0
	CO	Coracoid	0	\	0
	PSC	Postcleithrum	0	\	0
	PST	Posttemporal	1	\	0
	S	Scapula	0	\	2
	SUP	Supracleithrum	0	0	0
IV	**PCV1 (PCV2)**	1st (2nd) precaudal vertebra	26	2	8
	AAV	Anterior abdominal vertebra	16	3	5
	PAV	Posterior abdominal vertebra	3	3	9
V	**CV**	Caudal vertebra	4	2	5
	LC	Last caudal vertebra	6	\	1
VI	**VC**	Vertebral body (centrum)	0	1	0

Table 5.2.19: Anatomical element distribution (MAU) for main taxa for late **12th-13th c.**, for fine-sieved material (FS: mesh 2 mm) from the Upper Ward excavation (Site 485). **Group I** = Head elements (Minus II): Neurocranium, jaws, gill arches, gill covers; **Group II** = Head elements: Outer branchial skeleton; **Group III** = Pectoral and pelvic skeleton; **Group IV** = Precaudal vertebra; **Group V** = Caudal vertebrae; **Group VI** = undefined vertebrae. \ = missing/undeveloped or unidentified anatomical elements for eel (Methods, Chapter 4).

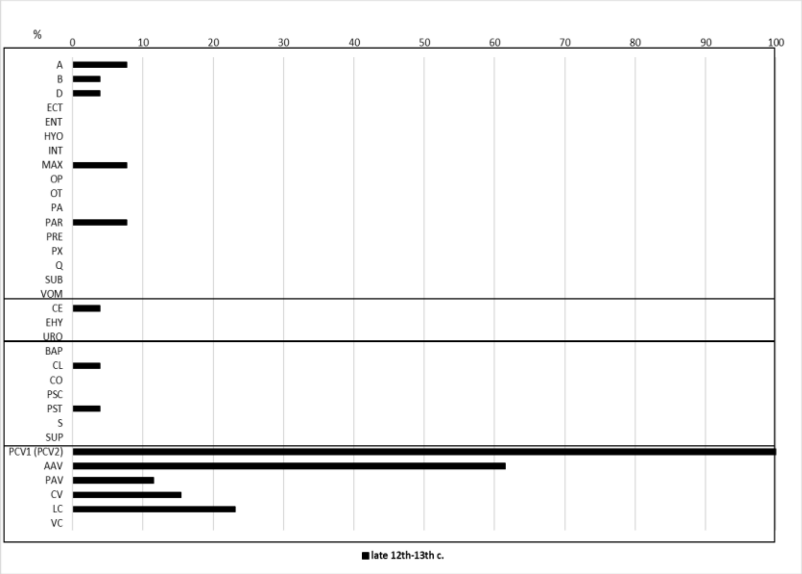


Fig. 5.2.41: Frequencies of element distribution (MAU) for *Clupea harengus* from **late 12th-13th c.**, for fine-sieved material (mesh 2mm) from the Upper Ward excavation (Site 485). Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

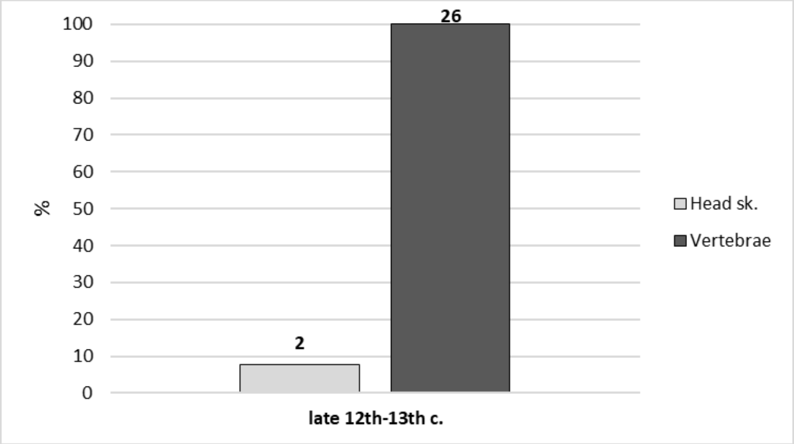


Fig. 5.2.42: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Clupea harengus* from **late 12th-13th c.**, for fine-sieved (mesh 2 mm) material from the Upper Ward excavation (Site 485).

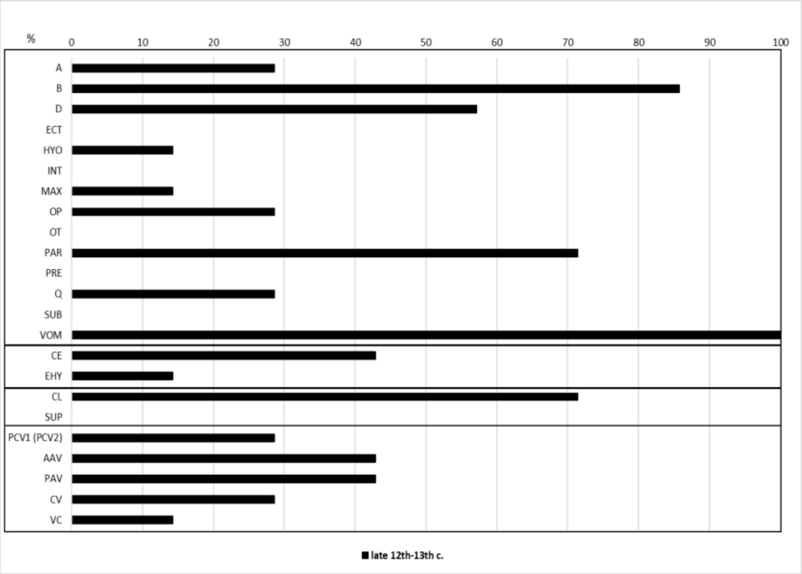


Fig. 5.2.43: Frequencies of element distribution (MAU) for *Anguilla anguilla* from **late 12th-13th c.**, for fine-sieved material (mesh 2mm) from the Upper Ward excavation (Site 485). Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

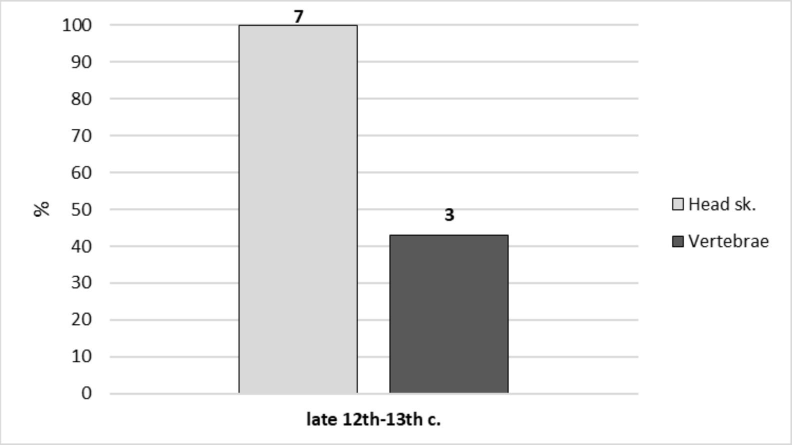


Fig. 5.2.44: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Anguilla anguilla* from **late 12th-13th c.**, for fine-sieved (mesh 2 mm) material from the Upper Ward excavation (Site 485).

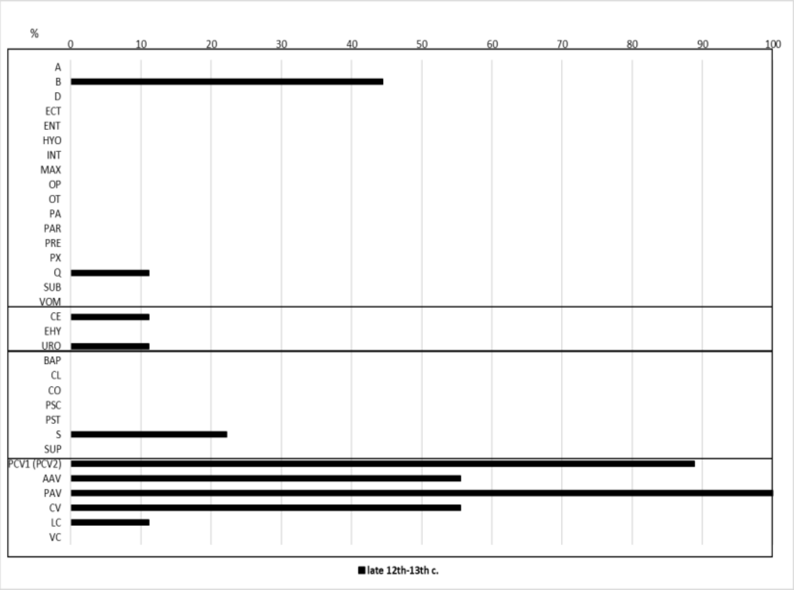


Fig. 5.2.45: Frequencies of element distribution (MAU) for Cyprinidae family from **late 12th-13th c.**, for fine-sieved material (mesh 2 mm) from the Upper Ward excavation (Site 485). Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

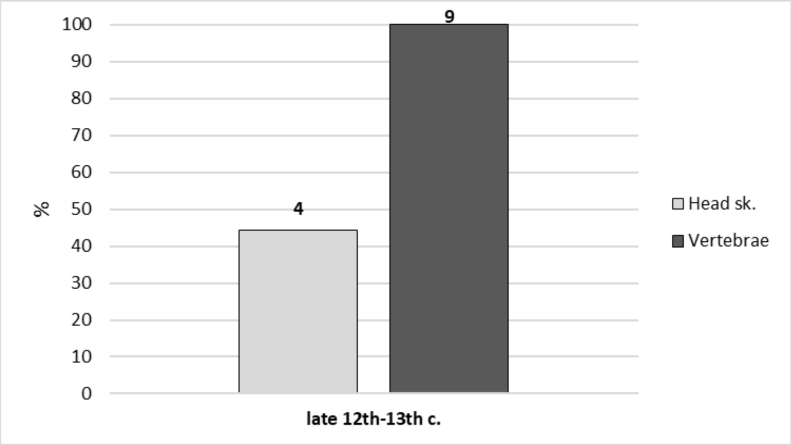


Fig. 5.2.46: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae for Cyprinidae family from **late 12th-13th c.**, for fine-sieved (mesh 2 mm) material from the Upper Ward excavation (Site 485).

TAXA **Burning**	*Anguilla anguilla*	*Clupea harengus*	Cyprinidae	Pleuronectidae	*Gadus morhua*	**TOT**
Burned	5	3	2	2	0	12
Tot burned						12 (0.6%)
Butchery marks						
Chop	3	0	1	0	1	5
Cut	1	0	0	0	0	1
Tot butchered	4	0	1	0	1	6 (0.3%)

Table 5.2.20: Taphonomic modifications for **12th c.** material by taxa from the Round Tower (Site 431), total NISP 1853, all recovery methods.

TAXA **Burning**	*Anguilla anguilla*	*Merlangius merlangus*	Salmonidae	Pleuronectidae	Triglidae	**TOT**
Burned	0	1	0	0	0	1
Tot burned						1 (0.1%)
Other modifications						
Crushed	1	0	0	1	0	2
Tot modified						2 (0.2%)
Butchery marks						
Chop	0	0	1	0	1	2
Tot butchered						2 (0.2%)

Table 5.2.21: Taphonomic modifications for **13th c.** material by taxa from the Round Tower (Site 431), total NISP 713, all recovery methods.

TAXA	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***	***13***	**TOT**
Burning														
Burned	773	6	0	7	0	0	1	2	2	0	1	0	0	792
Tot burned														792 (8%)
Other modifications														
Crushed	16	20	0	2	3	1	0	0	0	0	0	1	1	44
Tot modified														44 (0.4%)
Butchery marks														
Chop	1	6	9	1	4	1	1	0	0	0	0	0	0	22
Cut	0	1	1	0	0	0	0	0	0	1	0	0	0	3
Cut & Chop	0	0	1	0	0	1	1	0	0	0	0	0	0	3
Tot butchered	1	7	11	1	4	2	2	0	0	1	0	0	0	28 (0.3%)

Table 5.2.22: Taphonomic modifications for **14th c.** material by taxa from the Round Tower (Site 431), total NISP 9663, all recovery methods. ***1)*** *Clupea harengus*, ***2)*** *Anguilla anguilla*, ***3)*** *Gadus morhua*, ***4)*** *Gadus morhua*, ***5)*** *Pleuronectidae*, ***6)*** *Esox lucius*, ***7)*** *Salmonidae*, ***8)*** *Gadiformes*, ***9)*** *Clupeidae*, ***10)*** *Melanogrammus aeglefinus*, ***11)*** *Pleuronectes platessa*, ***12)*** *Merlangius merlangus*, ***13)*** *Rutilus rutilus*.

TAXA	*Clupea harengus*	*Esox lucius*	*Anguilla anguilla*	Cyprinidae	*Perca fluviatilis*	Triglidae	Pleuronectidae	**TOT**
Burning								
Burned	441	39	27	0	2	2	1	512
Tot burned								512 (37%)
Other modifications								
Crushed	0	2	6	5	0	0	0	13
Tot modified								13 (0.9%)
Butchery marks								
Chop	0	0	0	0	1	0	0	1
Cut	0	1	0	0	0	0	0	1
Tot butchered	0	1	0	0	1	0	0	2 (0.1%)

Table 5.2.23: Taphonomic modifications for **late 12th-13th c.** material by taxa from the Upper Ward excavation (Site 485), total NISP 1382, all recovery methods.

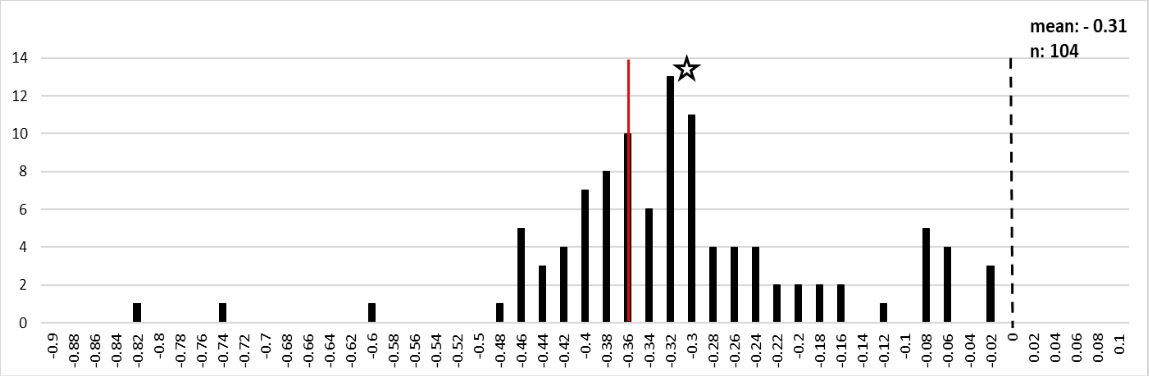


Fig. 5.2.47: Size distribution for all anatomical elements for *Esox lucius*, **12th c.** from the Round Tower (Site 431). The star indicates the mean (-0.31), the red line marker represents a modern pike (origin: unknown) with TL of 340 mm and SL of 300 mm (mean: -0.36). The standard set of values is represented by the value 0 (TL: 715 mm, SL: 650 mm; modern individual, origin: France). Bones measured: 43; n measures: 104.

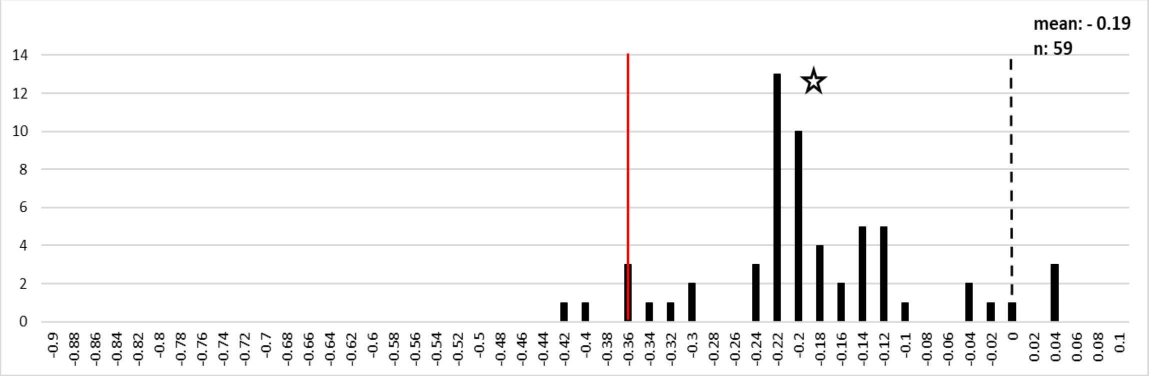


Fig. 5.2.48: Size distribution for all anatomical elements for *Esox lucius*, **13th c.** from the Round Tower (Site 431). The star indicates the mean (-0.19), the red line marker represents a modern pike (origin: unknown) with TL of 340 mm and SL of 300 mm (mean: -0.36). The standard set of values is represented by the value 0 (TL: 715 mm, SL: 650 mm; modern individual, origin: France). Bones measured: 21; n measures: 59.

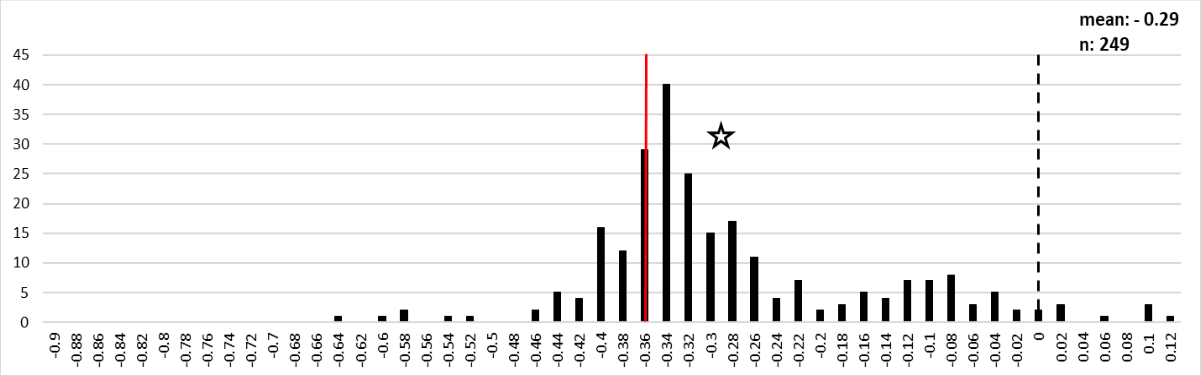


Fig. 5.2.49: Size distribution for all anatomical elements for *Esox lucius*, **14th c.** from the Round Tower (Site 431). The star indicates the mean (-0.29), the red line marker represents a modern pike (origin: unknown) with TL of 340 mm and SL of 300 mm (mean: -0.36). The standard set of values is represented by the value 0 (TL: 715 mm, SL: 650 mm; modern individual, origin: France). Bones measured: 93; n measures: 249.

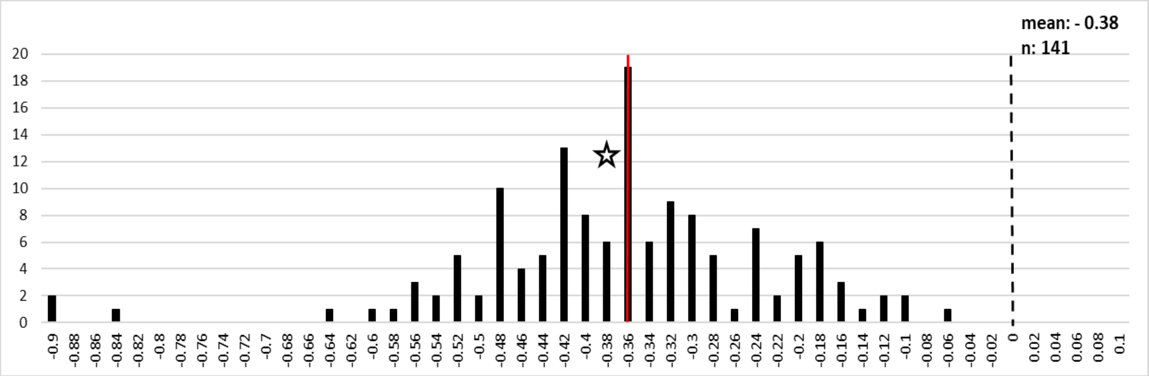


Fig. 5.2.50: Size distribution for all anatomical elements for *Esox lucius*, **late 12th-13th c.** from the Upper Ward excavation (Site 485). The star indicates the mean (-0.38), the red line marker represents a modern pike (origin: unknown) with TL of 340 mm and SL of 300 mm (mean: -0.36). The standard set of values is represented by the value 0 (TL: 715 mm, SL: 650 mm; modern individual, origin: France). Bones measured: 56; n measures: 141.

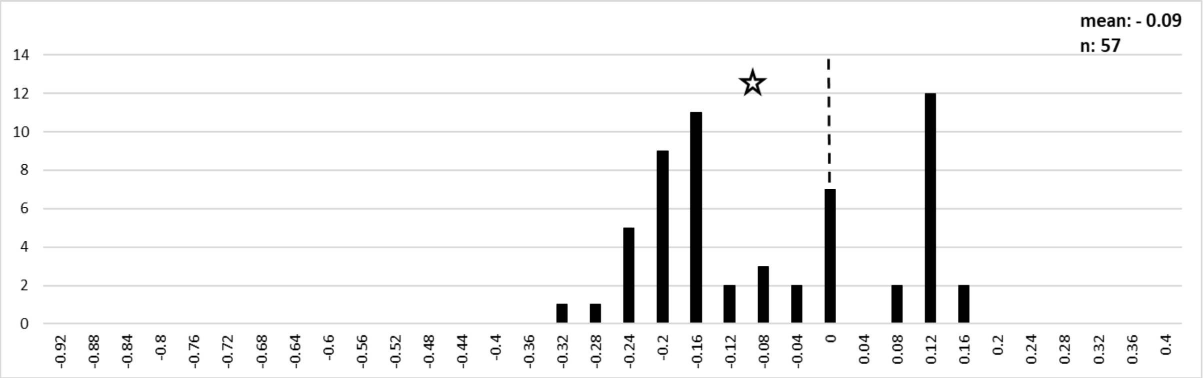


Fig. 5.2.51: Size distribution for all anatomical elements for *Perca fluviatilis*, **12th c.** from the Round Tower (Site 431). The star indicates the mean (-0.09). The standard set of values is represented by the value 0 (TL: 275 mm, SL: 240 mm; modern individual, origin: Italy). Bones measured: 28; n measures: 57.

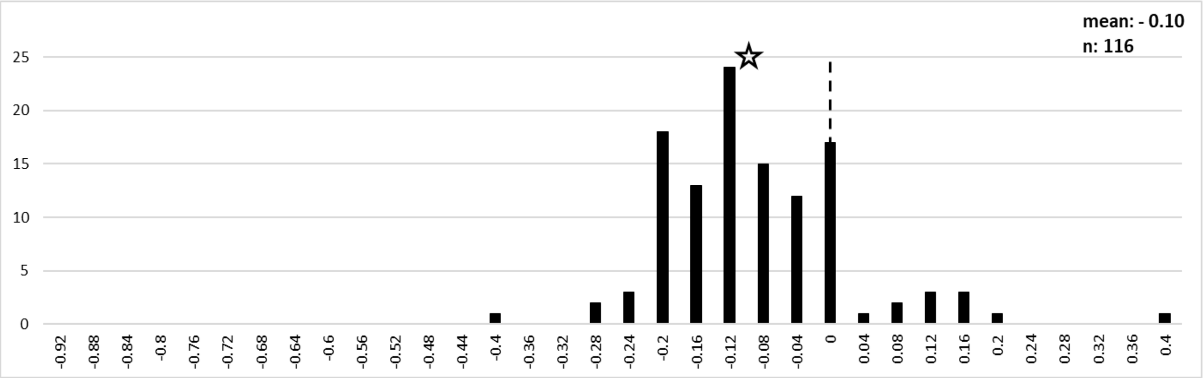


Fig. 5.2.52: Size distribution for all anatomical elements for *Perca fluviatilis*, **14th c.** from the Round Tower (Site 431). The star indicates the mean (-0.10). The standard set of values is represented by the value 0 (TL: 275 mm, SL: 240 mm; modern individual, origin: Italy). Bones measured: 49; n measures: 116.

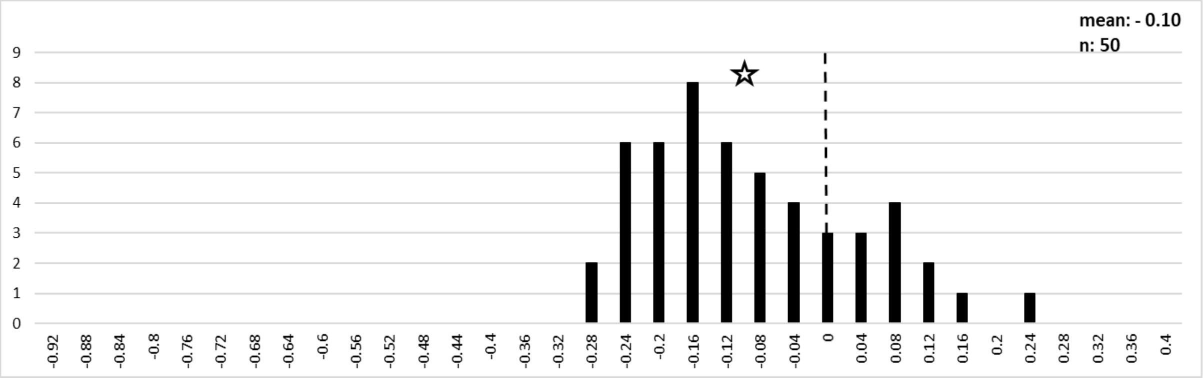


Fig. 5.2.53: Size distribution for all anatomical elements for *Perca fluviatilis*, **late 12th-13th c.** from the Upper Ward excavation (Site 485). The star indicates the mean (-0.10). The standard set of values is represented by the value 0 (TL: 275 mm, SL: 240 mm; modern individual, origin: Italy). Bones measured: 26; n measures: 50.

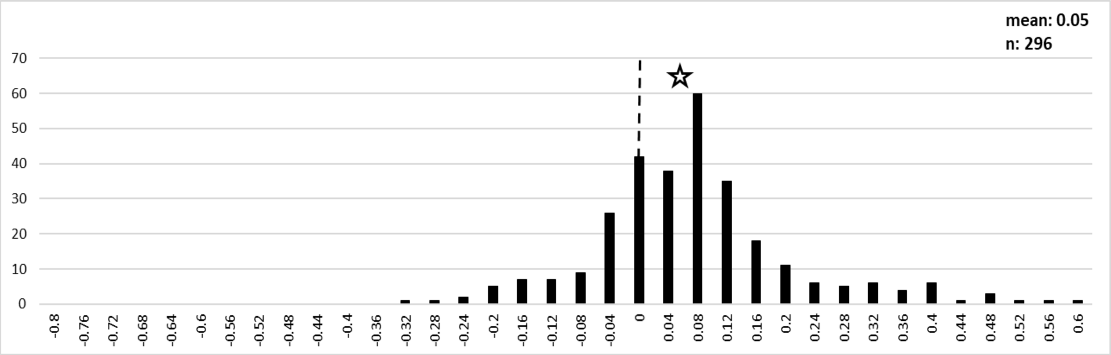


Fig. 5.2.54: Size distribution for all anatomical elements for Cyprinidae family, **12th c.** from the Round Tower (Site 431). The star indicates the mean (0.05). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 113; n measures: 296.

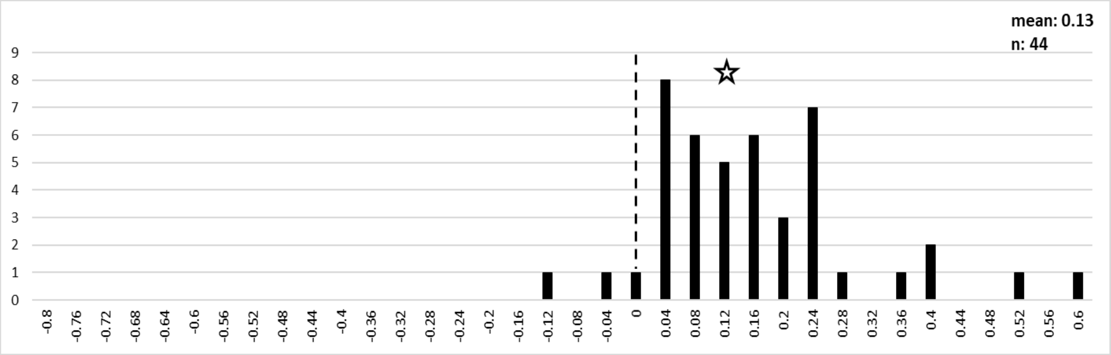


Fig. 5.2.55: Size distribution for all anatomical elements for Cyprinidae family, **13th c.** from the Round Tower (Site 431). The star indicates the mean (0.13). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 16; n measures: 44.

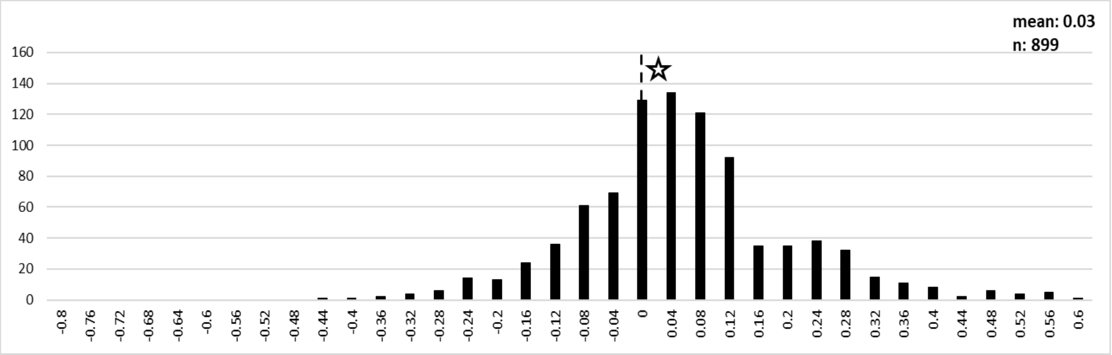


Fig. 5.2.56: Size distribution for all anatomical elements for Cyprinidae family, **14th c.** from the Round Tower (Site 431). The star indicates the mean (0.03). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 350; n measures: 899.

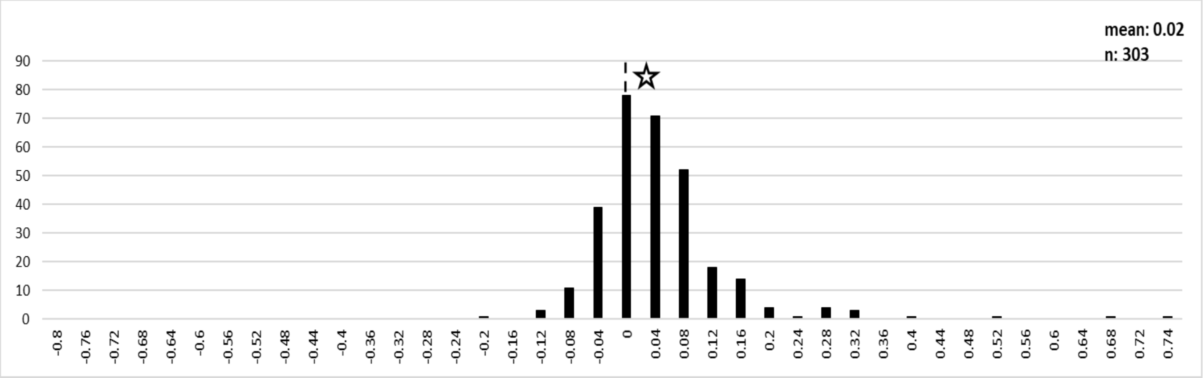


Fig. 5.2.57: Size distribution for all anatomical elements for Cyprinidae family, **late 12th-13th c.** from the Upper Ward excavation (Site 485). The star indicates the mean (0.02). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 103; n measures: 303.

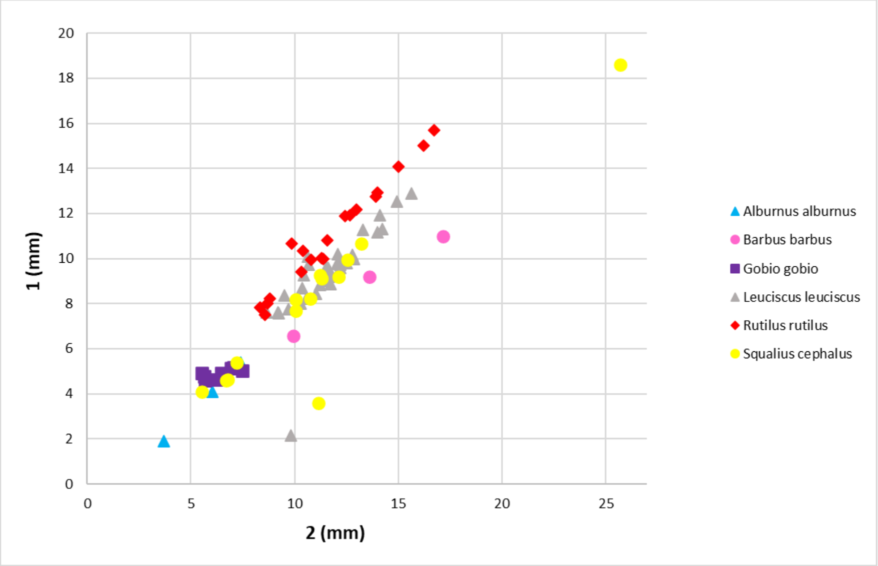


Fig. 5.2.58: Distribution of measurements (n 81) for Cyprinidae pharyngeal bones, **12th-14th**, all recovery methods for both sites; measure **1** (height), measure **2** (cord length).

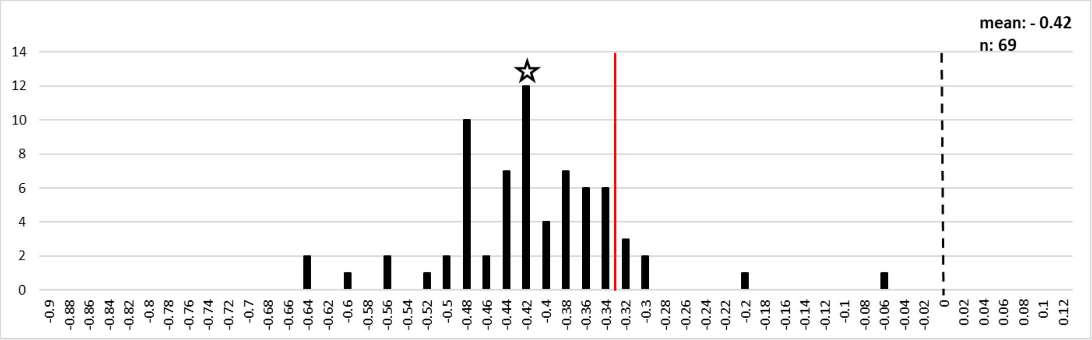


Fig. 5.2.59: Size distribution for all anatomical elements for *Anguilla anguilla*, **11th c.** from the Round Tower (Site 431). The star indicates the mean (-0.42). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 26; n measures: 69.

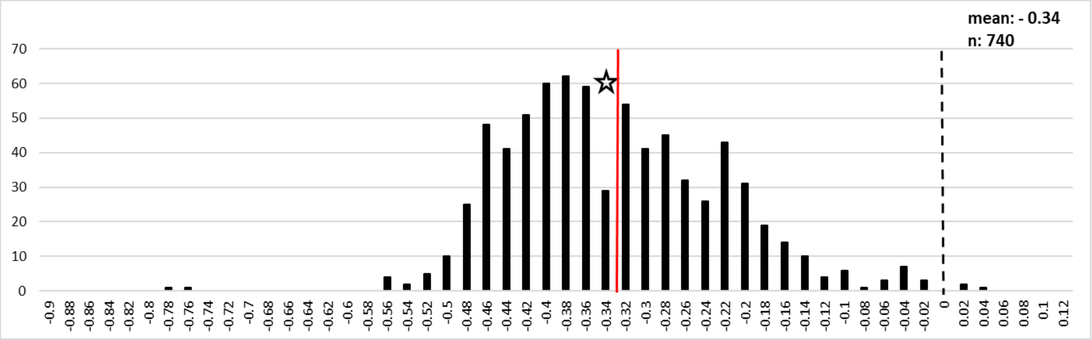


Fig. 5.2.60: Size distribution for all anatomical elements for *Anguilla anguilla*, **12th c.** from the Round Tower (Site 431). The star indicates the mean (-0.34). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 262; n measures: 740.

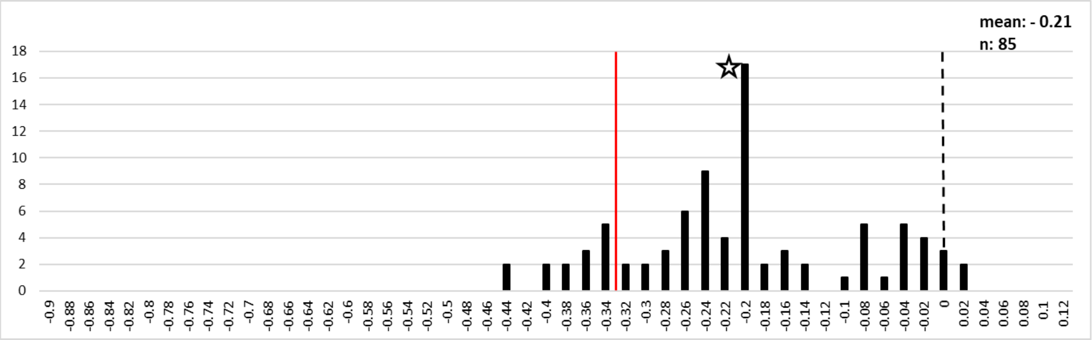


Fig. 5.2.61: Size distribution for all anatomical elements for *Anguilla anguilla*, **13th c.** from the Round Tower (Site 431). The star indicates the mean (-0.21). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 31; n measures: 85.

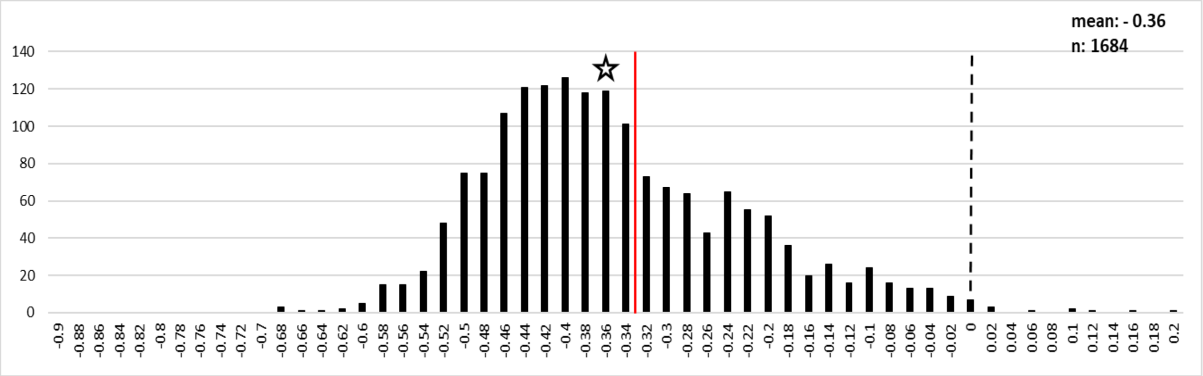


Fig. 5.2.62: Size distribution for all anatomical elements for *Anguilla anguilla*, **14th c.** from the Round Tower (Site 431). The star indicates the mean (-0.36). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 616; n measures: 1684.

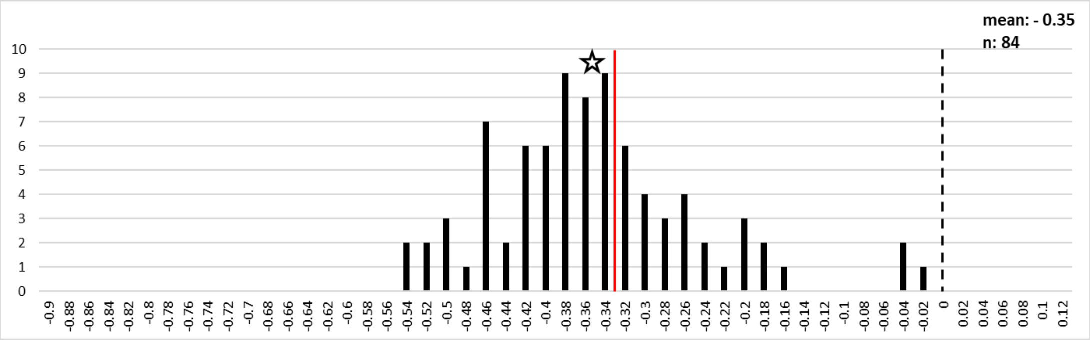


Fig. 5.2.63: Size distribution for all anatomical elements for *Anguilla anguilla*, **late 12th-14th c.** from the Round Tower (Site 431). The star indicates the mean (-0.35). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 29; n measures: 84.

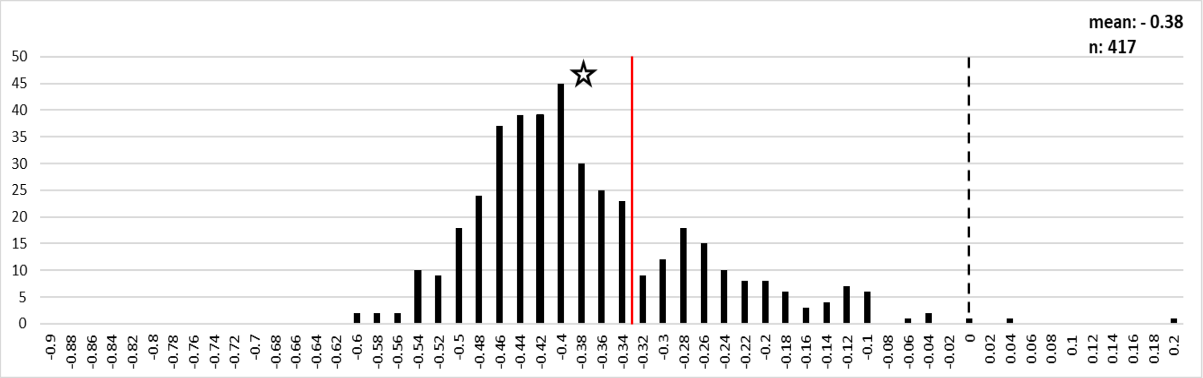


Fig. 5.2.64: Size distribution for all anatomical elements for *Anguilla anguilla*, late **12th-13th c.** from the Upper Ward excavation (Site 485). The star indicates the mean (-0.38). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 154; n measures: 417.

5.3 Eynsham Abbey

Major excavations at Eynsham Abbey were carried out by Oxford Archaeology from 1989 to 1992. This was a rescue excavation of a large part of St. Peter's churchyard before the expansion of the graveyard. The results of the excavation, post-excavation studies and associated documentary source analysis can be found in the publication 'Ælfric's Abbey: Excavation at Eynsham Abbey, Oxfordshire, 1989-1992' edited by Alan Hardy (2003). The following information, unless otherwise stated, is extracted from this volume.

5.3.1 The site: the abbey

The ruins of Eynsham Abbey are located in west Oxfordshire, on a floodplain surrounded by rivers and natural springs, the most important being the Thames, the Evenlode and the Chil Brook. The first mention of a church at Eynsham dates back to the Anglo-Saxon Chronicle; the Minister church was founded in the 7th-8th c. and identified as a high-ranking ecclesiastical establishment for missionary work. With the 10th c. religious restoration happening in England, mostly a consequence of increasing Vikings raids, new monasteries were established and those existing were regularized as Benedictine houses. This was the sort of the Minister church, which was refounded as a Benedictine abbey in 1005 by Æthelmær the Stout (one of king Æthelred II principal noblemen) as part of this process (Parrinder 2019). The invasion of the Danes and the associated famine were interpreted as God punishment; thus after the massacre of the Danes living in Oxford, the new refoundation of the abbey was done in honour of St. Saviour and all his Saints and, later on, to St. Mary and St. Benedict. The first abbot of the abbey was the famous writer Ælfric (1002-1005); he is mostly remembered for his 'Letter to the Monks of Eynsham', where he emphasized the need for a stricter approach to the Benedictine rule. The patron, Æthelmær the Stout, donated many possessions and lands (30 hides) to the abbey, including the church of St. Ebbe's, his urban manor and two mills and many other properties in Oxford, so the monks could acquire the rental incomes in money but also in food. Throughout the years the abbey was donated nearly 120 hides in Oxfordshire (Shifford, Yarnton, Shipton-on-Cherwell), Gloucestershire (Mickelton), Warwickshire (Marlcliff), Worcestershire (Bentley), Surrey (Esher and Ditton) and Sussex (Rye) (Parrinder 2019, 6). Eynsham Abbey became one of the wealthiest and most famous houses in Oxfordshire.

There is not much information about the abbey from 1010 to 1109, but documentary sources suggest that it declined with the Norman invasion. Archaeological evidence, however, clearly indicate that the establishment was still inhabited after the Norman invasion, and the remains from the kitchen reveal the presence of a lively community. By the words of Parrinder (2019, 8), "…the high levels of fish consumption, supports the idea of continued occupation by some fairly well-off monks at this time and certainly no great poverty".

Bishop Remigius in 1091 tried to add Eynsham Abbey to his new religious establishments in Lincolnshire, but after his death, the attempt was abandoned, and the monks returned to Oxfordshire, granted additional lands in the south.

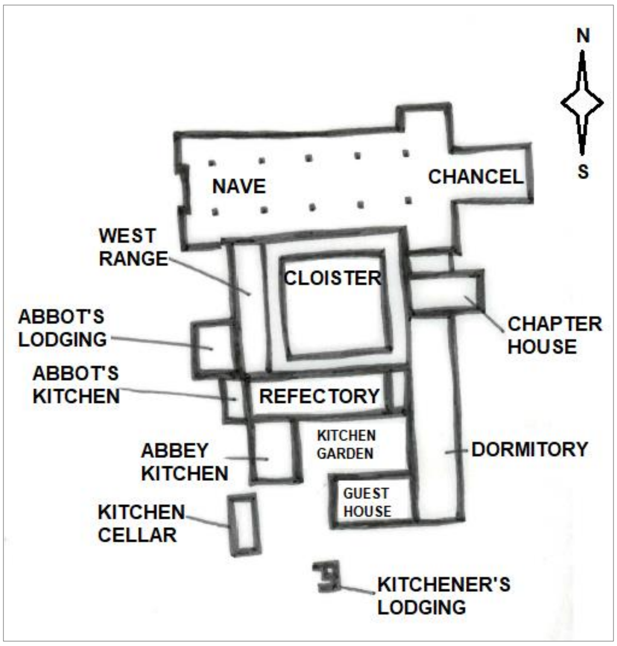


Fig. 5.3.1: Eynsham Abbey, Norman Abbey layout funded in 1109 (modified by https://eynsham-pc.gov.uk/).

In 1109 king Henry I signed the charter for a new foundation of the abbey (Fig. 5.3.1); the old Saxon building was demolished, and a new Christian establishment surged, with the major reconstruction completed in the 1200s. The abbey kept flourishing, thanks to donations and income mostly from rents and the sale of wool and livestock. However, despite this apparent wealth, it appears that no more than 30 monks ever lived there (Gordon 1990).

The wealth of the abbey is indicated by the numerous visits of the king itself, which would have hold court at the abbey with the bishops and the abbot during the trip at its nearby hunting lodge at Woodstock; the sumptuous banquets prepared for the occasion would have put a strain on the funds of the abbot, but at the same time they would have added to its prestige.

In the early 13th c., Abbot Adam bought land south-east of the growing abbey to establish a new precinct: fishponds were constructed, and a new borough (*Terra Nova*) created. This was one of the many expensive projects of the abbot which indebted the community and led to his destitution.

The Cartulary of the abbey indicates that the income kept increasing from the 14th to the 15th c. By the 15th c. only a few monks were living at the abbey. In the climate of the Dissolution of the monasteries, an inspection by the bishop of Lincoln found the monks to be lazy and spending their time mainly drinking and gambling, while neglecting their religious responsibilities. As consequence, Henry VIII confiscated the property in 1538. Stones collected from buildings located within the precinct were used to build houses in the village.

The fishponds at Eynsham Abbey were part of a more complex system of water features covering at least 7,400 sq m in the Chil Brook valley. Five or six large rectangular ponds were located at the western limit of the precinct and other four or five smaller ponds on the south-east limit; these latter were possibly used as breeding tanks or hatcheries (Bond 1992). Such a number of ponds was atypical for Benedictine houses, which generally only had three ponds at most. However, most Benedictine establishments were located in towns, where they would have struggled to find space to build more ponds, and they relied on the nearby rivers for additional fish supply (*ibid.*).

A survey of the abbey demesne from c.1360 mentioned 'recently built' fishponds located in the garden (Salter 1908, 37), which indicates that fishponds continued being built in later periods. The larger ponds were probably those built as part of the extension scheme of the Abbot Adam, around 1217, while the smaller ponds where probably the new addition (Bond 1992, 6-7; Hardy *et al.* 2003, 509-510). Payments were registered in 1389-90 for the cleaning of the fishponds in the garden and for the acquisition of pike to stock them. Another written source confirms that the fish used to fill the pond was pike: adult pike, young pike and other fish were brought from the rector of Stanlake to the abbey (Harleian Roll E. 31 in Salter 1906-7, vol. 2, lxxiv-lxxix in Hardy *et al.* 2003, 510).

Documentary sources report the existence of fishponds outside the abbey's precinct. In the 13th - mid 14th c. at least a dozen of fishponds from nine different places are recorded as belonging to the abbey, so as at least five manors controlled by the abbey had ponds (Bond 1973, 29-38).

Eynsham Abbey also owned several fisheries on the Thames and the Evenlode, as demonstrated by a reference in the Domesday Book, which also mentions an annual harvest of 450 eels from the abbey's mills (V.C.H. Oxon in Bond 1992; Hardy *et al.* 2003, 510).

Fisheries used to be leased out, as documented for 1284, 1302 and 1360 for the leas of river fisheries on the Thames between Standlake, Pinkhill and Wytham (Bond 1988, 91). The fishponds were not able to sustain the monks' diet all year round (Currie 1988; Bond 1992) and fish was frequently bought, as mentioned by written sources. In 1390 'red' (salted) and 'white' (pickled) herring, other preserved fish such as 'salt fish' and 'stock fish', 'haburdenes' (preserved fish from Aberdeen) were acquired; there is also mention of pickerel (small pike), a single *lupus aquaticus* (large pike) and salmon all probably purchased fresh; in 1406 fresh ‘fish’, salmon, red herring and oysters are listed to have been bought from Oxford for the bishop; in 1471, six months’ worth of fish meals were purchased for the abbot (Hardy *et al.* 2003, 400). An overview of what type of fish was typically sold in a town’s market in the late Saxon period can be read in *Colloquy,* a collection of interviews - compiled by Ælfric - with people of different professions (e.g. baker, hunter, leatherworker), to teach monks everyday Latin. One of the interviewees was a fisherman which mentions using nets in the stream set from his boat, baited hooks and basket traps to catch eel, pike, *mynas* or *means* (minnows, i.e. small fish, such as small Cyprinidae and stickleback; Bond 1988, 75; Dyer 1994, 106), burbot, trout and lamprey. It is important to consider that in Saxon time restrictions on rivers were probably not as strict as during the Norman period. Considering the distance from the coast, the fishermen went rarely to the sea, where the catch was mostly made of herring, salmon, dolphins, sturgeon, oyster, crab, mussel, winkle, cockle, plaice, flounder and lobster (Watkins 2010).

5.3.1.1 Excavations and zooarchaeological studies

Several small-scale programmes of archaeological work have taken place at Eynsham Abbey starting in 1962. However, the main investigations of the site were carried out in 1989-92 by Oxford Archaeology and revealed a complex stratigraphy dating back to the Bronze Age. Evidence of substantial occupation however, only begins with an early sixth century farm settlement (**Phase 2a**), which was replaced around 650 AD with a high-status settlement, either royal or monastic (**Phase 2b**). The first Minster church is dated to c. 750-c. 900 (**Phase 2c**). The 10th c. (**Phase 2d**) saw an intensification of the activities at the site, despite the numerous Viking incursions. The 11th c. (**Phases 2e-f**) is related to the reformed Benedictine abbey guided by Ælfric. During **Phase 3a**, starting with the Norman conquest, the continuous occupation of the abbey is attested by the building of a large kitchen above Saxon relicts. The 12th c. (**Phase 3b**) is characterised by a construction phase in the inner ward; excavations uncovered part of the great cloister with the *lavatorium*, part of the refectory, a kitchen with a courtyard (replacing the kitchen that was built in Phase 3a), a cellar, latrine pits, and a possible guest hall. Most of the construction activities were concluded in this phase and only some minor additions were built in the 13th-16th c. (**Phases 3c-e**). Archaeological evidence shows that the occupation of the inner ward did not end with the Dissolution (1538) as the kitchen was still in use in the early 17th c. but associated with the partial demolition of the abbey’s areas (**Phase 4a**), which became derelict by mid-17th c. (**Phase 4b**).

A small-scale excavation was carried out in 1991-1993, and focused on St. Peter's Church, which provided additional information on the layout of the establishments.

Several specialistic reports were produced as part of the post-excavation programme. The mammal bones were studied by Mulville (2003) and Ayres (2003), the bird bones by Serjeantson (2003), the oyster shell by Light (2003), and the fish bones by Locker (1997, 2003).

5.3.2 Material and recording methods

Fish remains were recovered from samples dated from the Saxon to the Post-Dissolution period; for this research, material collected from two different years of excavation (1990, 1991) from the Norman (**Phases 3a-b**) and later Medieval Abbey (**Phases 3c-e**) have been studied. The following phases were adopted: **3a** (1066-1109), **3b** (1120-1200), **3c** (1200-1330), **3d** (1330-1450), **3e** (1450-1538). Material attributed to more than one phase (e.g. 3b-e) has been recorded but excluded from analysis, though the appearance of odd species or large fish will be mentioned where relevant. Most of the samples from **Phases 3a** and **3b** were recovered from deposits associated with the kitchen, including cesspits and post holes near the kitchen. **Phases 3c**-**3e** material was collected primarily from the newly built 13th- 15th c. 'great' kitchen but also pits in the courtyard containing kitchen/general waste. A large part of the material originated from floor levels. Kitchen floors at the abbey were made out of mortar, which was laid regularly to seal debris and avoid fallen fire ashes from flying around; around 70 cm of the layered floor (covering over 300 years if occupation) were sealed in this way. This practice allowed the preservation of a vast quantity of small animal remains, including fish, which in some cases still retained some mortar concretions.

Fish remains were recovered through sieving and hand-collection. This information was not always available on bags containing fish bones, but relevant observations of the material allowed to make some inferences. Three (possibly four) types of mesh sizes were used for sieving the material. The material sieved through a 2 (possibly 1) mm mesh was included in 'fine-sieved' material; this includes bags labelled as bulk material, and others as wet sieved material. 'Coarse-sieved' material had been retained by 7 and 12 mm meshes. Twentyfour bags where labelled as 'flot residue' samples and represented unsorted mixed material (bones, wood, pottery, stones…). No indication of the adopted mesh size was available but through visual observation, it was clear that the material from these 24 bags was mostly sieved with a 2 (possibly 1) mm mesh. Considering the large quantity of unsorted material, it was decided to rapidly scan through the 24 bags, with the aid of an optical microscope. A tenth of the material for each bag was then recorded within the fine-sieved category. Other material was clearly sieved but the size of the mesh was difficult to establish, thus it was included in the analysis merely as sieved (S). Material from hand-collection was in some cases clearly labelled as such, while in others it was assumed, for instance when it included mainly large fragments. By comparing the results with Locker's (1997, 2003) reports, it appeared that she found from sieved material, **Phase 3d-e**, a total of 4 bones belonging to smelt (*Osmerus eperlanus*) and pilchard (*Sardina pilchardus*), together with few bones from Labridae and Sparidae, which were overlooked in this research. Smelt is a migratory species while the other taxa live in marine habitats, therefore no relevant data for freshwater species was missed with our selective type of approach.

5.3.3 Results

A total of 59,748 fish remains were counted for the relevant chronological period. Of these 9,906 were identified at different taxonomic levels and 9,148 were recorded as countable elements.

The large number of unidentified bones mainly originates from sieved samples from **Phase 3e**, in particular from context 1717 from the Great Kitchen floor, where meticulous recovery resulted in the collection of many unidentified fragments and undiagnostic fin rays and ribs. A high number of scales (c. 7,000) was recovered from various contexts of different periods, 97% of which originate from **Phase 3e**; some scales were attributed to perch but not included in the analysis, following the recommendations of the recording protocol. Around 30 dermal denticles from different contexts were attributed to Rajidae, including thornback ray (*Raja clavata*). Four scutes were attributed to Triglidae (one belonging to tub gurnard, *Chelidonichthys lucerna*) and one to Acipenseridae, which will be further discussed.

Overall, for all the phases most elements were represented by more than 50% of their total size and showed a medium level of preservation, with **Phase 3d** providing the best average preservation (Tables 5.3.1-2, Fig. 5.3.2-3).

5.3.3.1 Taxonomic frequencies

Sieved material

The larger samples from the undefined sieves fractions were those from **Phase 3a** and **3e**, and these are therefore analysed in greater detail (Table 5.3.3).

NISP calculation for **Phase 3a** (Table 5.3.3, Fig. 5.3.4) shows herring (66%) dominating the assemblage, followed by similar percentages of eel (12%) and pike (9%). Cyprinidae (5%) are represented for their 90% by unidentified remains, mostly vertebrae, while the remaining 10% has been attributed to a variety of species, including roach, chub, bleak, gudgeon, bream, barbel and dace (Table 5.3.4). Perch represents a little less than 2 %, while three-spined stickleback and burbot share similar percentages (1%). Within other Gadiformes (0.8%), four remains were attributed to whiting. Few remains were attributed to Pleuronectiformes, with plaice and sole identified. The occurrence of other taxa is minimal; however, it is worth mentioning the presence of Salmonidae and, among freshwater species, bullhead (*Cottus perifretum*).

The MNI for **Phase 3a** (Table 5.3.5, Fig. 5.3.5) shows an increase in the gap between herring (29 individuals) and other species, while eel (two individuals) is less abundant compared to NISP calculation, ranking after Cyprinidae (five individuals) and pike (three individuals). The overall pattern is, however, broadly similar.

In **Phase 3a** (Table 5.3.6, Fig. 5.3.6) marine taxa (67%) represent the larger part of the sample, followed by freshwater (18%) and migratory (14%) fish.

A small sample was recovered from **Phase 3b** (Table 5.3.3, Fig. 5.3.7), and this is represented by only five taxa. Herring (51%) and eel (22%) are the most abundant, followed by Cyprinidae (18%), pike (7%) and perch (0.6%). Among Cyprinidae the only species identified is bleak, with one pharyngeal bone (Table 5.3.4).

No taxa reach the threshold for MNI calculation, while frequencies of habitat distribution (Table 5.3.6, Fig. 5.3.8) show that marine fish (51%) represent about half of the small sample, while the rest is split between freshwater (26%) and migratory (23%).

Another small sample was recovered from **Phase 3c** (Table 5.3.3, Fig. 5.3.9), where the rank of the main species is the same as in Phase 3a, whit herring (60%) being the most abundant, followed by eel (23%), pike (7%), and Cyprinidae (6%). Among these, one bone each was attributed to roach, gudgeon and chub (Table 5.3.4). One bone belonged to a Salmonidae, while the presence of other taxa is insignificant.

For MNI calculations the only taxon reaching the threshold is herring with 28 individuals (Table 5.3.5).

Despite the small sample size, it is clear that marine taxa are most abundant (62%), followed by migratory (24%) and freshwater (14%) fish (Table 5.3.6, Fig. 5.3.10).

NISP frequencies for **Phase 3d** (Table 5.3.3, Fig. 5.3.11) are broadly similar to other phases. Herring (73%) is the most abundant by far, followed by eel (15%) and whiting (10%); among freshwater species, Cyprinidae (Table 5.3.4) and pike were found.

Herring is the only taxon reaching the threshold for MNI calculation, with three individuals (Table 5.3.5), and the common occurrence of the species is also reflected in habitat distribution frequencies (Table 5.3.6, Fig. 5.3.12), where marine fish represent over 80% of the sample, with the rest split between migratory (15%) and freshwater (4%) fish.

The largest sample was recovered from **Phase 3e** (Table 5.3.3, Fig. 5.3.13), where herring (81%) is by far the most common taxon. Once again eel (9%) is the second most common taxon and, as in the previous phase, whiting (3%) follows. Gadiformes represent around 1% of the sample, with cod and haddock present; Pleuronectiformes and Cyprinidae represent also 1%, with the latter including roach and gudgeon (Table 5.3.4). Freshwater fish include pike, bullhead (*Cottus perifretum*) and perch. Other taxa are scarce, but it is worth noticing the presence of Salmonidae.

The MNI for **Phase 3e** reflects NISP frequencies with the only featured species being herring (29 individuals) and eel (two individuals) (Table 5.3.5).

Overall, the **Phase 3e** sample is represented mostly by marine (88%) taxa, followed by migratory (10%) fish, while freshwater fish is barely present (2%) (Table 5.3.6, Fig. 5.3.14).

Whilst it is possible to see some of the major trends even in the smaller samples, **Phases 3a** and **3e** give a clearer view of the changes occurring from the 11th to the 15th-early 16th c. An increase in the frequencies of marine taxa is clearly perceivable, particularly with the intensification of the presence of herring, and, in smaller quantity, also whiting, to the detriment of migratory but in particular freshwater fish, especially pike, but also Cyprinidae and perch.

Fine-sieved material (1mm?, 2 mm)

Not many remains were collected from the fine-sieved fraction of **Phase 3a** (Table 5.3.3, Fig. 5.3.15). Herring (77%) is the most common species, followed by pike (11%) and eel (4%). Other taxa are scarce, though it is worth mentioning the presence of unidentified Cyprinidae (Table 5.3.7), perch and burbot.

Only herring reaches the threshold for MNI calculation, with five individuals (Table 5.3.8), and, as expected, marine (79%) taxa are most abundant, followed by freshwater (16%) and migratory fish (5 %) (Table 5.3.9, Fig. 5.3.16).

No remains from this fraction were collected from **Phase 3b** and very few from **Phase 3c** (Tables 5.3.3, 5.3.9); they mostly belong to herring and eel, with a few bones of freshwater taxa, such as pike, Cyprinidae (Table 5.3.7) and burbot.

Only 15 remains were collected for **Phase 3d** (Tables 5.3.3, 5.3.9) mostly eel and herring, while freshwater fish are represented by one perch remain and two from chub (Table 5.3.7).

A large sample was obtained for **Phase 3e** (Table 5.3.3, Fig. 5.3.17), and it has produced largely similar results to the sieved sample from the same period. Herring is by far the most common species (79%), followed by eel (8%) and whiting (4%). Other Clupeidae are represented by 2% of the identified material, while Cyprinidae by a little less than 2%, with roach being the only species identified (Table 5.3.7). Gadiformes (1%) and Pleuronectiformes (1%) are present in small quantities, with plaice, plaice/flounder and sole detected among the latter. Other freshwater species include pike and perch; it is worth noticing the presence of Salmonidae.

The MNI for **Phase 3e** (Table 5.3.8) shows similar rank and proportion to NISP frequencies, with herring being undoubtedly the most common species with 37 individuals, followed by eel (five individuals) and whiting (three individuals).

Overall, for **Phase 3e** (Table 5.3.9, Fig. 5.3.18) the relative percentage of marine fish is definitively higher (89%) than freshwater (9%) and migratory (2%) taxa.

Unfortunately, because of the small sample size of **Phase 3a,** it is difficult to detect chronological trends leading to **Phase 3e**. However, it is evident how the results mirror the trends of the sieved sample, with an overall decrease in the frequencies of freshwater taxa, in particular pike, versus an increase of marine species, with whiting becoming more abundant towards **Phase 3e**.

Coarse-sieved material (7, 12 mm)

Coarse-sieved fractions were identified only from **Phase 3d** and **3e**, in both cases with a negligible quantity of material - four remains from the earlier phase and six from the latter. In both cases, the samples are mostly represented by marine and large taxa, such as Gadiformes and conger (Tables 5.3.3, 5.3.10), as expected for this type of recovery.

Hand-collected material

Hand-collected material for **Phase 3a** (Table 5.3.3, Fig. 5.3.19) includes a similar taxonomic occurrence to the sieved sample from the same period but, unsurprisingly, a greater focus on large species. Herring (44%) is still the most common species, followed by pike (21%), eel (16%), and perch (4%). Cyprinidae and Salmonidae share similar proportions (little less than 4%). Among the Cyprinidae, three species have been identified (Table 5.3.11): roach, chub and tench. Other fish represented in the sample include cod (3%) and Pleuronectiformes (2%), with plaice, plaice/flounder and flounder identified. Among the rare species in the sample, noteworthy is the occurrence of burbot and sturgeon (Acipenseridae); the latter is represented by a skull fragment too broken to be assigned to species (*Acipenser sturio*/*Acipenser oxyrinchus*).

Herring (ten individuals) is the only taxon reaching the threshold for MNI calculation (Table 5.3.12).

The relative percentage of freshwater taxa from the hand-collected material, **Phase 3a**, is higher than in any other periods and fractions, covering 29 % of the sample (Table 5.3.13, Fig. 5.3.20). Marine (51%) fish is still the most common but less so, while migratory fish is represented by 20% of the material.

Only 38 remains were hand-collected from **Phase 3b** (Tables 5.3.3, 5.3.13), most of these belonging to cod and pike; only a few other taxa are present including perch and a skull fragment of sturgeon, which has the characteristic surface pattern of an Atlantic sturgeon (*Acipenser sturio*) (Thieren *et al.* 2015) but it is too fragmented to be confidently identified as such.

A larger number of remains were hand-recovered for **Phase 3c** (Table 5.3.3, Fig. 5.3.21), with herring (30%), pike (18%) and eel (15%) being once again the most common species. Characteristically for this type of recovery, the sample is skewed towards larger taxa, as confirmed by a higher percentage of large Gadiformes (13%) than in other fractions; these include cod, ling, haddock and hake. A haddock vertebra shows signs of hyperostosis, with the typical swelling and enlarged porosity of the bone tissue (von den Driesch 1994). The Pleuronectiformes (9%) are mostly represented by Pleuronectidae vertebrae, but plaice and plaice/flounder have also been identified. Perch and Cyprinidae are present in small quantities, with roach and tench being the only species recorded for the latter group (Table 5.3.11). Other taxa worth mentioning are burbot, Salmonidae and again a small fragment belonging to an Acipenseridae (*Acipenser sturio*/*Acipenser oxyrinchus*).

Like in Phase 3a, in **Phase 3c** the gap between marine fish (53%), freshwater (30%) and migratory (17%) fish is reduced compared to sieved samples (Table 5.3.13, Fig. 5.3.22).

A total of 80 remains was hand-retrieved from **Phase 3d** (Table 5.3.3), mostly represented by herring, Pleuronectiformes and large Gadiformes (cod, ling, haddock). Only two freshwater taxa are present with a handful of bones (Table 5.3.13): pike and Cyprinidae (Table 5.3.11). Salmonidae are also present with two remains.

Even fewer freshwater taxa were present from **Phase 3e**, where only two remains of pike and one of Cyprinidae were retrieved, the rest being mostly whiting and other large Gadiformes and Pleuronectiformes (Tables 5.3.3, 5.3.11, 5.3.13).

Overall, despite the small sample size, it is clear how the relative frequency of freshwater fish is higher in the hand-collected material than in sieved material. This could be due to an underrepresentation of herring, which, in the sieved sample, is by far the most common species. Nevertheless, the hand-collected samples provide a useful insight into the larger species that were consumed at the site and reinforce the value of pike for **Phases 3a** and **3c**.

5.3.3.2 Anatomical element distribution

The anatomical element distribution was performed for the five most frequent taxa recovered from various fractions of different phases (Table 5.3.14).

For the sieved fraction, the MAU comparison of frequencies of head skeleton and vertebrae for herring resulted slightly skewed towards vertebrae among all phases, except for **Phase 3c**, where head elements prevailed (Fig. 5.3.23). In **Phase 3a,** herring is mostly represented by vertebrae, particularly first (and second) vertebra (Fig. 5.3.24). In **Phase 3c** the species is mostly represented by Group I head elements, with an unusual concentration of articulars compared to other anatomical elements (Fig. 5.3.25). In **Phase 3d** the most common anatomical elements are first, second and anterior abdominal vertebrae (Fig. 5.3.26). In **Phase 3e** caudal vertebrae are the most common element (Fig. 5.3.27).

Similarly, in the fine sieved sample, MAU frequencies for herring show vertebrae being more common in **Phase 3a** and even more so in **Phase 3e**, where the sample is more reliable (Fig. 5.3.28). In **Phase 3a** herring is mostly represented by epihyal (Fig. 5.3.29), while in **Phase 3e** vertebrae are by far the most common element, especially first (and second) vertebra (Fig. 5.3.30).

For the hand-collected sample from **Phase 3a**, vertebrae are barely present, and parasphenoid is by far the most common element (Fig. 5.3.31-32).

For eel retrieved from sieved material, **Phase 3a**, head and vertebrae are equally represented by MAU comparison (Fig. 5.3.33-34). In **Phase 3e** vertebrae are a little more abundant than head elements by MAU comparison (Fig. 5.3.33), with most common anatomical elements been caudal vertebrae (Fig. 5.3.35).

For the fine-sieved sample, **Phase 3e**, eel is primarily represented by head elements, particularly the basioccipital; in this case, vertebrae are by far less represented (Fig. 5.3.36-37).

The MAU for Cyprinidae from the sieved sample, **Phase 3a**, by MAU comparison, head elements are slightly less abundant than vertebrae, with first vertebra been the most common anatomical element (Fig. 5.3.38-39).

Pike recovered from sieved samples, **Phase 3a**, is mostly represented by ceratohyal, supracleithrum and pre-caudal vertebrae, with an overall MAU percentage of vertebrae higher than the head (Fig. 5.3.40-41).

From the fine-sieved sample, **Phase 3e**, maxilla and posterior-abdominal vertebrae are the most common anatomical elements for whiting; by MAU comparison of frequencies, head elements and vertebrae are equally abundant (Fig. 5.3.42-43).

5.3.3.3 Taphonomic alterations

Taphonomic evidence for **Phase 3a** is limited and summarised in Table 5.3.15. The species most affected is eel; overall, the most common taphonomic alteration is crushing (mechanical and/or chemical bone deformation, Chapter 4) with 0.5 % of the identified material affected, generally vertebrae, except one pike dentary. Burning evidence (0.2%) is also uncommon, and so are butchery marks (0.1%), which are only represented by one cut on an eel cleithrum and a chop on a cod caudal vertebra.

Little evidence was detected from **Phase 3b** contexts; burning marks were recorded on 12 remains (6%), mostly belonging to herring (Table 5.3.16), while only one remain of eel from **Phase 3c** showed evidence of crushing (Table 5.3.17).

Taphonomic evidence for **Phase 3d** is also rare: three herring bones were burned, three eel bones crushed, and an anterior-abdominal vertebra of Salmonidae chopped (Table 5.3.18).

Similarly, within the larger sample from **Phase 3e** (Table 5.3.19) only 1% of the identified material showed burning evidence (mostly on herring and Cyprinidae bones), 2 % showed crushing (mostly on herring and eel bones) and for butchery marks only one chop was recorded on a precaudal vertebra of a pike of 60-70 cm of total length.

5.3.3.4 Biometrical analysis

Most measurements in the Log ratio histogram for pike (**Phase 3a**; Fig. 5.3.44) plot below the red line marker of 34 cm of total length (standard length 30 cm). These measurements are within the range of juvenile/maturing pike, as most modern pikes reach sexual maturity at 17-40 cm of standard length (Kottelat & Freyhof 2007, 342). Measurements for older/larger pike are less frequent and none of these reaching the size of the standard of 71.5 cm of total length (dotted line). Many bones were too broken to be measured and were visually compared with the large collection of the Royal Belgian Institute of Natural Science (Brussels). Four bones roughly matched pikes of 62 cm of total length, representing the largest individuals for the phase. The remaining bones matched pikes of 42.5 cm of total length (14 individuals), 29.5 cm (21 individuals), 24.5 cm (seven individuals) and 21.5 cm (three individuals).

The sample size for **Phase 3b** is small, but most specimens belonged to fish of less than 34 cm of total length, with some individuals possibly smaller than 15 cm. However, a broken articular matched an individual of 62 cm of total length.

Only 32 bones were measured for pike from **Phase c** (Fig. 5.3.45), and they show a higher mean value than the previous phases; most measurements fall in the range of adult fish, above the red line marker (34 cm of total length). There are three large outliers, one of which is a precaudal vertebra consistent with a modern pike of over 1 m of total length. Some broken bones were compared with pike from the Brussels reference collection, the largest being a broken articular that matched a modern pike of 62 cm of total length, and a urohyal that matched an 80 cm individual.

Only a few bones of pike could be measured for **Phases 3d** and **3e**, mostly belonging to small juvenile fish or individual slightly larger than the red line marker (34 cm of total length); an exception is a supracleithrum from **Phase 3d** matching a modern individual of 80 cm of total length and a caudal vertebra from **Phase 3e** with measurements larger than the first vertebra (typically the largest among caudal vertebrae in the spine; Chapter 4) of a modern individual of around 1 m of total length.

For perch, **Phase 3a**, the Log ratio histogram (Fig. 5.3.46) shows that most measurements plot below the standard (standard length: 24 cm) and represent individuals of juvenile/adult age, considering that the standard length of a modern adult unsexed perch is around 20 cm (Kottelat & Freyhof 2007).

From **Phases 3b-3e** there were very few measurements for perch, all in the same range of size as Phase 3a.

Cyprinidae measurements can represent various stages of life of the fish together with species size variation. For **Phase 3a** (Fig. 5.3.47) the main bulk of measurements is distributed in an approximate unimodal manner around the mean, which is slightly smaller than the standard value. The standard is represented by a modern roach of 19 cm of total length and 15 cm of standard length. Some bones are much larger than the standard, possibly reaching and exceeding the 50 cm of standard length (the largest Cyprinidae species identified in the assemblage, can grow up to 50-90 cm of standard length, Kottelat & Freyhof 2007). The very large outlier might represent a large freshwater bream or a barbel (among the largest Cyprinidae, when excluding carp; see Table 1.3 in Chapter 1).

A small set of measurements was recorded for Cyprinidae in **Phase 3b**, with a mean value slightly smaller than the previous Phase (Fig. 5.3.48). A broken chub pharyngeal bone was larger than any other modern chub from the reference collection, and it belonged to an individual over 40 cm of total length (average size for the species is 30-40 cm; Table 1.3, Chapter 1).

In **Phase 3c**, the Cyprinidae mean value almost exactly coincides with the standard (Fig. 5.3.49).

From **Phase 3d,** only one bone was measured, and it was smaller than the standard.

In **Phase 3e** Cyprinidae measurements are distributed around a mean value similar to Phase 3c and the standard (Fig. 5.3.50).

Overall, it was possible to measure 18 pharyngeal bones belonging to roach, chub and gudgeon collected from each phase (Fig. 5.3.51). The species with a wider size range is chub, which gave the largest and smallest measurements, while gudgeon and roach plotted in the middle.

A good sample of measurements is available for eel from **Phase 3a**, which appears to have non-normal distribution, with roughly two-three peaks (Fig. 5.3.52). The mean value plots beyond the marker of 49 cm of total length (red line), in the range of yellow/silver eel (over 30 cm of total length; Tesch 2003, 150); very small and very larger eels are not well-represented, and no eel reaches the standard value of 96 cm of total length. Most of the individuals over the mean value could represent female eels, as that males rarely grow beyond 54 cm of total length (Tesch 2003, 168). A broken vertebra from this phase is larger than its equivalent in a modern individual of 76 cm of total length (from the Brussels collection).

Only a few measurements could be recorded for eels from **Phase 3b** and they all plot around the red line marker (49 cm of total length).

For **Phase 3c** eel measurements are distributed roughly bimodally around the mean value, which matches with the standard (dotted line; Fig. 5.3.53). Juveniles are scarce; one bone matches the value of the standard of 96 cm of total length, belonging to a large female silver eel (average common length of modern female silver eel is 50-60 cm; Tesch 2003, 168). A few other larger outliers are only slightly smaller. Seven caudal vertebrae (not plotted; see Chapter 4), are larger than the first caudal vertebra of the standard, representing, therefore, individuals larger than the standard.

Both in Phases 3a and 3c bimodal distribution of eel sizes could represent seasonal exploitation or sexual dimorphism.

For **Phase 3d**, the eel sample size is much smaller, with a mean similar to the previous phase. The measurements appear heterogeneously scattered, with some larger individuals approaching the size of the standard value (dotted line), which would represent female silver eels (Fig. 5.3.54). A cleithrum from this phase was larger than a modern individual of 76 cm of total length (Brussels collection).

The largest sample of eel measurements is from **Phase 3e** (Fig. 5.3.55). Eels from this phase have the widest range of measurements and the smallest mean value, slightly smaller than the red line marker (49 cm of total length). The measurement distribution seems roughly sinusoidal, representing mostly yellow/silver eel; some very young eels and some very large females are present, even matching the rather large size of the standard (96 cm of total length).

5.3.4 Discussion

Herring was by far the most common fish consumed at the site, followed by eel. It is clear how from the 11th c. towards the 15th -16th c. the focus on herring increases at the expenses of freshwater taxa, such as Cyprinidae, perch and, in particular, pike, which becomes rare by the later period. To give the right value to each species, it is important to consider fish size and amount of flesh provided so that the incidence of larger but rarer species (e.g. pike, cod, ling) is not underestimated. Like herring, whiting also became more common throughout time. Overall, this relative rise in the frequency of marine taxa reflects the general trend observed in England from the 11th c. onwards, where increased exploitation of marine resources occurred at the expense of local resources, focussing in particular on herring and Gadiformes (Barrett 2004a, 2004b; Chapters 2-3).

At Eynsham Abbey, herring represented a staple food, whiting a frequent meal from the 14th c. onwards, while the consumption of large Gadiformes was infrequent. The hand-collected and coarse sieved samples provide more information on the larger marine species. Concerning Gadiformes, cod, ling and haddock are present; other taxa such as conger, rays, bass and mackerel are rarer. Considering the inland location of the site, it is reasonable to think that these species were more difficult to acquire. Perhaps the position of the site explains also the small contribution of Pleuronectiformes to the monks' diet (mostly plaice and flounder); these tend to be estuary fish, even though flounder occasionally swims several kilometres upriver (Kottelat & Freyhof 2007, 593). A variety of other species contributed to the diet, such as Salmonidae, but they do not appear to have a significant role. It is important to emphasise, however, that Salmonidae tend to be underrepresented in the archaeological record as their bones do not preserve well (Hamilton-Dyer 2007, 181).

As mentioned, Eynsham Abbey owned fisheries on rivers and several fishponds (at least from the 13th c.), which would have been the main source of freshwater fish and eel. Rivers and streams would have provided pike, eel, Cyprinidae, perch, salmon/trout and burbot. Possibly towards the 13th c., the freshwater supply would have been supplemented by the fishponds, which would have provided pike, perch, the larger Cyprinidae (bream, tench, roach, chub and barbel) and the smallest dace, and possibly also eel. Juvenile and smallest Cyprinidae species (gudgeon, bleak), together with stickleback and bullhead, often referred to as 'minnows', may not represent a targeted river catch, but they were likely eaten nonetheless, consumed fresh in soups, pies, pastries or preserved as pickles (Locker 2018a). Indeed, they could also represent the stomach content of larger predators (e.g. pike), which would also reveal on-site cleaning of these (Hamilton-Dyer 2007, 184).

The construction of the ponds in the early 13th c. is not detectable from the fish assemblage, as there is no increase in freshwater fish and eel. Something to consider is that in the same period when the ponds were constructed some of the fisheries owned by the abbey on the River Thames were leased out and this event could have negatively affected the proportion of freshwater catch that was consumed. Furthermore, fishponds require constant maintenance, cleaning and restocking (Dyer 1994, 101) and they would represent an economic drain for the abbey. The fluctuation in the wealth of the abbey through the years and the later decline could have caused a reduced use of the ponds and perhaps their abandonment. In this sense the decrease of pike frequency could support the hypothesis that the ponds were a failure. Other theories have been formulated for explaining the decrease of freshwater fish in conjunction with the construction of the fishponds at Eynsham Abbey and they are described in Hardy *et al.* (2003, 510). Bond (1988, 103-104) considered unlikely the possibility that fishponds were run for commercial purposes (meaning that the surplus of freshwater fish would have been sold to the market). Not only there is no documentary evidence for this, but the fact that the abbey needed to purchase fish demonstrates that the ponds probably were not producing enough surplus to be sold. Another possibility is that freshwater fish from the ponds was reserved for the abbot and the excavated fish remains rather pertain to the diet of the ordinary monks. There seems indeed to have been a separate kitchen for the abbott (Ayres *et al.* 2003).

However, a possible evidence of the construction of the fishponds could be seen in the increase of pike size (**Phase 3c**). The small pike of the 11th c. probably was sourced from river fisheries, while from the 13th c. onwards it was also bred in ponds, where it could have grown to a larger size. The largest individuals in all periods would anyway come from natural environments and represented targeted catch as large pikes, because of their predatory and aggressive behaviour, tend to be solitary and rare.

Eel frequencies remain fairly stable between the 11th (**Phase 3a**) and 15th-16th c. (**Phase 3e**), despite some limited fluctuations. Eel size decreases from the 13th c. onwards. Until the 13th c. eel was probably sourced from the river fisheries. The availability of the species from the rivers is testified by written sources, as an annual yield of 450 eels from the mills was recorded for the abbey in the 11th c. With the lease of the fisheries and the construction of the fishponds, the monks would have relied more on the latter for eel supply, perhaps supplemented by purchases of the fish from the market. Consequently, the high size variability of the 15th c. could represent different sources of supply.

Cyprinidae and perch frequencies are related only to a small extent to the fishpond construction event, because as suggested by Ayres *et al.* (2003) fishponds may have mainly been used for pike and large eel, which would therefore leave other species unaffected by their existence. The decrease in the frequency of perch and Cyprinidae may rather be associated with the lease of the fisheries. However, the increase in the size of Cyprinidae from the 11th c. to the 15th possibly suggests that some ponds may have been dedicated to the growth of the larger species of Cyprinidae (e.g. roach and chub).

Leaving the issue of the fishponds aside, the next step will be to focus on the ways and forms in which fish was consumed. The sieved sample shows herring represented mostly by vertebrae; this could be a taphonomic bias as herring head bones tend to be fragile. Small fish such as herring tend to be eaten whole (with the head) and possibly gutted; however, some other form of preparation of the fish cannot be excluded. For instance, in the case of lack of bones specifically from the hyoid arch, gill arches and shoulder girdle (as, for instance, the cleithrum in the case of Eynsham), ethnographic evidence suggests that the pattern could reflect a type of preparation, where parts of the gill region were removed before salting and packing herrings into barrels (Enghoff 1996). At Eynsham herring was likely bought preserved (e.g. pickled, salted) and barrelled (Locker 1997, 2003). However, they may have occasionally been eaten fresh. There is archaeological evidence of fresh herring having been transported and consumed fresh at religious sites, as in the case of Bicester Priory (Bond 1988, 77).

In two cases, herring heads are more abundant than vertebrae: from the hand-collected sample from the 11th c. (**Phase 3a**) and from the sieved sample from the 13th c. (**Phase 3c**), where an odd concentration of articular bones was observed. The first case could be representative of a recovery bias where the smallest vertebrae were not seen and collected; the second case is more mysterious, possibly representing waste from fish preparation on-site?

Eel anatomical element distribution suggests the consumption of the whole fish; eel could have been consumed fresh, as expected from the ready availability from the fishponds and the river fisheries, but also in preserved form, perhaps when acquired from the marked. For the 15th-16th c., the higher percentage of vertebrae against heads seems to be rebalanced in the fine sieved sample, therefore the disproportion appears to be the consequence of a recovery bias.

For pike and Cyprinidae, the relatively smaller number of head elements does not seem significant and could be a consequence of preservation bias. Pike would have probably been consumed fresh and served whole or beheaded; Cyprinidae also were likely consumed whole and fresh, with perhaps the larger individual served as beheaded. Salmonidae were rare and likely served whole and fresh. The remains of sturgeon from 11th-13th c. contexts (**Phases 3a-c**) would represent an occasional festive meal, where the fish would have been consumed fresh and cooked as a whole. Sturgeon had an undisputed high social/economic value in medieval England, especially after the 12th c. when it became rarer (Hoffmann 2005, 2008; Chapter 2).

Whiting was probably consumed whole, possibly both fresh and preserved, but it is reasonable to think that when the fish became more common from the 13th c. (**Phase 3c**) it would be purchased mostly preserved. Cod was probably transported to the abbey in a preserved form, and so was ling, as Locker (1997, 3) suggested that their habitat ranges could be too northern and western for them to reach the abbey fresh. Other marine species may have also been eaten fresh and imported from the east coast and/or the London market (*ibid.*). The consumption of preserved Gadiformes and other marine species was not a significant part of the diet at the abbey.

The high number of scales, especially from 15th-16th c. contexts (**Phase 3e**), suggests on-site cleaning (e.g. Bond & O'Connor 1999) at least for perch.

The evidence of burned bones from various phases affecting particularly herring and Cyprinidae could represent the disposal of kitchen and/or meal waste.

Bone deformation, in the case of smaller species (i.e. herring, Cyprinidae, small eel, maybe small whiting), suggests damage resulting from human consumption and digestion (Jones 1984, 1986). The mechanical crushing visible in larger species (i.e. pike, large eel), could represent trampling or cooking, such as hammering the carcass to release the flavour from the flesh, before preparation (e.g. Wubs-Mrozewicz 2009).

Very little butchery evidence was recorded on the bones. One cut on an eel cleithrum could represent the decapitation of the fish; chops on cod, salmon/trout and pike vertebrae could represent splitting along the vertebral column or severing into pieces. In particular, in the case of cod, most of the individuals were over 75 cm in total length and represented mostly by vertebrae and bones from the shoulder girdles; this could be evidence of the import of large beheaded fish at the site (i.e. stockfish).

From all this evidence the assemblage appears to be the combination of kitchen/table waste and possibly cesspit refuse.

Overall, the fish assemblage seems to reflect the fluctuations of the wealth of the religious establishments. Despite the diet been mostly based on herring, freshwater fish represents still a significant part of the monks diet; this evidence together with the presence of highly regarded species such as pike, sturgeon, Salmonidae and freshwater bream may suggest high status.

Completeness	PHASE 3a	PHASE 3b	PHASE 3c	PHASE 3d	PHASE 3e
> 75% present	725	57	189	77	1786
75-50% present	1098	95	274	162	2756
50-25% present	452	24	84	30	699
< 25% present	164	12	30	19	293

Table 5.3.1: Bone completeness by phase, all recovery methods.

Preservation	PHASE 3a	PHASE 3b	PHASE 3c	PHASE 3d	PHASE 3e
Excellent	0	0	0	0	1
Good	50	3	59	109	231
Medium	2386	184	500	178	5296
Bad	3	1	18	1	6
Awful	0	0	0	0	0

Table 5.3.2: Bone preservation by phase, all recovery methods.

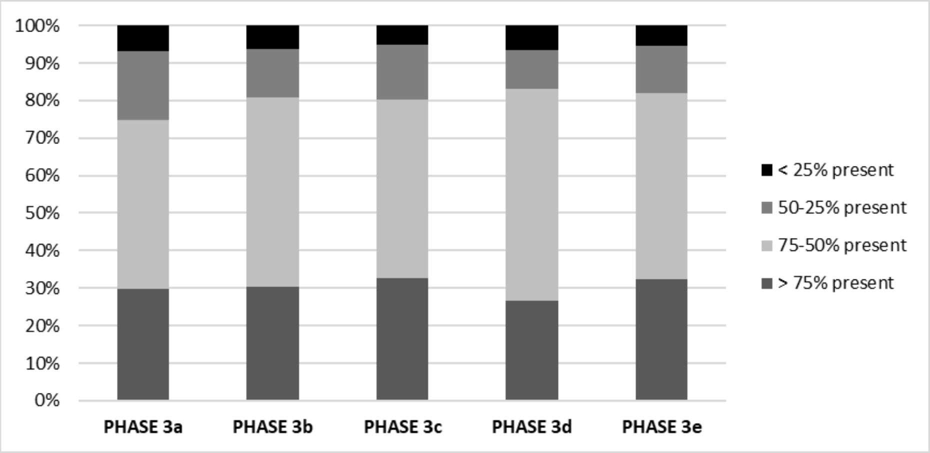


Fig. 5.3.2: Percentage of bone completeness by phase (**Phase 3a**, NISP: 2458; **Phase 3b**, NISP: 211; **Phase 3c**, NISP: 617; **Phase 3d**, NISP: 289; **Phase 3e**, NISP: 5620), all recovery methods.

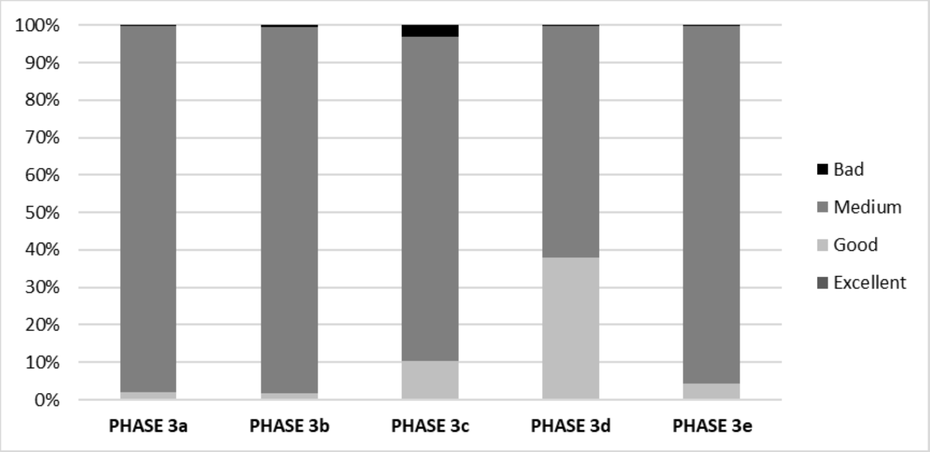


Fig. 5.3.3: Percentage of bone preservation by phase (**Phase 3a**, NISP: 2458; **Phase 3b**, NISP: 211; **Phase 3c**, NISP: 617; **Phase 3d**, NISP: 289; **Phase 3e**, NISP: 5620), all recovery methods.

TAXA		**PHASE 3a**			**PHASE 3b**		**PHASE 3c**			**PHASE 3d**				**PHASE 3e**				**TOT**
Latin name	**Common name**	**S**	**FS**	**HC**	**S**	**HC**	**S**	**FS**	**HC**	**S**	**FS**	**CS**	**HC**	**S**	**FS**	**CS**	**HC**	
Clupea harengus	Atlantic herring	1220	161	161	77	5	222	51	38	138	4	0	22	2192	2185	0	5	6481
Anguilla anguilla	European eel	224	10	61	34	2	86	17	19	29	9	1	8	262	231	0	12	1005
Esox lucius	Northern pike	170	23	77	11	10	26	2	23	2	0	0	5	7	5	0	2	363
Cyprinidae	-	99	4	11	27	0	24	1	3	6	0	0	2	45	52	0	1	275
Merlangius merlangus	Whiting	4	0	1	0	0	4	4	0	10	0	0	3	94	133	1	15	269
Gadiformes	-	11	3	5	0	3	1	3	5	0	0	1	0	40	52	0	8	132
Pleuronectiformes	-	3	0	5	0	0	0	1	3	0	0	0	14	30	25	1	6	88
Perca fluviatilis	European perch	35	4	16	1	1	3	0	6	0	1	0	0	1	3	0	0	71
Clupeidae	-	2	0	0	0	0	0	0	0	2	0	0	0	3	55	0	0	62
Gadus morhua	Atlantic cod	0	0	11	0	12	0	0	7	0	0	1	9	6	0	1	5	52
Lota lota	Burbot	25	2	3	0	0	0	1	2	0	0	0	0	0	0	0	0	33
Gasterosteus aculeatus	Three-spined stickleback	31	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	33
Salmonidae	-	4	0	14	0	0	1	0	2	0	0	0	3	4	2	0	0	30
Conger conger	European conger	0	0	7	0	3	0	1	4	0	0	1	4	0	0	2	1	23
Pleuronectes platessa	European plaice	3	0	1	0	0	1	0	5	0	0	0	2	0	7	0	0	19
Molva molva	Ling	0	0	1	0	1	0	0	2	0	0	0	4	0	0	1	10	19
Scomber scombrus	Atlantic mackerel	1	0	6	0	0	0	0	0	2	0	0	0	3	2	0	0	14
Rajidae	-	0	0	3	0	0	0	0	0	0	0	0	0	5	2	0	0	10
Pleuronectes platessa/ Platichtys flesus	European plaice/flounder	0	0	1	0	0	0	0	4	0	0	0	2	0	1	0	1	9
Melanogrammus aeglefinus	Haddock	0	0	0	0	0	0	0	2	0	0	0	2	1	0	0	3	8
Rutilus rutilus	Roach	3	0	1	0	0	0	0	1	0	0	0	0	0	2	0	0	7

Cottus perifretum	Bullhead	2	0	0	0	0	0	0	0	0	1	0	0	3	0	0	0	6
Triglidae	-	1	0	0	0	1	0	0	0	0	0	0	0	1	1	0	1	5
Tinca tinca	Tench	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	3
Solea solea	Common sole	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2
Gobio gobio	Gudgeon	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Platichthys flesus	European flounder	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Barbus barbus	Barbel	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Abramis brama	Freshwater bream	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Merluccius merluccius	European hake	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Alosa sp.	-	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Alburnus alburnus	Bleak	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Acipenseridae*	-	0	0	*	0	0	0	0	*	0	0	0	0	0	0	0	0	0
*cfr. Acipenser sturio**	cfr. Atlantic sturgeon	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0
*Leuciscus Leuciscus**	Common dace	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Squalius cephalus**	Chub	0	0	*	0	*	*	0	0	0	*	0	0	0	0	0	0	0
*Chelidonichthys lucerna**	Tub gurnard	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Raja clavata**	Thornback ray	0	0	0	0	0	0	0	*	0	0	0	0	*	0	*	0	0
TOTAL		2439			188		577			288				5534				9026

Table 5.5.3: NISP of taxa by phase based on diagnostic elements (other records noted as *) for sieved (S), fine-sieved (FS: mesh 2 mm), and coarse-sieved (CS: 7, 12 mm) and hand-collected material (HC). *Acipenseridae** are represented by parts of the cranium, *Cyprinidae** are represented by pharyngeal plates, *Chelidonichthys lucerna* is represented by a scute, *Raja clavata* is represented by a dermal denticle.

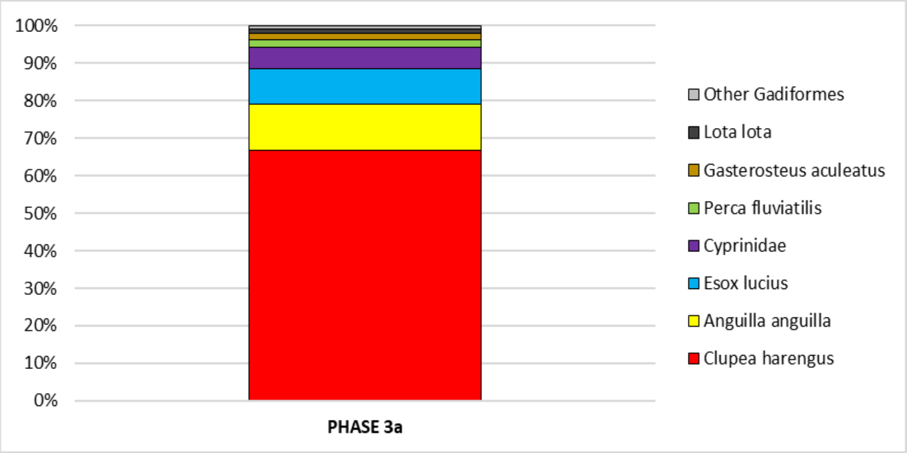


Fig. 5.3.4: Frequencies for the 8 most common taxa for **Phase 3a** (NISP: 1826), for sieved (S) material. Threshold by phase: tot NISP ≥ 100.

TAXA	PHASE 3a	PHASE 3b	PHASE 3c	PHASE 3d	PHASE 3e
Rutilus rutilus	4	0	1	0	2
Gobio gobio	1	0	1	0	2
Squalius cephalus	2	0	1	0	0
Alburnus alburnus	2	1	0	0	0
Abramis brama	1	0	0	0	0
Barbus barbus	1	0	0	0	0
Leuciscus leuciscus	1	0	0	0	0
Cyprinidae unid.	104	28	29	10	50

Table 5.3.4: NISP for the Cyprinidae family by phase for sieved (S) material based on all counted specimens and pharyngeal bones; although regarded as not countable, pharyngeal bones will be represented in this table because they have been consistently recorded for all Cyprinidae.

TAXA	3a	An.E.	3c	An.E.	3d	An.E.	3e	An.E.
Clupea harengus	29	B	28	A	3	PCV1	29	PCV1/vertebrae
Cyprinidae	5	B	\		\		\	
Anguilla anguilla	2	B/vertebrae	\		\		2	various
Esox lucius	3	SUP/CE	\		\		\	

Table 5.3.5: MNI by phase for main taxa, sieved (S) material. Threshold by phase: taxa NISP > 100. **An.E.** is the anatomical element used for MNI calculation. B: basioccipital, CE: ceraohyal, PCV1: first precaudal vertebra, SUP: supracleithrum, /: threshold requirement no fulfilled.

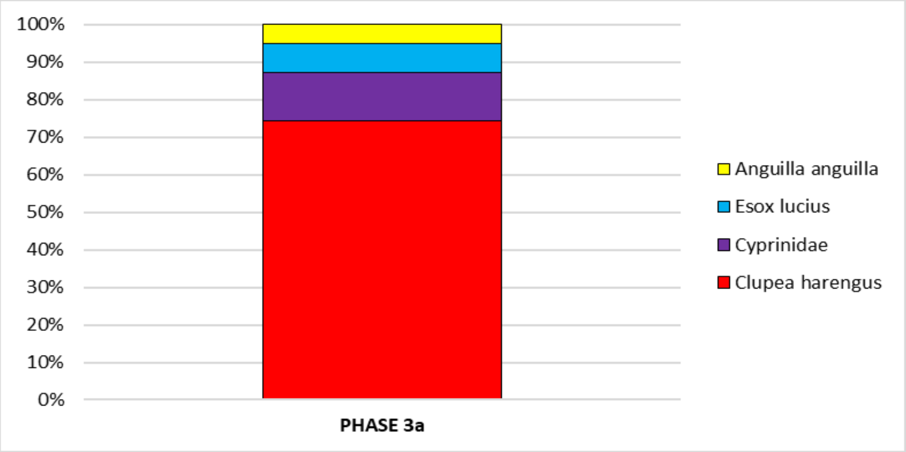


Fig. 5.3.5: MNI total n (39) for main taxa for **Phase 3a**, sieved (S) material. Threshold by phase: taxa NISP ≥ 100.

HABITAT	PHASE 3a	PHASE 3b	PHASE 3c	PHASE 3d	PHASE 3e
Freshwater	338	39	53	8	56
Marine	1233	77	227	152	2328
Migratory	259	34	87	29	268
Other	13	0	1	0	47

Table 5.3.6: Taxa habitat distribution by phase, sieved material (S).

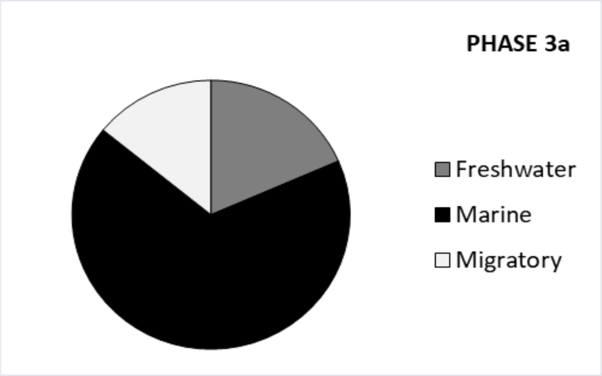


Fig. 5.3.6: Frequencies of habitat distribution for **Phase 3a** (NISP: 1830) for sieved material (S). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

Fig. 5.3.7: Frequencies for main taxa for **Phase 3b** (NISP: 150), for sieved (S) material. Threshold by phase: tot NISP ≥ 100.

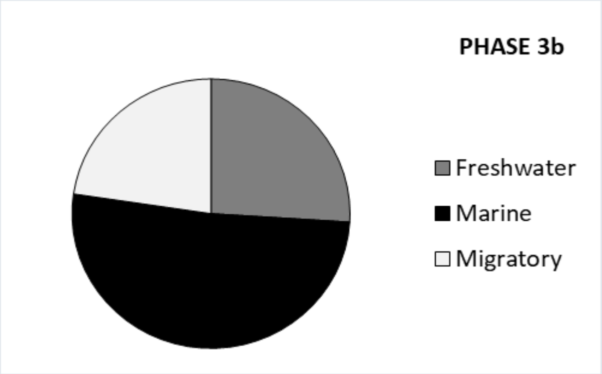


Fig. 5.3.8: Frequencies of habitat distribution for **Phase 3b** (NISP: 150) for sieved material (S). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

Fig. 5.3.9: Frequencies for the 8 most common taxa for **Phase 3c** (NISP: 367), for sieved (S) material. Within other Gadiformes, *Lota lota* is excluded. Threshold by phase: tot NISP ≥ 100.

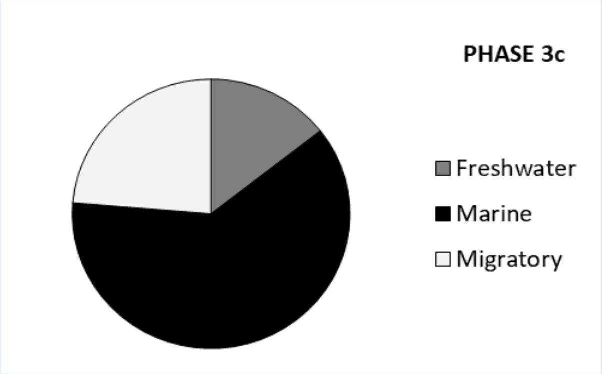


Fig. 5.3.10: Frequencies of habitat distribution for **Phase 3c** (NISP: 367) for sieved material (S). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

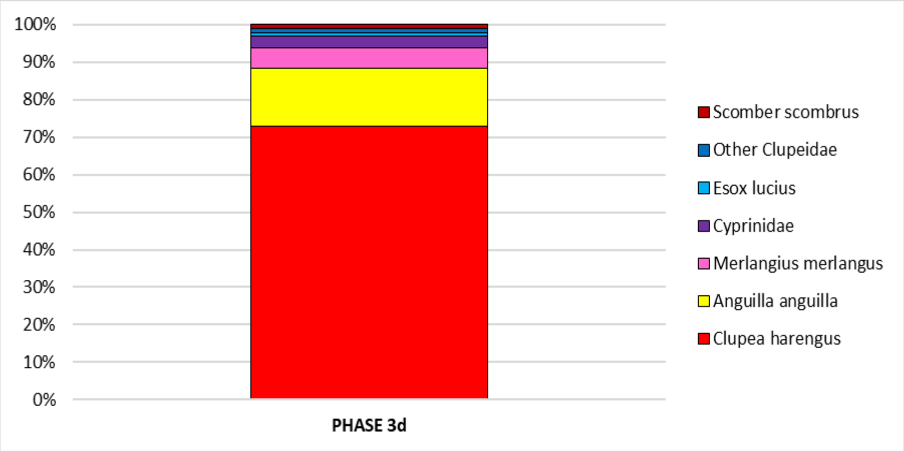


Fig. 5.3.11: Frequencies for the main taxa for **Phase 3d** (NISP: 189), for sieved (S) material. Threshold by phase: tot NISP ≥ 100.

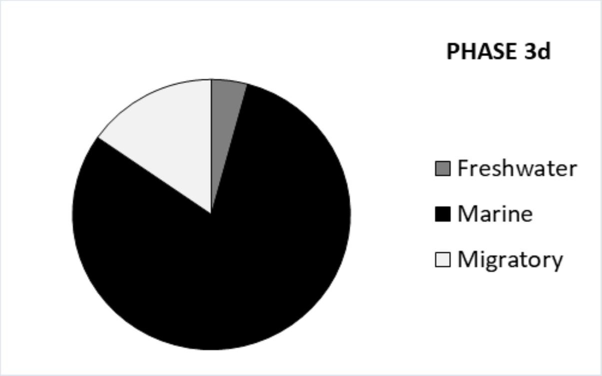


Fig. 5.3.12: Frequencies of habitat distribution for **Phase 3d** (NISP: 189) for sieved material (S). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

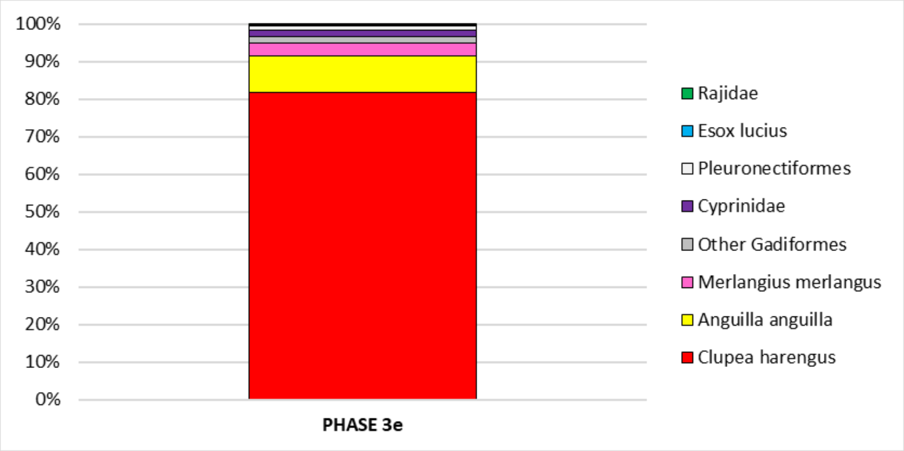


Fig. 5.3.13: Frequencies for the 8 most common taxa for **Phase 3e** (NISP: 2682), for sieved (S) material. Threshold by phase: tot NISP ≥ 100.

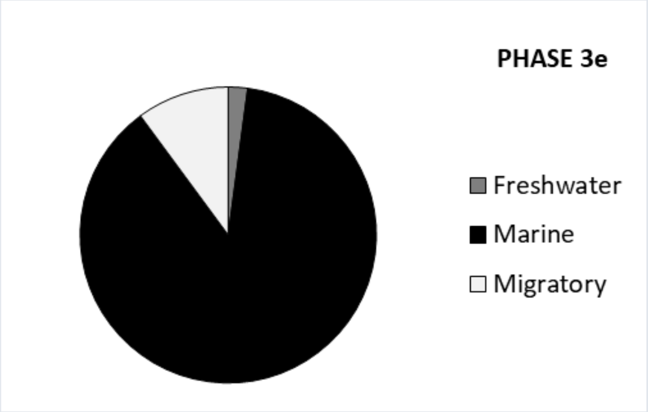


Fig. 5.3.14: Frequencies of habitat distribution for **Phase 3e** (NISP: 2652) for sieved material (S). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

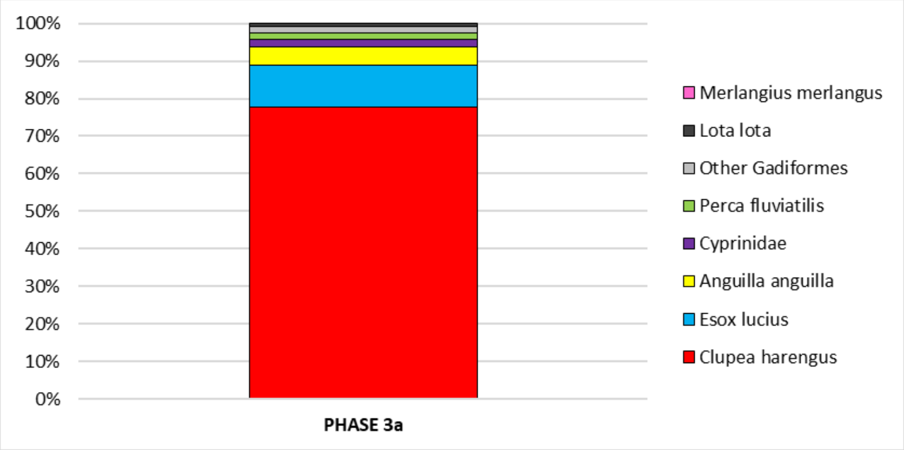


Fig. 5.3.15: Frequencies for the 8 most common taxa for **Phase 3a** (NISP: 207), for fine-sieved (FS: mesh 2 mm) material. Threshold by phase: tot NISP ≥ 100.

TAXA	PHASE 3a	PHASE 3c	PHASE 3d	PHASE 3e
Rutilus rutilus	0	0	0	2
Squalius cephalus	0	0	2	0
Cyprinidae unid.	5	1	2	55

Table 5.3.7: NISP for the Cyprinidae family by phase for fine-sieved (FS: mesh 2 mm) material based on all counted specimens and pharyngeal bones; although regarded as not countable, pharyngeal bones will be represented in this table because they have been consistently recorded for all Cyprinidae.

TAXA	PHASE 3a	An.E.	PHASE 3e	An.E.
Clupea harengus	5	EHY	37	PCV1
Anguilla anguilla	\		5	B
Merlangius merlangus	\		3	MAX

Table 5.3.8: MNI by phase for main taxa, fine-sieved (FS: mesh 2 mm) material. Threshold by phase: taxa NISP > 100. **An.E.** is the anatomical element used for MNI calculation. B: basioccipital, EHY: epihyal, MAX: maxilla, PCV1: first precaudal vertebra, /: threshold requirement no fulfilled.

HABITAT	PHASE 3a	PHASE 3c	PHASE 3d	PHASE 3e
Freshwater	33	4	2	62
Marine	161	57	4	2409
Migratory	10	17	9	233
Other	3	3	0	55

Table 5.3.9: Taxa habitat distribution by phase, fine-sieved (FS: mesh 2 mm) material.

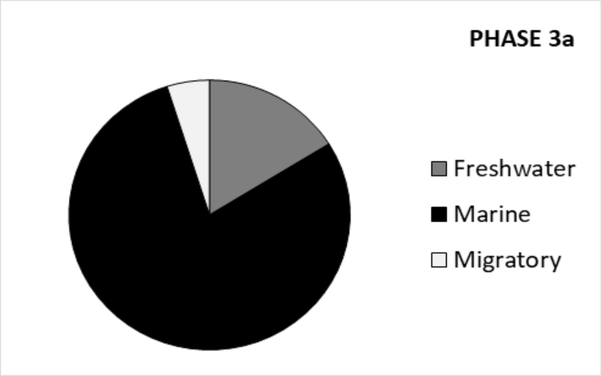


Fig. 5.3.16: Frequencies of habitat distribution for **Phase 3a** (NISP: 204) for fine-sieved (FS: mesh 2 mm) material. "Other" excluded. Threshold by phase: tot NISP ≥ 100.

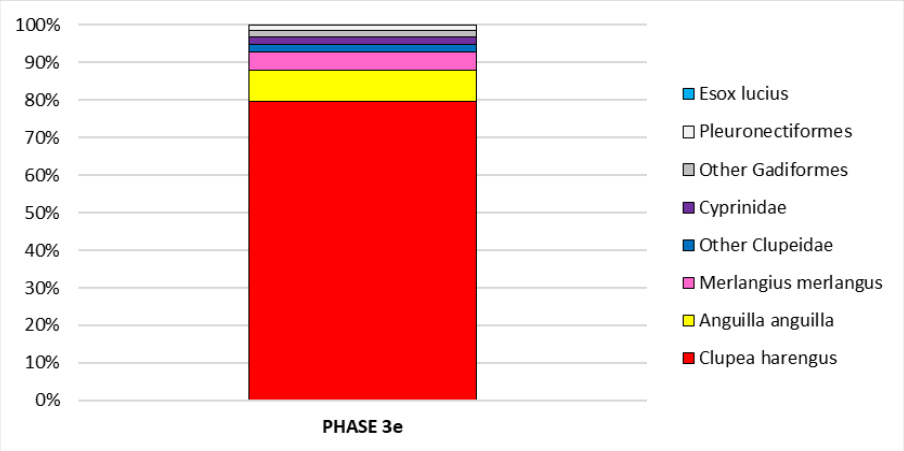


Fig. 5.3.17: Frequencies for the 8 most common taxa for **Phase 3e** (NISP: 2749), for fine-sieved (FS: mesh 2 mm) material. Within other Gadiformes, *Lota lota* is excluded. Threshold by phase: tot NISP ≥ 100.

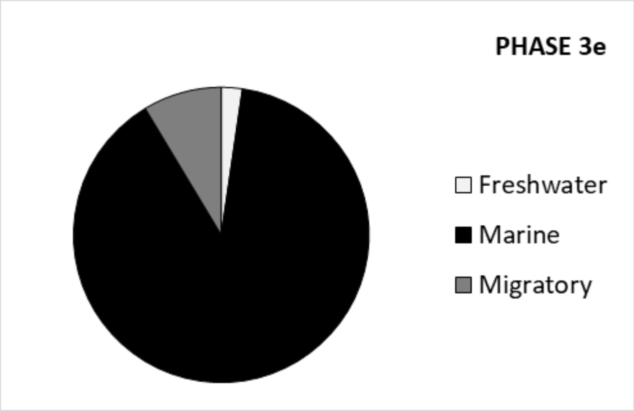


Fig. 5.3.18: Frequencies of habitat distribution **Phase 3e** (NISP: 2704) for fine-sieved (FS: mesh 2 mm) material. "Other" excluded. Threshold by phase: tot NISP ≥ 100.

HABITAT	PHASE 3d	PHASE 3e
Freshwater	0	0
Marine	3	5
Migratory	1	0
Other	0	1

Table 5.3.10: Taxa habitat distribution by phase, coarse-sieved (CS: mesh 7, 12 mm) material.

Fig. 5.3.19: Frequencies for the 8 most common taxa for **Phase 3a** (NISP: 362), for hand-collected material (H-C). Threshold by phase: tot NISP ≥ 100.

TAXA	PHASE 3a	PHASE 3b	PHASE 3c	PHASE 3d	PHASE 3e
Rutilus rutilus	3	0	4	0	0
Squalius cephalus	3	1	0	0	0
Tinca tinca	2	0	1	0	0
Cyprinidae unid.	12	0	3	2	2

Table 5.3.11: NISP for the Cyprinidae family by phase for hand collected (H-C) material based on all counted specimens and pharyngeal bones; although regarded as not countable, pharyngeal bones will be represented in this table because they have been consistently recorded for all Cyprinidae.

TAXA	HC	An.E.
Clupea harengus	10	PAR

Table 5.3.12: MNI for **Phase 3a** for main taxa for hand-collected (H-C) material. Threshold by phase: taxa NISP > 100. **An.E.** is the anatomical element used for MNI calculation. PAR: parasphenoid, /: threshold requirement no fulfilled.

HABITAT	PHASE 3a	PHASE 3b	PHASE 3c	PHASE 3d	PHASE 3e
Freshwater	110	11	36	7	3
Marine	193	25	64	46	45
Migratory	77	2	21	11	12
Other	9	0	7	16	10

Table 5.3.13: Taxa habitat distribution by phase, hand-collected material (H-C).

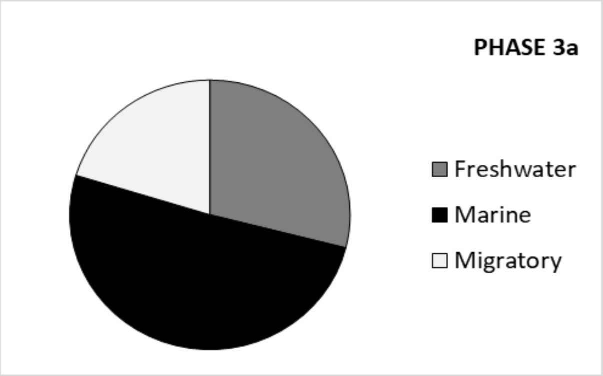


Fig. 5.3.20: Frequencies of habitat distribution for **Phase 3a** (NISP: 380) for hand-collected material (H-C). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

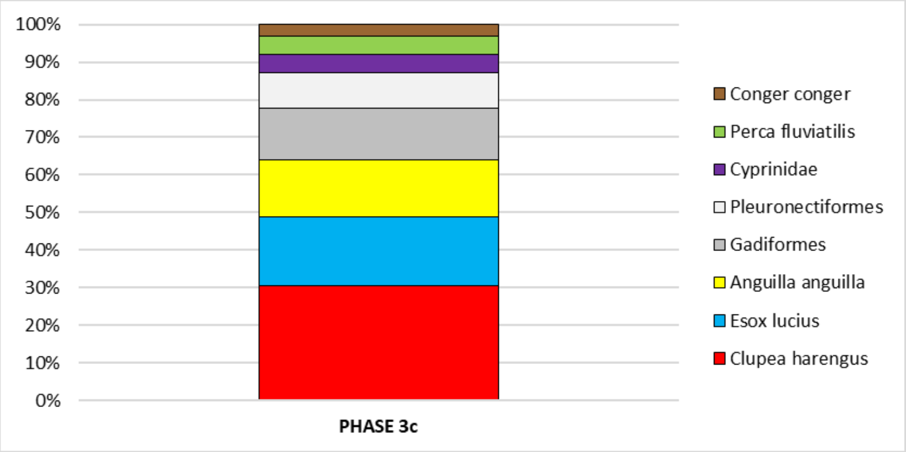


Fig 5.3.21: Frequencies for the 8 most common taxa for **Phase 3c** (NISP: 125), for hand-collected material (H-C). Within Gadiformes, *Lota lota* is excluded. Threshold by phase: tot NISP ≥ 100.

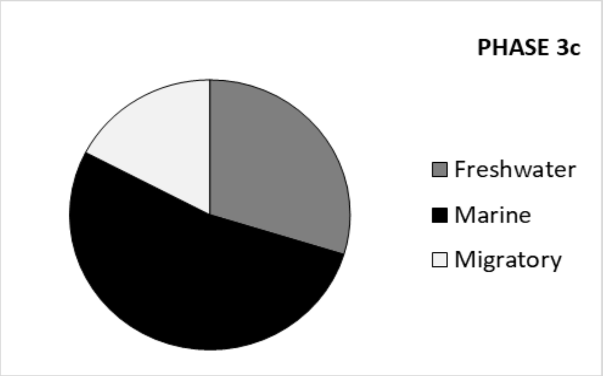


Fig. 5.3.22: Frequencies of habitat distribution for **Phase 3c** (NISP: 121) for hand-collected material (H-C). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

GROUP	Element		*Clupea harengus*							*Anguilla anguilla*			Cyprinidae	*Esox lucius*	*Merlangius merlangus*
			3a			3c	3d	3e		3a	3e		3a	3a	3e
			S	FS	HC	S	S	S	FS	S	S	FS	S	S	FS
I	**A**	Articular	4	0	2	28	1	8	7	0	0	2	1	1	0
	B	Basioccipital	29	0	0	0	0	5	5	2	1	5	5	0	2
	D	Dentary	5	0	4	0	1	4	2	0	0	3	3	0	1
	ECT	Ectopterygoid	0	0	0	0	0	2	4	0	0	0	0	2	0
	ENT	Entopterygoid	0	0	0	0	0	0	0	\	\	\	0	1	0
	HYO	Hyomandibular	2	0	3	0	0	3	5	0	2	1	0	0	0
	INT	Interopercular	0	0	0	0	0	2	1	0	1	0	0	0	1
	MAX	Maxilla	1	1	3	0	2	6	4	0	2	3	0	0	3
	OP	Opercular	0	0	5	0	1	6	3	0	1	1	2	0	0
	OT	Otolith	0	0	0	2	0	0	0	0	0	0	0	0	1
	PA	Palatine	0	0	0	0	0	0	0	\	\	\	0	2	1
	PAR	Parasphenoid	4	0	10	0	0	2	3	0	0	0	0	0	0
	PRE	Preopercular	1	0	3	1	0	6	2	1	0	1	1	1	0
	PX	Premaxilla	9	0	0	2	1	2	2	\	\	\	1	0	2
	Q	Quadrate	15	2	0	2	2	22	15	0	1	0	0	1	2
	SUB	Subopercular	4	0	1	1	1	9	8	0	1	0	0	0	0
	VOM	Vomer	1	0	0	1	0	3	2	0	2	2	0	0	2
II	**CE**	Ceratohyal	7	0	3	0	0	15	21	1	1	3	1	3	0
	EHY	Epihyal	20	5	1	1	1	11	16	0	2	1	0	1	0
	URO	Urohyal	25	0	3	1	1	10	8	\	\	\	0	0	1
III	**BAP**	Basipterygium	4	0	0	1	0	2	1	\	\	\	0	1	0
	CL	Cleithrum	0	1	7	0	1	2	6	1	2	2	0	1	0
	CO	Coracoid	2	0	0	0	0	1	4	\	\	\	0	2	0
	PSC	Postcleithrum	0	0	0	0	0	0	0	\	\	\	0	0	0

	PST	Posttemporal	10	0	1	0	1	4	3	\	\	\	0	0	1
	S	Scapula	5	0	0	1	0	2	1	\	\	\	0	0	0
	SUP	Supracleithrum	9	0	1	1	0	4	3	0	0	0	1	3	1
IV	**PCV1 (PCV2)**	1st (2nd) precaudal vertebra	47	0	0	11	3	29	37	1	2	0	7	0	0
	AAV	Anterior abdominal vertebra	15	3	1	3	3	32	33	1	2	1	3	3	2
	PAV	Posterior abdominal vertebra	7	1	1	2	1	16	18	2	2	2	1		3
V	**CV**	Caudal vertebra	8	1	2	2	2	35	29	2	3	2	2	2	2
	LC	Last caudal vertebra	5	0	1	1	0	15	19	\	\	\	0	0	0
VI	**VC**	Vertebral body (centrum)	1	0	0	0	0	0	0	0	0	0	0	0	0

Table 5.3.14: Anatomical element distribution (MAU) by phase for main taxa, for sieved (S), fine-sieved (FS: mesh 2 mm) and hand-collected (HC) material. Cyprinidae are grouped together. Group I = Head elements (Minus II): Neurocranium, jaws, gill arches, gill covers; Group II = Head elements: Outer branchial skeleton; Group III = Pectoral and pelvic skeleton; Group IV = Precaudal vertebra; Group V = Caudal vertebrae; Group VI = undefined vertebrae. \ = missing/undeveloped or unidentified anatomical elements for eel (Chapter 4).

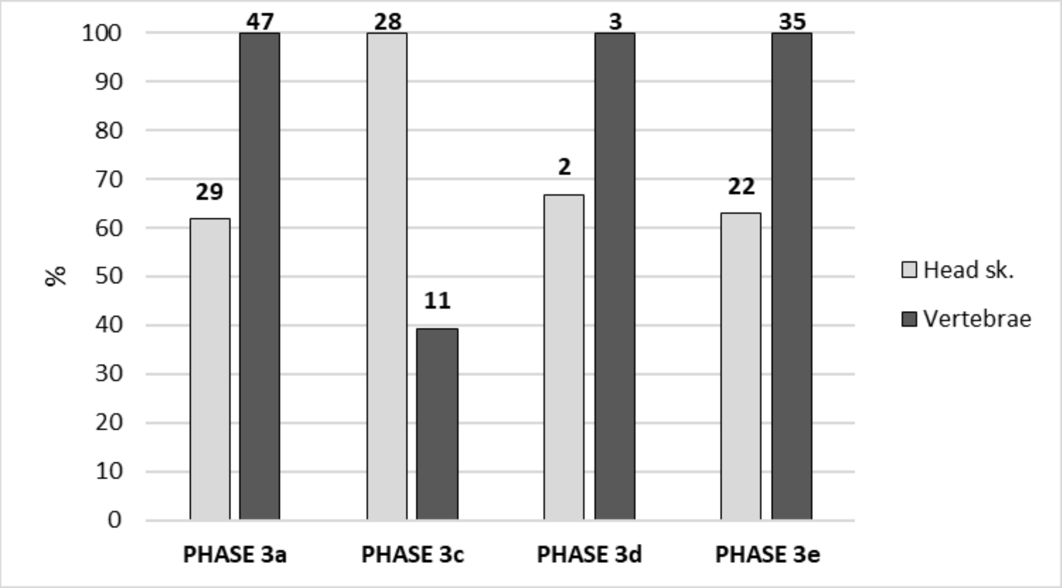


Fig. 5.3.23: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Clupea harengus* by phase for sieved (S) material.

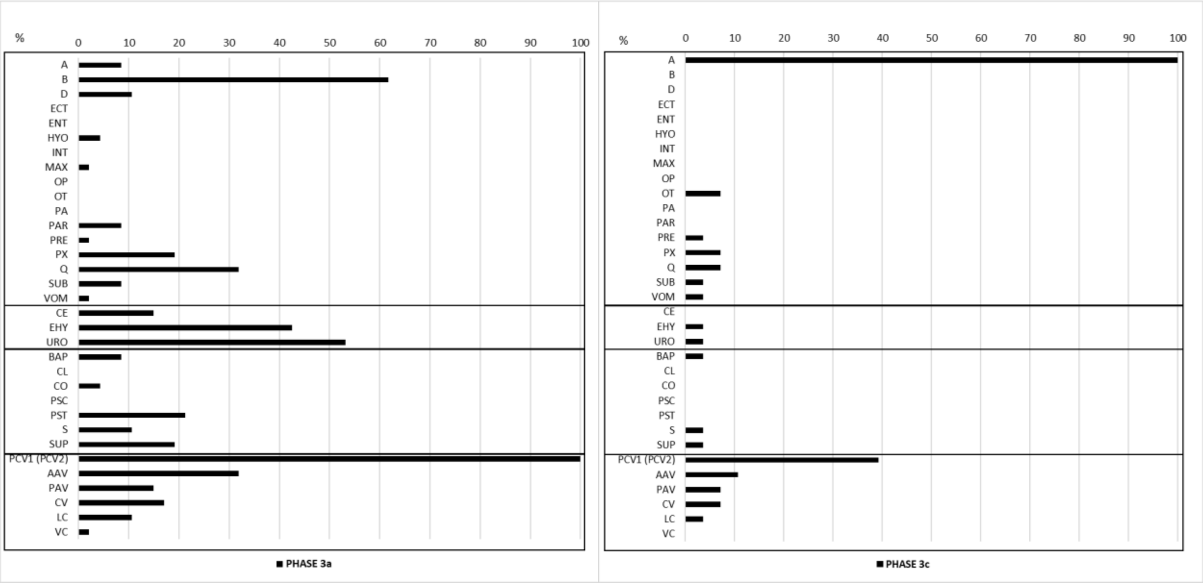


Fig. 5.3.24-25: Frequencies of anatomical element distribution (MAU) for Clupea harengus, **Phases 3a** and **3c**, for sieved (S) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

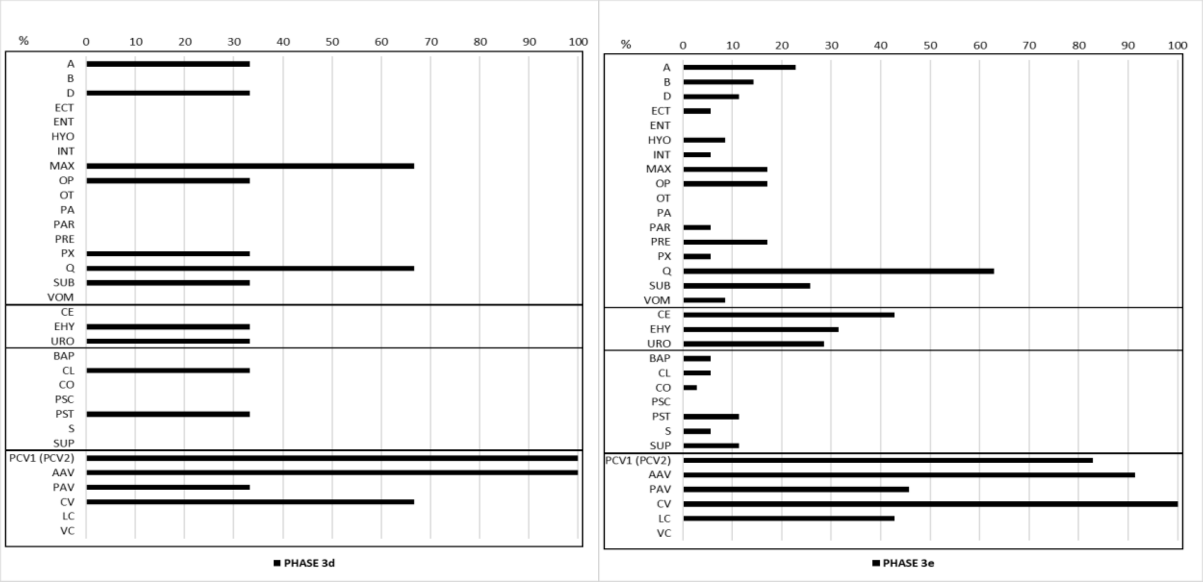


Fig. 5.3.26-27: Frequencies of anatomical element distribution (MAU) for Clupea harengus, **Phases 3d** and **3e**, for sieved (S) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

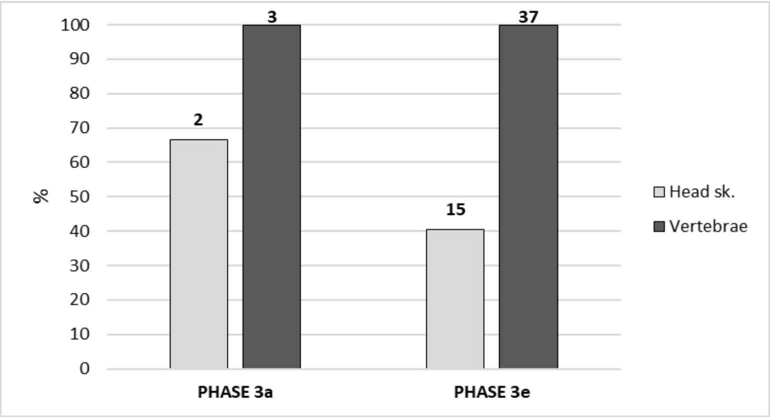


Fig. 5.3.28: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Clupea harengus* by phase for fine-sieved (FS: mesh 2 mm) material.

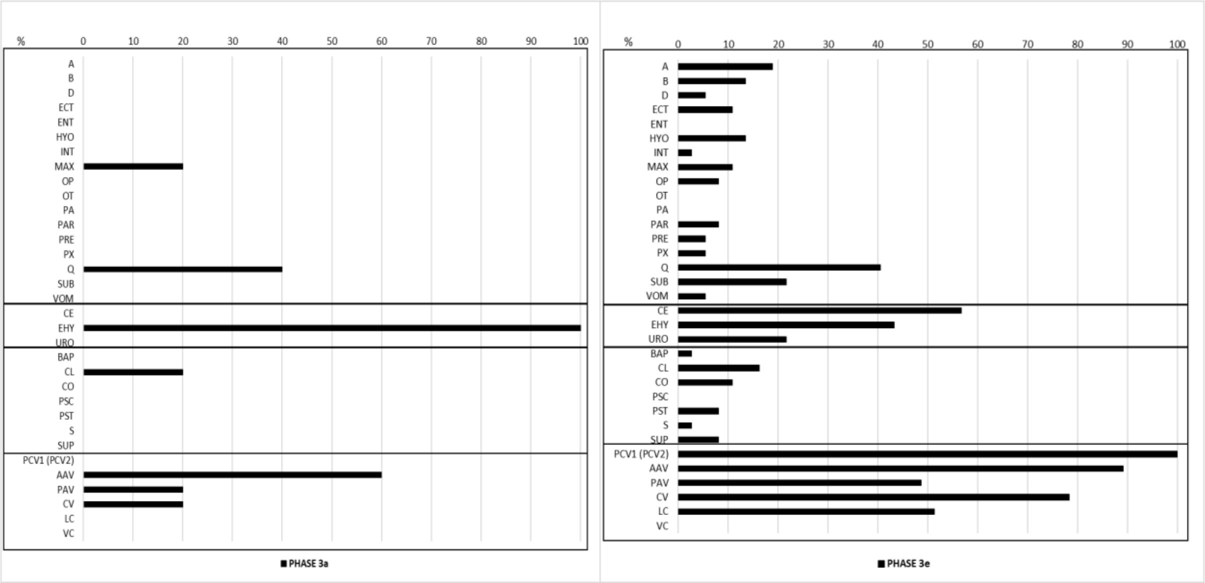


Fig. 5.3.29-30: Frequencies of anatomical element distribution (MAU) for Clupea harengus, **Phases 3a**, **3e**, for fine-sieved (FS: mesh 2 mm) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

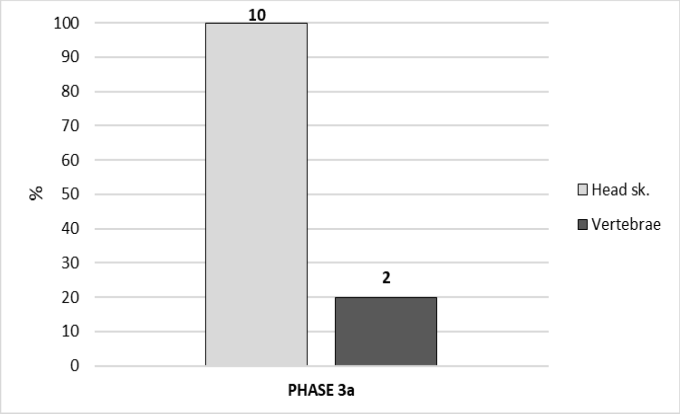


Fig. 5.3.31: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Clupea harengus*, **Phase 3a** for hand-collected material (H-C).

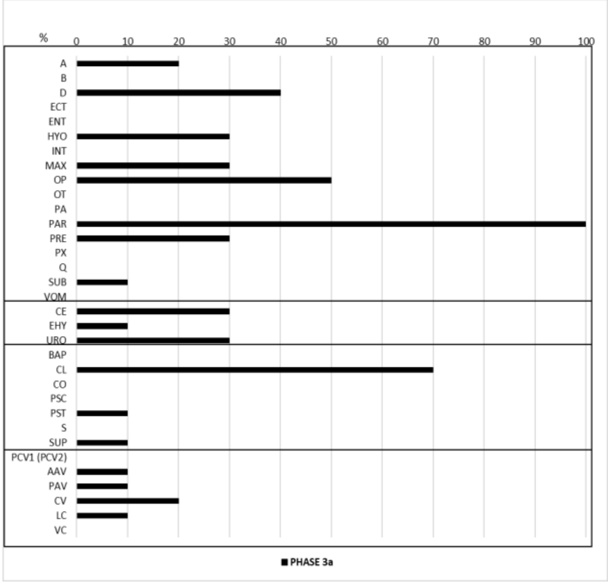


Fig. 5.3.32: Frequencies of anatomical element distribution (MAU) for *Clupea harengus*, **Phases 3a**, for hand-collected material (H-C). Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

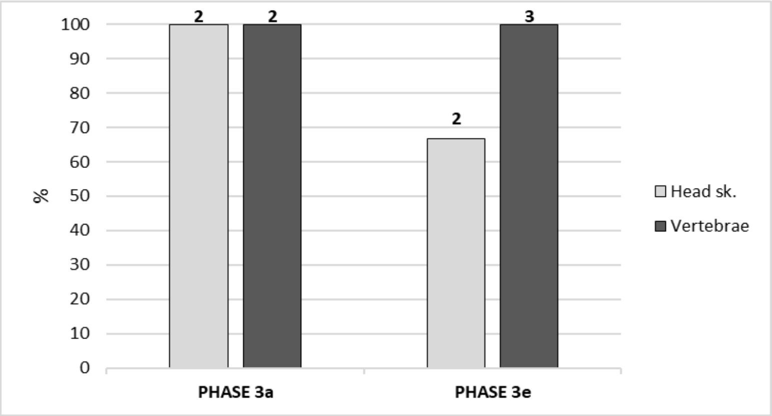


Fig. 5.3.33: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Anguilla anguilla* by phase for sieved (S) material.

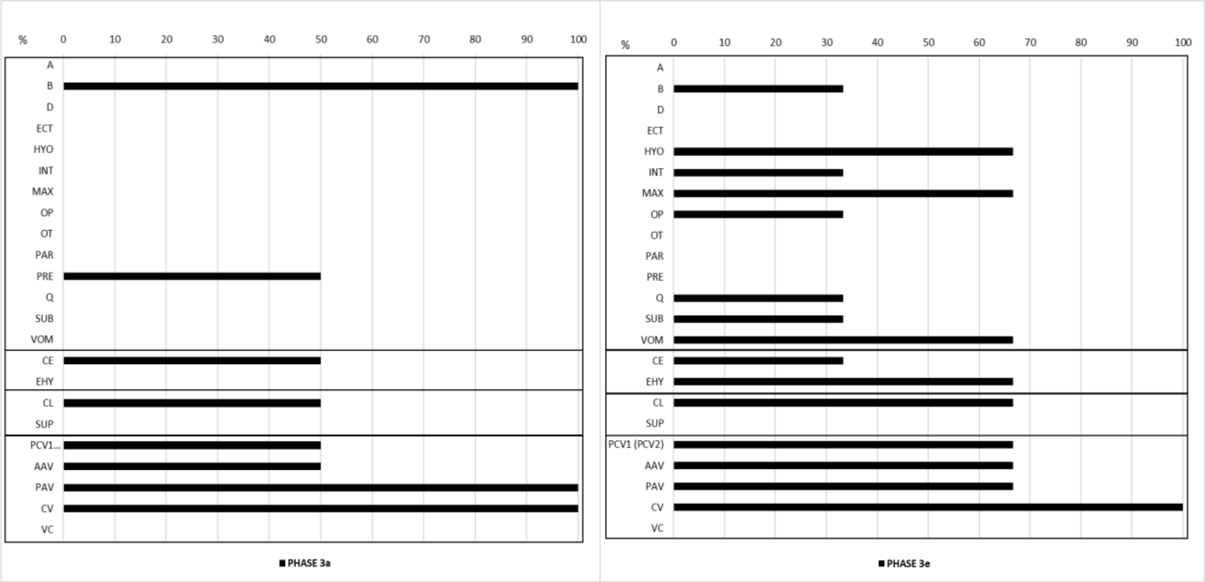


Fig. 5.3.34-35: Frequencies of anatomical element distribution (MAU) for *Anguilla anguilla*, **Phases 3a**, **3e**, for sieved (S) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

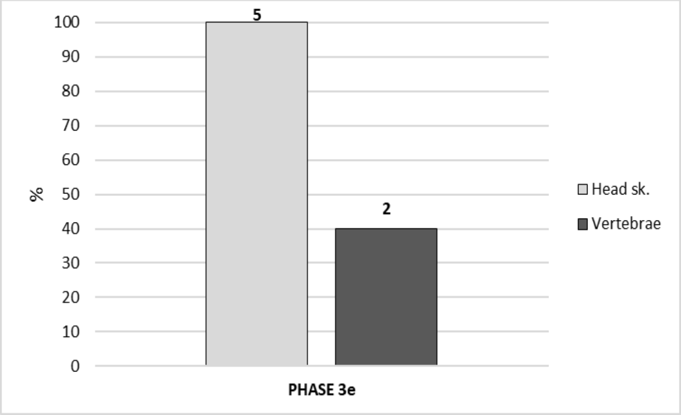


Fig. 5.3.36: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Anguilla anguilla*, **Phase 3e** for fine-sieved (FS: mesh 2 mm) material.

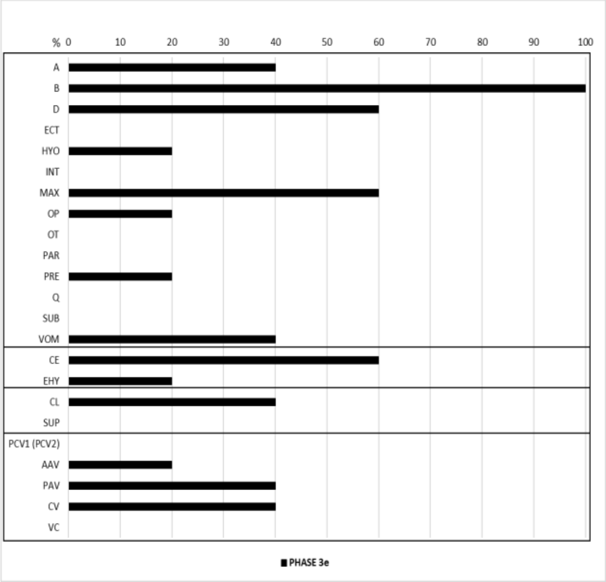


Fig. 5.3.37: Frequencies of anatomical element distribution (MAU) for *Anguilla anguilla*, **Phase 3e**, for fine-sieved (FS: mesh 2 mm) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

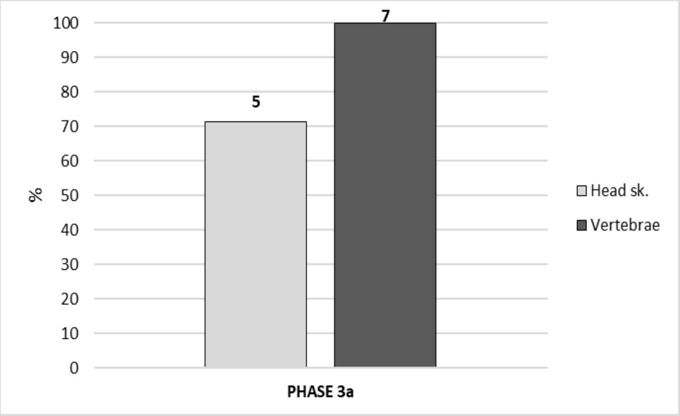


Fig. 5.3.38: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in Cyprinidae family, **Phase 3a** for sieved (S) material.

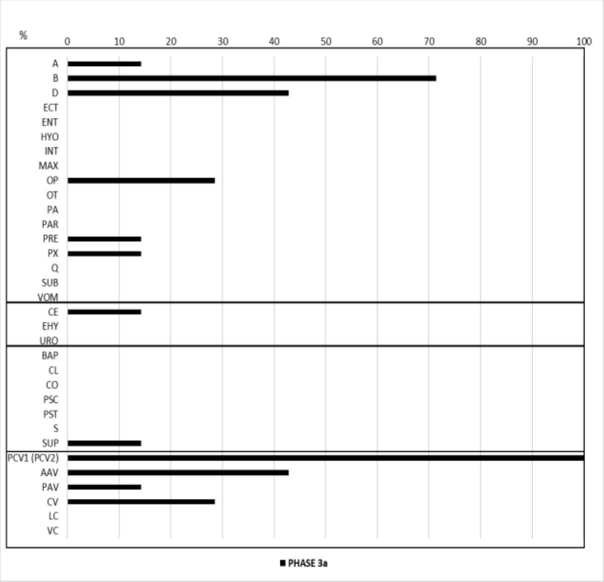


Fig. 5.3.39: Frequencies of anatomical element distribution (MAU) for Cyprinidae family, **Phase 3a**, for sieved (S) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

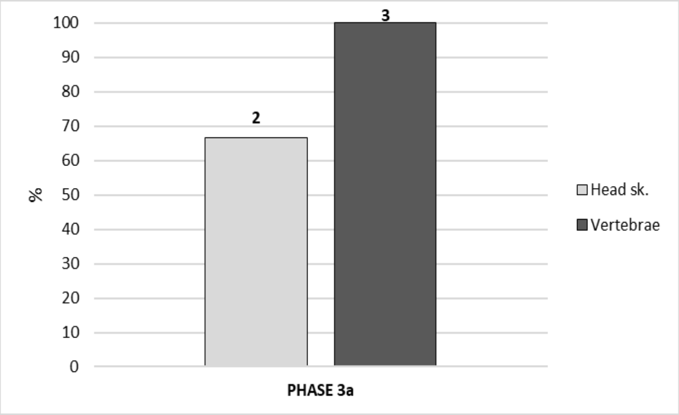


Fig. 5.3.40: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Esox lucius*, **Phase 3a** for sieved (S) material.

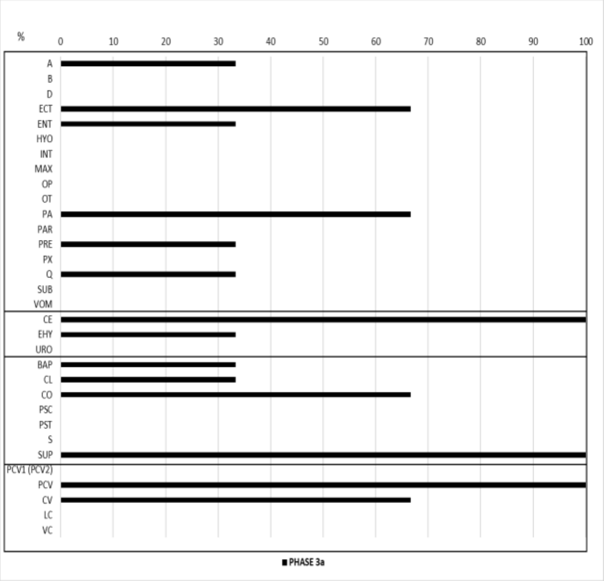


Fig. 5.3.41: Frequencies of anatomical element distribution (MAU) for *Esox lucius*, **Phase 3a**, for sieved (S) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens. NB: PCV (precaudal vertebra) corresponds to AAV (anterior abdominal vertebra) + PAV (posterior abdominal vertebra) for other species.

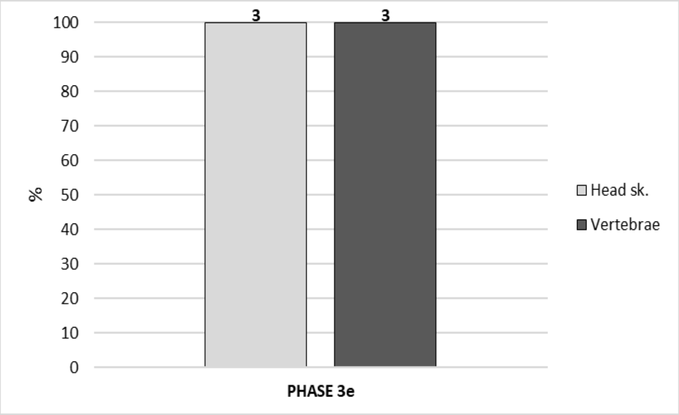


Fig. 5.3.42: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Merlangius merlangus*, **Phase 3e** for fine-sieved (FS: mesh 2 mm) material.

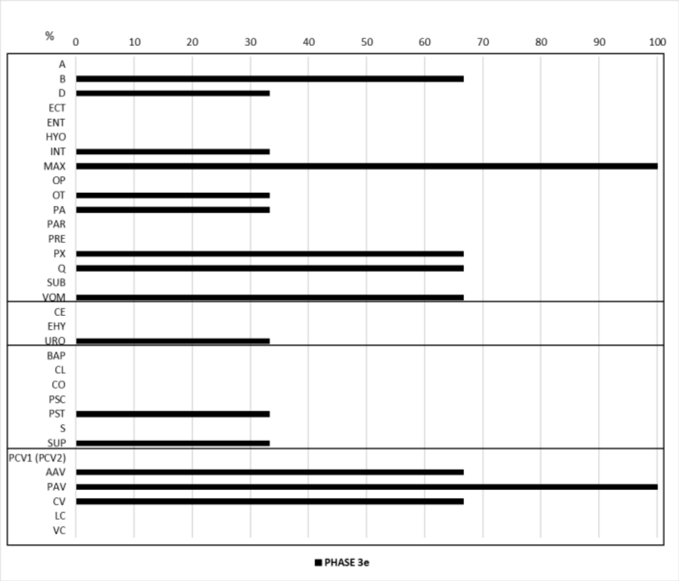


Fig. 5.3.43: Frequencies of anatomical element distribution (MAU) for *Merlangius merlangus*, **Phase 3e**, for fine-sieved (FS: mesh 2 mm) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

TAXA	*Anguilla anguilla*	*Esox lucius*	*Clupea harengus*	*Perca fluviatilis*	*Gadus morhua*	Cyprinidae	Clupeidae	**TOT**
Burning								
Burned	1	1	1	0	0	1	1	5
Calcined	0	1	0	0	0	0	0	1
Tot burned	1	2	1	0	0	1	1	6 (0.2%)
Other modifications								
Crushed	9	2	1	1	0	0	0	13
Tot modified								13 (0.5%)
Butchery marks								
Chop	0	0	0	0	1	0	0	1
Cut	1	0	0	0	0	0	0	1
Tot butchered	1	0	0	0	1	0	0	2 (0.1%)

Table 5.3.15: Taphonomic modifications for **Phase 3a** material by taxa, total NISP 2439, all recovery methods.

TAXA	*Clupea harengus*	Cyprinidae	*Anguilla anguilla*	**TOT**
Burning				
Burned	9	2	1	12
Tot burned				12 (6%)

TAXA	*Anguilla anguilla*	**TOT**
Other modifications		
Crushed	1	1
Tot modified		1 (0.2%)

Tables 5.3.16-17: Taphonomic modifications for **Phase 3b** (left), total NISP 188, and for **Phase 3c** (right), total NISP 577, material by taxa, all recovery methods.

TAXA	*Clupea harengus*	*Anguilla anguilla*	Salmonidae	**TOT**
Burning				
Burned	3	0	0	3
Tot burned				3 (1%)
Other modifications				
Crushed	0	3	0	3
Tot modified				3 (1%)
Butchery marks				
Chop	0	0	1	1
Tot butchered				1 (0.3%)

Table 5.3.18: Taphonomic modifications for **Phase 3d** material by taxa, total NISP 288, all recovery methods.

TAXA	*Clupea harengus*	*Anguilla anguilla*	Clupeidae	Cyprinidae	*Merlangius merlangus*	*Esox lucius*	Gadidae	**TOT**
Burning								
Burned	50	1	20	1	0	0	0	72
Calcined	0	0	0	0	0	0	1	1
Tot burned	50	1	20	1	0	0	1	76 (1%)
Other modifications								
Crushed	51	32	0	3	3	1	0	90
Tot modified								90 (2%)
Butchery marks								
Chop	0	0	0	0	0	1	0	1
Tot butchered								1 (0.01%)

Table 5.3.19: Taphonomic modifications for **Phase 3e** material by taxa, total NISP 5534, all recovery methods.

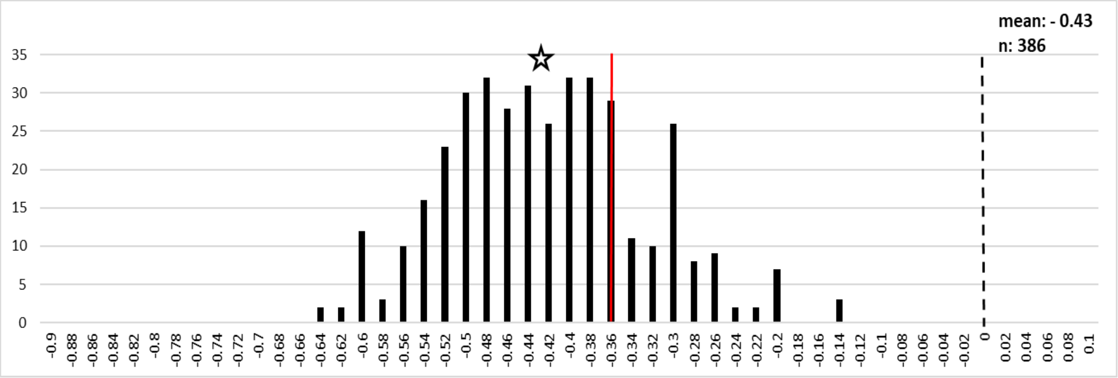


Fig. 5.3.44: Size distribution for all anatomical elements for *Esox lucius*, **Phase 3a**. The star indicates the mean (-0.43), the red line marker represents a modern pike (origin: unknown) with TL of 340 mm and SL of 300 mm (mean: -0.36). The standard set of values is represented by the value 0 (TL: 715 mm, SL: 650 mm; modern individual, origin: France). Bones measured: 147; n measures: 386.

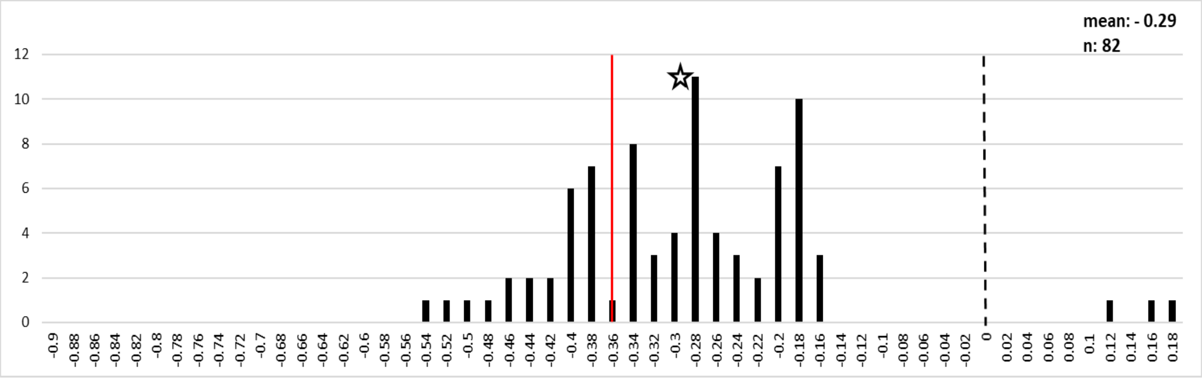


Fig. 5.3.45: Size distribution for all anatomical elements for *Esox lucius*, **Phase 3c**. The star indicates the mean (-0.29), the red line marker represents a modern pike (origin: unknown) with TL of 340 mm and SL of 300 mm (mean: -0.36). The standard set of values is represented by the value 0 (TL: 715 mm, SL: 650 mm; modern individual, origin: France). Bones measured: 32; n measures: 82.

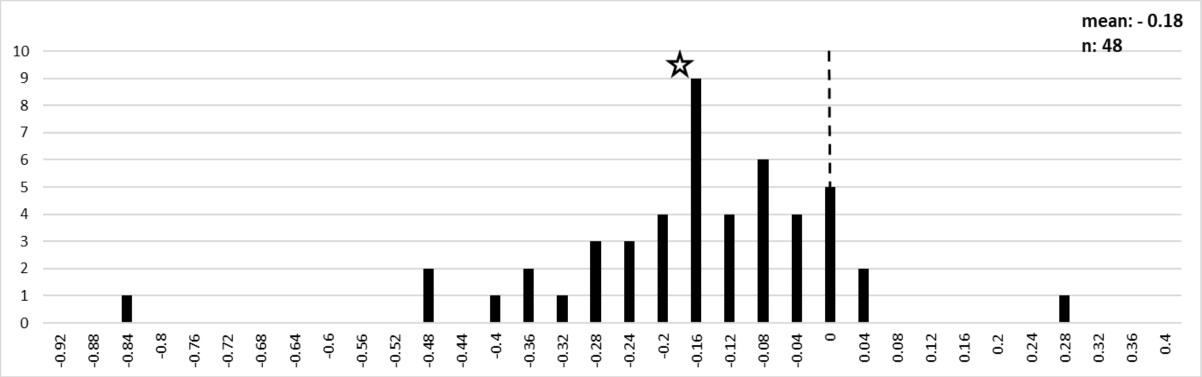


Fig. 5.3.46: Size distribution for all anatomical elements for *Perca fluviatilis*, **Phase 3a**. The star indicates the mean (-0.18). The standard set of values is represented by the value 0 (TL: 275 mm, SL: 240 mm; modern individual, origin: Italy). Bones measured: 24; n measures: 48.

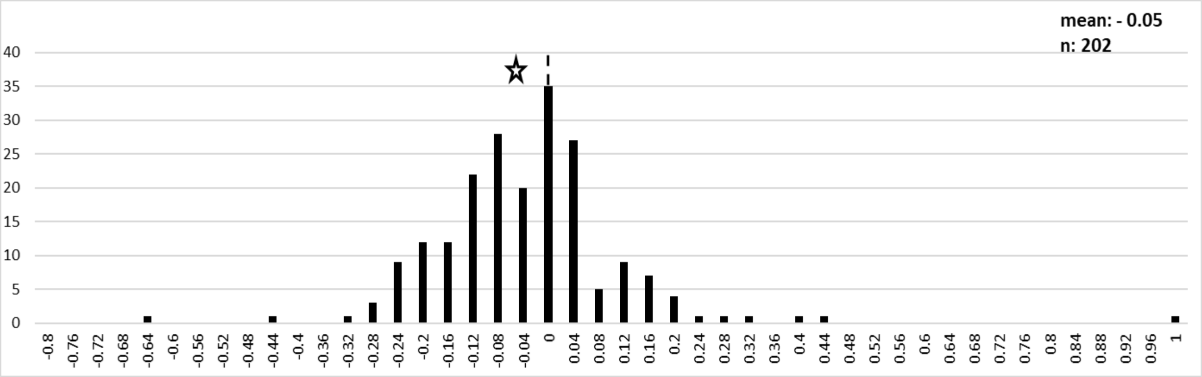


Fig. 5.3.47: Size distribution for all anatomical elements for *Cyprinidae* family, **Phase 3a**. The star indicates the mean (-0.05). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 72; n measures: 202.

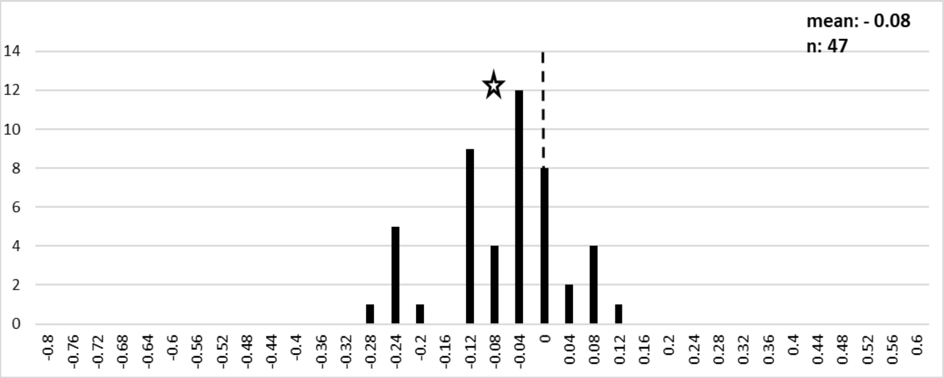


Fig. 5.3.48: Size distribution for all anatomical elements for *Cyprinidae* family, **Phase 3b**. The star indicates the mean (-0.08). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 19; n measures: 47.

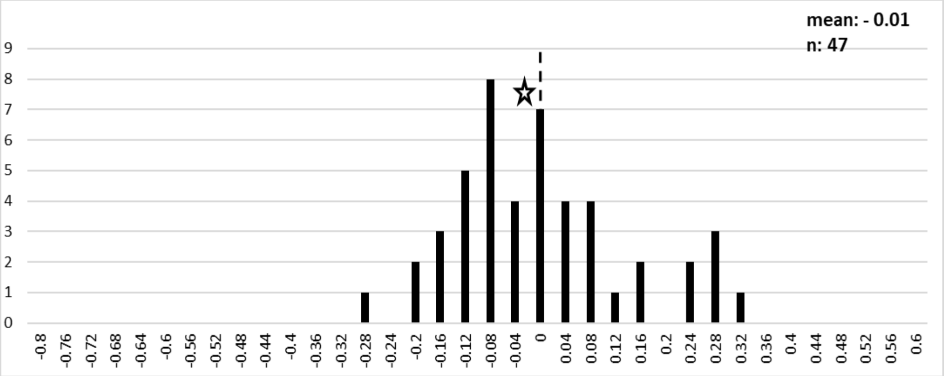


Fig. 5.3.49: Size distribution for all anatomical elements for *Cyprinidae* family, **Phase 3c**. The star indicates the mean (-0.01). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 17; n measures: 47.

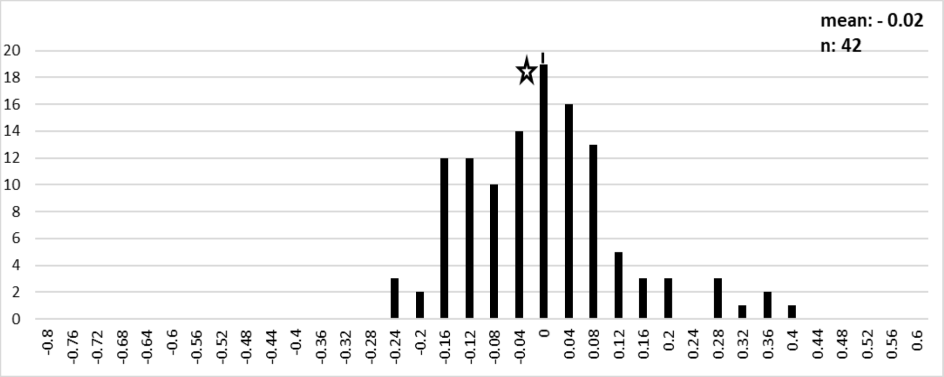


Fig. 5.3.50: Size distribution for all anatomical elements for *Cyprinidae* family, **Phase 3e**. The star indicates the mean (- 0.02). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 42; n measures: 119.

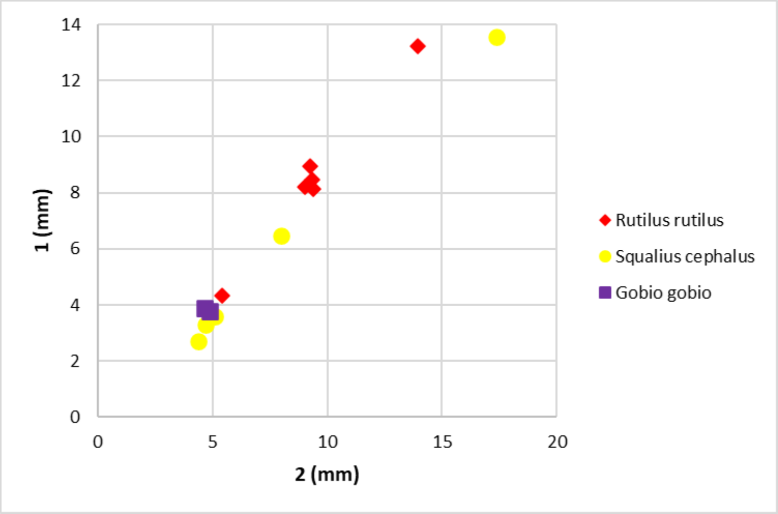


Fig. 5.3.51: Distribution of measurements (n 13) for Cyprinidae pharyngeal bones, **Phases 3a-e**, all recovery methods; measure **1** (height), measure **2** (cord length).

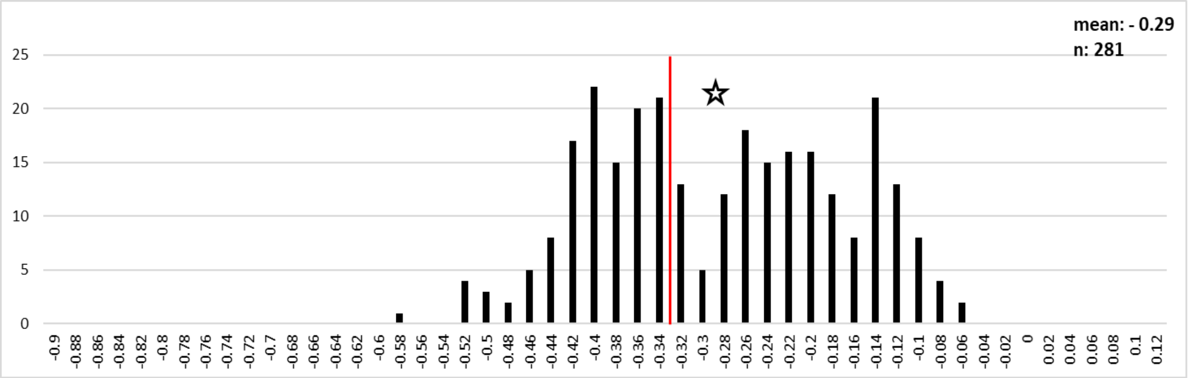


Fig. 5.3.52: Size distribution for all anatomical elements for *Anguilla anguilla*, **Phase 3a**. The star indicates the mean (-0.29). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 96; n measures: 281.

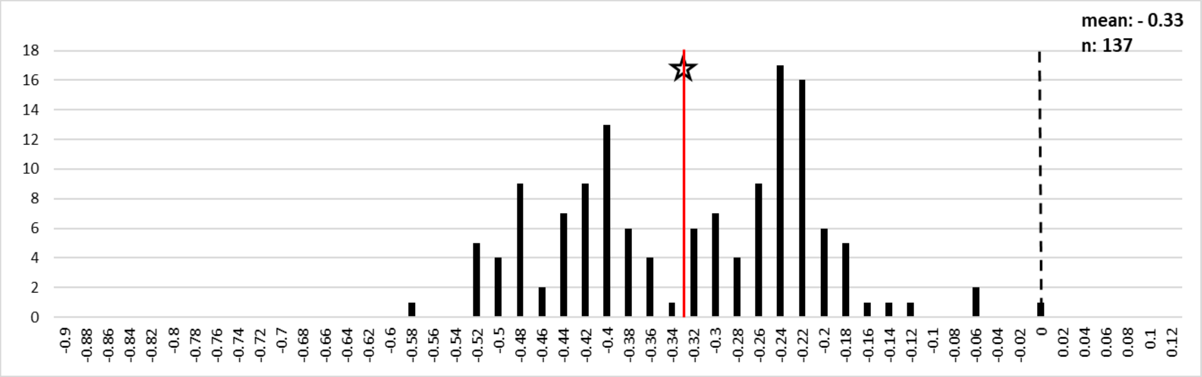


Fig. 5.3.53: Size distribution for all anatomical elements for *Anguilla anguilla*, **Phase 3c**. The star indicates the mean (-0.33). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 48; n measures: 137.

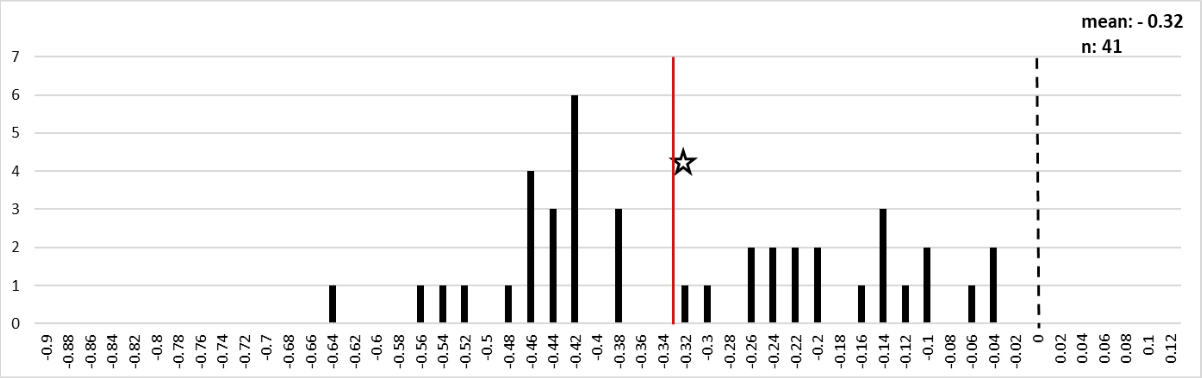


Fig. 5.3.54: Size distribution for all anatomical elements for *Anguilla anguilla*, **Phase 3d**. The star indicates the mean (-0.32). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 19; n measures: 41.

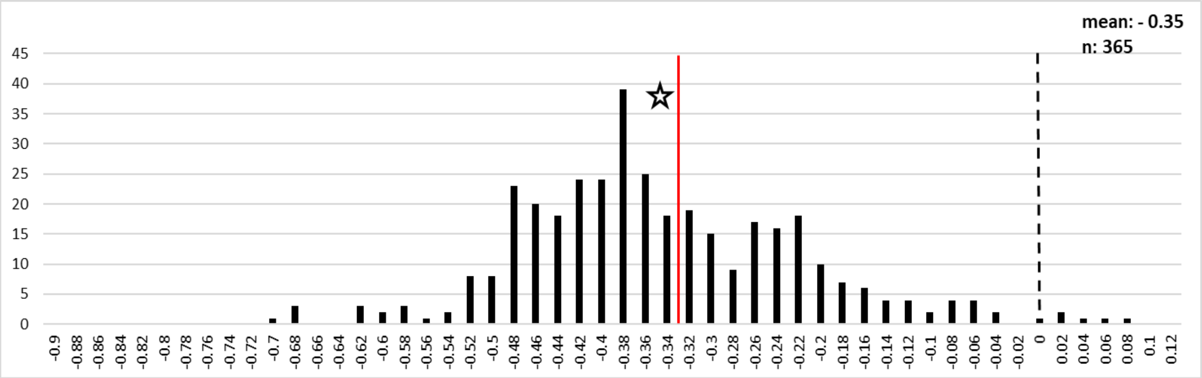


Fig. 5.3.55: Size distribution for all anatomical elements for *Anguilla anguilla*, **Phase 3e**. The star indicates the mean (-0.35). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 147; n measures: 365.

5.4 Royal Mint, St. Mary Graces, City of London

The former Royal Mint was the object of an extensive archaeological project published by MOLA (Museum of London Archaeology) as a trilogy of Monograph Series representing the main phases of archaeological interest. Specifically, the first volume describes the area of the Black Death cemetery and its chapel (1348-1350; Grainger *et al.* 2008), the second volume describes the archaeology of the Cistercian Abbey of St. Mary Graces (1350-1539; Grainger & Phillpotts 2011) and the last volume illustrates the Royal Navy victualling Yard (1560-1785; Grainger & Phillpotts 2010). The following information, unless otherwise stated, is extracted from the second volume of the trilogy.

5.4.1 The site: the Cistercian Abbey of St. Mary Graces (MIN86)

The Cistercian abbey of St. Mary Graces, East Smithfield, London, was funded by Edward III in 1350 and it was the last house for the order to be built before the Dissolution. The location of the abbey is unusual, as Cistercian houses generally required a certain degree of isolation and were located in remote areas (Fig. 5.4.1). The abbey was funded primarily as a memorial for the people who had lost their lives during the Black Death (1348) and in the early phases, the area nearby was used as emergency burial ground for the victims of the plague. 759 burials were excavated in the nearby cemetery and Holy Trinity chapel, but a total of 2,400 of burials have been estimated. Excavations of the early abbey revealed a limited number of buildings: a large refectory, an aisled church, a simple rectangular presbytery, and a subsidiary cloister. No dormitory area was identified for this period. The abbey was slowly built and completed in over 50 years, as financial issues plagued the construction project. Some later additions occurred, such as the building of two further chapels in c. 1400-1539. Despite all the financial troubles, the abbey was the Cistercian house with the third-highest net value right before its dissolution in 1539. The abbey owned a considerable number of properties including around 30 parishes, rural assets, acres of woodland, manors, whose rents and sale of material contributed to the abbey income. The abbey widely exploited the Thames river frontage owning several proprieties and economic activities, such as a several wharves, including one at Gravesend, breweries and gardens at Wapping, and two mills on the river that were leased out in 1528. Furthermore, the cemetery was the burial place of many affluent and important people, and the sale of the burial space contributed greatly to the income of the religious house.

After the dissolution, the site was used as a manor house from 1539-1560. Documentary sources indicate that during the 16th c. the house owned many buildings and activities, such as a dairy house, a granary, stables, woods, and with these also fishing and fowling rights.

In 1560 the Crown purchased the site, which became a victualling yard or food supply depot for the Royal Navy until 1785. The last use of the site was as a government warehouse (1785-1805) and as a Royal Mint (1805-1971).

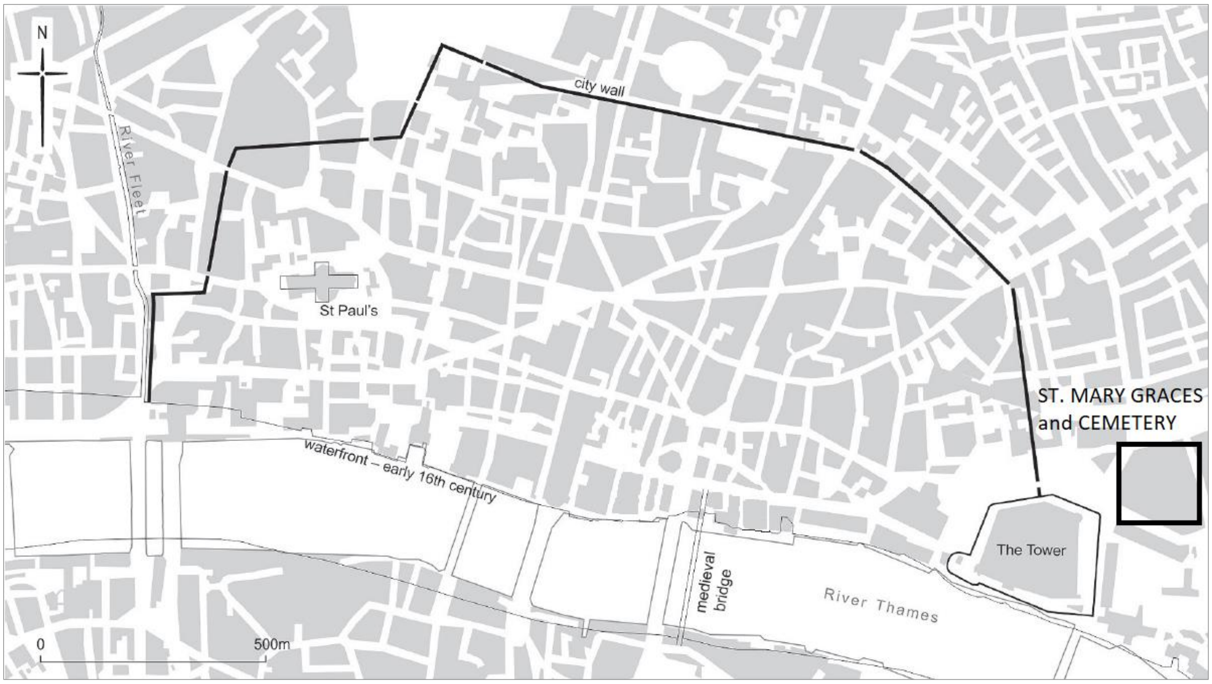


Fig. 5.4.1: The location of St. Mary Graces and the area of the cemetery within the City of London (modified by Schofield *et al.* 2018, 1).

5.4.1.1 Excavations and zooarchaeological studies

The monastic foundation was initially exposed north-east of the Tower of London in 1900, during the construction of new offices within the Royal Mint. The first archaeological work on the site was in 1972, directed by Brian Davison, where two small trenches were excavated. MOLA, which at the time was called DGLA (Museum of London's Department of Greater London Archaeology), carried out further archaeological investigations in 1983-84 (MIN84) under the direction of Peter Mills. In 1986, the full excavation of the site (MIN86) started, funded by the City Merchant Developers, ending 2 years later, in 1988, with a total excavated area of 4.94 acres.

The excavation uncovered scattered prehistoric and Roman finds and a substantial stratigraphic sequence which was divided into three periods: **Period A** (the Black Death Cemetery and the chapel), **Period B** (the Abbey and the manor house), **Period C** (the victualling yard). Within the short life span of the abbey (189 years), the monastic deposits with datable finds were few, and there was also a limited number of datable architectural features. For these reasons, it was not possible to create a detailed sequence of the abbey construction and the definition of the subperiods is currently under discussion; however, a wider chronology of occupation of the site was available and summarised in Table 5.4.1.

Period	**Phase**	**Chronology**
A1	pre-Black Death	c. 1050-1348
A2	Black Death cemetery	1348-1350
B1	abbey	1350-1361
B2	abbey	1361-c. 1400
B3	abbey	c. 1400-1539
B4	Dissolution and manor house	1539-1560
C1	victualling yard	1560-c. 1660
C2	victualling yard	c.1660-1785
C3	post-victualling yard	1785-1970

Table 5.4.1: Summary of the chronological periods for the Royal Mint (after Grainger & Phillpotts 2011, 4).

Large mammal bones and bird bones from different areas of the site were studied by West (1992), small mammals and amphibian by Hibberd (2011a, 2011b), eggshells by Sidell (2011) and fish bones by Locker (2011); fish bones from St. Mary Graces were also part of a larger project on the City of London fish exploitation (Orton *et al.* 2016).

5.4.2 Material and recording methods

Fish bones were recovered from Period A and B from the 1986 excavation. However, for the purpose of this research, only **Period B3 (c. 1400-1539)** has been studied in detail and reported here. Only two dermal denticles were recovered from **Period B2 (1361-c. 1400)**; they belong to Rajidae, one on which to thornback ray (*Raja clavata*) and will not be further discussed. Fish remains were largely recovered through wet-sieving of soil samples and, in small part, were also hand-collected. Unfortunately, no information on mesh size was available, and possibly hand collected and sieved material were merged (MIX). At the time of the St. Mary Graces' excavations, MOLA typically used 1 mm meshes and, therefore, this may have also been the case for that site.

Fish remains were collected from several context, mostly pits, including cess pits, a storage pit filled with domestic refuse within a drain passing through the kitchen yard and a pit within the abbot lodging. The largest sample was recovered from a rubbish pit (context 9592) within the area of the gardens in the north-west part of the abbey's precinct.

5.4.3 Results

For the **Period B3 (c. 1400-1539)** sample, 3,157 fish remains were counted, 1,012 of which were identified taxonomically (with various degrees of precision) and 979 represented countable specimens. Most of the unidentified bones were collected from the larger context 9592 (a rubbish pit) and were represented by undiagnostic fin rays, ribs and bone fragments, possibly reflecting the high degree of recovery from the pit.

A number of scales and dermal denticles were collected from various areas (in particular context 9592); a few scales were identified as belonging to perch and at least two as dermal denticles of thornback ray. Dermal denticles, because of their sturdiness, size and weight, cannot be compared to scales, which typically are recovered through flotation both of these elements have not been included in the analysis, following the guidelines of the recording protocol.

The sample shows an even level of completeness (Table 5.4.2, Fig. 5.4.2) with most of the elements represented by more than 50% material and a medium preservation (Table 5.4.3, Fig. 5.4.3).

5.4.3.1 Taxonomic frequencies

Mixed recovery material, hand-collected and (fine-)sieved (1 mm?)

The NISP calculation for **Period B3 (c. 1400-1539)**, presented in Table 5.4.4 and Fig. 5.4.4, shows an assemblage dominated by Clupeidae (32%) and herring (19%); among Clupeidae, sprat has been identified, while the other remains were mostly small vertebrae probably belonging to herring, but not easily distinguishable from sprat. Cod (10%) is the next most common taxon, followed by whiting (10%). Eel represents 8% of the identified material and Pleuronectiformes 7%, mostly being unidentified Pleuronectidae vertebrae, but also plaice, plaice/flounder, sole and turbot. These are followed by smelt (6%) and Cyprinidae (4%); for this family, one remain has been attributed to each of the following species: dace, chub, roach and tench (Table 5.4.5). The presence of other species is negligible, being mostly marine taxa, with the exception of 15 remains belonging to pike, four to Salmonidae and two to burbot.

Clupeidae (unidentified, herring and sprat) are the only taxon reaching the threshold for MNI calculation and are represented by eight individuals (Table 5.4.6).

Overall, habitat distribution shows marine taxa dominating the assemblage (79%), while migratory (14%) and freshwater (7%) fish are much less frequent (Table 5.4.7, Fig. 5.4.5).

5.4.3.2 Anatomical element distribution

The analysis of anatomical element distribution was only performed for Clupeidae, the only taxon reaching the threshold required by the recording protocol (Table 5.4.8). As in the case of MNI calculation, all Clupeidae have been grouped together as most of the unidentified Clupeidae were probably represented by small herring; furthermore, herring and sprat bones would sustain taphonomic alterations in a similar way and presumably they would be processed and consumed in the same manner.

Clupeidae mostly represented by caudal vertebrae (Fig. 5.4.6); elements from the outer branchial skeleton (Group II) are completely missing and elements from the pectoral and pelvic skeleton (Group III) are scarce. The MAU comparison of frequencies for head skeleton and vertebrae shows Clupeidae being mostly represented by vertebrae, with head elements less common (Fig. 5.4.7).

5.4.3.3 Taphonomic alterations

The taphonomic evidence recorded for **Period B3 (c. 1400-1539)** material is scanty, possibly reflecting the small size of the sample, and it is summarised in Table 5.4.9.

A few bones belonging to herring and eel were calcined (0.8%); a few bones belonging to smelt and eel appeared crushed (mechanical and/or chemical bone deformation, Chapter 4); chop marks were recorded on vertebrae belonging to eel, cod and Rajidae.

5.4.3.4 Biometrical analysis

Measurements for pike are scanty as only 11 bones were measured. Some of the measurements were slightly smaller than a modern pike with a total length of 71.5 cm, while others belonged to very small individuals, nearly half the size of a modern specimen of 34 cm of total length.

Only 13 bones were measured for Cyprinidae and they mostly belong to individuals slightly larger than a modern roach of 19 cm of total length. It was possible to measure only two pharyngeal bones for Cyprinidae, one chub and one roach, the latter being smaller.

Of the non-strictly marine species, eel has provided the best metric sample size, sufficient to produce a log ratio histogram (Fig. 5.4.8). The measurements appeared scattered around the mean value, which is smaller than the marker of 49 cm of total length (red line). Only a few measurements are larger than in the 49 cm individual, and none reaches the standard value (0) of 96 cm of total length. Eels from the sample appear to be rather small, considering that the size of modern unsexed eel has a mean value of 35-60 cm (Tesch 2003, 168). These sizes are comparable to the maturation stages of elvers (over 8 cm of total length; *ibid.*, 137) for the smallest individual and yellow/silver eel (over 30 cm of total length; *ibid.*, 150) for the largest.

5.4.4 Discussion

The diet of the people living at the abbey was primarily based on marine fish, probably purchased at the London market. Herring was the most commonly eaten fish, followed by cod and whiting. Considering the high frequency of these species, it is likely that they were largely bought in a preserved form and stored, at least for in case of the herring, which is easily perishable. Other marine fish consumed were sprat, haddock, sole, rays, turbot and conger. Because of the small frequency of these latter marine fish and the relative vicinity of the coast, it is possible that they were occasionally bought fresh at the market, rather than in bulk in a preserved form. Turbot, a highly prised fish, was probably served during festive meals or to the abbot.

The Thames river would have provided eel, Cyprinidae, pike, Salmonidae, perch and burbot. Salmonidae, due to the porous structure of their bones, tend to survive less in the archaeological record and are often underrepresented (Hamilton-Dyer 2007, 181). The Thames estuary area could have been the source of plaice and flounder (which can also swim several kilometres upriver), smelt and possibly also the smallest eel, which at the stage of glass eel/elver (below 7-8 cm of total length) can also be found in estuaries (Churchward 1996 in Tesch 2003, 137). The eels found at the abbey were probably elvers and yellow/silver eels, maturation stages in which the fish tend to be found in rivers. The overall rather small but variable eel sizes could reflect sporadic and occasional fishing; good sources of eel for the abbey were probably the water mills, where the fish was typically caught with traps attached to the sluice of the waterwheels. Eel was consumed both fresh and preserved (e.g. salted, smoked) during that period, however, if we consider the small frequency and ready availability of the species, it is possible that most eels were consumed fresh. Smelt is a fish that appears commonly in medieval London assemblages, but it tends to be infrequent elsewhere. There was an important smelt fishery on the tidal Thames, which would follow the seasonal migrations of the fish, and was especially productive in winter and early spring (Wheeler 1979b, 48; Locker 1992a, 1). Wheeler (1979b, 48) refers also to the seasonal catching of white bait (juvenile herring, sprats) from the Thames estuary, where the proportion between herring and sprat would depend on the season (e.g. sprat was more abundant from February to April).

Freshwater fish was rarer and likely consumed fresh. The small size of the Cyprinidae and of some of the pike could indicate that they represent a bycatch; nonetheless, there is no reason to think they were not eventually eaten. In medieval times, small freshwater fish was consumed in dishes such as soups, pies and pastries, or preserved as pickles (Locker 2018a). The smallest individuals could also represent the stomach content of a larger predator (e.g. pike), possibly demonstrating on-site processing. The larger pike would have been specifically targeted as, in nature, they tend to be solitary and uncommon, due to their predatory and aggressive behaviour also towards individuals of their same species. This fish would have been reserved for special occasions or for the abbot table.

The anatomical element distribution for Clupeidae (herring and sprat) shows a prevalence of vertebrae but this representation could by biased by the effect of taphonomy, considering that Clupeidae head bones tend to be fragile and, when fragmented, difficult to identify. This type of fish was typically eaten whole, with gutting being the only preparatory action. However, there is documentation of certain preservation techniques where the head of the fish was removed, prior to salting for instance (Van Neer & Ervynck 2004, 210), or where part of the gill region was discarded before salting and packing the fish into barrels (Enghoff 1997). As mentioned above, as a staple food for the abbey and a fish that spoils quickly, herring was probably purchased mostly preserved (e.g. pickled, dried, salted) but, considering the proximity of the coast, it is possible that small quantities of herring were also bought and consumed fresh.

The presence of fish scales on archaeological sites has been used to demonstrate on-site cleaning (e.g. Bond & O’Connor 1999), which, at St Mary Graces, could have been the case for perch, though this possibility cannot be ruled out for other fish too.

The few calcined bones could represent accidental or intentional disposal of kitchen and/or meal waste into the fire. Bone deformation recorded on small species, such as smelt and eel, is a sign of damage typical of human consumption and digestion (Jones 1984, 1986) and, therefore, evidence of cess pit filling.

Butchery evidence is scarce; chops on vertebrae of cod, eel and rays could represent the severing of the vertebral column into pieces or its longitudinal splitting. Around 45% of cod bones belonged to individual with a total length of 75 cm or over. This, together with the presence of butchery marks on vertebrae and a prevalence of vertebrae and bones from the shoulder girdle, supports the hypothesis of the import of preserved cod at the site (i.e. stockfish). However, the presence of head elements suggests that some cods were purchase whole and prepared at the site.

From the evidence mentioned above, it appears that the assemblage results from the combination of kitchen refuse, table waste and cesspit refuse. The reliance of the religious establishment largely on marine fish and the small contribution of freshwater fish to the diet could be related to the location of the site near the coast. The large availability of marine fish at the local market would have limited the need to supply the abbey with freshwater sources.

Completeness	c. 1400-1539
> 75% present	202
75-50% present	635
50-25% present	90
< 25% present	52

Table 5.4.2: Bone completeness for **c. 1400-1539**, all recovery methods.

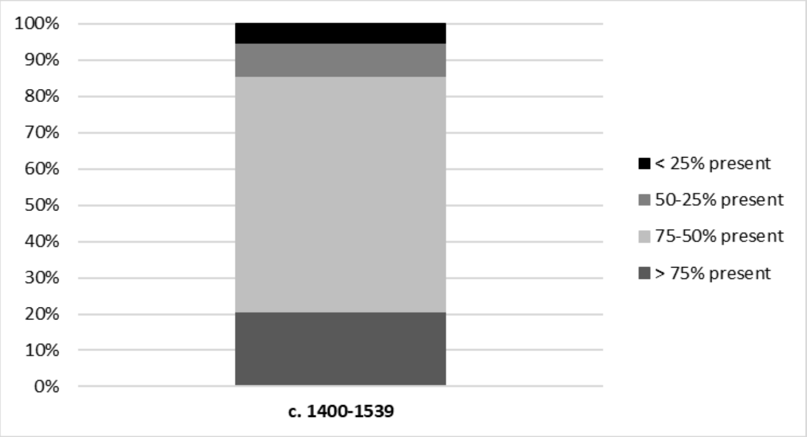


Fig. 5.4.2: Percentage of bone completeness for **c. 1400-1539** (NISP 979), all recovery methods.

Preservation	c. 1400-1539
Excellent	0
Good	185
Medium	788
Bad	6
Awful	0

Table 5.4.3: Bone preservation **c. 1400-1539**, all recovery methods.

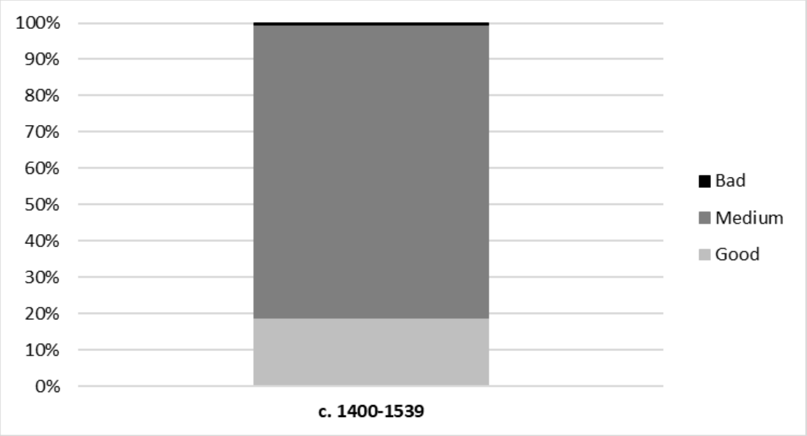


Fig. 5.4.3: Percentage of bone preservation for **c. 1400-1539** (NISP 979), all recovery methods.

TAXA		**c. 1400-1539**
Latin name	**Common name**	**MIX**
Clupeidae	-	274
Clupea harengus	Atlantic herring	176
Gadus morhua	Atlantic cod	101
Merlangius merlangus	Whiting	97
Anguilla anguilla	European eel	74
Osmerus eperlanus	European smelt	56
Pleuronectiformes	-	52
Cyprinidae	-	41
Sprattus sprattus	European sprat	30
Gadiformes	-	16
Melanogrammus aeglefinus	Haddock	16
Esox lucius	Northern pike	15
Pleuronectes platessa	European plaice	8
Pleuronectes platessa/Platichtys flesus	European plaice/flounder	4
Salmonidae	-	4
Solea solea	Common sole	4
Rajidae	-	3
Scophtalmus maximus	Turbot	3
Lota lota	Burbot	2
Conger conger	European conger	1
Leuciscus leuciscus	Common dace	1
Tinca tinca	Tench	1
*Perca fluviatilis**	European perch	*
*Raja clavata**	Thornback ray	*
*Squalius cephalus**	Chub	*
*Rutilus rutilus**	Roach	*
	TOTAL	979

Table 5.4.4: NISP of taxa for **c. 1400-1539** based on diagnostic elements (other records noted as *) for mixed recovery (MIX) material. *Perca fluviatilis** is represented by scales, *Raja clavata** is represented by dermal denticles, *Squalius cephalus** and *Rutilus rutilus** are represented by pharyngeal plates.

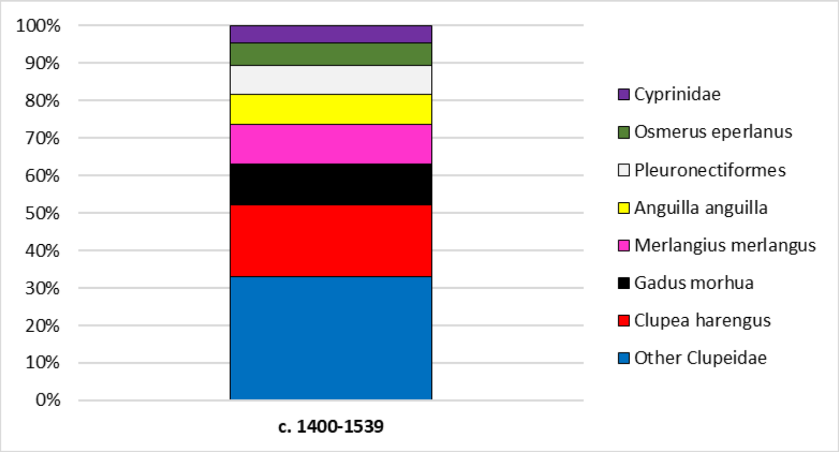


Fig. 5.4.4: Frequencies for the 8 most common taxa for **c. 1400-1539** (NISP: 922) for mixed recovery (MIX) material. Threshold by phase: tot NISP ≥ 100.

TAXA	c. 1400-1539
Leuciscus leuciscus	1
Squalius cephalus	1
Rutilus rutilus	1
Tinca tinca	1
Cyprinidae unid.	42

Table 5.4.5: NISP for the Cyprinidae family **c. 1400-1539** for mixed recovery (MIX) material based on all counted specimens and pharyngeal bones; although regarded as not countable, pharyngeal bones will be represented in this table because they have been consistently recorded for all Cyprinidae.

TAXA	c. 1400-1539	An.E.
Clupeidae	8	vertebrae

Table 5.4.6: MNI for **c. 1400-1539** for Clupeidae family for mixed recovery (MIX) material. Threshold by phase: taxa NISP ≥ 100. **An.E.** is the anatomical element used for MNI calculation.

HABITAT	c. 1400-1539
Freshwater	61
Marine	727
Migratory	134
Other	57

Table 5.4.7: Taxa habitat distribution for **c. 1400-1539**, for mixed recovery (MIX) material.

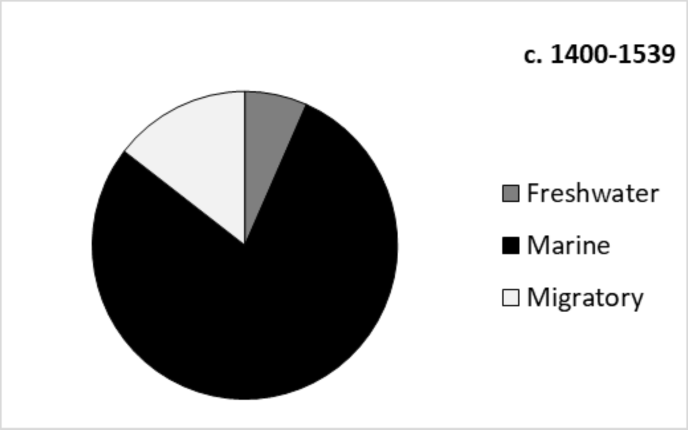


Fig. 5.4.5: Frequencies of habitat distribution for **c. 1400-1539** (NISP: 922) for mixed recovery (MIX) material. "Other" excluded. Threshold by phase: tot NISP ≥ 100.

GROUP	Element		Clupeidae
			c. 1400-1539
I	**A**	Articular	4
	B	Basioccipital	0
	D	Dentary	2
	ECT	Ectopterygoid	2
	ENT	Entopterygoid	0
	HYO	Hyomandibular	0
	INT	Interopercular	0
	MAX	Maxilla	4
	OP	Opercular	1
	OT	Otolith	0
	PA	Palatine	0
	PAR	Parasphenoid	0
	PRE	Preopercular	0
	PX	Premaxilla	0
	Q	Quadrate	1
	SUB	Subopercular	0
	VOM	Vomer	1
II	**CE**	Ceratohyal	0
	EHY	Epihyal	0
	URO	Urohyal	0
III	**BAP**	Basipterygium	0
	CL	Cleithrum	0
	CO	Coracoid	0
	PSC	Postcleithrum	0
	PST	Posttemporal	1
	S	Scapula	0
	SUP	Supracleithrum	1
IV	**PCV1 (PCV2)**	1st (2nd) precaudal vertebra	6
	AAV	Anterior abdominal vertebra	6
	PAV	Posterior abdominal vertebra	4
V	**CV**	Caudal vertebra	10
	LC	Last caudal vertebra	3
VI	**VC**	Vertebral body (centrum)	0

Table 5.4.8: Anatomical element distribution (MAU) for **c. 1400-1539** for Clupeidae family, for mixed recovery (MIX) material. Group I = Head elements (Minus II): Neurocranium, jaws, gill arches, gill covers; Group II = Head elements: Outer branchial skeleton; Group III = Pectoral and pelvic skeleton; Group IV = Precaudal vertebra; Group V = Caudal vertebrae; Group VI = undefined vertebrae.

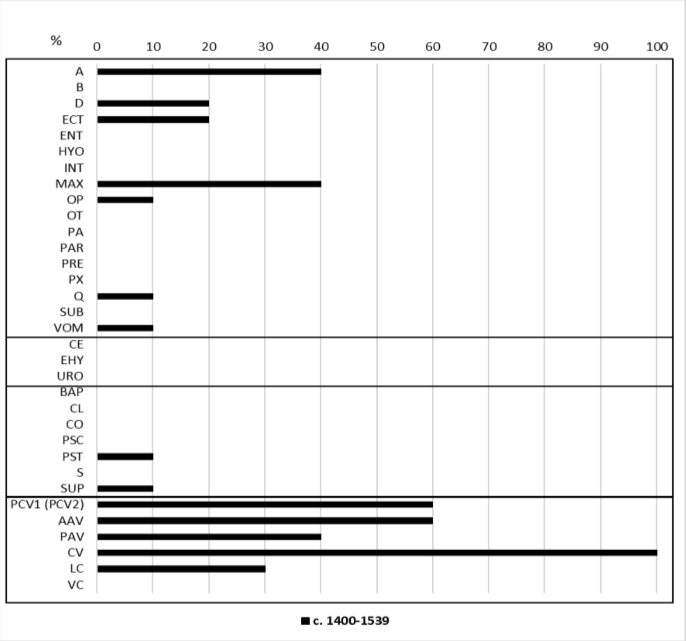


Fig. 5.4.6: Frequencies of anatomical element distribution (MAU) for Clupeidae family, **c. 1400-1539,** for mixed recovery (MIX) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

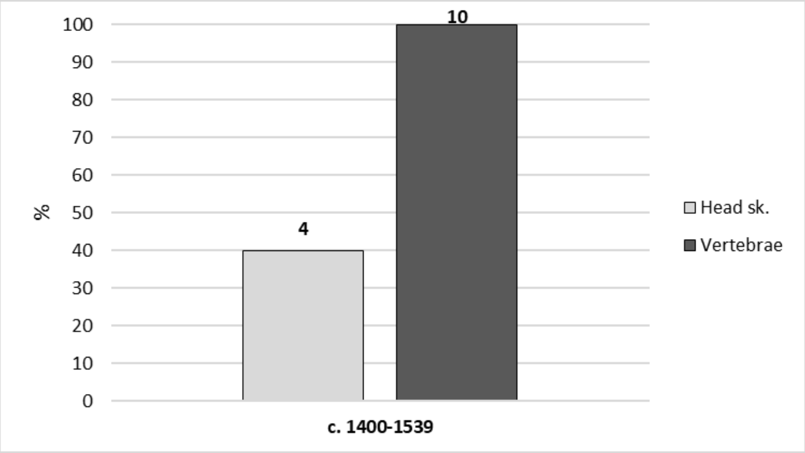


Fig. 5.4.7: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in Clupeidae family for **c. 1400-1539**, for mixed recovery (MIX) material.

TAXA	*Clupea harengus*	*Anguilla anguilla*	*Osmerus eperlanus*	*Gadus morhua*	Rajidae	**TOT**
Burning						
Calcined	6	2	0	0	0	8
Tot burned						8 (0.8%)
Other modifications						
Crushed	0	1	4	0	0	5
Tot modified						5 (0.5%)
Butchery marks						
Chop	0	1	0	2	1	4
Tot butchered						4 (0.4%)

Table 5.4.9: Taphonomic modifications for **c. 1400-1539**, total NISP 979, all recovery methods.

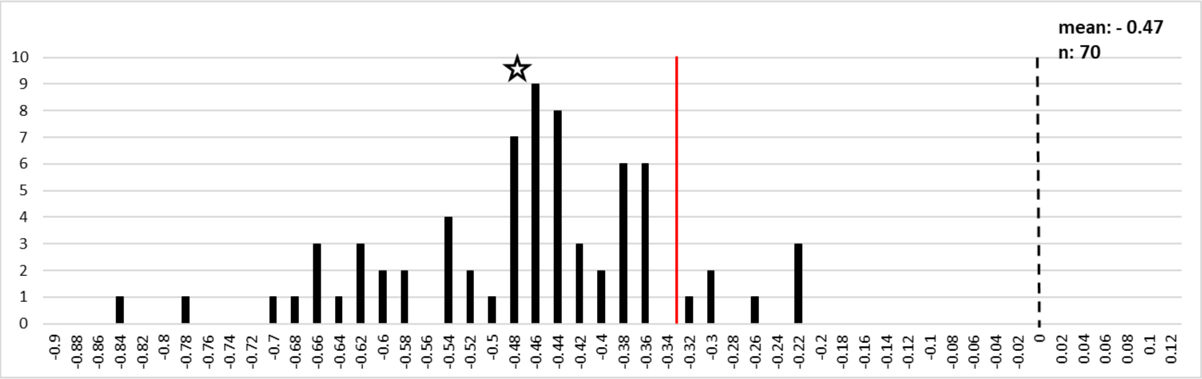


Fig. 5.4.8: Size distribution for all anatomical elements for *Anguilla anguilla*, **c. 1400-1539**. The star indicates the mean (-0.47). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 25; n measures: 70.

5.5 St. Gregory’s Priory

St. Gregory’s Priory was excavated in four years (1988-1991) by the Canterbury Archaeological Trust. A history of the ecclesiastical establishment and details of its excavation results can be found in Hicks & Hicks (2001). The following information, unless otherwise stated, is extracted from this volume.

5.5.1 The site: the priory

St. Gregory’s Priory is located in the northern area of Canterbury (Northgate), Kent (Fig. 5.5.1). The original foundation, outside the city wall, was a church with a simple nave, no aisles and a square chancel with a cemetery located to the south. This foundation in 1084 was part of the archbishop Lanfranc’s plan of creating a new ecclesiastic community (six priests and twelve clerks) to take care of the inhabitants of the poor parish (Sparks 1998). Within this project the church appears to be a sister establishment of the nearby St. John’s Hospital.

The church raised its social status in 1133, when it became a priory with the archbishop William of Corbeil; during that occasion, a prior and a number of Augustinian canons were transferred from Merton Priory. The newly established priory was extended with many additions, for instance, a new east chancel was built and a choir was added to the chancel. The canons kept caring for the poor and sick in the neighbour hospital, while the priory was also used as law office and secretarial record-keeper for the archbishop, from 1181 until the Dissolution (Sparks 1998).

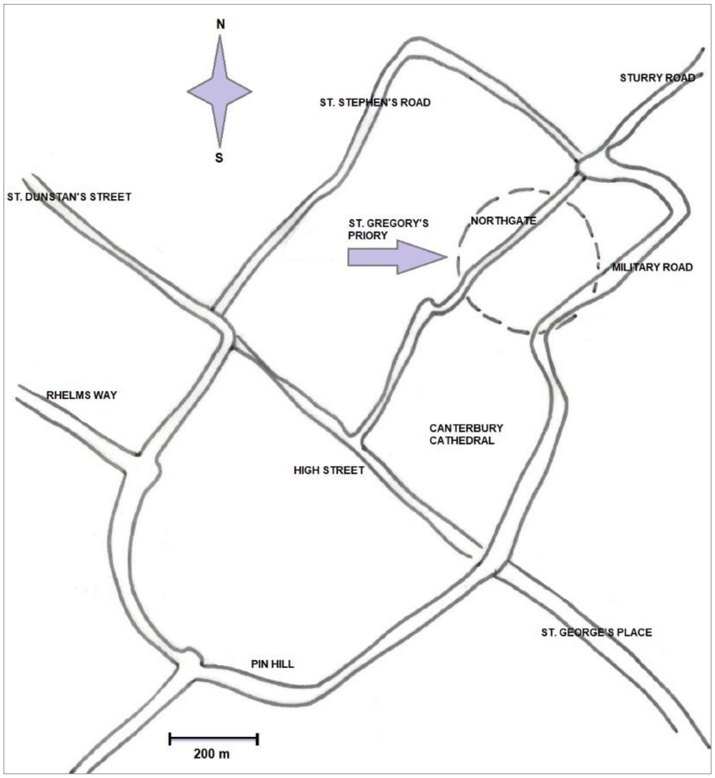


Fig. 5.5.1: Location of St. Gregory’s Priory in Canterbury (modified by Miszkiewicz 2015).

After a fire in 1145, which destroyed part of the establishment, the archbishop Theobald commissioned the rebuilding of the priory in larger scale. This restructuration kept going until the 13th c. with many additions, such as the rebuilding of the main cloister and the remodelling of the chapter house in use from c. 1220. The refectory and the dormitory were in use by c. 1225, while the prior's lodge and the kitchen not before c. 1250; before this date, the kitchen must have had an alternative method of providing food. It is also unknown where the prior would have lodged before the completion of his private quarter and whether he would have consumed his meals with the canons in the refectory.

After an earthquake in 1382, another building program was undertaken at the priory and this was the last major renovation before the Dissolution. It appears that by the later 14th c. there was a decline in the fortune of the priory, perhaps as result of the strain of resources following the last extensive rebuilding.

The priory was dissolved in 1537 and the canons sent away. Contemporary drawings show that the major buildings were still in good shape after 400 years. In 1616, the church and the claustral buildings were terraced and transformed into gardens, while the other buildings were destroyed for further construction.

The wealth of the priory fluctuated throughout years; a priory's cartulary dated 1265 (Woodcock 1956 in Hicks & Hicks 2001, 376) listed the number of possessions of the church which appeared still accounted for in 1535. For instance, the possessions included 11 churches with nearby patches of land and the Howfield manor in Chartham (..). Income for the canons' support would have also come from rents from houses and gardens within Canterbury and tithes from the archbishop's estates. However, even in the most flourishing periods, the priory had little real wealth.

5.5.1.1 Excavations and zooarchaeological studies

During the construction of a Post Office and a garage in 1954 and the cutting of service trenches in 1979 for the first time some of the priory's features were revealed. Despite these first observations, only in 1988, when the Post Office facility was due to renovation, the Canterbury Archaeological Trust was consulted to assess the site. This led to the first archaeological investigation under the direction of Martin Hicks, during which, the foundations of the archbishop

Lanfranc and Theobald establishments were discovered. The construction of ornamental gardens above the buildings, shortly after the dissolution of the priory, favoured their good preservation. Many rooms and features were preserved and identified within the Theobald's complex, including the refectory and the kitchen with hearts and a free-standing oven.

Excavations proceeded until 1991, when funds were exhausted. In 1995, English Heritage provided an additional grant, finalised to analyse and interpret the materials collected during the excavations and to produce the above-mentioned comprehensive publication (Hicks & Hicks 2001).

The stratigraphic sequence comprises pre-Norman activities starting from Prehistoric time but also including Roman and Anglo-Saxon levels of occupation. The Lanfranc foundation (c. 1084-1145) and the Theobald's Priory (c. 1145-1537) could be dated thanks to the identification of the 1145 fire event. A more detailed discussion of the site phasing can be found in Hicks and Hicks (2001).

Animal bones were recovered from five areas of the Theobald's Priory (kitchen, refectory, kitchen/cellarer's range, prior's lodge, northern courtyard), and grouped into four broad periods of activity (Powell *et al.* 2001, 289):

mid-12th - mid-13th c.: Theobald's Priory construction
mid-13th - late-14th c.: early Priory occupation (possibly prior the earthquake of 1382)
late 14th - early 16th c.: later Priory occupation (reconstruction after the earthquake)
16th c.: Dissolution

Mammal, reptile and amphibian bones were studied by Powell (2001, 289-308), bird bones by Serjeantson (2001, 317-333) and Metz (2017), fish bones by Smith (2001, 308-317) and invertebrates by Allison and Hall (2001, 334-338).

5.5.2 Material and recording methods

Fish bones were collected from a number of contexts dated from the mid-12th to the 16th c., mostly during the 1989-1990 excavations. The largest samples were recovered from the kitchen and the refectory. All the material was hand-collected with the exception of two contexts, 1180 and 2210, where the material was bulk wet sieved using a 1 mm mesh and then sorted into mammal, bird and fish bones (Serjeantson 2001, 317); furthermore, one tenth of both samples (around 30 kg each) was washed and the floating material collected on a 300 micron sieve and then sorted (Allison Unpublished). Context 1180 derives from the refectory floor, dated to the late **14th - 15th c.**, where the material collected was interpreted as food debris dropped while transporting food into the room. Context 2210 originates from kitchen floor layers, dated to the **15th - early 16th c.**, and interpreted as occupation debris probably spilled during food preparation; the recurring reflooring of the kitchen sealed the bones into the layers, helping their preservation (Smith 2001, 313).

For the purpose of this research, only material coming from these two contexts will be further analysed. Other material was recorded but has been excluded from the analysis because of the uncertain phasing and/or small sample size. Additionally, these remains from other contexts were hand-retrieved and would have provided only a partial view of the fish consumed at the site, biased towards larger species, and lacking comparability with other sites. This data will not be included in the quantifications, but it will be considered during the discussion, where relevant.

5.5.3 Results

A grand total of 106,504 fish remains were present in the assemblage. Of these 99,125 derive from contexts 1180 and 2210 and were further analysed; 9,683 were identified taxonomically and 9,356 were registered as countable elements, according to the recording protocol.

Such a high number of unidentified bones is the consequence of a combination of different factors. Reflooring of the kitchen (context 2210), **15th - early 16th c.**, allowed the preservation of the smallest fragments, later collected by the archaeologists thanks to a very meticulous recovery. Most of the unidentified remains (63,943) were collected from the refectory (context 1180), **late 14th - 15th c.**, 74% of which were represented by ribs and fin rays. Smith (2001) noticed a higher frequency of ribs and fin rays from the refectory (1180) and a higher representation of head remains and scales from the kitchen (2210). She interpreted this distribution as a consequence of on-site processing of the fish, where the fish was beheaded and descaled in the kitchen and afterword served in the refectory, where some of the waste, mostly ribs and vertebrae, was dropped on the floor.

Both contexts produced scales, scutes and dermal denticles; scutes were attributed to Triglidae, dermal denticles to Rajidae, some of which belonging to the thornback ray (*Raja clavata*).

For both contexts, the completeness of the bones was good, with about 90% of the identified material more than 50% intact; the level of preservation of the bone surface was medium/good (Tables 5.5.1-2, Fig. 5.5.2-3).

5.5.3.1 Taxonomic frequencies

Fine-sieved material (1 mm)

NISP calculation for the **late 14th - 15th c.** sample from the refectory floor (context 1180) (Table 5.5.3, Fig. 5.5.4) shows an assemblage dominated mostly by herring (35%) and other Clupeiformes (11%); these latter are mostly small vertebrae probably belonging to herring but not easily distinguishable from sprat; furthermore, 86 remains were attributed to sprat and two to anchovy. Pleuronectiformes (21%) are the second most common taxon, mostly being unidentified Pleuronectidae vertebrae, but also including sole (551 remains), plaice (111 remains) plaice/flounder (30 remains) and flounder (one remain). These are followed by whiting (18%) and eel (5%). Other Gadiformes represent around 4% of the identified material and include cod and haddock. For Triglidae (1%), red, grey and tub gurnard have been found and among Sparidae (1%), nearly half of the remains belong to black seabream. The presence of other species is negligible, being mostly marine taxa, but it is worth mentioning 36 remains of freshwater Cyprinidae, one of which attributed to roach (Table 5.5.4), and another to perch. Among migratory fish, smelt (*Osmerus eperlanus*) with 29 remains, Salmonidae, with nine remains, and three-spined stickleback (*Gasterosteus aculeatus*) with three remains, have been recorded.

The MNI (Table 5.5.5, Fig. 5.5.5) for the **late 14th - 15th c.** sample largely reflects NISP frequencies, with Clupeiformes (mostly herring) being by far the most abundant taxon, followed by sole and other Pleuronectiformes, and then whiting. Eel and Gadiformes have the same MNI of three individuals.

Overall, for the refectory sample (Table 5.5.6, Fig. 5.5.6) marine taxa (92%) represent by far the largest part of the assemblage, while migratory (7%) and especially freshwater (1%) fish are much less common.

NISP frequencies for the kitchen floor material (context 2210), **15th - early 16th c.** (Table 5.5.3, Fig. 5.5.7), show a similar rank of taxa than the previous sample, but with different proportions. Herring (55%) and other Clupeidae (9%), represented by sprat and probably mostly small herring, are more abundant than in the refectory sample (context 1180), **late 14th - 15th c.**, to the detriment of whiting (11%), sole (7%) and other Pleuronectiformes (6%), which are less common. Among Pleuronectiformes, plaice (54 remains), plaice/flounder (25 remains) and dab (one remain) have been identified. Other Gadiformes (5%) are represented with similar percentages to the refectory sample (context 1180), **late 14th - 15th c.**, with 31 bones attributed to cod, 22 to haddock and five to ling. Eel (2%) appears less common, followed by Triglidae, with little less than 1% of the identified material. The occurrence of other taxa has little value, but it is worth noticing the presence of freshwater taxa, such as Cyprinidae with 19 remains, with one bone attributed to roach and one to tench (Table 5.5.4), bullhead (*Cottus perifretum*) with three remains and perch with two remains. Other migratory species include smelt with 25 remains and Salmonidae with five remains, one of which was a vertebral body attributed to Atlantic salmon/sea trout (*Salmo salar/Salmo trutta trutta*) because of its large size.

The MNI for the kitchen sample (context 2210), **15th - early 16th c.** (Table 5.5.5, Fig. 5.5.5), shows a substantial gap between Clupeidae and other taxa. The MNI of sole and other Pleuronectiformes, and whiting reflect NISP calculation, appearing less common than in the refectory sample (context 1180), **late 14th - 15th c.**, followed by a small presence of Gadiformes and eel.

The habitat distribution (Table 5.5.6, Fig. 5.5.8) shows an increase in the percentage of marine taxa (96%), at the expenses of migratory fish (4%), which appears less common. Freshwater fish maintain the same small percentage (1%).

Hand-collected material

Only one remain was recorded as countable from the hand-collected fraction for the contexts analysed: a posterior abdominal vertebra of a plaice from the kitchen, context 2210 (**15th - early 16th c.**).

5*.5.3.1.1 Other contexts*

A number of 1,055 taxonomically identified countable remains were recovered from other contexts; these remains showed a range of taxa largely similar to contexts 1180 and 2210. The only exceptions were two remains, one belonging to *Scophthalmus sp.* and another to turbot (*Scophthalmus maximus*), recovered from contexts dated **14th - early 16th c.**

5.5.3.2 Anatomical element distribution

The analysis of anatomical element distribution was performed for the six more frequent taxa identified from the two contexts (Table 5.5.7). As in the case of MNI calculation, Clupeiformes have been grouped together as most of the unidentified Clupeidae would be represented by small herring; furthermore, herring and sprat bones are likely to have similarly been affected by taphonomic alterations and presumably they were processed and consumed in the same manner.

The MAU for Clupeiformes for **both samples** shows an overwhelming majority of vertebrae compared to head elements, with the most common anatomical element being first (and second) precaudal vertebra, followed by anterior abdominal vertebrae (Fig. 5.5.9-11).

For whiting, the most common anatomical elements are posterior abdominal vertebrae in both samples (Fig. 5.5.12-13). A MAU comparison of head and vertebrae frequencies confirms that the species is mostly represented by vertebrae, with head elements even less common in the refectory (context 1180), **late 14th - 15th c.** (Fig. 5.5.14).

Likewise, common sole is mostly represented by vertebrae, especially caudal vertebrae in the refectory (context 1180), **late 14th - 15th c.** (Fig. 5.5.15) and anterior abdominal vertebrae in the kitchen (context 2210), **15th - early 16th c.** (Fig. 5.5.16). MAU is skewed towards vertebrae in both samples, but with definitively more head elements present in the kitchen, **15th - early 16th c.** (Fig. 5.5.17).

For Pleuronectiformes, the most common elements are anterior abdominal vertebrae in the refectory (context 1180), **late 14th - 15th c.** (Fig. 5.5.18), and palatine in the kitchen (context 2210), **15th - early 16th c.** (Fig. 5.5.19); the MAU comparison shows a clear predominance of vertebrae for the earlier sample and a predominance of head elements for the latter (Fig. 5.5.20).

Similarly to the previous taxa, large Gadiformes are represented mostly by caudal vertebrae in the refectory (context 1180), **late 14th - 15th c.** (Fig. 5.5.21), and vomer in the kitchen sample (context 2210), **15th - early 16th c.** (Fig. 5.5.22). The MAU comparison shows nearly equal proportions of head elements and vertebrae in both samples, with slightly more vertebrae in the refectory and head elements within the kitchen (Fig. 5.5.23).

A small sample represents eel in the refectory (context 1180), **late 14th - 15th c.**, were no head elements Group I are present, and the most common element are posterior abdominal and caudal vertebrae (Fig. 5.5.24-25). Conversely, in the kitchen (context 2210), **15th - early 16th c.**, the MAU for eel (Fig. 5.5.25) is represented by similar proportions of head elements and vertebrae, slightly skewed towards the latter, with the most common anatomical element being anterior abdominal vertebrae (Fig. 5.5.26).

5.5.3.3 Taphonomic alterations

Taphonomic alterations recorded on material recovered from the refectory floor (1180), **late 14th - 15th c.**, are summarised in Table 5.5.8. Overall, taphonomic alterations were uncommon; only 1% of the identified material showed burning marks, in particular herring and whiting, and 1% showed crushing (mechanical and/or chemical bone deformation, Chapter 4), with eel being the most affected species. Finally, only two bones exhibited butchery marks: one cut on a posterior abdominal vertebra of whiting and one chop on a posttemporal of cod with a total length of 53-75 cm.

A slightly higher percentage (4%) of burned bones have been recorded on material from the kitchen (2210), **15th - early 16th c.**, with the most affected taxa being again herring and whiting (Table 5.5.9). Crushing was observed on 0.5% of the identified material, more commonly on herring, and 0.1% of the material showed butchery marks. All the chops and cuts were recorded on vertebrae, in particular one cut was recorded on the posterior abdominal vertebra of a cod with a total length of over 75 cm. A number of butchery marks has been noticed on bones recovered from other contexts, in particular on cod bones (eight vertebrae, one supracleithrum and one posttemporal), eight of which belonging to individuals over 75 cm of total length, dated **14th - early 16th c.**

5.5.3.4 Biometrical analysis

Unfortunately, the small percentage of freshwater fish recovered from the priory did not allow the production of log ratio histograms for many species.

A small sample represent Cyprinidae (Fig. 5.5.27) from the refectory floor (1180), **late 14th - 15th c.**, where measurements appear heterogeneously scattered around the mean value, which is slightly smaller than the standard. The standard is represented by a modern roach of 19 cm of total length and 15 cm of standard length. It is important to remember that the different values will represent different stages of life of the fish but also different species. Considering that the two species found within the assemblage (tench and roach) grow up to 50-60 cm of standard length in modern individuals (Kottelat & Freyhof 2007, 246, 296), the Cyprinidae at the priory seem rather small. A pharyngeal bone belonged to a tench of a total length around 35 cm (Libois & Hallet-Libois 1988); modern tench common length is 25-35 cm (Maitland & Campbell 1992, 194).

Very few measures were recovered from the kitchen sample (context 2210), **15th - early 16th c.**, but they have similar values as the previous phase.

From the refectory floor (1180), **late 14th - 15th c.** (Fig. 5.5.28), eel measurements appears unimodally distributed below the marker of 49 cm of total length (red line). These appear to be yellow/silver eel (over 30 cm of total length; Tesch 2003, 150) and rather small individuals in comparison with modern unsexed eels, which have a mean value of 35-60 cm (*ibid.*, 168). Two much larger outliers represent probably large female silver eel, considering that males rarely grow beyond 54 cm of total length (*ibid.*, 168).

A smaller sample represent eel from the kitchen context (2210), **15th - early 16th c.** (Fig. 5.5.29). The mean value appears slightly larger than the previous sample and the sizes less uniformly distributed. Some individuals are larger than the marker of 49 cm of total length (red line), thus representing yellow/silver eel individuals.

5.5.4 Discussion

Considering the wide chronological overlap (15th c.) between the two samples from the refectory (1180), **late 14th - 15th c.**, and the kitchen (2210), **15th - early 16th c.**, a consideration regarding the two different types of contexts is as important as diachronic analysis for the interpretation of the material.

Herring was the most consumed fish at the priory, followed by whiting, sole and plaice/flounder. To a lesser extent, eel and large Gadiformes also had a significant role in the diet. The two samples, supplemented by information deriving from hand-collected material from other contexts, provide an idea of which were the larger species consumed at the site, namely cod, ling, haddock and conger eel. We must also consider the larger amount of flesh provided by these larger species compared to the smallest but more frequent species, in order to correctly evaluate their contribution to human diet. Smith (2001, 311) suggests that in the case of large fish, such as cod, their low frequency, in particular in the refectory (context 1180), **late 14th - 15th c.**, could be associated with the fact that the fish may have been served as fillets, therefore boneless. Furthermore, as Locker (2018a) pointed out at Windsor Castle, it is possible that the poor representation of the larger taxa could be a consequence of the practice of regularly clearing larger debris from the floor, which favoured the preservation of the smaller specimens.

The predominance of marine taxa from both samples is also associated with a large variety of species; other species identified are black seabream, seabass, rays, mackerel, gurnards (etc..). The procurement of such a range of species is likely to have been facilitated by the location of the site, close to the coast and the main ports. St. Gregory's Priory is only 17 miles away from the port of Dover and 18 miles from the port of Folkestone (Smith 2001). The array of species and their small frequency suggest that marine fish was bought irregularly when available and consumed fresh, rather than in bulk in a preserved form. There is an important exploitation of estuarine/costal species, such as Pleuronectiformes and possibly whiting and small eel. Most eels live the first part of their lives (glass eel stage) in costal and estuarine areas and start colonising rivers at the stage of elvers (from roughly 7-8 cm of total length; Churchward, 1996 in Tesch 2003, 137). Most individuals found at the priory tend to be around the size range of yellow/silver eel and in the smaller cases possibly elver; during these maturation stages individuals can be fished typically in rivers. The larger specimen of eel from the refectory (context 1180), **late 14th - 15th c.**, was probably a sexually mature female eel, caught during the autumnal seaward migration towards the spawning ground, the Sargasso Sea (see species overview Chapter 1).

Freshwater fish was rarely consumed at the priory. The small and scattered range of size of Cyprinidae and the presence of bullhead and stickleback suggest accidental river catch, while larger Cyprinidae, eel and the rare perch, and salmon/trout could have been targeted fishing from the river. Salmonidae, because of the porous structure of their bones tend to survive less in the archaeological record and are often underrepresented (Hamilton-Dyer 2007, 181). Furthermore, it cannot be excluded that the larger Atlantic salmon/sea trout was a sea catch, as these taxa spend part of their life in marine water, before to return to the river of their birth (see species overview in Chapter 1).

The access to ponds to source Cyprinidae and eel seems unlikely, considering the low frequency of these species and in general the small size of the catch, but cannot be excluded. Furthermore, documentary evidence of tenure of fishing rights on rivers or ponds from the priory seems to be missing. As in the case of marine fish, freshwater catch was probably also purchased and most likely consumed fresh. The small range of eel size at the refectory (context 1180) in the **early 14th - 15 c.** suggests a managed catch, maybe representing seasonal fishing; a wider and more scattered distribution of eel size recovered from the kitchen (context 2210), **15th - early 16th c.**, in the later period could represent a more randomised fishing strategy, perhaps reflecting the decrease in consumption of eel during the last years of the priory. The large female silver eel was probably consumed for a special occasion.

The anatomical element distribution for herring and other Clupeiformes, mostly sprat, shows a striking prevalence of vertebrae for both samples; however, this pattern can at least in part be explained with the fragility of herring head bones and the typical trampling processes happening on floor layers. Being a staple food at the priory, herring was probably mostly consumed whole and preserved (e.g. pickled, dried, salted), with gutting being the only preparatory action. However, there are many preservation techniques for herring which imply the decapitation of the fish, such as sprinkling salt on the beheaded fish (Van Neer & Ervynck 2004, 210). The dearth of bones from all anatomical areas, except vertebrae, could therefore also represent the purchase of gutted and beheaded preserved herring. Considering the proximity of the coast, it is reasonable to think that some of the fish was also bought and consumed fresh.

Whiting and sole were also probably consumed in both fresh and preserved forms. It appears that the fish mostly arrived in the kitchen (context 2210), **15th - early 16th c.**, whole. Here it was prepared, cooked and served as beheaded in the refectory (context 1180), **late 14th - 15th c.** The presence of some head elements in the refectory, however, suggests that some fish would have been served whole. Head elements of whiting and sole are also fragile, so as in the case of herring, taphonomic processes would have acted against their preservation.

A different situation occurs for other Pleuronectiformes, mostly plaice and flounder, as head remains are more common for these species, especially in the kitchen context (2210), **15th - early 16th c.** The anatomical distribution, however, does not fully clarify whether this fish was consumed fresh or preserved, but it appears it was purchased whole; possibly the fish was then prepared, and partly served whole and partly beheaded. Large Gadiformes seem to have been served whole in most of the cases, with perhaps some individuals beheaded in the kitchen. The greater robustness of head elements in these species almost certainly also contributed to the pattern. The small sample for eel could suggest that the fish was probably reaching the site whole and was then was served beheaded in the refectory (context 1180), **late 14th - 15th c.**

The presence of unidentified scales supports the thesis of on-site cleaning (e.g. Bond & O'Connor 1999).

As expected, a higher frequency of taphonomic evidence was observed on remains from the kitchen (context 2210), **15th - early 16th c.**, where the fish was prepared and cooked. Most of the burning and calcination is probably a consequence of bones intentionally or accidentally discarded into a fire. Evidence of crushing and deformation was recorded on various species, especially vertebrae. Trampling is likely to be the primary cause for crushing of the vertebrae, but for smaller species, such as herring, eel, smelt and small Cyprinidae, this type of bone deformation can also be a sign of damage caused by human consumption and digestion (Jones 1984, 1986). In the case of larger fish, such as cod, plaice and conger eel, it could also be connected with specific preparation techniques, where the fresh or dried fish is pounded or compressed in order to release the flavour from the flesh or break the fibres of the stockfish (e.g. Wubs-Mrozewicz 2009; Davidson 2012).

The butchery evidence is rather limited but chops on vertebrae of cod, conger eel and mackerel could represent the severing of the vertebral column into pieces, while cuts on the posterior abdominal vertebrae of cod and whiting could represent splitting along the vertebral column. A chop on a cod posttemporal could suggest decapitation. Butchery marks on cod were recorded on vertebrae and bones from the shoulder girdle belonging mostly to individuals of over 75 cm of total length; in the specific case of cod, vertebrae were more abundant than head elements, but there is not enough evidence to prove the import of preserved fish at the site, for instance as beheaded stockfish. Possibly also ling, because of the northern habitat range (Camphuysen & Henderson 2017, 128), may have been transported already preserved at the priory.

The nature of the two contexts studied can only give a partial view of the food that was cooked and consumed at the site. Unfortunately, no rubbish pits for waste material were found during the excavation (Hicks & Hicks 2001, 35), which would have added interesting information to this interpretation. Overall, it is clear how the diet at the priory was based on a combination of fresh and preserved fish and mostly focussed on marine species, in particular herring, especially in the later period. This increase of marine species to the detriment of eel and Pleuronectiformes, could represent a temporal trend or a differential spatial distribution. Smith (2001, 317) suggested that this higher frequency of marine fish from the kitchen (context 2210), **15th - early 16th c.**, could be connected with the fact that servants ate there, and they would have consumed cheap preserved herring as staple food (Chapter 2). While within the refectory (context 1180), **late 14th - 15th c.**, the diet of the canons was more varied, including for instance more eel and Pleuronectiformes. The consumption of freshwater fish was rare, and this could be connected to the fact that there is no direct evidence of priory's ownership of rights on freshwater sources (Smith 2001, 316). Furthermore, the location of the Priory near the coast and the easy accessibility to fresh marine species would have make the need to acquire fresh fish from rivers and ponds less pressing. Freshwater fish was occasionally sourced, possibly from the market or from donations/rents, and in particular, species such as salmon/trout or large eel would have been reserved for special occasions or for the prior diet (Chapter 2). It has been suggested that the presence of cooking pots in the prior lodge could indicate that the prior meal was cooked and, perhaps, served in a different location than the canons' refectory (Powell 2001, 294; Smith 2001, 316). Mammal and bird bones were also collected from the prior's lodge deposits, but unfortunately no fish was retrieved; in any case, it appears that mammal and bird bones do not show particular clear evidence of a better diet for the prior (Powell 2001, 308; Serjeantson 2001, 327).

Completeness	refectory late 14th-15th c. (1180)	kitchen 15th-early 16th c. (2210)
> 75% present	1404	1521
75-50% present	3298	2175
50-25% present	258	284
< 25% present	206	210

Table 5.5.1: Bone completeness by chronology, all recovery methods.

Preservation	refectory late 14th-15th c. (1180)	kitchen 15th-early 16th c. (2210)
Excellent	5	15
Good	1728	495
Medium	3428	3675
Bad	5	5
Awful	0	0

Table 5.5.2: Bone preservation by chronology, all recovery methods.

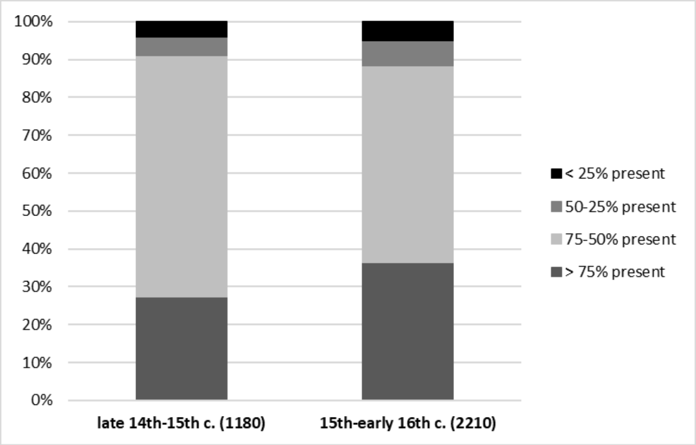


Fig. 5.5.2: Percentage of bone completeness by chronology (**refectory**, **late 14th-15th c.,** NISP: 5166; **kitchen**, **15th-early 16th c.**, NISP: 4190), all recovery methods.

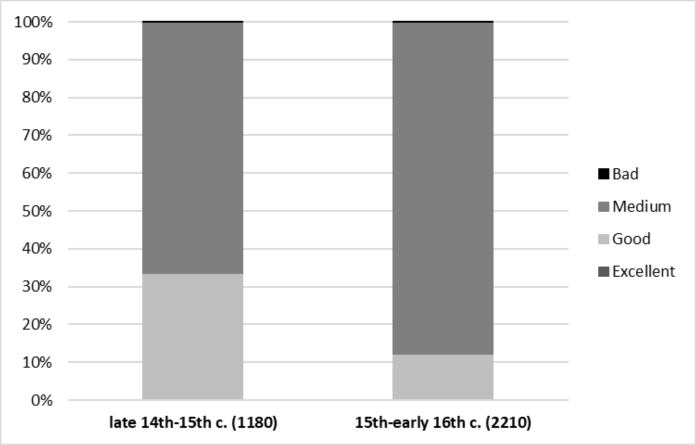


Fig. 5.5.3: Percentage of bone preservation by chronology (**refectory**, **late 14th-15th c.**, NISP: 5166; **kitchen**, **15th-early 16th c.**, NISP: 4190), all recovery methods.

TAXA		**(1180)**	**(2210)**	**TOT**
Latin name	**Common name**	**FS**	**FS**	
Clupea harengus	Atlantic herring	1821	2279	4100
Merlangius merlangus	Whiting	870	453	1323
Clupeidae	-	480	370	850
Solea solea	Common sole	551	296	847
Pleuronectiformes	-	440	185	625
Anguilla anguilla	European eel	301	116	417
Gadiformes	-	131	161	292
Pleuronectes platessa	European plaice	111	54	165
Sprattus sprattus	European sprat	86	29	115
Triglidae	-	65	34	99
Gadus morhua	Atlantic cod	61	31	92
Melanogrammus aeglefinus	Haddock	55	22	77
Cyprinidae	-	36	19	55
Pleuronectes platessa/Platichtys flesus	European plaice/flounder	30	25	55
Osmerus eperlanus	European smelt	29	25	54
Sparidae	-	32	7	39
Spondyliosoma cantharus	Black seabream	30	6	36
Conger conger	European conger	4	20	24
Scomber scombrus	Atlantic mackerel	10	12	22
Rajidae	-	0	18	18
Salmonidae	-	9	4	13
Molva molva	Ling	0	5	5
Dicentrarchus labrax	European seabass	1	3	4
Chelidonichthys cuculus	Red gurnard	3	1	4
Mugilidae	-	0	4	4
Perca fluviatilis	European perch	1	2	3
Gasterosteus aculeatus	Three-spined stickleback	3	0	3
Cottus perifretum	Bullhead	0	3	3
Engraulis encrasicolus	European anchovy	2	0	2
Eutrigla gurnardus	Grey gurnard	1	1	2
Trachurus trachurus	Mediterranean horse mackerel	0	2	2
Limanda limanda	Common dab	0	1	1
Platichthys flesus	European flounder	1	0	1
Rutilus rutilus	Roach	0	1	1
Pagellus sp.	-	1	0	1
Chelidonichthys lucerna	Tub gurnard	1	0	1
*Salmo salar/Salmo trutta trutta***	Atlantic salmon/sea trout	0	1	1
*Raja clavata**	Thornback ray	0	*	0
*Tinca tinca**	Tench	0	*	0
TOTAL		5166	4190	9356

Table 5.5.3: NISP of taxa by chronology based on diagnostic elements (other records noted as *) for fine-sieved (FS: mesh 1 mm) material from refectory, late 14th-15th c. **(1180)** and kitchen, 15th-early 16th c. **(2210)**. ** probably *Salmo salar/Salmo trutta trutta* by size. *Raja clavata** is represented by dermal denticle and *Tinca tinca** is represented by pharyngeal plate.

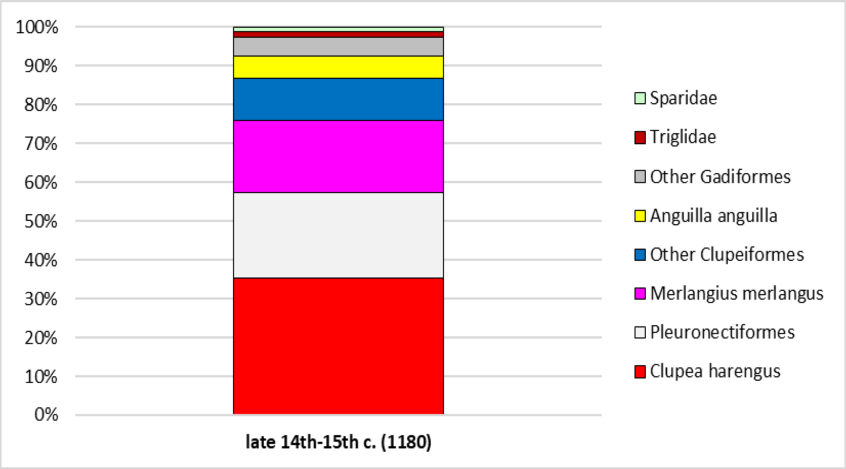


Fig. 5.5.4: Frequencies for the 8 most common taxa for **refectory (1180)**, **late 14th-15th c.** (NISP: 5159) for fine-sieved (FS: mesh 1 mm) material. Threshold by phase: tot NISP ≥ 100.

TAXA	refectory late 14th-15th c. (1180)	kitchen 15th-early 16th c. (2210)
Rutilus rutilus	1	1
Tinca tinca	0	1
Cyprinidae unid.	39	19

Table 5.5.4: NISP for the Cyprinidae family by chronology for fine-sieved (FS: mesh 1 mm) material based on all counted specimens and pharyngeal bones; although regarded as not countable, pharyngeal bones will be represented in this table because they have been consistently recorded for all Cyprinidae.

TAXA	refectory late 14th-15th c. (1180)	An.E.	kitchen 15th-early 16th c. (2210)	An.E.
Clupeiformes	87	PCV1	391	PCV1
Solea solea	14	vertebrae	10	URO
Merlangius merlangus	15	vertebrae	6	vertebrae/MAX
Other Pleuronectiformes	12	PST	9	PA
Large Gadiformes	3	various	5	VOM
Anguilla anguilla	3	vertebrae	2	VOM

Table 5.5.5: MNI by chronology for main taxa for fine-sieved (FS: mesh 1 mm) material. Threshold by phase: taxa NISP > 100. **An.E**. is the anatomical element used for MNI calculation. MAX: maxilla, PA: palatine, PCV1: first precaudal vertebra, PST: posttemporal, URO: urohyal, VOM: vomer, /: threshold requirement no fulfilled.

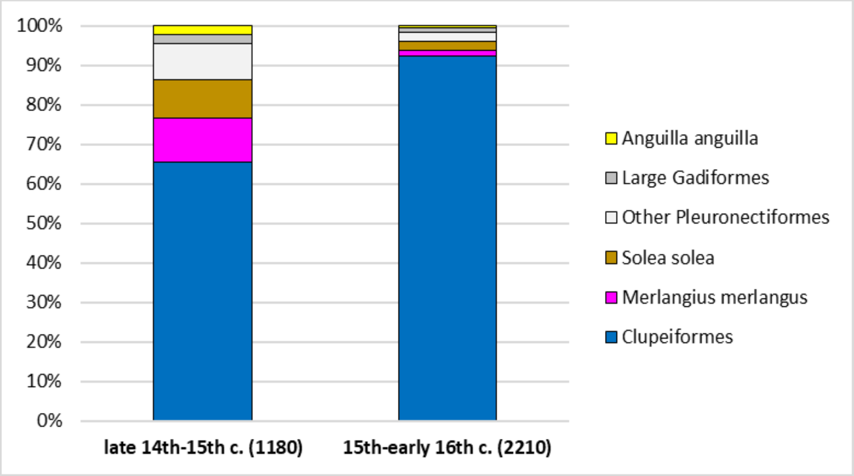


Fig. 5.5.5: MNI total n by chronology (**refectory, 1180**, **late 14th-15th c.**, n: 134; **kitchen**, **2210**, **15th-early 16th c.**, n: 423) for main taxa, fine-sieved (FS: mesh 1 mm) material. Threshold by phase: taxa NISP ≥ 100.

HABITAT	refectory late 14th-15th c. (1180)	kitchen 15th-early 16th c. (2210)
Freshwater	37	25
Marine	4251	3752
Migratory	343	144
Other	535	269

Table 5.5.6: Taxa habitat distribution by chronology, for fine-sieved (FS: mesh 1 mm) material.

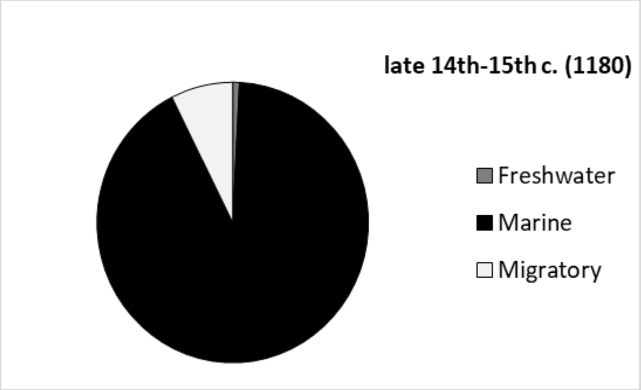


Fig. 5.5.6: Frequencies of habitat distribution for refectory (1180), **late 14th-15th c.** (NISP: 4631), for fine-sieved (FS: mesh 1 mm) material. "Other" excluded. Threshold by phase: tot NISP ≥ 100.

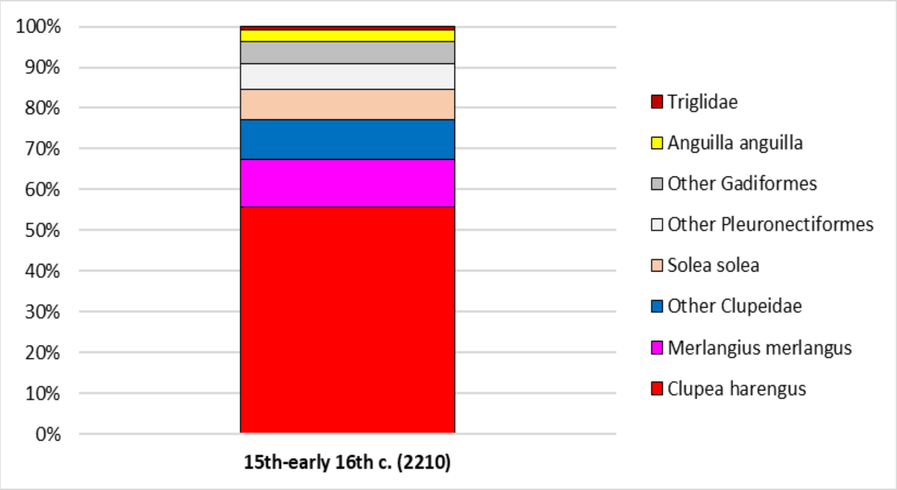


Fig. 5.5.7: Frequencies for the 8 most common taxa for **kitchen (2210)**, **15th-early 16th c.** (NISP: 4092), for fine-sieved (FS: mesh 1 mm) material. Threshold by phase: tot NISP ≥ 100.

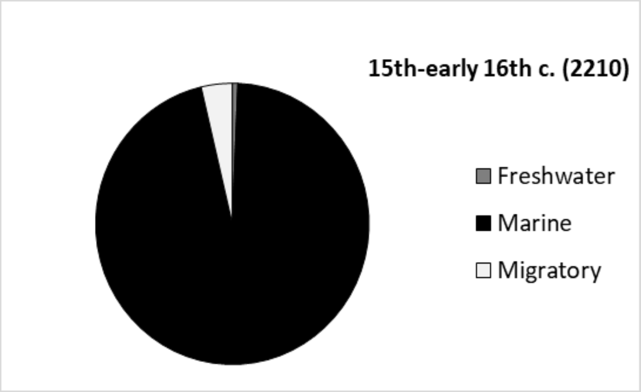


Fig. 5.5.8: Frequencies of habitat distribution for kitchen (2210), **15th-early 16th c.** (NISP: 3921), for fine-sieved (FS: 1 mm) material. "Other" excluded. Threshold by phase: tot NISP ≥ 100.

GROUP	**Element**		Clupeiformes		*Merlangius merlangus*		*Solea solea*	
			1180	**2210**	**1180**	**2210**	**1180**	**2210**
I	**A**	Articular	1	4	2	4	2	8
	B	Basioccipital	0	9	4	2	0	0
	D	Dentary	0	2	1	2	0	4
	ECT	Ectopterygoid	0	1	0	1	0	3
	ENT	Entopterygoid	0	0	0	0	0	0
	HYO	Hyomandibular	1	5	0	0	0	7
	INT	Interopercular	2	1	2	1	0	0
	MAX	Maxilla	1	3	0	6	0	7
	OP	Opercular	2	5	0	0	1	4
	OT	Otolith	0	0	2	4	1	2
	PA	Palatine	0	0	1	2	0	0
	PAR	Parasphenoid	0	1	1	0	0	0
	PRE	Preopercular	0	4	1	1	0	7
	PX	Premaxilla	0	2	0	3	0	3
	Q	Quadrate	2	6	0	5	0	9
	SUB	Subopercular	1	6	0	0	0	0
	VOM	Vomer	0	1	0	2	0	0
II	**CE**	Ceratohyal	2	4	1	2	1	3
	EHY	Epihyal	2	7	0	1	0	1
	URO	Urohyal	0	8	0	1	0	10
III	**BAP**	Basipterygium	1	3	0	0	0	0
	CL	Cleithrum	3	7	0	0	1	6
	CO	Coracoid	1	4	0	0	0	0
	PSC	Postcleithrum	0	0	0	0	0	0
	PST	Posttemporal	2	5	3	5	1	3
	S	Scapula	0	6	0	0	0	0
	SUP	Supracleithrum	1	1	2	4	0	1
IV	**PCV1 (PCV2)**	1st (2nd) precaudal vertebra	87	391	0	0	1	8
	AAV	Anterior abdominal vertebra	55	40	10	6	6	14
	PAV	Posterior abdominal vertebra	18	18	24	11	1	1
V	**CV**	Caudal vertebra	38	39	13	5	17	4
	LC	Last caudal vertebra	10	13	0	0	10	4
VI	**VC**	Vertebral body (centrum)	0	0	1	0	0	0

Table 5.5.7 (PART 1).

GROUP	Element		Other Pleuronectiformes		Large Gadiformes		*Anguilla anguilla*	
			1180	**2210**	**1180**	**2210**	**1180**	**2210**
I	**A**	Articular	8	1	3	3	0	1
	B	Basioccipital	4	6	2	4	0	0
	D	Dentary	2	3	1	2	0	1
	ECT	Ectopterygoid	10	3	1	2	0	0
	ENT	Entopterygoid	0	0	0	0	\	\
	HYO	Hyomandibular	2	3	1	0	0	0
	INT	Interopercular	2	2	0	0	0	0
	MAX	Maxilla	3	3	0	0	0	1
	OP	Opercular	1	2	1	1	0	1
	OT	Otolith	2	2	1	4	0	0
	PA	Palatine	7	9	1	4	\	\
	PAR	Parasphenoid	1	0	0	0	0	0
	PRE	Preopercular	2	2	0	0	0	0
	PX	Premaxilla	5	4	1	1	\	\
	Q	Quadrate	6	1	2	0	0	0
	SUB	Subopercular	0	0	0	0	0	0
	VOM	Vomer	3	8	1	5	0	2
II	**CE**	Ceratohyal	2	2	0	0	1	0
	EHY	Epihyal	4	4	1	3	0	1
	URO	Urohyal	9	6	0	3	\	\
III	**BAP**	Basipterygium	1	4	0	0	\	\
	CL	Cleithrum	2	1	1	0	1	1
	CO	Coracoid	0	0	0	0	\	\
	PSC	Postcleithrum	0	0	1	0	\	\
	PST	Posttemporal	12	2	3	1	\	\
	S	Scapula	0	0	1	1	\	\
	SUP	Supracleithrum	9	3	3	0	0	0
IV	**PCV1 (PCV2)**	1st (2nd) precaudal vertebra	5	7	0	0	0	0
	AAV	Anterior abdominal vertebra	24	3	3	4	1	3
	PAV	Posterior abdominal vertebra	5	3	2	1	3	2
V	**CV**	Caudal vertebra	10	4	4	3	3	1
	LC	Last caudal vertebra	3	5	0	0	\	\
VI	**VC**	Vertebral body (centrum)	0	0	0	0	0	0

Table 5.5.7 (PART 2): Anatomical element distribution (MAU) by chronology for main taxa, for fine-sieved (FS: mesh 1 mm) material from refectory, late 14th-15th c. **(1180)** and kitchen, 15th-early 16th c. **(2210)**. Group I = Head elements (Minus II): Neurocranium, jaws, gill arches, gill covers; Group II = Head elements: Outer branchial skeleton; Group III = Pectoral and pelvic skeleton; Group IV = Precaudal vertebra; Group V = Caudal vertebrae; Group VI = undefined vertebrae. \ = missing/undeveloped or unidentified anatomical elements for eel (Methods, Chapter 4).

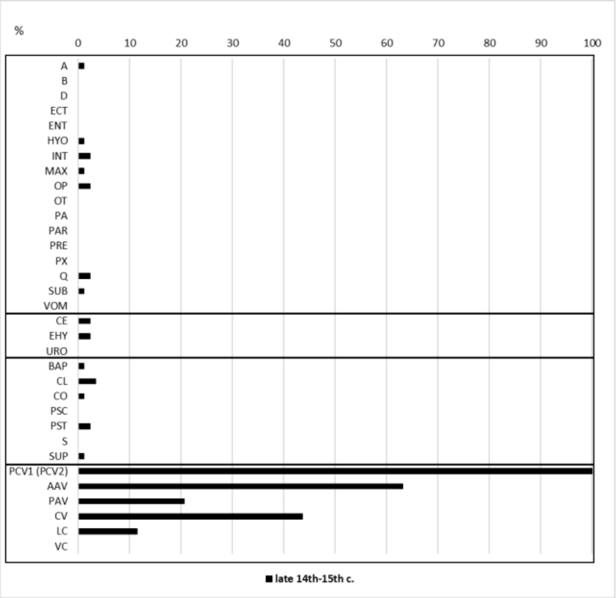


Fig. 5.5.9: Frequencies of anatomical element distribution (MAU) for Clupeiformes, **refectory (1180)**, **late 14th-15th c.**, for fine-sieved (FS: mesh 1 mm) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

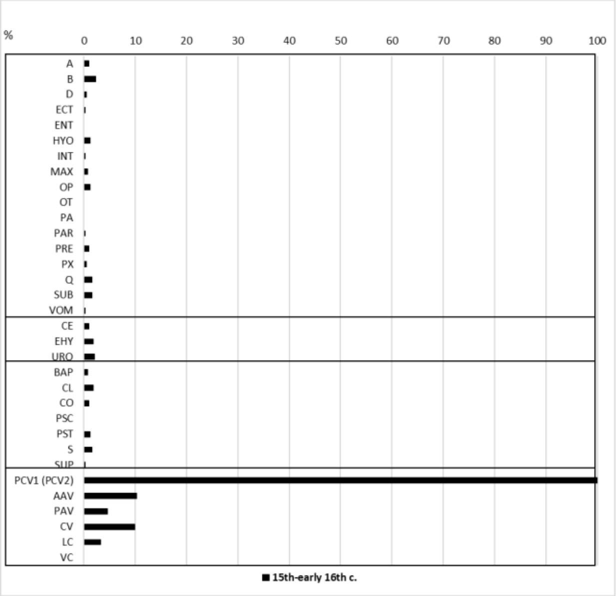


Fig. 5.5.10: Frequencies of anatomical element distribution (MAU) for Clupeiformes, **kitchen (2210)**, **15th-early 16th c.**, for fine-sieved (FS: mesh 1 mm) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

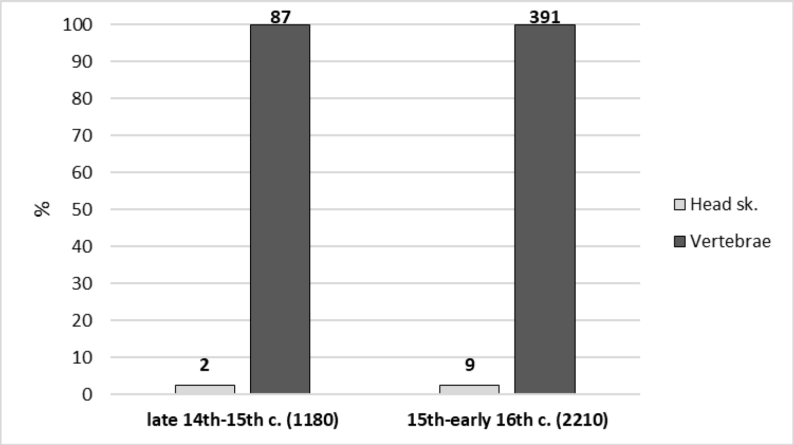


Fig. 5.5.11: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in Clupeiformes by chronology for fine-sieved (FS: mesh 1 mm) material.

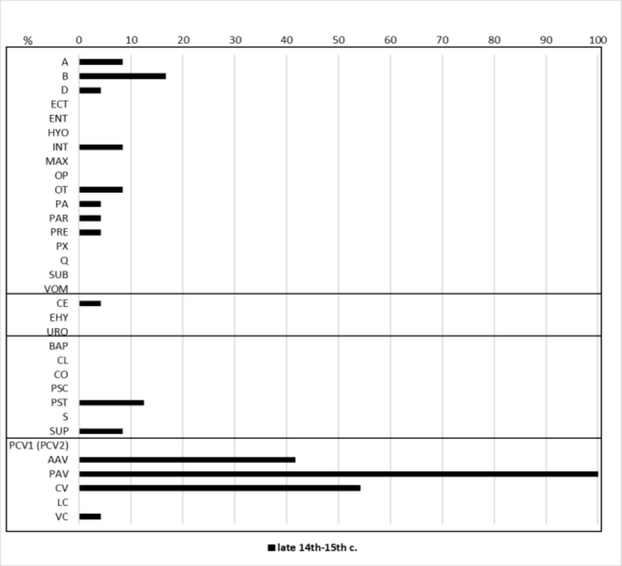


Fig. 5.5.12: Frequencies of anatomical element distribution (MAU) for *Merlangius merlangus*, **refectory (1180)**, **late 14th-15th c.**, for fine-sieved (FS: mesh 1 mm) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

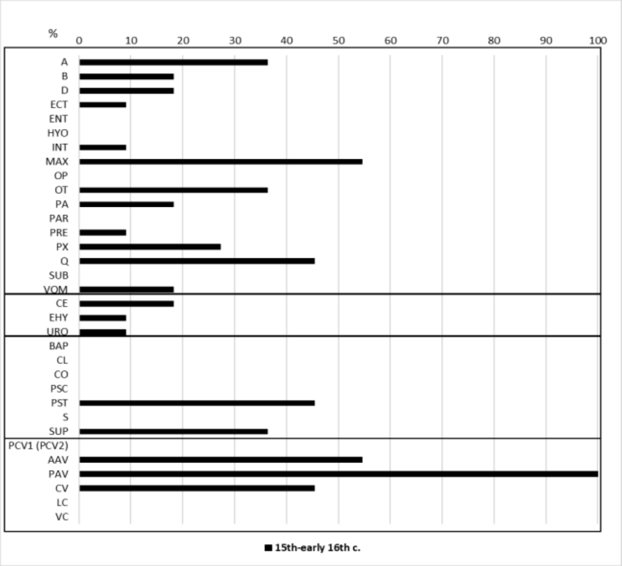


Fig. 5.5.13: Frequencies of anatomical element distribution (MAU) for *Merlangius merlangus*, **kitchen (2210)**, **15th-early 16th c.**, for fine-sieved (FS: mesh 1 mm) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens

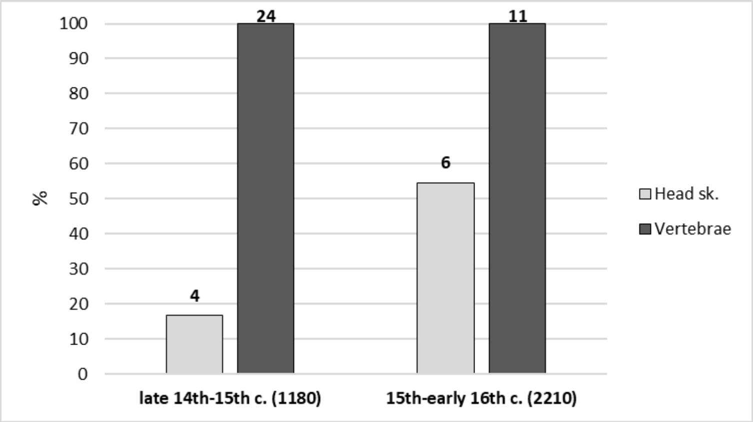


Fig. 5.5.14: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Merlangius merlangus* by chronology for fine-sieved (FS: mesh 1 mm) material.

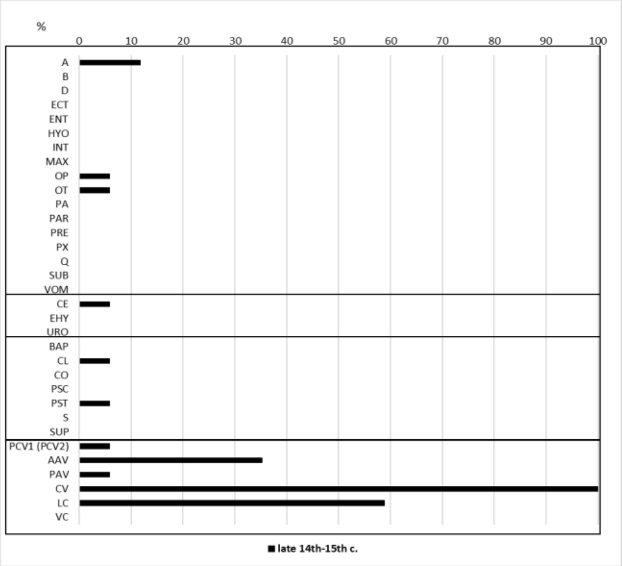


Fig. 5.5.15: Frequencies of anatomical element distribution (MAU) for *Solea solea*, **refectory (1180)**, **late 14th-15th c.**, for fine-sieved (FS: mesh 1 mm) material. Rectangles represent different anatomical areas. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

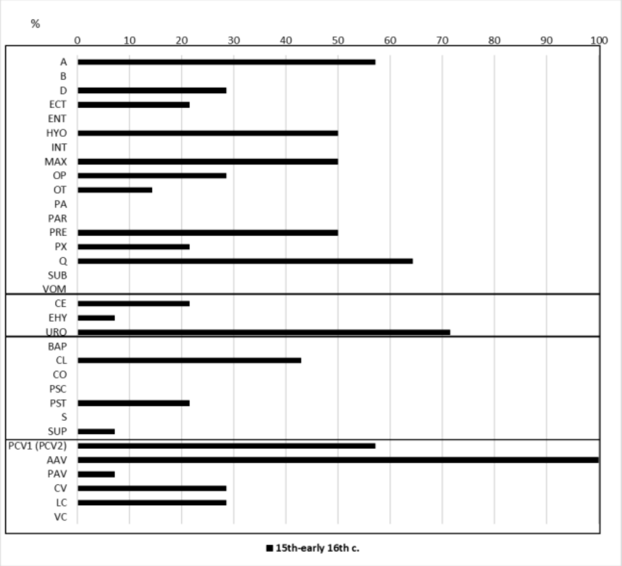


Fig. 5.5.16: Frequencies of anatomical element distribution (MAU) for *Solea solea*, **kitchen (2210)**, **15th-early 16th c.**, for fine-sieved (FS: mesh 1 mm) material. Rectangles represent different anatomical areas. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

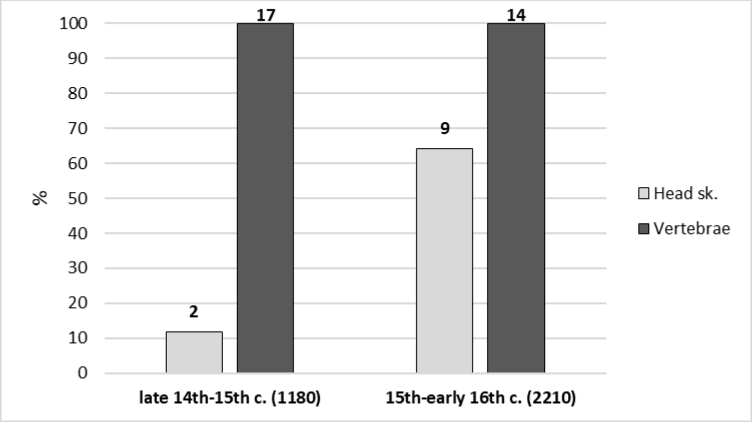


Fig. 5.5.17: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Solea solea* by chronology for fine-sieved (FS: mesh 1 mm) material.

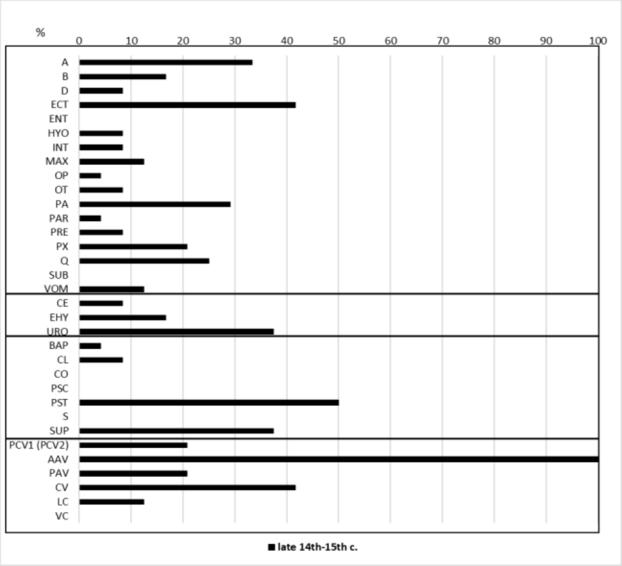


Fig. 5.5.18: Frequencies of anatomical element distribution (MAU) for other Pleuronectiformes, **refectory (1180)**, **late 14th-15th c.**, for fine-sieved (FS: mesh 1 mm) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

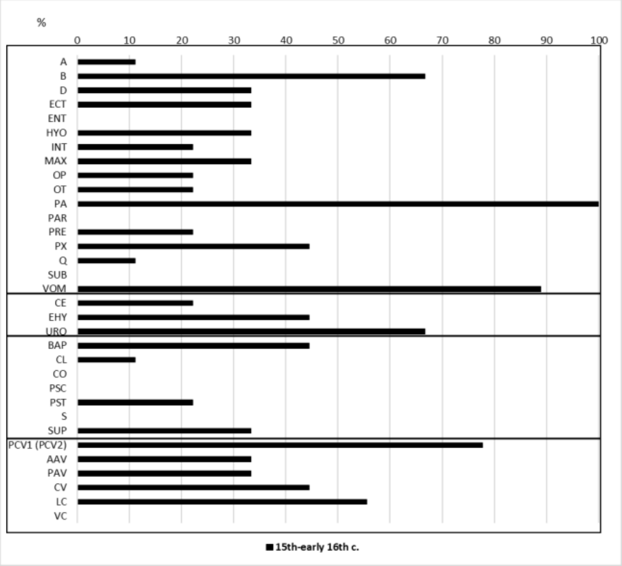


Fig. 5.5.19: Frequencies of anatomical element distribution (MAU) for other Pleuronectiformes, **kitchen (2210)**, **15th-early 16th c.**, for fine-sieved (FS: mesh 1 mm) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

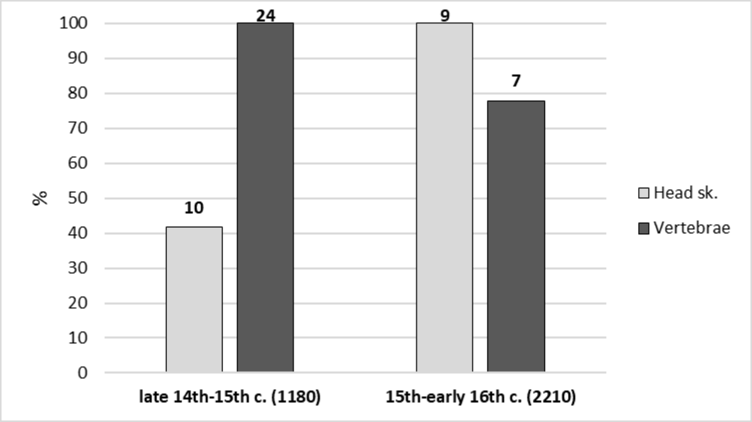


Fig. 5.5.20: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in other Pleuronectiformes by chronology for fine-sieved (FS: mesh 1 mm) material.

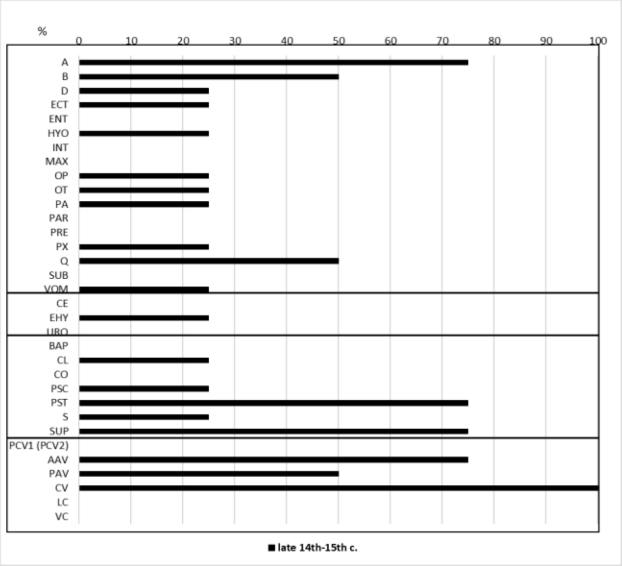


Fig. 5.5.21: Frequencies of anatomical element distribution (MAU) for large Gadiformes, **refectory (1180)**, **late 14th-15th c.**, for fine-sieved (FS: mesh 1 mm) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

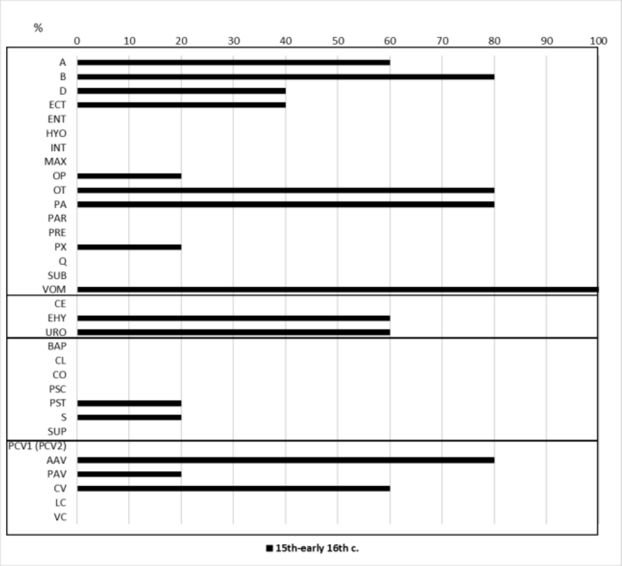


Fig. 5.5.22: Frequencies of anatomical element distribution (MAU) for large Gadiformes, **kitchen (2210)**, **15th-early 16th c.**, for fine-sieved (FS: mesh 1 mm) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

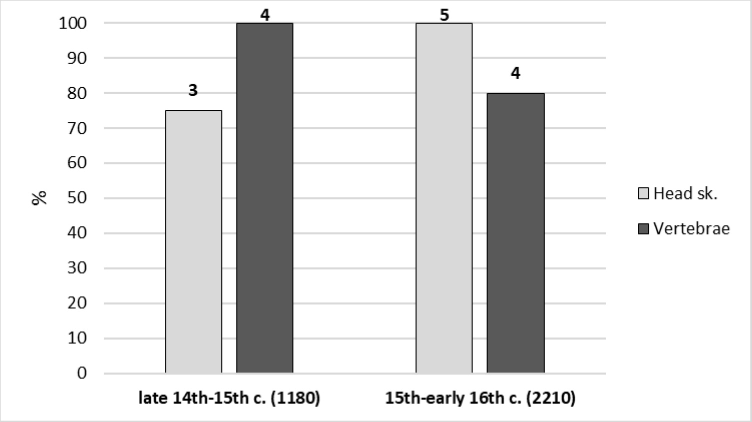


Fig. 5.5.23: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in other Gadiformes by chronology for fine-sieved (FS: mesh 1 mm) material.

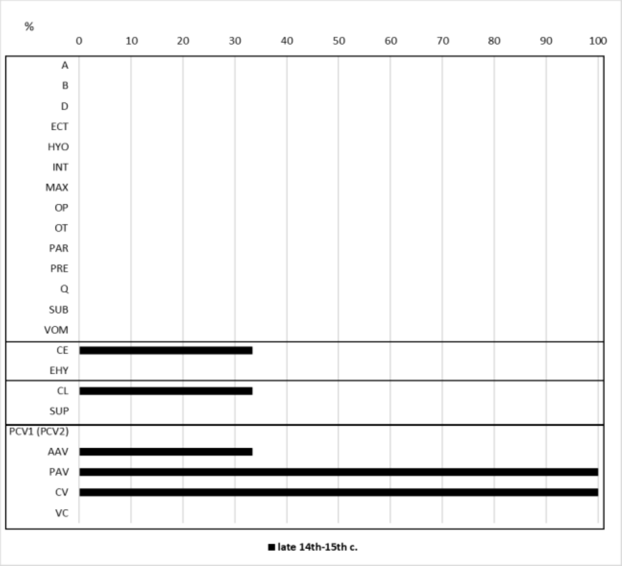


Fig. 5.5.24: Frequencies of anatomical element distribution (MAU) for *Anguilla anguilla*, **refectory (1180)**, **late 14th-15th c.**, for fine-sieved (FS: mesh 1 mm) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

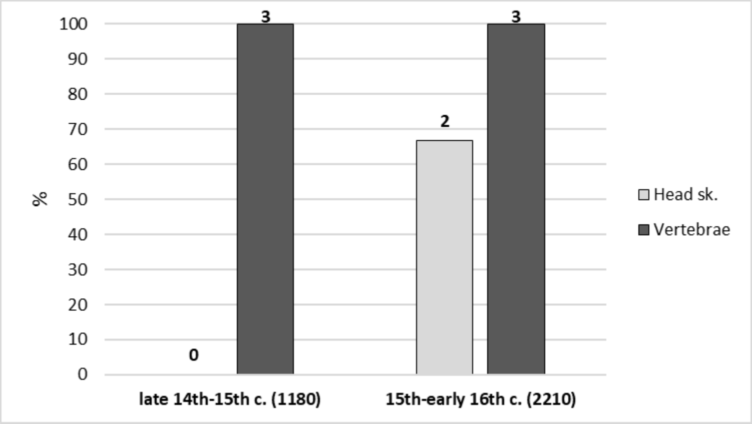


Fig. 5.5.25: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Anguilla anguilla* by chronology for fine-sieved (FS: mesh 1 mm) material.

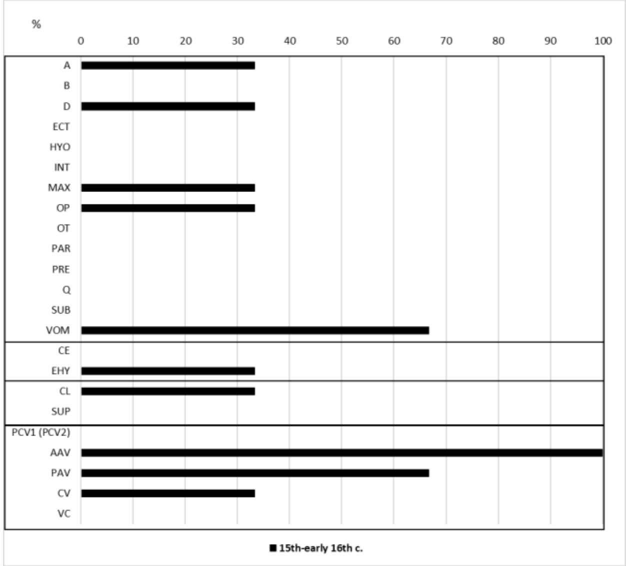


Fig. 5.5.26: Frequencies of anatomical element distribution (MAU) for *Anguilla anguilla*, **kitchen (2210)**, **15th-early 16th c.**, for fine-sieved (FS: mesh 1 mm) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

TAXA	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	**TOT**
Burning											
Burned	20	20	9	0	1	2	0	1	0	0	53
Tot burned											53 (1%)
Other modifications											
Crushed	12	5	13	21	3	0	0	0	1	1	56
Tot modified											56 (1%)
Butchery marks											
Chop	0	0	0	0	0	0	1	0	0	0	1
Cut	0	1	0	0	0	0	0	0	0	0	1
Tot butchered	0	1	0	0	0	0	1	0	0	0	2 (0.03%)

Table 5.5.8: Taphonomic modifications for the **refectory**, **late 14th-15th c.** material **(context 1180)**, total NISP 5166, all recovery methods. ***1)*** *Clupea harengus*, ***2)*** *Merlangius merlangus*, ***3)*** *Solea solea*, ***4)*** *Anguilla anguilla*, ***5)*** Pleuronectiformes, ***6)*** Gadidae, ***7)*** *Gadus morhua*, ***8)*** Triglidae, ***9)*** *Osmerus eperlanus*, ***10)*** Cyprinidae.

TAXA	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	**TOT**
Burning												
Burned	56	37	18	14	5	1	1	3	3	1	1	140
Calcined	15	12	0	1	2	1	1	0	0	0	0	32
Tot burned	71	49	18	15	7	2	1	3	3	1	1	172 (4%)
Other modifications												
Crushed	12	4	0	0	0	2	4	0	0	0	1	23
Tot modified												23 (0.5%)
Butchery marks												
Chop	0	0	0	0	0	3	0	2	0	1	0	6
Cut	0	0	0	0	0	0	0	1	0	0	0	1
Tot butchered	0	0	0	0	0	3	0	3	0	1	0	7 (0.1%)

Table 5.5.9: Taphonomic modifications for the **kitchen**, **15th-early 16th c.** material **(context 2210)**, total NISP 4190, all recovery methods. ***1)*** *Clupea harengus*, ***2)*** *Merlangius merlangus*, ***3)*** Clupeidae, ***4)*** *Solea solea*, ***5)*** Pleuronectiformes, ***6)*** *Scomber scombrus*, ***7)*** *Anguilla anguilla*, ***8)*** *Gadus morhua*, ***9)*** Gadidae, ***10)*** *Conger conger*, ***11)*** *Osmerus eperlanus*.

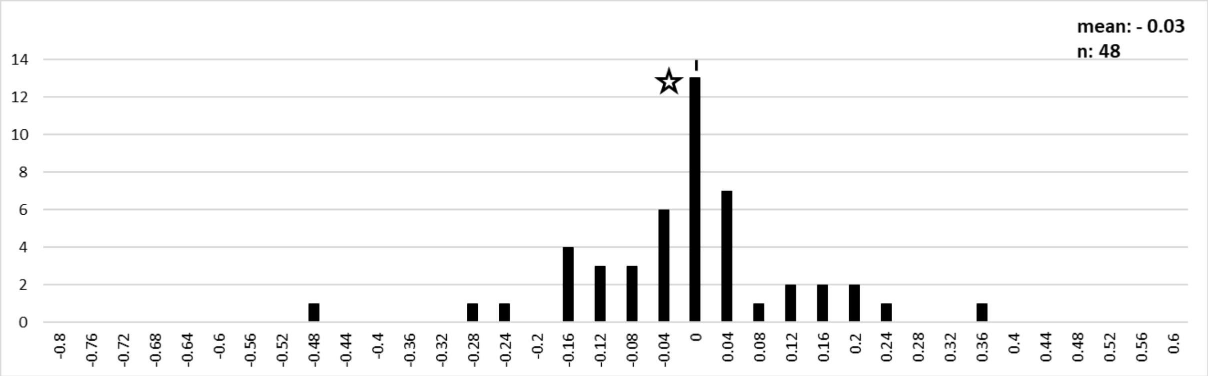


Fig. 5.5.27: Size distribution for all anatomical elements for Cyprinidae, **refectory (1180)**, **late 14th-15th c**. The star indicates the mean (-0.03). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 18; n measures: 48.

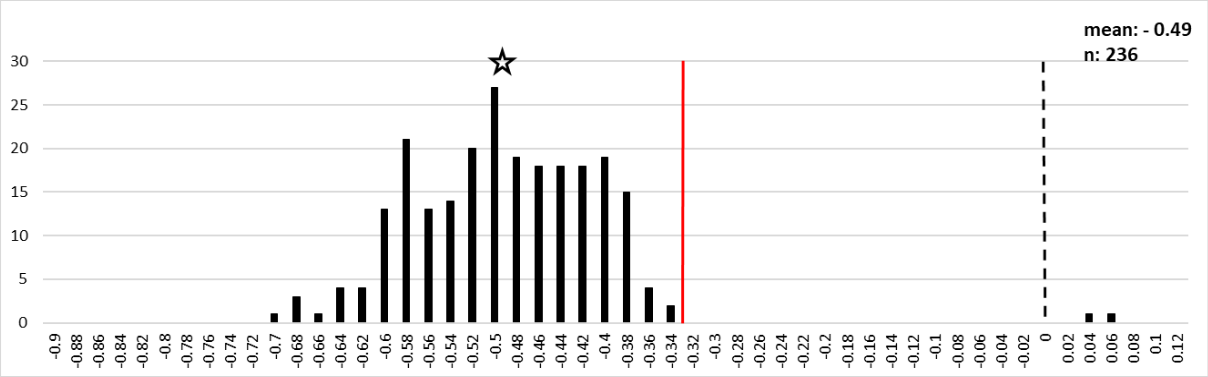


Fig. 5.5.28: Size distribution for all anatomical elements for *Anguilla anguilla*, **refectory (1180)**, **late 14th-15th c**. The star indicates the mean (-0.49). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 83; n measures: 236.

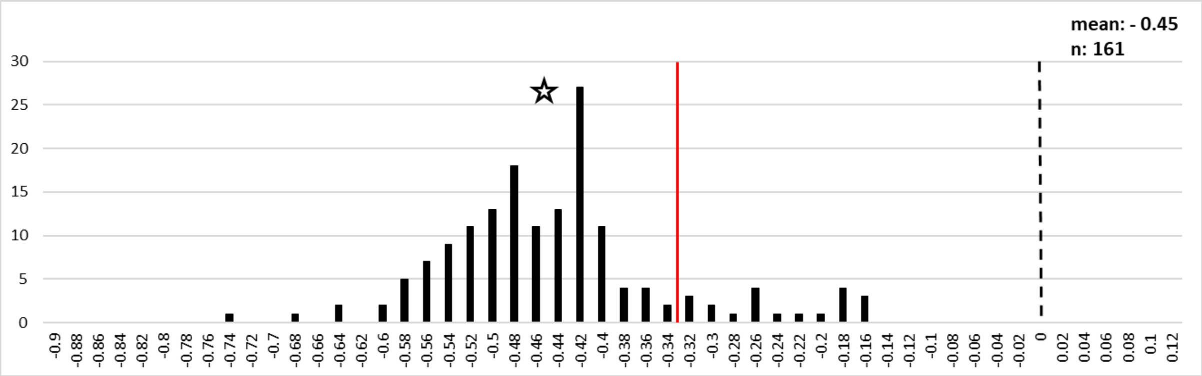


Fig. 5.5.29: Size distribution for all anatomical elements for *Anguilla anguilla*, **kitchen (2210)**, **15th-early 16th c**. The star indicates the mean (-0.45). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 56; n measures: 161.

5.6 Stert Street

A number of medieval and post-medieval features were excavated in the 1970s at Stert Street, No. 40, in the town of Abingdon. The results of this research were published a few years later by Parrington (1979); unless otherwise stated, the information provided in the next section is extracted from this publication.

5.6.1 The site: Stert Street, No. 40

Stert Street (Fig. 5.6.1) is located in Abingdon, Oxfordshire, and named after the river Stert, a small watercourse which was culverted in the 18th c.

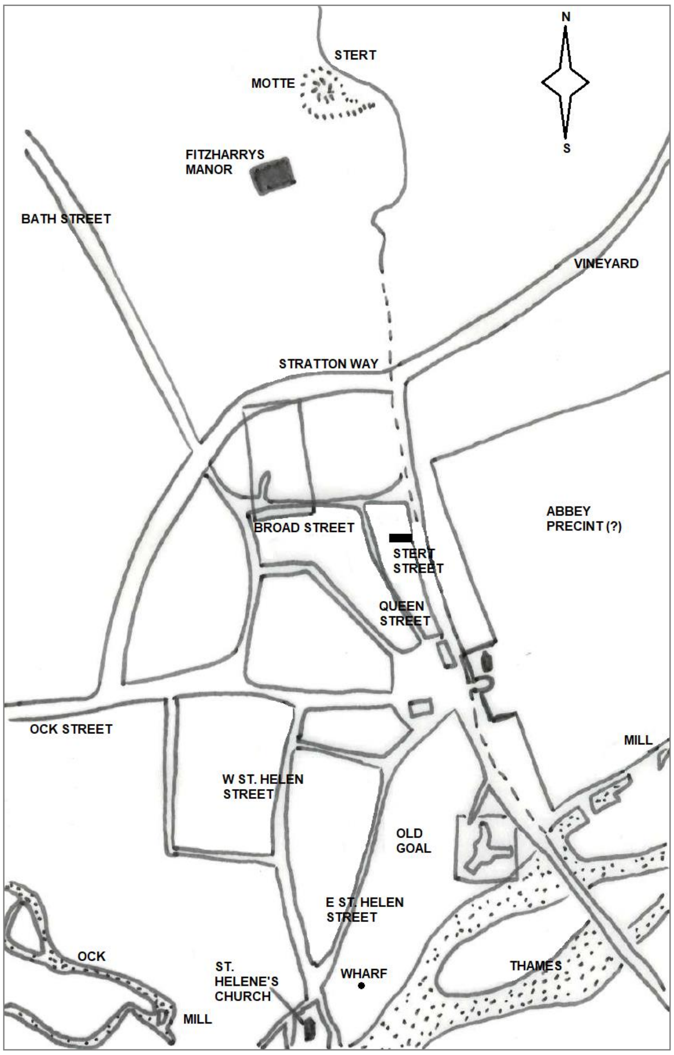


Fig. 5.6.1: Location of Stert Street also showing previous excavations at Abingdon (modified by Parrington 1979).

The town of Abingdon was located on a favourable trading position at the confluence of the River Stert and Ock with the Thames. Probably back to the 7th c., the St. Mary’s Abbey was funded within the town, which increased in status during the 10th c., after becoming a Benedictine centre of cultural and religious life (AAAHS 2013). The Domesday Book (1086) mentions a medieval market in the town, contemporary to the abbey, which also favoured Abingdon economic activities. Stert Street was adjacent to the wall of the abbey, which probably was a stimulus to the construction of new tenements. It was inhabited since Roman times, but little is known of it until c. 1247, when a reference to a property in the street is mentioned in a deed. In 1316, a mention to the “Street of Sterte” suggests the construction of buildings on the west bank of the river. A survey from

1554 reports 20-30 houses on the street between the river and the abbey wall, and other 10-13 on the west side. At the time of the survey, many houses were in need of repair and there were still several empty plots (AAAHS 2013). From the 16th to the 18th c., the street was inhabited by a variety of people; innkeepers, bargemasters, boatmen but also “gents” (AAAHS 2013). In particular, the house No. 40, located over the excavation site, was built in the 17th c. and demolished in the 1960s; up to the time of the excavation the plot was used as site for the display of gardening equipment.

5.6.1.1 Excavations and zooarchaeological studies

In 1975 a small trench was excavated prior redevelopment, by members of the Abingdon and District Archaeological Society; excavations continued intermittently until 1976. During these two years distinct phases of activities were identified; a **Roman period**, consisting mostly in pottery and coins findings; a **Medieval period**, characterized by a number of pits, an infant burial, a well and other stone structures, possibly buildings; and a **Post-medieval period**, comprising the foundation of the No. 40 building, a cellar, a stone wall, several pits and other features mostly dated to the 19th-20th c.

Mammal bones recovered from the site were studied by Wilson (1979), bird bones by Bramwell and Wilson (1979), arthropods by Robinson (1979) and fish bones by Wheeler (1979a).

5.6.2 Material and recording methods

Fish remains were retrieved from both 1975 and 1976 years of excavation, from contexts dated to the 13th-19th c. For the purpose of this research, only material dated to the 13th - 16th c. has been analysed; this was recovered from eight pits and one layer. Fish remains were hand-collected and occasionally sieved in small quantities with a 2.5 mm mesh; the quantity of sieved soil varied between different samples (Wilson 1979, 17). Most of the fish bones were retrieved from pit 34, which was interpreted as a well, dated 15th-early 16th c.

In some cases, the recovery method was not specified but I compared observations made during recording of the material with information from the animal bone report (*ibid.*). In this way, it was possible to create two recovery categories, following the recording protocol: coarse-sieved material (2.5 mm mesh) and hand-collected material.

The fish remains were further grouped into three chronological periods, **13th c.**, **13th-14th c.** and **15th-16th c.** Material from the 13th-14th c., is represented by only few bones but it was kept separated in order not to blur the chronological definition of the 13th c. sample and it will be only mentioned where relevant.

5.6.3 Results

Within the selected sample, a total of 4,154 fish remains were counted, 2,327 of these were identified taxonomically (with various degrees of precision) and 2,214 represented countable specimens. This high number of unidentified bones is probably a consequence of a high degree of recovery from pit 34, which was mostly represented by a mix of undiagnostic fin rays, ribs and bone fragments.

A few scales were recovered for the **13th c.**, while for the **15th-16th c.** around 40 scales were counted, five of which were attributed to perch but not included in the analysis.

For both periods, the material showed a good level of completeness, as most elements were represented by more than 50% (Table 5.6.1, Fig. 5.6.2), and a good level of preservation of the bone surface (Table 5.6.2, Fig. 5.6.3).

5.6.3.1 Taxonomic frequencies

Coarse-sieved material (2.5 mm)

The small **13th c.** sample (Table 5.6.3, Fig. 5.6.4) is dominated by herring (58%), followed by eel (14%) and unidentified Cyprinidae (6%, Table 5.6.4). Pike and whiting are both represented by little less than 5% of the identified material, and they are followed by the freshwater burbot (4%) and perch (2%). There is a dearth of other marine Gadiformes (1%), the only identified species being cod with two remains. Only a few other taxa are present, one of these being Pleuronectiformes, with one Pleuronectidae remain and one attributed to plaice/flounder.

Herring is the only species reaching the threshold for MNI calculation and is represented by two individuals (Table 5.6.5).

Despite the small size, it is clear how the **13th c.** sample (Table 5.6.6, Fig. 5.6.5) is mostly represented by marine taxa (66%), the rest being split between freshwater (19%) and migratory (14%) fish.

Only two remains of Cyprinidae represent the coarse-sieved sample for the **13th-14th c.** (Tables 5.6.3-4, 5.6.6).

The **15th-16th c.** coarse-sieved sample is much larger (Table 5.6.3, Fig. 5.6.6). There is a clear predominance of eel (77%) over other taxa, followed by a reduced percentage of herring (12%). Cyprinidae are slightly less well represented than in the previous phase (4%), with a variety of species identified (Table 5.6.4, Fig. 5.6.7): bleak, gudgeon, rudd, silver bream, roach and chub. Wheeler (1979a, 22) identified also barbel and dace, both represented by one remain, but I have not found them. Whiting is less well represented than in the previous phase (1%) and other taxa appearing with little less than 1% are: other Clupeidae, including pilchard and shads (*Alosa alosa*/*Alosa fallax*) but probably mostly belonging to small herring; the freshwater bullhead (*Cottus perifretum*); other marine Gadiformes, with cod, ling and pouting all represented by just one bone; Pleuronectiformes, mostly Pleuronectidae vertebrae, but with six remains assigned to plaice. Other freshwater taxa present are the Nemacheilidae (ten remains), probably belonging to stone loach (*Barbatula barbatula*), pike and perch (eight remains each), burbot (one remain) and ruffe (one remain). Other migratory taxa identified are three-spined stickleback (*Gasterosteus aculeatus*), smelt (*Osmerus eperlanus*) and Salmonidae. The presence of other species is negligible.

The MNI for the **15th-16th c.** sample (Table 5.6.5) confirms NISP calculations by showing a clear predominance of eel over herring. No other species reached the threshold for MNI calculation.

Overall, as expected, for the **15th-16th c.** (Table 5.6.6, Fig. 5.6.8), migratory taxa dominate the assemblage (77%), while marine (17%) and freshwater (6%) fish are much less frequent.

Hand-collected material

Hand-collected material is very scarce for all three samples and it is mostly represented by marine species (Tables 5.6.3, 5.6.7), such as cod, haddock (including one cleithrum showing hyperostosis; von den Driesch 1994), conger and gurnards. It is worth mentioning the presence of pike from both **13th c.** and **15th-16th c.** hand-collected samples.

5.6.3.2 Anatomical element distribution

The analysis of anatomical element distribution was performed only for the two most common species recovered from the coarse-sieved samples, herring and eel (Table 5.6.8).

For the **13th c.** sample, herring is nearly entirely represented by vertebrae, in particular posterior-abdominal vertebrae (Fig. 5.6.9-10). For the **15th-16th c.**, the most common anatomical element are anterior-abdominal vertebrae (Fig. 5.6.11). Head elements are better represented than in the previous period, but still less abundant than vertebrae (Fig. 5.6.10).

For the **15th-16th c.** coarse-sieved sample for eel, the most common element is opercular. Head elements (Group I) predominate, though only marginally so (Fig. 5.6.12-13).

5.6.3.3 Taphonomic alterations

The taphonomic evidence recorded on the **13th c.** material is scanty, reflecting the small size of the sample, and is summarised in Table 5.6.9. Few bones were burned; only one eel vertebra was crushed (mechanical and/or chemical bone deformation, Chapter 4) and one cut mark was recorded on one eel pre-caudal vertebra.

For the **13th-14th c.** sample several cut and chop marks were observed on a cleithrum belonging to a particularly large cod, possibly reaching 1.5 m of total length.

For the larger **15th-16th c.** sample (Table 5.6.10), taphonomic alterations were more common; around 7% of the identified bones, mostly belonging to eel, showed burning, and around 4% showed crushing, again predominantly on eel. Several cut and chop marks were recorded on eel precaudal vertebrae and on a quadrate; cuts were also observed on two pike anterior-abdominal vertebrae.

5.6.3.4 Biometrical analysis

For the **13th c.**, measurable bones for pike were scanty (22) and they had a mean value around 34 cm of total length. Only five bones were measured for the **15th-16th c.** pike, belonging to individuals smaller than 34 cm of total length.

The few measurements recorded for the **15th-16th c.** perch belonged mostly to individual smaller than 27.5 cm of total length.

Cyprinidae measurements for the **13th c.** and **13th-14th c.** samples had a mean value slightly smaller than a modern roach of 19 cm of total length (15 cm of standard length), which was used as standard.

From the **15th-16th c.** sample, a greater number of measurements allowed to produce a log ratio histogram (Fig. 5.6.14). The graph shows a number of measurements plotting roughly unimodally around the mean value, which is smaller than the standard. It is important to remember that different values may represent different stages of life of the fish but also different species. Considering that the larger species found in the assemblage can grow up to 50-60 cm of standard length in modern individuals (the barbel found by Wheeler grows up to 90 cm of standard length, Kottelat & Freyhof 2007), the Cyprinidae recorded at Stert Street were rather small.

Overall, 16 pharyngeal bones for Cyprinidae were measured; these all belonged to bleak with the exception of one chub, which is considerably larger, consistently with the known differences between these species (Fig. 5.6.15).

Eel measurements for the **13th c.** (Fig. 5.6.16) are represented by a small sample and are scattered heterogeneously around the marker of 49 cm of total length (red line). Some larger outliers are present, including three measurements plotting beyond the standard value (0) of 96 cm of total length and two plotting just below, which probably represent female silver eels (considering that males rarely grow beyond 54 cm in total length; Tesch 2003, 168).

The **15th-16th c.** eel is represented by a good sample of measurements (Fig. 5.6.17), distributed unimodally around the mean value, which is smaller than the previous phase and comparable to the maturation stage of yellow/silver eel (over 30 cm of total length; *ibid.*, 150); these eels seem rather small in comparison with modern unsexed eel, which have a mean value of 35-60 cm (*ibid.*, 168). No large eel is present.

5.6.4 Discussion

Eel and herring were the most common fish eaten by the community living around Stert Street. From the **13th c.** to the **15th-16th c.**, eel is by far the predominant species. Considering that only the **15th-16th c.** sample has a large sample size, apparent diachronic changes must be interpreted cautiously. With the exception of herring, the site was largely relying on local resources. Fisheries on the Thames would have provided eel, Cyprinidae, pike, burbot, perch, ruffe and the odd salmon/trout. It is important to point out that Salmonidae tend to be underrepresented in the archaeological record as they are particularly affected by taphonomic processes

(Hamilton-Dyer 2007, 181); Wheeler (1979a, 22) also suggested that salmon may have been scarce in the Thames during that period. All this fish would have been readily available and therefore most likely consumed fresh.

The overall small size of Cyprinidae, representing juvenile or small Cyprinidae species (bleak, gudgeon), together with the presence of other small taxa such as stickleback, stone loaches and sculpins (i.e. bullhead) suggest by-catch from eel fisheries, although small freshwater species still had a dietary value of their own as they could be consumed fresh in soups, pies, pastries or preserved as pickles (Locker 2018a). They could also represent the stomach content of larger predators, such as pike or perch, which would also reveal on-site cleaning (Hamilton-Dyer 2007, 184).

The inland position of the site explains the small contribution made to the diet by fish caught in estuaries, such as Pleuronectiformes, and probably mostly plaice and flounder; flounder occasionally can also swim several kilometres upriver (Kottelat & Freyhof 2007, 593). Estuary/coastal areas could have also provided whiting, smelt and the smallest eels. Most eel lives the first part of their lives (glass eel stage) in costal and estuarine areas and start to colonise rivers at the stage of elvers (from roughly 7-8 cm of total length; Churchward 1996 in Tesch 2003, 137). Most individuals found at the site were partially mature or at the stage of becoming silver eels, and, in the smallest cases, possibly elvers; at these age stages eels are typically fished from rivers. The very large eels from the 13th c. sample were probably sexually mature female individuals, caught during the autumnal seaward migration towards the spawning ground, the Sargasso Sea (see species overview in Chapter 1). These larger specimens were probably consumed during a festive meal. The scattered measurements for **13th c.** eel could suggest occasional or seasonal fishing, but the sample is too small to be sure. Conversely, the unimodal distribution of eel for the **15th-16th c.** suggests a non-seasonal (Morales-Muñiz 2014) managed catch focused on small/medium individuals; the small size of these fish is possibly the result of a combination of fish availability and fishing pressure due to increased demand. Fishing from rivers was definitively focused on eel; the small size of other freshwater fish (also perch and pike) is probably a consequence of the fact that these species were not specifically targeted, but rather represented a by-product of eel catching. Furthermore, there is the possibility that large freshwater fish, such as large pike, was not affordable for the community living in Stert Street (for further discussion see Chapter 6).

A wide variety of marine species was recovered, but, except for herring and partially withing, they seem to have had a marginal role in the diet. In particular, it is worth noticing the low occurrence of large Gadiformes, such as cod and ling. Large fish (e.g. cod, ling, conger) would have provided larger amount of flesh, but there is the possibility that this was bought in cuts (e.g. steaks, fillets), thus becoming almost invisible in the archaeological record for the site. The lively Abingdon market would have offered the opportunity to purchase a large variety of marine species, such as cod, haddock, ling, rays, conger, gurnards, mackerel and seabass (..). Some of this fish could have been imported fresh and others in a preserved form (e.g. smoked, salted, pickled). Typically, oily fish such as herring, pilchard, and mackerel tend to spoil fast; therefore, considering the inland position of the town, they were likely to be traded in a cured form. However, there is archaeological evidence from inland Bicester Priory of fresh herring having been transported and consumed fresh (Bond 1988, 77 in Locker 1997a, 3). Similarly, ling, because of their northern and western habitat range (Locker 1997a, 3), would have probably been purchased in a preserved form.

The anatomical element distribution for herring shows that in the **13th c.** and **15th-16th c.** the fish was mostly consumed whole, possibly gutted, and probably preserved; the predominance of vertebrae is likely to be a consequence of differential destruction of the more fragile herring head bones. However, many preservation techniques are known to involve the decapitation of the fish (Van Neer & Ervynck 2004, 210), which means that an alternative explanation is that herring was purchased already gutted and beheaded.

Eel was consumed whole, possibly fresh and it is reasonable to think that, considered how common this fish was, it would have also been eaten in a preserved form.

The presence of scales has been used as evidence of on-site cleaning (e.g. Bond & O’Connor 1999), and we have evidence of that for perch.

Most of the taphonomic evidence was observed on eel bones, which is unsurprising, given the high frequency of the species. Evidence of burning is visible on bones of different species, and generally indicates the disposal of kitchen and/or meal waste into a fire and it is typical of kitchen deposits. In the case of the 31 singed eel bones, this evidence could possibly reflect the consumption of cooked fish.

Some small specimens (eel, herring, Cyprinidae) show evidence of bone deformation and erosion which typically characterize waste from human consumption and digestion (Jones 1984, 1986). Mechanical crushing on larger species, such as pike, is usually associated with trampling; however, certain cooking procedures, such as the pressing and pounding of the fresh or dried carcass (e.g. Wubs-Mrozewicz 2009; Davidson 2012), could leave similar types of marks on bones.

Cut and chop marks on eel pre-caudal vertebrae could suggest gutting, splitting along the vertebral column or severing the fish into chunks; four cut marks on a quadrate may be the result of an attempt to extract the hook or represent tongue/gut removal (Barrett *et al.* 1997, 13).

Cuts on pike anterior-abdominal vertebrae could represents decapitation of the fish or splitting along the column. Cuts and chops on the large cod cleithrum could represent the decapitation of the fish; this evidence together with the fact that the species is mostly represented by vertebrae and bones from the pectoral skeleton could indicate the import of beheaded preserved fish (e.g. stockfish).

The evidence above suggests that the assemblage probably derives from the combination of kitchen/table waste and cesspit refuse; this is particularly the case for the material recovered from the well (pit 34), where a high concentration of organic matter alternating with layers of rubbish suggests the intermittent use of the feature as cesspit and waste pit (Wilson 1979, 20).

In conclusion, it appears that the community at Stert Street was mostly focussed on the exploitation of river resources, in particular eel, supplemented by preserved herring in particular in the earlier period. The scarcity of herring for the **15th-16th c.** and in general of Gadiformes, in particular cod, is remarkable and perhaps it reflects the fact that fish demand was already covered by eel. Wheeler (1979a, 23) suggested that the scarcity of large Gadiformes, such as ling and cod, could imply a trade of fish with fishing ports located on the Thames mouth, the southern North Sea and/or the eastern English Channel, where cod and in particular ling occur rarely.

Diachronic changes are difficult to explore considering the small size of the 13th c. and 13th-14th c. samples; nevertheless, it is possible to hypothesize a swap from a diet focussed on herring, eel and freshwater fish, pike included, to one almost entirely based on eel. This change would be supported by the observation of eel sizes which appear to have a more homogeneous and regular distribution in the later period, feasibly representing a more organised commercial eel fishing, perhaps supplying the demand of an increased affluence in the town. This change is also suggested by mammal bone trends, such as an increase in the variety of species eaten (Wilson 1979, 19).

Completeness	13th c.	13th-14th c.	15th-16th c.
> 75% present	55	3	1191
75-50% present	130	1	659
50-25% present	11	1	67
< 25% present	14	1	81

Table 5.6.1: Bone completeness by chronology, all recovery methods.

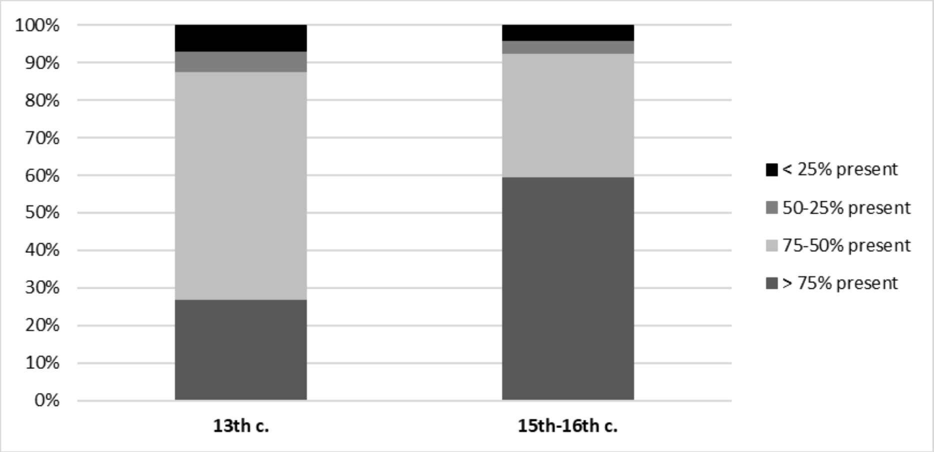


Fig. 5.6.2: Percentage of bone completeness by chronology (**13th c.**, NISP: 210; **15th-16th c.**, NISP: 1998), all recovery methods.

Preservation	13th c.	13th-14th c.	15th-16th c.
Excellent	0	0	198
Good	156	6	1307
Medium	54	0	486
Bad	0	0	7
Awful	0	0	0

Table 5.6.2: Bone preservation by chronology, all recovery methods.

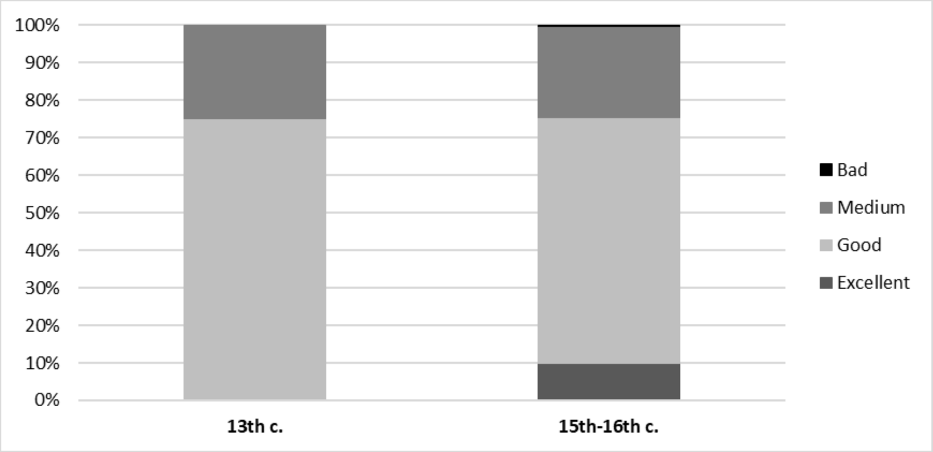


Fig. 5.6.3: Percentage of bone preservation by chronology (**13th c.**, NISP: 210; **15th-16th c.**, NISP: 1998), all recovery methods.

TAXA		**13th c.**		**13th-14th c.**		**15th-16th c.**		**TOT**
Latin name	**Common name**	**CS**	**H-C**	**CS**	**H-C**	**CS**	**H-C**	
Anguilla anguilla	European eel	27	5	0	0	1501	0	1533
Clupea harengus	Atlantic herring	109	1	0	0	247	1	358
Cyprinidae	-	12	0	2	0	75	0	89
Merlangius merlangus	Whiting	11	0	0	0	28	1	40
Esox lucius	Northern pike	11	3	0	0	8	1	23
Gadiformes	-	1	2	0	2	14	0	19
Clupeidae	-	0	0	0	0	19	0	19
Cottus perifretum	Bullhead	0	0	0	0	18	0	18
Perca fluviatilis	European perch	4	0	0	0	8	0	12
Pleuronectiformes	-	1	0	0	0	10	0	11
Gadus morhua	Atlantic cod	2	3	0	2	1	2	10
Lota lota	Burbot	9	0	0	0	1	0	10
Nemacheilidae	-	0	0	0	0	10	0	10
Pleuronectes *platessa*	European plaice	0	0	0	0	6	0	6
Elasmobranchii	-	0	0	0	0	6	0	6
Gasterosteus aculeatus	Three-spined stickleback	0	0	0	0	6	0	6
Alosa sp.	-	0	1	0	0	3	2	6
Salmonidae	-	0	0	0	0	3	2	5
Melanogrammus aeglefinus	Haddock	0	2	0	0	0	2	4
Conger conger	European conger	0	1	0	0	3	0	4
Gobio gobio	Gudgeon	0	0	0	0	4	0	4
Osmerus eperlanus	European smelt	0	0	0	0	4	0	4
Chelidonichthys lucerna	Tub gurnard	0	3	0	0	0	0	3

Scomber scombrus	Atlantic mackerel	1	0	0	0	1	0	2
Rajidae	-	0	0	0	0	2	0	2
Sardina pilchardus	European pilchard	0	0	0	0	2	0	2
Molva molva	Ling	0	0	0	0	1	1	2
Pleuronectes platessa/Platichtys flesus	European plaice/flounder	1	0	0	0	0	0	1
Dicentrarchus labrax	European seabass	0	0	0	0	1	0	1
Trisopterus luscus	Pouting	0	0	0	0	1	0	1
Pagellus sp.	-	0	0	0	0	1	0	1
Gymnocephalus cernua	Ruffe	0	0	0	0	1	0	1
Blicca bjoerkna	Silver bream	0	0	0	0	1	0	1
*Alburnus alburnus**	Bleak	0	0	0	0	*	0	0
*Scardinius erythrophthalmus**	Rudd	0	0	0	0	*	0	0
*Rutilus rutilus**	Roach	0	0	0	0	*	0	0
*Squalius cephalus**	Chub	0	0	0	0	*	0	0
	TOTAL	210		6		1998		2214

Table 5.6.3: NISP of taxa by chronology based on diagnostic elements (other records noted as *) for coarse-sieved (CS: mesh 2.5 mm) and hand-collected (H-C) material. *Alburnus alburnus**, *Scardinius erythrophthalmus**, *Rutilus rutilus** and *Squalius cephalus** are represented by pharyngeal plates.

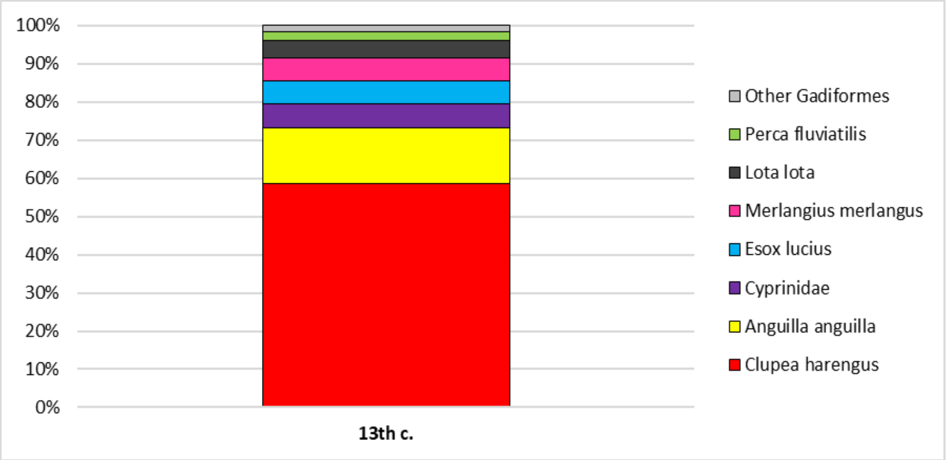


Fig. 5.6.4: Frequencies for the 8 most common taxa for **13th c.** (NISP: 186) for coarse-sieved (mesh 2.5 mm) material. Threshold by phase: tot NISP ≥ 100.

TAXA	13th c.	13th-14th c.	15th-16th c.
Alburnus alburnus	0	0	23
Gobio gobio	0	0	5
Scardinius erythrophthalmus	0	0	3
Blicca bjoerkna	0	0	2
Rutilus rutilus	0	0	1
Squalius cephalus	0	0	1
Cyprinidae unid.	13	2	84

Table 5.6.4: NISP for the Cyprinidae family by chronology for coarse-sieved (mesh 2.5 mm) material based on all counted specimens and pharyngeal bones; although regarded as not countable, pharyngeal bones will be represented in this table because they have been consistently recorded for all Cyprinidae.

TAXA	13th c.	An.E.	15th-16th c.	An.E.	TOT
Anguilla anguilla	/		19	OP	20
Clupea harengus	2	vertebrae	3	various	5

Table 5.6.5: MNI by chronology for main taxa for coarse-sieved material (mesh 2.5 mm). Threshold by phase: taxa NISP > 100. **An.E.** is the anatomical element used for MNI calculation. OP: opercular, /: threshold requirement no fulfilled.

HABITAT	13th c.	13th-14th c.	15th-16th c.
Freshwater	36	2	126
Marine	124	0	328
Migratory	27	0	1517
Other	2	0	15

Table 5.6.6: Taxa habitat distribution by chronology, for coarse-sieved (mesh 2.5 mm) material.

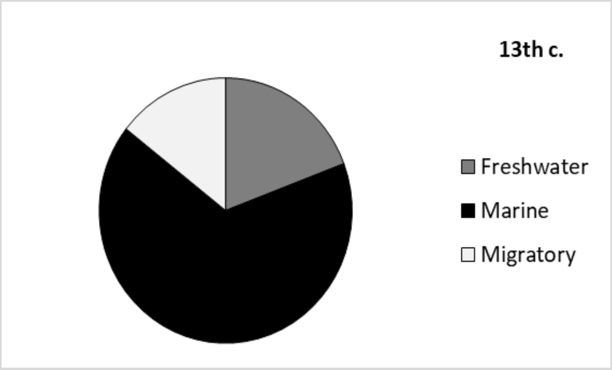


Fig. 5.6.5: Frequencies of habitat distribution for **13th c.** (NISP: 187), for coarse-sieved (mesh 2.5 mm) material. Threshold by phase: tot NISP ≥ 100.

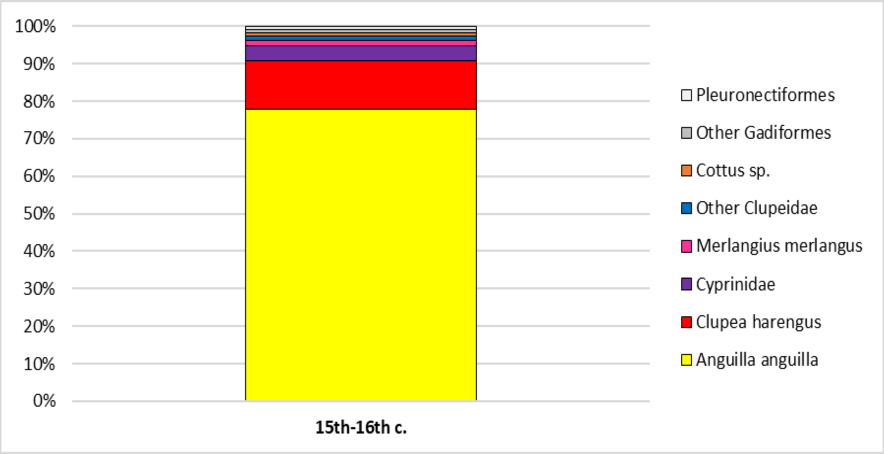


Fig. 5.6.6: Frequencies for the 8 most common taxa for **15th-16th c.** (NISP: 1926) for coarse-sieved (mesh 2.5 mm) material. Within other Gadiformes *Lota lota* is excluded. Threshold by phase: tot NISP ≥ 100.

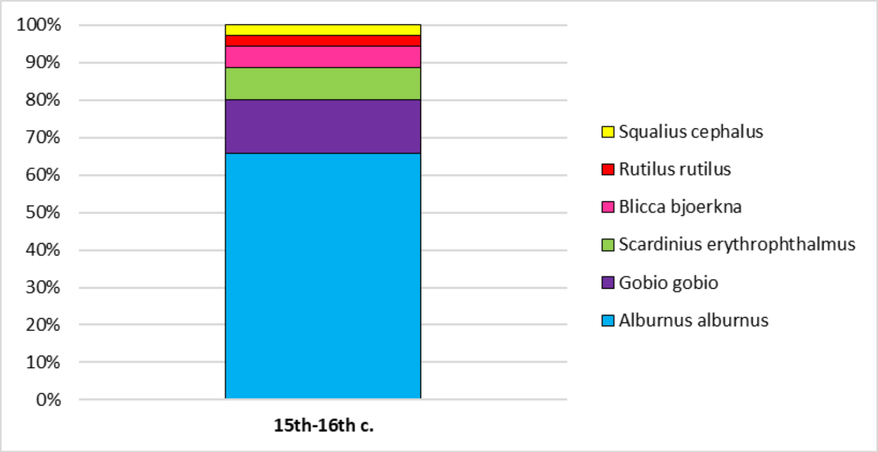


Fig. 5.6.7: Frequencies of species for the Cyprinidae family for **15th-16th c.** (NISP: 35) for coarse-sieved (mesh 2.5 mm) material. Threshold by phase: tot NISP ≥ 25.

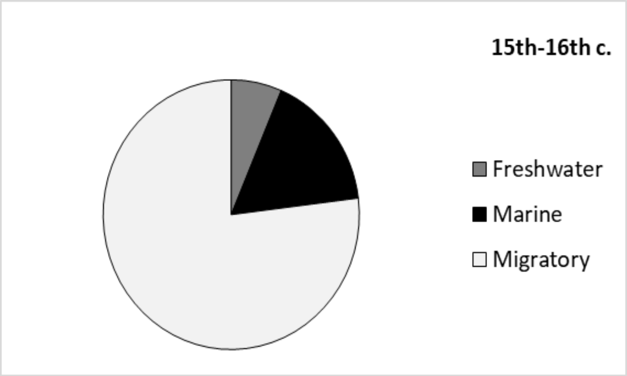


Fig. 5.6.8: Frequencies of habitat distribution for **15th-16th c.** (NISP: 1971), for coarse-sieved (mesh 2.5 mm) material. Threshold by phase: tot NISP ≥ 100.

HABITAT	13th c.	13th-14th c.	15th-16th c.
Freshwater	3	0	1
Marine	12	4	7
Migratory	6	0	4
Other	0	0	0

Table 5.6.7: Taxa habitat distribution by chronology, for hand-collected material.

GROUP	Element		*Clupea harengus*		*Anguilla anguilla*
			13th c.	**15th-16th c.**	**15th-16th c.**
I	**A**	Articular	0	3	1
	B	Basioccipital	0	1	7
	D	Dentary	0	1	1
	ECT	Ectopterygoid	0	1	0
	ENT	Entopterygoid	0	0	\
	HYO	Hyomandibular	0	2	16
	INT	Interopercular	0	0	0
	MAX	Maxilla	0	3	1
	OP	Opercular	0	1	19
	OT	Otolith	0	0	0
	PA	Palatine	0	0	\
	PAR	Parasphenoid	0	1	7
	PRE	Preopercular	0	1	1
	PX	Premaxilla	0	0	\
	Q	Quadrate	0	2	2
	SUB	Subopercular	0	1	2
	VOM	Vomer	0	0	3
II	**CE**	Ceratohyal	1	1	7
	EHY	Epihyal	0	1	1
	URO	Urohyal	0	1	\
III	**BAP**	Basipterygium	0	2	\
	CL	Cleithrum	0	1	14
	CO	Coracoid	0	0	\
	PSC	Postcleithrum	0	0	\
	PST	Posttemporal	0	3	\
	S	Scapula	0	1	\
	SUP	Supracleithrum	0	0	2
IV	**PCV1 (PCV2)**	1st (2nd) precaudal vertebra	0	1	0
	AAV	Anterior abdominal vertebra	2	5	5
	PAV	Posterior abdominal vertebra	3	1	17
V	**CV**	Caudal vertebra	2	3	11
	LC	Last caudal vertebra	1	1	\
VI	**VC**	Vertebral body (centrum)	0	0	1

Table 5.6.8: Anatomical element distribution (MAU) for main taxa by chronology, for coarse-sieved (mesh 2.5 mm) material. Group I = Head elements (Minus II): Neurocranium, jaws, gill arches, gill covers; Group II = Head elements: Outer branchial skeleton; Group III = Pectoral and pelvic skeleton; Group IV = Precaudal vertebra; Group V = Caudal vertebrae; Group VI = undefined vertebrae. \ = missing/undeveloped or unidentified anatomical elements for eel (Methods, Chapter 4).

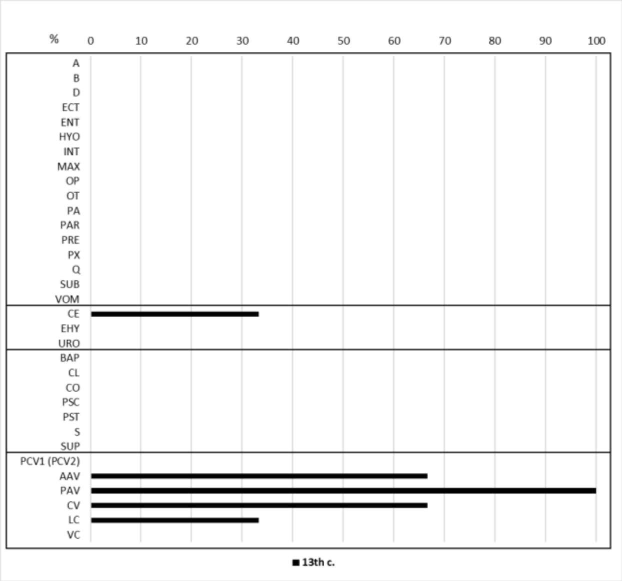


Fig. 5.6.9: Frequencies of element distribution (MAU) for *Clupea harengus*, **13th c.**, for coarse-sieved (mesh 2.5 mm) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

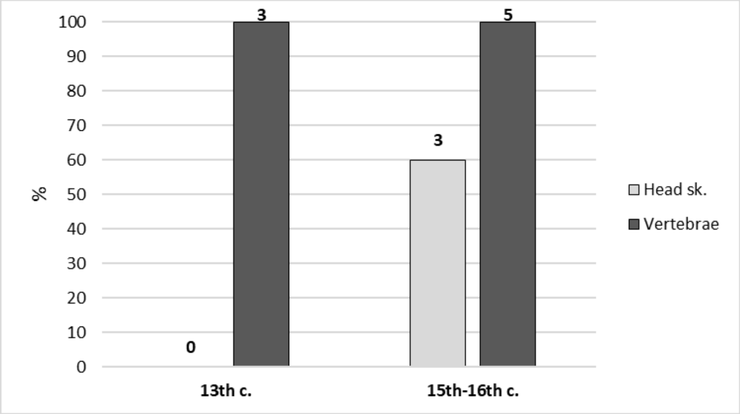


Fig. 5.6.10: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Clupea harengus* by chronology, for coarse-sieved (mesh 2.5 mm) material.

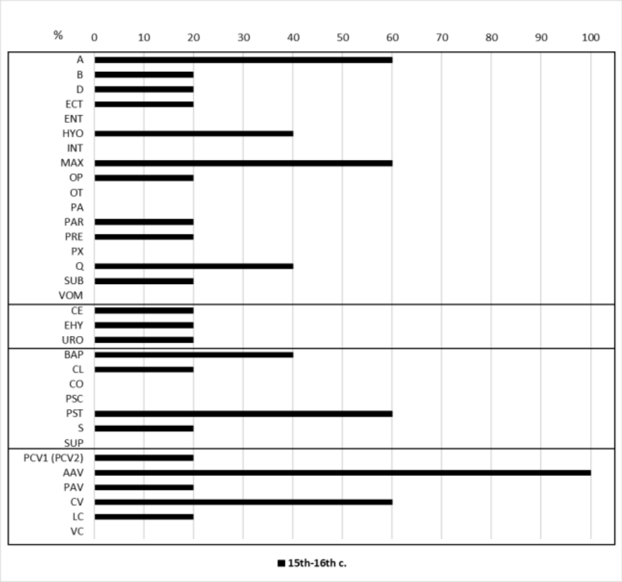


Fig. 5.6.11: Frequencies of element distribution (MAU) for *Clupea harengus*, **15th-16th c.**, for coarse-sieved (mesh 2.5 mm) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

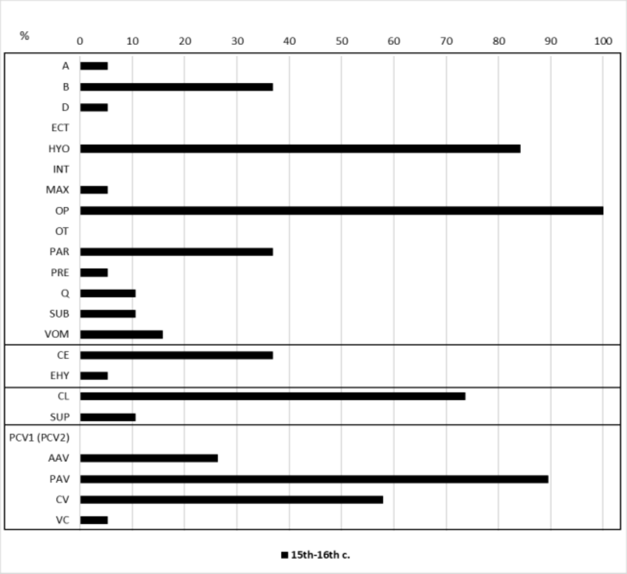


Fig. 5.6.12: Frequencies of element distribution (MAU) for *Anguilla anguilla*, **15th-16th c.,** for coarse-sieved (mesh 2.5 mm) material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

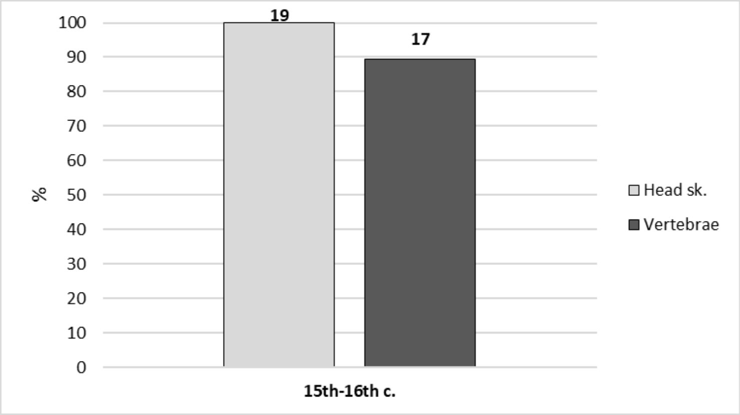


Fig. 5.6.13: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Anguilla anguilla* for **15th-16th c.**, for coarse-sieved (mesh 2.5 mm) material.

TAXA	*Anguilla anguilla*	*Gadus morhua*	*Clupea harengus*	**TOT**
Burning				
Burned	1	0	2	3
Calcined	0	2	0	2
Tot burned	1	2	2	5 (2%)
Other modifications				
Crushed	1	0	0	1
Tot modified				1 (0.4%)
Butchery marks				
Cut	1	0	0	1
Tot butchered				1 (0.4%)

Table 5.6.9: Taphonomic modifications for **13th c.** material, total NISP 210, all recovery methods.

TAXA	*Anguilla anguilla*	*Clupea harengus*	*Esox lucius*	Clupeidae	Cyprinidae	**TOT**
Burning						
Singed	31	0	0	0	0	31
Burned	102	2	1	2	0	107
Calcined	1	0	1	0	1	3
Tot burned	134	2	2	2	1	141 (7%)
Other modifications						
Crushed	62	15	2	0	1	80
Tot modified						80 (4%)
Butchery marks						
Chop	20	0	0	0	0	20
Cut	2	0	2	0	0	4
Cut & Chop	1	0	0	0	0	1
Tot butchered	23	0	2	0	0	25 (1.2%)

Table 5.6.10: Taphonomic modifications for **15th-16th c.** material, total NISP 1998, all recovery methods.

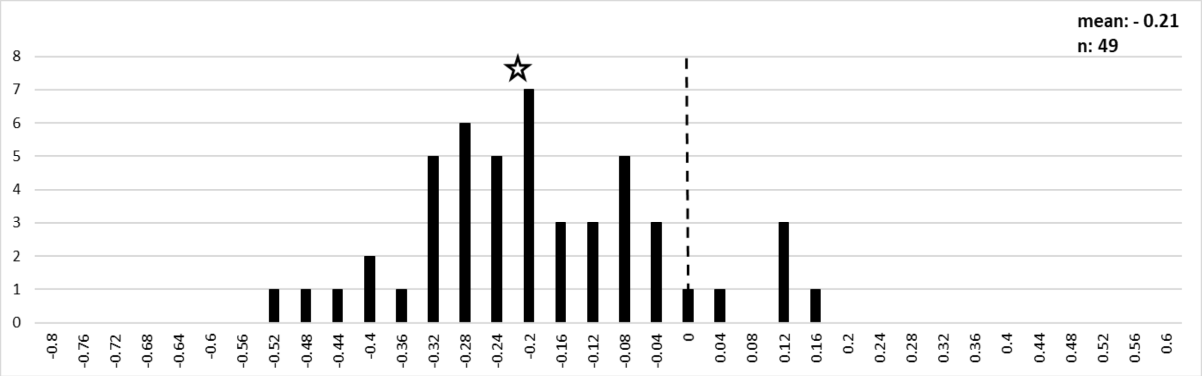


Fig. 5.6.14: Size distribution for all anatomical elements for Cyprinidae family, **15th-16th c**. The star indicates the mean (- 0.21). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 22; n measures: 49.

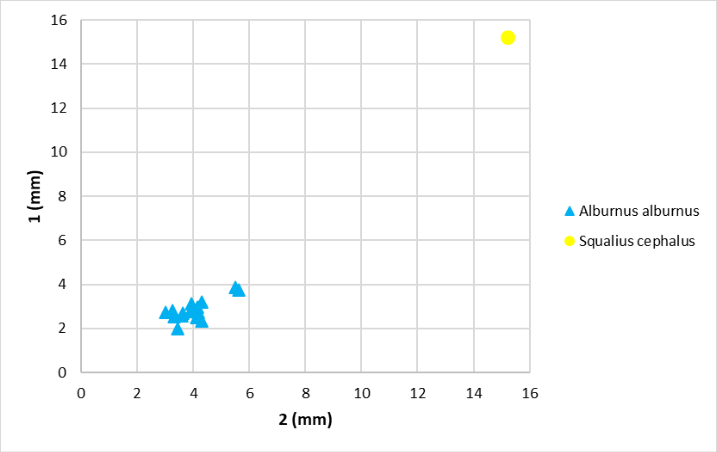


Fig. 5.6.15: Distribution of measurements (n 16) for Cyprinidae pharyngeal bones, **15th-16th**, all recovery methods; measure **1** (height), measure **2** (cord length).

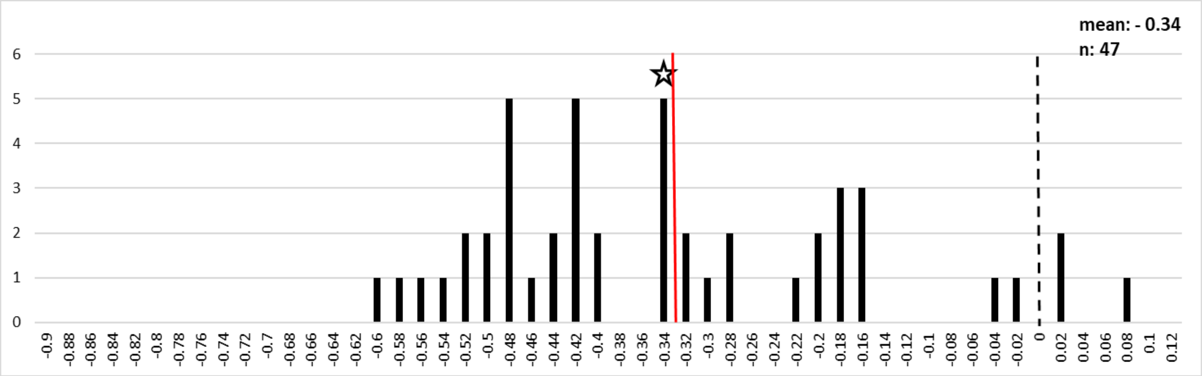


Fig. 5.6.16: Size distribution for all anatomical elements for *Anguilla anguilla*, **13th c**. The star indicates the mean (-0.34). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 18; n measures: 47.

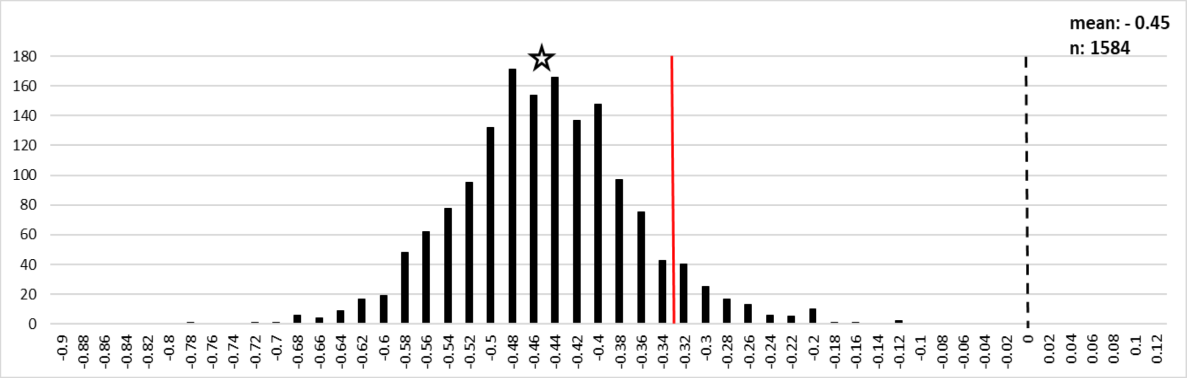


Fig. 5.6.17: Size distribution for all anatomical elements for *Anguilla anguilla*, **15th-16th**. The star indicates the mean (-0.45). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 578; n measures: 1584.

5.7 Orchard Lane

Excavation and post-excavation analyses at Orchard Lane were funded by English Heritage, (today Historic England) in the 1990s and led to the publication of a comprehensive report, including the study of the animal bones (Oakey & Spoerry 1997). Unless otherwise stated, the following information is extracted from this publication.

5.7.1 The site: Orchard Lane, Huntingdon

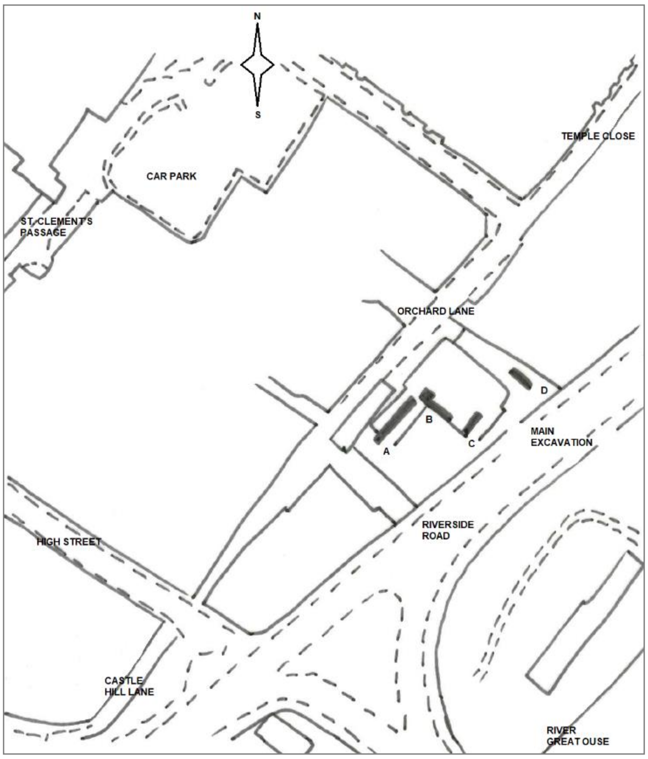


Fig. 5.7.1: Orchard Lane, Huntingdon. Location of excavation (modified by Oakey & Spoerry 1997).

Orchard Lane is a street of Huntingdon, Cambridgeshire, a town strategically located on the north bank of the River Great Ouse (Fig. 5.7.1). The town was first mentioned in the Anglo-Saxon Chronicle, when in 917 king Edward the Elder conquered the settlement from the Danes and established Huntingdon as the centre of Huntingdonshire. From the 10th c., the town underwent a period of prosperity which lasted until the 14th c. The Domesday Book (1086) describes Huntingdon as a flourishing town, with a stone castle and a newly built church (St. Mary's church). By the 13th c., the fortune of Huntingdon had peaked: a total of six monastic houses and hospitals were built, and 17 abbeys and priories owned proprieties within the town. In the 14th c. the town went suddenly into decline because of a combination of factors, such as epidemics, primarily the Black Death, but also the interruption of the of the flow of the river Ouse towards the sea, with consequent harm to commercial activities. In 1461 Huntingdon was raided by a Lancastrian army. By the beginning of the 16th c. half of the dwelling proprieties had become empty and only four parish churches were still active. In 1645, during the Civil War, the town was taken by Charles I army, but from this point onwards Huntingdon started to recover; throughout the 18th and 19th c. it became an important coaching centre connected with the city of London, until the advent of the railway in 1850, which destroyed the business.

5.7.1.1 Excavations and zooarchaeological studies

Archaeological excavations at Orchard Lane started in 1994, at a site located around 100 m north of the Bridge across the Ouse. The Huntingdonshire District Council commissioned the archaeological evaluation to the Archaeological Field Unit of the Cambridgeshire County Council, prior the development of a hostel at the site. The discovery of human remains, after this first survey, signed the start of an extensive archaeological excavation, which was completed within the same year.

The excavations revealed scattered evidence of prehistoric artefacts and a Romano-British settlement; from the Saxon period onwards, the chronological sequence was more detailed and divided as follow:

Period 1: 10th-early 12th c., characterised by the use of a number of pits for the disposal of domestic rubbish;

Period 2: 11th -14th c., characterised by human burials;

Period 3: 15th-18th c., characterised by a number of pits and backfilling with spoil and bricks, identified as quarries to extract clay and sand;

Period 4: 19th c., characterised by agricultural and horticultural activities;

Period 5: 19th-20th c., characterised by the use of the site as a builder's yard.

Many of the periods were subjected to various degree of disturbance and redeposition, causing a contamination of material through contexts. For this reason, only animal bones and samples from **Period 1**, which seems undisturbed, were selected for further study.

Mammal, bird and amphibian bones were studied by Albarella (1997), arthropods and molluscs by Murphy (1997) and fish bones by Smith (1997).

5.7.2 Material and recording methods

The material here analysed originates from a number of pits, the larger sample recovered from context 1093, ascribed to **Period 1** and dated **10th-mid 12th c.** Most of the pits with fish bones were interpreted as having been used for the dumping of domestic rubbish. Contexts 1093 and 1114, due to the recovery of mineralised plant remains and fly puparia, were related to structures probably used intermittently as cess pits.

All fish remains were recovered from bulk samples, wet sieved through a 0.5 mm mesh (Albarella 1997, 147; Smith 1997, 149) and categorised as fine-sieved material, following the recording protocol.

5.7.3 Results

The assemblage is small as a grand total of 244 bones were counted; 215 of these were identified at various taxonomic levels and 196 recorded as countable specimens.

Only two contexts produced a few scales, all unidentified and not included in the analysis.

The sample shows an uneven level of completeness (Table 5.7.1. Fig. 5.7.2) and a medium level of surface preservation (Table 5.7.2, Fig. 5.7.3).

5.7.3.1 Taxonomic frequencies

Fine-sieved material (0.5 mm)

A small number of taxa was identified, reflecting the small size of the assemblage (Table 5.7.3 Fig. 5.7.4). NISP calculations show that eel dominates the assemblage with 70% of the identified material. This is followed by Cyprinidae (15%), represented mostly by unidentified remains. However, roach, bleak, chub and gudgeon were identified (Table 5.7.4). The other taxa are represented by herring (8%) and the freshwater pike (2%) and perch (2%). No taxa reach the threshold for MNI calculation.

As expected, the sample is mostly represented by migratory taxa (71%); freshwater fish (20%) is still well represented, followed by marine fish (9%) (Table 5.7.5, Fig. 5.7.5).

5.7.3.2 Anatomical element distribution

No taxa reach the threshold for the calculation of the MAU and consequently no analysis of anatomical element distribution was possible. From a brief scrutiny of eel bones, with the exception of one dentary, one cleithrum and two hyomandibulars, the species is entirely by vertebrae (134 fragments), which is not surprising considered the high number of vertebrae of each individual (on average 114, Chapter 4). All eel bones that were found could potentially represent no more than two individuals.

5.7.3.3 Taphonomic alterations

Taphonomic alteration was observed on 10% of the material in the form of crushing (mechanical and/or chemical bone deformation, Chapter 4) on 20 vertebrae, 19 belonging to eel and one to herring (Table 5.7.6).

5.7.3.4 Biometrical analysis

Measurements for pike, perch and Cyprinidae were scanty and indicate the occurrence of small individuals, with no large outliers.

A larger number of eel measurements allowed to produce a log ratio histogram (Fig. 5.7.6). The bulk of measurements is distributed roughly unimodally around the mean value, which is smaller than the marker of 49 cm of total length (red line). These eel sizes are comparable to the maturation stage of yellow/silver eel (over 30 cm of total length; Tesch 2003, 150). They are rather small in comparison to the size of modern unsexed eel, which have a mean value of 35-60 cm (*ibid.*, 168). Some larger individuals (including an outlier) are present, but none reach the standard value (0) of 96 cm of total length, which represent a large eel.

5.7.4 Discussion

The community living at Orchard Lane was mostly focussed on the exploitation of the local river resources, the Ouse or the nearby Fens. The fish sourced there was probably composed of eel and a variety of freshwater species such as Cyprinidae, pike and perch. Juveniles and the smallest Cyprinidae species (bleak, gudgeon) could represent accidental river catches; however, it is reasonable to think that they would end up being eaten, most typically in soups, pies, pastries or preserved as pickles as it was traditional in medieval times (Locker 2018a). Freshwater fish was most likely consumed fresh, in view of its ready availability, while eel may have been consumed both fresh and preserved (e.g. salted, smoked). The relative uniformity of eel size may fit well with the representation of a managed catch, such as the regular exploitation of river fisheries, but the sample is too small to be confident about it. Similarly, the focus on small/medium size individuals is difficult to interpret as material from only one context is available. The smallest eel could have been also caught in estuary areas, the nearest point of access to the sea being the Wash, down the Ouse. Most eels live the first part of their lives (glass eel stage) in costal and estuarine areas and start to colonise rivers when they are at the stage of elvers (from roughly 7-8 cm of total length; Churchward 1996 in Tesch 2003, 137). In those areas they then mature into yellow and silver eels.

The only marine species present in the assemblage is herring; this species became widespread from the 11th c. onwards in England, becoming a staple food in later medieval times (Chapter 2). However, the wide chronological span of the original context, makes the small quantity of herring difficult to interpret. Herring was typically eaten whole, possibly gutted, and, because of its oily flesh, it was preserved to avoid spoiling too quickly. There are archaeological examples of herring transported and consumed fresh inland, but these are limited to religious sites (e.g. Bicester Priory; Bond 1988, 77 in Locker 1997a, 3).

Eel bones, and in one case herring, show bone deformation and erosion which is typical evidence of human consumption and digestion (Jones 1984, 1986). This fits well with the interpretation of some of the contexts as cesspits. Not much can be said about the generic small size of the fish recovered and the lack of butchery marks makes it difficult to identify the material as either kitchen or table waste. From context 1093 and 1114 a high number of immature intact marine mollusc shells and valves were recovered. Because of their little nutritional value these remains were interpreted as waste from the processing of shellfish catches (Murphy 1997, 149-153). Because of the consistent small size of the fish recovered it was hypothesized that the small fish assemblage could also result from the disposal of inedible catch; this is a possibility, but the evidence of possible digestion on some remains from these two contexts seems to make this interpretation less likely.

Completeness	10th-mid 12th c.
> 75% present	41
75-50% present	96
50-25% present	48
< 25% present	11

Table 5.7.1: Bone completeness for **10th-mid 12th c.**, all recovery methods.

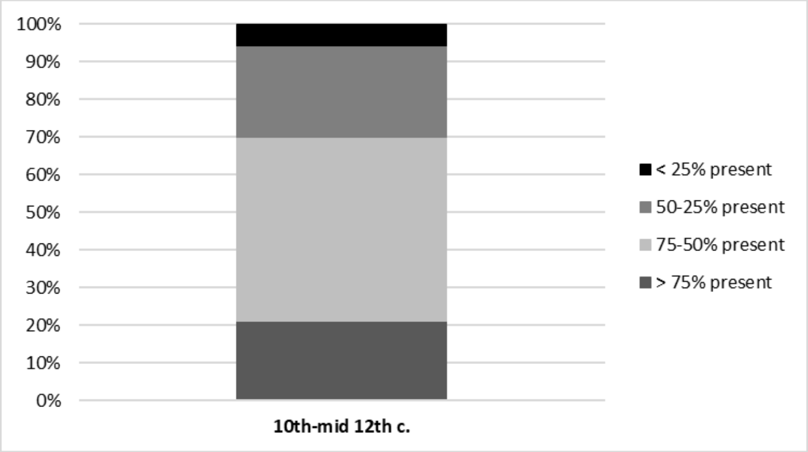


Fig. 5.7.2: Percentage of bone completeness for **10th-mid 12th c.** (NISP: 196), all recovery methods.

Preservation	10th-mid 12th c.
Excellent	0
Good	18
Medium	165
Bad	13
Awful	0

Table 5.7.2: Bone preservation for **10th-mid 12th c.**, all recovery methods.

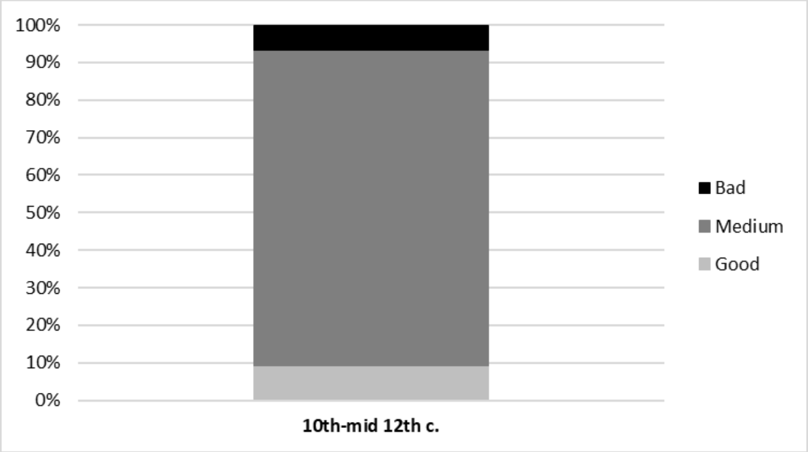


Fig. 5.7.3: Percentage of bone preservation for **10th-mid 12th c.** (NISP: 196), all recovery methods.

TAXA		**10th-mid 12th c.**
Latin name	**Common name**	**FS**
Anguilla anguilla	European eel	138
Cyprinidae	-	30
Clupea harengus	Atlantic herring	17
Esox lucius	Northern pike	5
Perca fluviatilis	European perch	5
Rutilus rutilus	Roach	1
*Squalius cephalus**	Chub	*
*Gobio gobio**	Gudgeon	*
*Alburnus alburnus**	Bleak	*
	TOTAL	196

Table 5.7.3: NISP of taxa for **10th-mid 12th c.** based on diagnostic elements (other records noted as *) for fine-sieved material (FS: mesh 0.5 mm). *Squalius cephalus**, *Gobio gobio** and *Alburnus alburnus** are represented by pharyngeal plates.

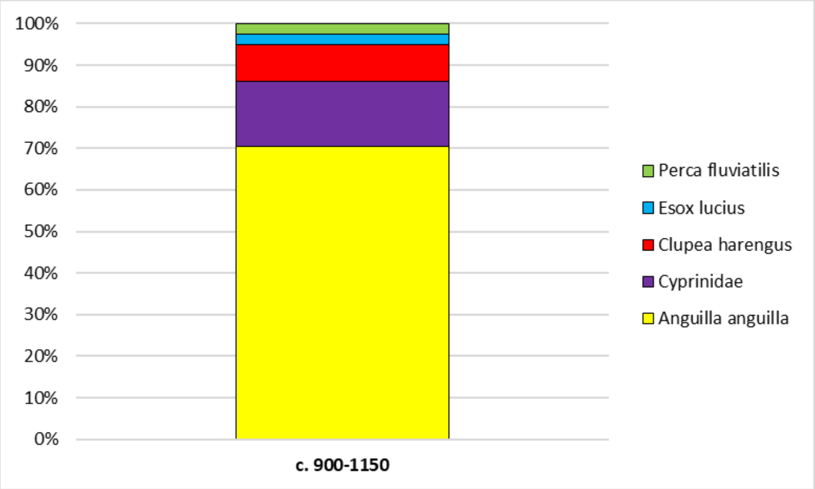


Fig. 5.7.4: Frequencies for the main taxa for **10th-mid 12th c.** (NISP: 196), for fine-sieved material (mesh 0.5 mm). Threshold by phase: tot NISP ≥ 100.

TAXA	**10th-mid 12th c.**
Rutilus rutilus	8
Alburnus alburnus	4
Squalius cephalus	1
Gobio gobio	1
Cyprinidae unid.	35

Table 5.7.4: NISP for the Cyprinidae family for **10th-mid 12th c.** for fine-sieved material (mesh 0.5 mm) based on all counted specimens and pharyngeal bones; although regarded as not countable, pharyngeal bones will be represented in this table because they have been consistently recorded for all Cyprinidae.

HABITAT	c. 900-1150
Freshwater	40
Marine	17
Migratory	139
Other	0

Table 5.7.5: Taxa habitat distribution for **10th-mid 12th c.**, for fine-sieved material (mesh 0.5 mm).

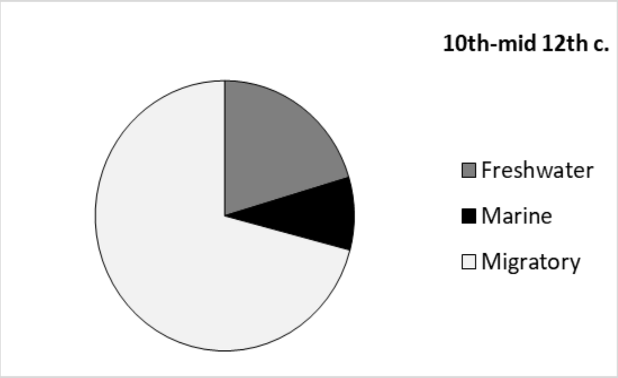


Fig. 5.7.5: Frequencies of habitat distribution for **10th-mid 12th c.** (NISP: 196) for fine-sieved material (mesh 0.5 mm). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

TAXA **Other modifications**	*Anguilla anguilla*	*Clupea harengus*	**TOT**
Crushed	19	1	20
Tot modified			20 (10%)

Table 5.7.6: Taphonomic modifications for **10th-mid 12th c.** material, total NISP 196, all recovery methods.

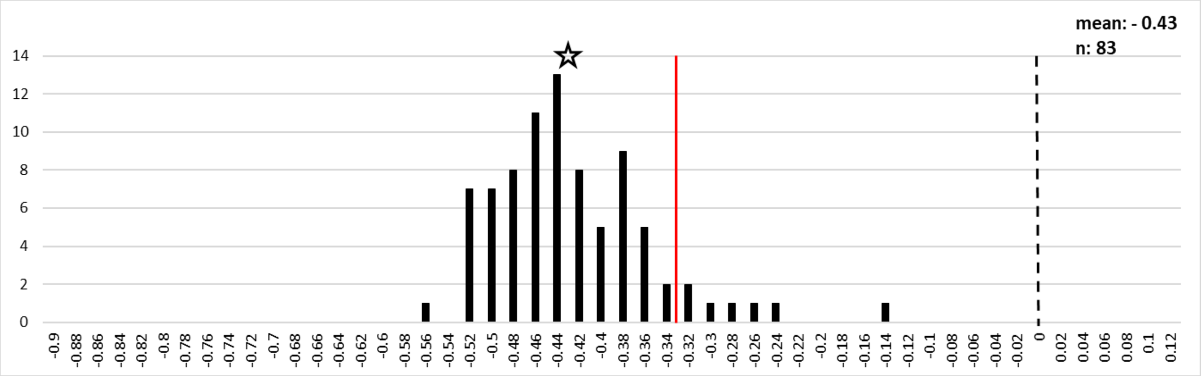


Fig. 5.7.6: Size distribution for all anatomical elements for *Anguilla anguilla*, **10th-mid 12th c.** The star indicates the mean (-0.43). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 30; n measures: 83.

5.8 Fleet Valley, City of London

The excavation of the Fleet Valley area is part of a large project within the City of London funded by RSD (Rosehaugh Stanhope Developments PLC), which lasted for more than five years (1988-1992). Unless differently stated, the following information was sourced from the project unpublished interim report, held at the Archive of the Museum of London (McCann 1993).

5.8.1 The site: Fleet Valley (VAL88)

The site is located in the area of Ludgate Circus, along the eastern bank of the mouth of the ancient river Fleet, at the confluence with the river Thames (Fig. 5.8.1). The history of London rivers and river banks is strictly connected with the history of the city, but it is far too complex to be summarised here; some historic events connected with medieval London and the occupation of the site will be briefly mentioned in the next paragraph.

5.8.1.1 Excavations and zooarchaeological studies

The excavations of the Fleet Valley site took place in 1988 prior the redevelopment of the Ludgate area, between Blackfriars and Holborn Viaduct railway Station, and covered over 50,000 m^2, with more than 100 excavated areas. Excavations were directed by Bill McCann. Most of the post-excavation analysis took place in 1991 and the project was completed in 1992.

The archaeological excavation revealed a complex and long sequence of occupation, from pre-Roman to modern times (Table 5.8.1).

Period	Description	Chronology
1	Early Roman period	40-200
2	Later Roman period	200-450
3	Saxon period	450-1033
4	Norman period	1066-1154
5	Early Plantagenet period	1154-1270
6	Later Plantagenet period	1270-1399

7	English period	1399-1485
8	Tudor period	1485-1603
9	Early Stuart period	1600-1666
10	Later Stuart period	1666-1714
11	Early Hanoverian period	1780-1840
12	Later Hanoverian period	1780-1840
13	Modern and miscellaneous context	?

Table 5.8.1: Summary of the phasing for the excavated area of Fleet Valley (after McCann 1993).

Archaeologists were able to describe a detailed succession of events concerning the medieval period (Period 4-7). To mention just a few, in the 11th c. a wall was constructed, running parallel to the previous Roman wall. Several features were associated with the Templars and connected with their reclamation of a large tract of land in 1159, from Fleet Bridge to the Thames bank. The knights arrived in London in 1128 and by 1159 they were granted by Henry II the above mentioned land on the Fleet river, in order to build a house for the order and a mill; through the years, their possessions and reclamations of the river banks expanded.

Other archaeological features were related to the construction of the Black Friars Priory between Ludgate and the Thames probably in 1278. The Black Friars were a religious order founded by St. Dominic in 1216, which arrived in England in 1222.

The river Thames and its tributaries, through the centuries, kept rising and advancing inland; from the 12th to the 16th c., a gradual reclamation of the land started by erecting timber and/or stone revetments. Excavations uncovered the evidence of a number of buildings in Ludgate Hill, erected shortly after the land reclamation, possibly before 1200, and a number of cesspits in the area, which has been interpreted as a common latrine.

However, one of the constructions with the longest sequence of occupation, is represented by the Fleet Prisons; the structure was built in the 1070s/1080s as a debtors' prison at first, and consisted in a small rectangular tower with circular turrets at each corner; later on, the prison was also used to hold those condemned by the King's Council and the Court of Chancery. By the 13th c., the tower was enclosed in an artificial moat and, in 1261, a second prison was erected on the southwest limit of the first one. The prison underwent many renovations and reparations (1335, 1355), in particular after the 1666 Great Fire, which destroyed the buildings together with a large area of west London. The prison was reconstructed in 1672 and again in 1780, after suffering major damage during the anti-Catholic Gordon riots; by 1845 it was auctioned and demolished, becoming a stone yard.

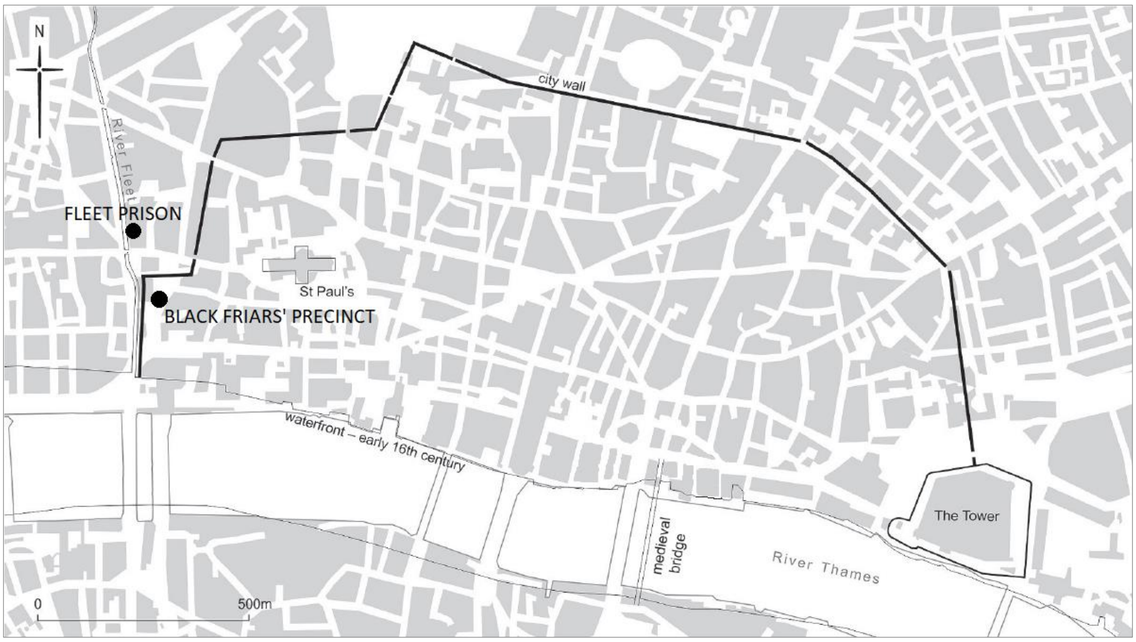


Fig. 5.8.1: Location of the Fleet Prison and the Black Friars' precinct (Fleet Valley site) within the City of London (modified by Schofield *et al.* 2018, 1).

Mammal and bird bones were studied by Pipe (1993) and fish bones by Locker (1994). This latter report was part of a larger project on the City of London fish exploitation (Orton *et al.* 2016).

5.8.2 Material and recording methods

Fish bones were collected from the 1988 excavation (VAL88) from various areas of the site covering different chronological periods, however, for the purpose of this research only material recovered and from Periods 4 to 7 will be reported here. Dating of the contexts was done following the "Phasing Index" document provided by the Archive of the Museum of London.

During the excavation, a total of 1266 samples were collected from occupation deposits, fills of rubbish pits, cess pits and drains, and processed using flotation and sieving techniques. No information about the type of sieve used was available from the interim report, but relevant information could generally be gathered on bag labels. When this was not specified, some relevant observations were done during the recording process and material was compared with bags of known recovery method. Following the recording protocol, three categories of recovery were created: fine-sieved material (1 mm mesh), coarse-sieved material (4 and 8 mm mesh), and hand-collected material.

A number of problems concerning the contextualisation of the fish remains emerged during the recording of the material. Excavation diaries with context information were unavailable as data have not yet been digitalised; additionally, during the post-excavation process, the context numeration changed. However, Locker's (1994) report has been extremely useful in helping some understanding of the nature of some contexts, though most of the numbers did not correspond with the bag labels, as probably she followed the old numeric system. As a consequence, several contexts had to be excluded from the data analysis and perhaps will be reintegrated in the study when more detailed information will become available. Furthermore, some of the fish remains were displayed during the recording of the site at the event "Secret Rivers", organised by the Museum of London, and inaccessible; however, they mostly belonged to Period 8, which is not relevant to this research. By comparing the results with Locker's report, it emerged that two freshwater taxa were missed: barbel (*Barbus barbus*) from **Period 5** and a fragment of scute belonging to sturgeon from **Period 6**. Other sturgeon bones were found during this research from Period 8 and 10, and a large fragment was on display at the exhibition; in particular, two scutes were identified with the help of Wim Wouters (Royal Belgian Institute of Natural Science) as Atlantic sturgeon (*Acipenser oxyrinchus*). It is also worth mentioning that the large quantity of **Period 7** eel bones found during this research is not mentioned by Locker, which raises some questions about the nature of the material available for the two studies.

Only three remains were collected from **Period 4** (1066-1154) fine-sieved samples; two of these bones belong to herring and one to Cyprinidae and they will not be further discussed.

Fish remains from **Period 5 (1154-1270)** are associated with the river frontage reclamation and the foreshore accumulation connected with the Templars activity in 1159. The area was also used for dumping rubbish and as a latrine, and most of the zooarchaeological material comes from here. On the basis of Locker's report, it is clear that only a few remains are directly connected with the Templar occupation.

For **Period 6-7 (1270-1485)** the contexts containing fish remains are almost entirely associated with the Fleet prison. They derive from occupation layers, pits located outside the perimeter walls and dumps, which were rather placed inside.

5.8.3 Results

The selected assemblage was represented by a total of 6,041 bones, 1,451 of which were identified at various taxonomic levels and 1,369 recorded as countable specimens.

Most of the unidentified remains were small fragments and undiagnostic fin rays and ribs recovered from different contexts; this very high number of unidentified remains is likely to be a consequence of the high degree of recovery and the result of trampling on some of the occupation layer.

A small number of scales, dermal denticles and scutes were observed from **Periods 5-7**, but not included in the quantifications following the recording protocol; among these, one scale was attributed to perch (*Perca fluviatilis*), five dermal denticles to thornback ray (*Raja clavata*) and three scutes to tub gurnard (*Chelidonichthys lucerna*).

For the **Period 5-7** samples the completeness of the bones was generally good, with more than 80% of the identified material being more than 50% intact. The degree of completeness was especially good for **Period 7** (Table 5.8.2, Fig. 5.8.2). The level of preservation of the bone surface largely ranged from medium to good (Table 5.8.3, Fig. 5.8.3).

5.8.3.1 Taxonomic frequencies

Fine-sieved material (1 mm)

NISP calculation for the fine-sieved sample from **Period 5 (1154-1270)** (Table 5.8.4, Fig. 5.8.4) shows that nearly half of the assemblage is made of herring (45%) , followed by whiting (21%) and Pleuronectiformes (10%), represented mostly by Pleuronectidae, with sole and plaice present with a small number of remains. Other Clupeidae constitute around 7% of the assemblage, mostly small herring vertebrae but sprat has also been identified. Eel (4%), cod (3%) and Cyprinidae (3%) (including tench and chub) also occur (Table 5.8.5). Among other Gadiformes, haddock is present. Other taxa are sparsely represented; however, it is worth mentioning the presence of the freshwater pike (one bone), and the migratory Salmonidae (one bone) and smelt (six bones).

Only herring reaches the threshold for MNI calculation and is represented by four individuals (Table 5.8.6).

Overall, the sample is mostly represented by marine taxa (89%), while the rest is split between migratory (7%) and freshwater (4%) fish (Table 5.8.7, Fig. 5.8.5).

For the **Period 6 (1270-1399)** sample (Table 5.8.4, Fig. 5.8.6) the range of taxa is similar to the previous period, but with different proportions. Herring (35%), whiting (20%) and Pleuronectiformes (19%) are still the most common taxa; among Pleuronectiformes, nine bones have been attributed to plaice, three to plaice/flounder, one to sole and one to turbot. Cyprinidae (7%) appear to be more frequent during this period, with only roach identified to species (Table 5.8.5). Eel is represented by 5% of the identified material, followed by cod (4%), other Gadiformes (3%), including haddock and ling, and mackerel (3%). Other species are represented by pike (three remains) and smelt (four remains).

As in the previous period, only for herring (two individuals) it is possible to reliably calculate an MNI (Table 5.8.6).

Habitat distribution for this period (Table 5.8.7, Fig. 5.8.7) varies little from the Period 5 sample, with marine taxa (83%) dominating the assemblage; however, there is a slightly higher incidence of freshwater fish (9%) and migratory fish (8%).

The **Period 7 (1399-1485)** sample is the largest (Table 5.8.4, Fig. 5.8.8) and shows a rank of taxa that differs substantially from the previous periods. The assemblage from this period is mostly dominated by eel (69%), followed by herring (17%). Other taxa have a very small incidence: Cyprinidae, with one bone attributed to dace and one to roach (Table 5.8.5), represent 4% of the identified material; smelt and Pleuronectiformes (with plaice and plaice/flounder identified) by 3%, whiting and Salmonidae by 1% and mackerel by 0.9%. The other taxa identified are mostly marine, with the exception of one bone attributed to pike.

MNI calculation shows eel represented by three individuals (Table 5.8.6).

As expected, the presence of migratory taxa (73%) is far higher than the previous samples, to the detriment of marine taxa (22%) (Table 5.8.7, Fig. 5.8.9). Freshwater fish has similar percentages from previous samples and represents 5% of the material.

Coarse-sieved material (4, 8 mm)

Only 51 remains represent the coarse sieved sample from **Period 5 (1154-1270)** and they are mostly represented by herring and whiting, and in general marine taxa (Table 5.8.4, 5.8.8). Only exceptions were four remains attributed to unidentified Cyprinidae (Table 5.8.5), two to eel and one to plaice/flounder.

With a similar size, the coarse sieved sample from **Period 6 (1270-1399)** shows the most common species being herring and Pleuronectiformes (with plaice and plaice/flounder identified) (Table 5.8.4). The sample is again mostly represented by marine fish (Table 5.8.8), with the exception of two remains belonging to pike and two to Salmonidae, one of which was attributed to salmon/sea trout (*Salmo salar/Salmo trutta trutta*).

Hand-collected material

No countable elements were recovered from the hand-collected sample from **Period 7 (1399-1485)**.

5.8.3.2 Anatomical element distribution

The analysis of the anatomical element distribution was performed on the two most common species recovered from the fine-sieved sample, herring and eel (Table 5.8.9).

For the **Period 5 (1154-1270)**, herring is mostly represented by vertebrae, in particular first (and second) precaudal vertebra, but with head elements still present (Fig. 5.8.10-11). Differently, in **Period 6 (1270-1399)**, herring is equally represented by head elements and vertebrae (Fig. 5.8.11-12).

Eel in **Period 7 (1399-1485)** is represented only by vertebrae and Group I head elements, with the most common anatomical elements being posterior abdominal vertebrae (Fig. 5.8.13). Consequently, the MAU comparison for head vs vertebrae shows a dominance of the latter elements (Fig. 5.8.14).

5.8.3.3 Taphonomic alterations

For **Period 6 (1270-1399)** only one burned herring bone and one crushed Pleuronectiformes bone were recorded (Table 5.8.10).

For **Period 7 (1399-1485)** taphonomic evidence is slightly more abundant (Table 5.8.11). Crushing (mechanical and/or chemical bone deformation, Chapter 4) was recorded, in particular on eel bones; one chop was observed on an eel caudal vertebra.

5.8.3.4 Biometrical analysis

Measurements for pike and Cyprinidae were too scanty to produce log ratio histograms. For **Period 6 (1270-1399)** two pike bones probably belonged to an adult pike of around 50-70 cm of total length, while most of the Cyprinidae for all three periods had an average total length comparable to the size of a modern roach of 19 cm.

The few measurements for eel from **Period 5 (1154-1270)** belonged to individuals slightly larger than 49 cm of total length, while for **Period 6 (1270-1399)** eels were smaller. The bone of a very large eel of around 1 m of total length (size of modern unsexed eel has a mean value of 35-60 cm; Tesch 2003, 168) was recovered from **Period 5**, probably belonging to a female silver eel, as males rarely grow beyond 54 cm of total length (*ibid.*). A couple of very small individuals were recovered from **Period 6**, around one third of the size of a modern eel of 49 cm of total length.

A greater number of measurements for eels from **Period 7 (1399-1485)** allowed to produce a log ratio histogram (Fig. 5.8.15). The measurements appear unimodally distributed around the mean value, which is smaller than the marker of 49 cm of total length (red line). Only a few measurements are larger than the red marker. Overall, the eels from the sample appear to be rather small and comparable to the maturation stages of elvers (over 7-8 cm of total length; *ibid.*, 137), for the smallest individual, and yellow/silver eel (over 30 cm of total length; *ibid.*, 150), for the largest. Two outliers are clearly distinct from the main group and even larger than the standard value (0) of 96 cm of total length; probably they represent female silver eels of over 1 m of total length.

5.8.4 Discussion

Despite the number of problems mentioned above, it was possible to gather a wealth of valuable information from the assemblage.

For the 12th to the 14th c. material (**Period 5-6**), it appears that herring, whiting and Pleuronectiformes were the most consumed fish, together with small quantities of a variety of other species, mostly marine. From the area of the Fleet prison, from the 15th c. (**Period 7**), eel becomes the most frequent species, followed by much smaller percentages of herring. This could suggest a shift during the 15th c., from an exploitation of the sea and the coastal area to the rivers and local resources.

The variety of marine fish, such as herring, sprat, cod, whiting, haddock, mackerel, rays, gurnards, turbot, sole and conger could have been available at the market and sourced in the coastal area near the Thames estuary. Such a large selection of species reflects the position of the site, close to the coast and the main ports. The wide range and rarity of some of these species, together with the easy accessibility to the coast, suggest that marine fish was bought irregularly when available and consumed fresh, rather than in bulk in a preserved form. Ling has a rather northern distribution (Camphuysen & Henderson 2017, 128), therefore it may have been imported to the London market already preserved. Cod is mostly represented by vertebrae and individuals of over 75-100 cm of length, which makes it likely to have been purchased mostly beheaded and in preserved form (e.g. stockfish).

Freshwater and migratory fish is also likely to have been purchased. However, it is also possible that some of the contexts from the reclamation and foreshore accumulations (**Period 5**) were connected with properties owning fishing rights or mills on the Thames or Fleet. The river would have provided eel, Cyprinidae, pike, salmon/trout and possibly flounder and sturgeon (found by Locker for these contexts, Section 2). Sturgeon, as an anadromous species, could have been fished both from the estuary/costal area or the river. Also the Atlantic salmon/sea trout could have been a sea catch, as these fish spend parts of their lives in marine water, before returning to the river of their birth (see species overview in Chapter 1). All the species mentioned above, with the exception of eel, were typically consumed fresh.

The exploitation of the estuarine area could have provided plaice/flounder, the seasonal smelt, and possibly the smallest eel. Most eels live the first part of their lives (glass eel stage) in costal and estuarine areas and start to colonise rivers at the stage of elvers (from roughly 7-8 cm of total length; Churchward 1996 in Tesch 2003, 137). Most individuals found at the Fleet prison tend to be around the size range of elvers and yellow/silver eel where they tend to be fished in rivers. However, for the smaller cases, possibly at the stage of glass eel/elvers, they could have also been caught in the estuary. The larger specimens of eel from **Period 5** and **7** were probably sexually mature female eel, caught on the autumnal seaward migration towards the spawning ground, the Sargasso Sea (see species overview in Chapter 1). These typically would represent some special/prestigious meal. The relatively small size range for eel focussed on smaller individuals, from **Period 7,** could suggest that fishing was carried out only during one season, or from the same source of fishing (e.g. the estuary). Smelt is a fish that appears commonly in London assemblages from medieval times, but it tends to be rare elsewhere. There was an important smelt fishery on the tidal Thames, which would follow the seasonal migrations of the fish, being more productive in winter and early spring (Wheeler 1979b, 48; Locker 1992a, 1). Wheeler (1979b, 48) refers also to seasonal catching of white bait (juvenile herring, sprats) from the Thames estuary, where the proportion between herring and sprat would depend on the season (e.g. sprat was more abundant in from February to April).

It appears that in **Period 7** there is an underrepresentation of large Gadiformes, and in general, of large species. This scarcity would fit with the above-mentioned suggestion of a switch from offshore sea exploitation, targeting older/larger fish, to local sources. Furthermore, this dearth of larger species, in the case of contexts related to dumping areas within the Fleet Prisons, could also result from the regular clearing of larger fragments from floors, favouring the presence of smaller species. Furthermore, some of the large fish could have been purchased as fillets, therefore boneless. In general, it is also important to consider the larger amount of flesh provided by these larger species, compared to the smaller but more frequent species, in order to correctly evaluate their contribution to human diet.

The anatomical element distribution for herring shows a prevalence of vertebrae for **Period 5** and an equal representation of heads/vertebrae for **Period 6**. Herring was typically eaten whole, possibly gutted, and because of the oily flesh, preserved in order to prevent spoiling. It is likely that in both periods, herring was consumed whole and preserved and the dearth of head elements from the earlier period is a consequence of taphonomic bias affecting the fragile herring head bones. Considering the proximity of the coast, some herrings were probably eaten fresh.

Eel anatomical distribution for **Period 7** shows a prevalence of vertebrae, possibly indicating that in some case the fish was purchased beheaded or that the heads were removed and disposed separately from the rest of the body during cooking and preparation of the fish. Eel was typically consumed both fresh and preserved (e.g. salted, smoked) but, considering the high frequency from **Period 7,** it is likely that at least some were preserved. The single chop on an eel caudal vertebra suggests the splitting of the carcass into pieces or along the spine.

The presence of unidentified scales supports the thesis of on-site cleaning (e.g. Bond & O’Connor 1999).

The single burned bone from **Period 6** could represent accidental or intentional disposal of kitchen and/or meal waste into the fire.

Some small specimens (eel, smelt, Cyprinidae) from **Period 7** show evidence of bone deformation and erosion which generally is characteristic of human consumption and digestion (Jones 1984, 1986). The single bone of Pleuronectiformes, which appeared mechanically crushed, could be associated with trampling, but human agency cannot be excluded as certain cooking preparations required the pressing and pounding of the fish (e.g. Wubs-Mrozewicz 2009; Davidson 2012) and could leave this type of marks on the bones.

The two highly prised fish from the assemblage, turbot and sturgeon, may possibly represent a festive meal. Sturgeon had a high social/economic value in medieval England (Hoffmann 2005, 2008; Chapter 2), but Locker (1994, 3) observed that the frequent identification of this fish from medieval deposits in London may suggest that the fish was also available on the open market.

The presence of sturgeon and turbot, together with other valuable fish, such as pike and salmon/trout, is surprising in contexts associated with the Fleet Prison (**Period 6-7**). It is possible that these remains are a combination of meal waste from staff of the prison, prisoners and people dwelling nearby. Furthermore, it is conceivable that the prison area included damps coming from different and wealthier areas of the city, thus the contexts would be representing a generic urban deposit.

Overall, it is difficult to identify the nature of the assemblage, but in general the variety and quality of the species seems to indicate domestic refuse; the few cut marks, a burned bone and the presence of edible species suggests a combination of kitchen refuse and table waste; the evidence of human digestion on some of the fish bones could be connected to cesspit refuse.

Completeness	Period 4	Period 5	Period 6	Period 7
> 75% present	1	85	95	248
75-50% present	2	241	267	202
50-25% present	0	41	47	76
< 25% present	0	21	19	24

Table 5.8.2: Bone completeness by periods, all recovery methods.

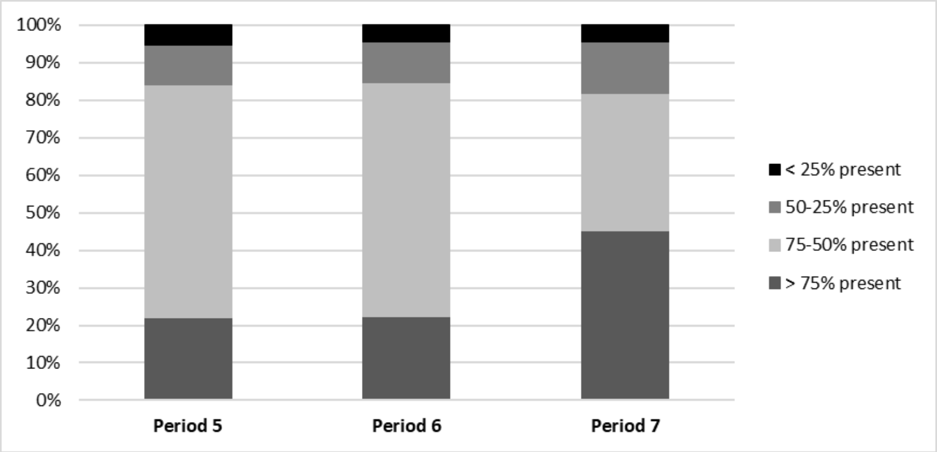


Fig. 5.8.2: Percentage of bone completeness by phase (**Period 5**, NISP: 388; **Period 6**, NISP: 428; **Period 7**, NISP: 550), all recovery methods.

Preservation	Period 4	Period 5	Period 6	Period 7
Excellent	0	0	0	25
Good	0	26	99	143
Medium	3	343	326	357
Bad	0	19	3	25
Awful	0	0	0	0

Table 5.8.3: Bone preservation by periods, all recovery methods.

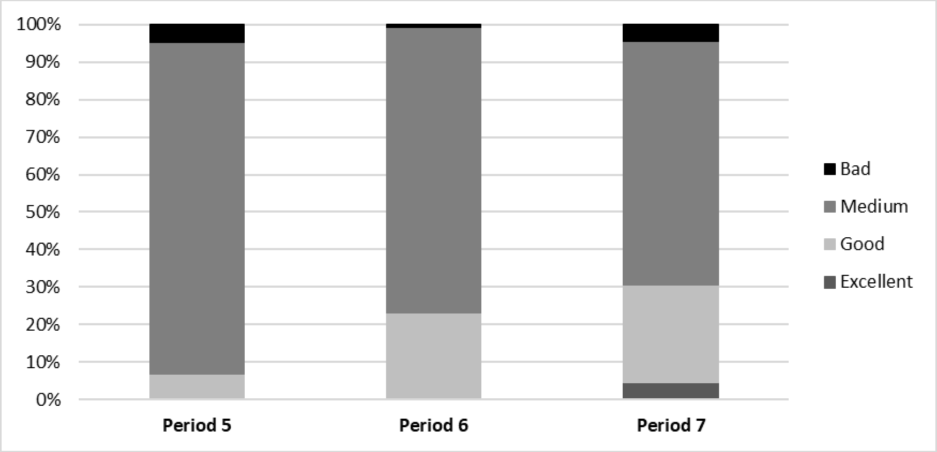


Fig. 5.8.3: Percentage of bone preservation by phase (**Period 5**, NISP: 388; **Period 6**, NISP: 428; **Period 7**, NISP: 550), all recovery methods.

TAXA		Period 4	Period 5		Period 6		Period 7		TOT
Latin name	**Common name**	**FS**	**FS**	**CS**	**FS**	**CS**	**FS**	**H-C**	
Clupea harengus	Atlantic herring	2	146	19	128	13	97	0	405
Anguilla Anguilla	European eel	0	14	2	21	0	364	0	401
Merlangius merlangus	Whiting	0	68	10	74	6	9	0	167
Pleuronectiformes	-	0	25	7	56	11	12	0	111
Cyprinidae	-	1	10	4	25	0	22	0	62
Gadus morhua	Atlantic cod	0	12	1	15	9	1	0	38
Osmerus eperlanus	European smelt	0	6	0	4	0	21	0	31
Clupeidae	-	0	19	1	2	0	1	0	23
Scomber scombrus	Atlantic mackerel	0	2	1	11	3	5	0	22
Gadiformes	-	0	7	1	9	0	0	0	17
Pleuronectes platessa	European plaice	0	3	0	9	1	1	0	14
Triglidae	-	0	4	0	3	2	3	0	12
Melanogrammus aeglefinus	Haddock	0	4	1	3	2	0	0	10
Pleuronectes platessa/Platichtys flesus	European plaice/flounder	0	0	1	3	2	4	0	10
Sprattus sprattus	European sprat	0	6	2	2	0	0	0	10
Salmonidae	-	0	1	0	0	1	6	0	8
Solea solea	Common sole	0	7	0	1	0	0	0	8
Esox lucius	Northern pike	0	1	0	3	2	1	0	7
Conger conger	European conger	0	0	0	1	0	1	0	2
Rajidae	-	0	0	1	1	0	0	0	2
Rutilus rutilus	Roach	0	0	0	1	0	1	0	2
Leuciscus leuciscus	Common dace	0	0	0	0	0	1	0	1
Scophtalmus maximus	Turbot	0	0	0	1	0	0	0	1
Chelidonichthys lucerne	Tub gurnard	0	1	0	0	0	0	0	1
Tinca tinca	Tench	0	1	0	0	0	0	0	1
Molva molva	Ling	0	0	0	1	0	0	0	1
Pagellus sp.	-	0	0	0	0	1	0	0	1
*Salmo salar/Salmo trutta trutta***	Atlantic salmon/sea trout	0	0	0	0	1	0	0	1
*Raja clavata**	Thornback ray	0	0	0	*	*	0	*	0
*Squalius cephalus**	Chub	0	*	0	0	0	0	0	0
	TOTAL	3	388		428		550		1369

Table 5.8.4: NISP of taxa by phase based on diagnostic elements (other records noted as *) for fine-sieved (FS: mesh 1 mm) and for coarse-sieved (CS: mesh 4, 8mm) material. *Raja clavata** is represented by dermal denticles and *Squalius cephalus** is represented by pharyngeal plates, ** probably *Salmo salar/Salmo trutta trutta* by size.

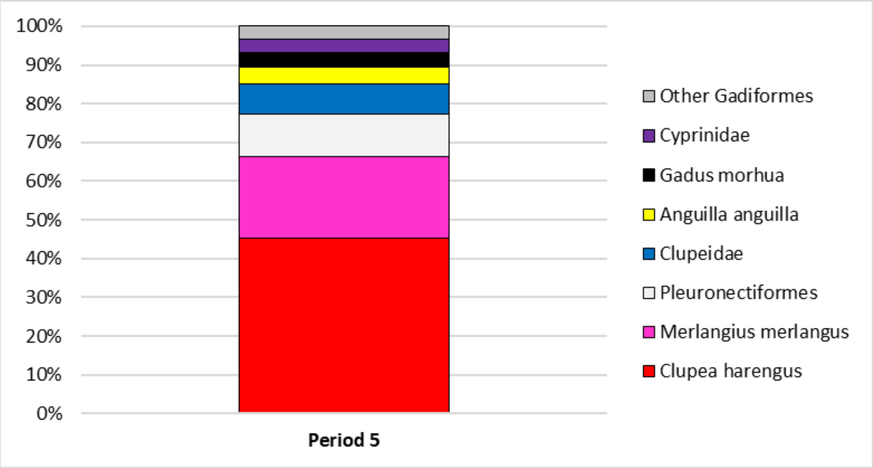


Fig. 5.8.4: Frequencies for the 8 most common taxa for **Period 5** (NISP: 322) for fine-sieved material (FS: mesh 1 mm). Threshold by phase: tot NISP ≥ 100.

TAXA	Period 4	Period 5		Period 6	Period 7
	FS	FS	CS	FS	FS
Leuciscus leuciscus	0	0	0	0	1
Tinca tinca	0	2	0	0	0
Rutilus rutilus	0	0	0	1	1
Squalius cephalus	0	1	0	0	0
Cyprinidae unid.	1	11	4	25	23

Table 5.8.5: NISP for the Cyprinidae family by period for fine-sieved (FS: mesh 1 mm) and coarse-sieved (CS: mesh 4, 8mm) material based on all counted specimens and pharyngeal bones; although regarded as not countable, pharyngeal bones will be represented in this table because they have been consistently recorded for all Cyprinidae.

TAXA	Period 5	An.E.	Period 6	An.E.	Period 7	An.E.
Clupea harengus	4	PCV1	2	various	\	
Anguilla anguilla	\		\		3	vertebrae

Table 5.8.6: MNI by period for main taxa, for fine-sieved material (FS: mesh 1 mm). Threshold by phase: taxa NISP > 100. **An.E**. is the anatomical element used for MNI calculation. PCV1: first precaudal vertebra, /: threshold requirement no fulfilled.

HABITAT	Period 4	Period 5	Period 6	Period 7
Freshwater	1	12	29	25
Marine	2	278	261	117
Migratory	0	21	25	392
Other	0	26	59	16

Table 5.8.7: Taxa habitat distribution by period, for fine-sieved material (FS: mesh 1 mm).

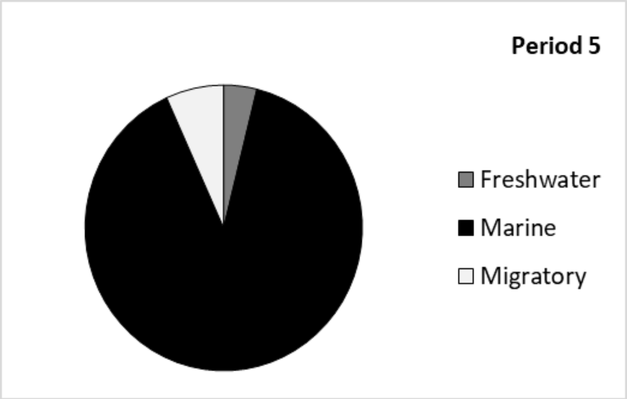


Fig. 5.8.5: Frequencies of habitat distribution for **Period 5** (NISP: 311) for fine-sieved material (FS: mesh 1 mm). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

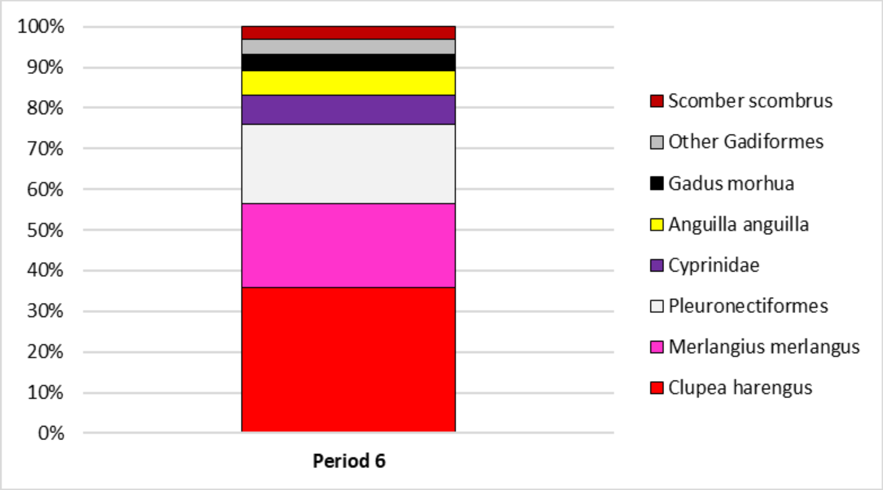


Fig. 5.8.6: Frequencies for the 8 most common taxa for **Period 6** (NISP: 358) for fine-sieved material (FS: mesh 1 mm). Threshold by phase: tot NISP ≥ 100.

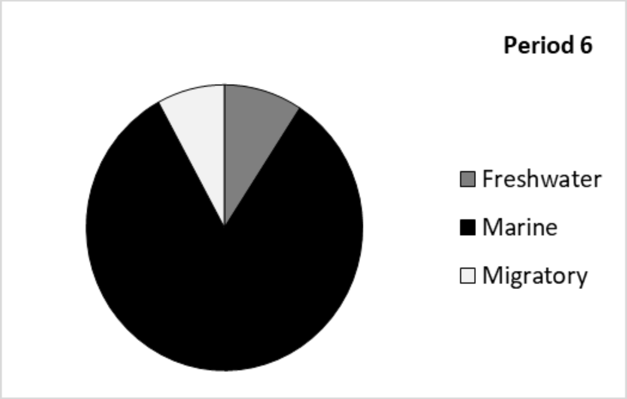


Fig. 5.8.7: Frequencies of habitat distribution for **Period 6** (NISP: 315) for fine-sieved material (FS: mesh 1 mm). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

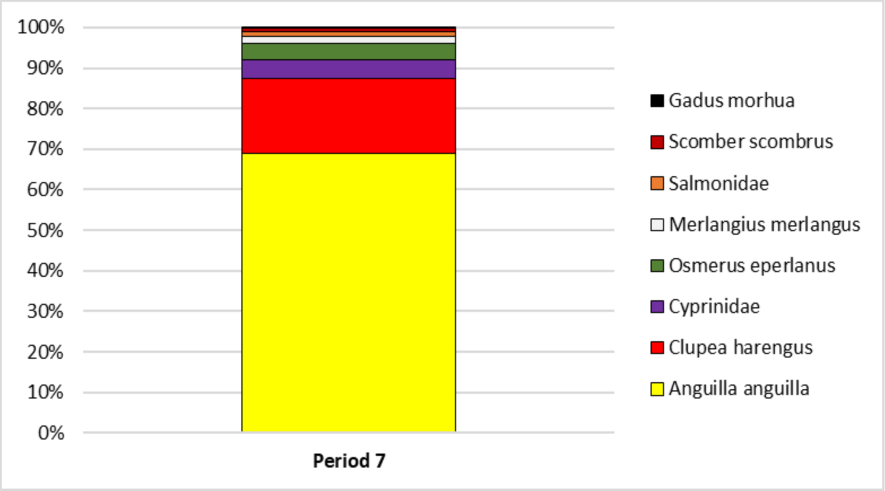


Fig. 5.8.8: Frequencies for the 8 most common taxa for **Period 7** (NISP: 543) for fine-sieved material (FS: 1 mm). Threshold by phase: tot NISP ≥ 100.

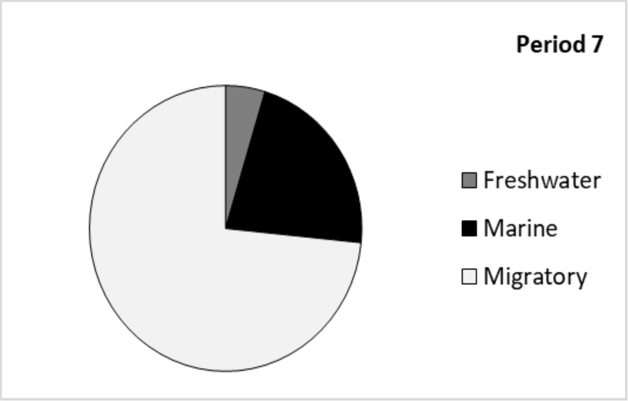


Fig. 5.8.9: Frequencies of habitat distribution for **Period 7** (NISP: 534) for fine-sieved material (FS: mesh 1 mm). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

HABITAT	**Period 5**	**Period 6**
Freshwater	4	2
Marine	37	37
Migratory	2	2
Other	8	13

Table 5.8.8: Taxa habitat distribution by period, for coarse-sieved material (CS: mesh 4, 8 mm).

GROUP	**Element**		*Clupea harengus*		*Anguilla anguilla*
			Period 5	**Period 6**	**Period 7**
I	**A**	Articular	2	1	1
	B	Basioccipital	0	0	0
	D	Dentary	1	1	0
	ECT	Ectopterygoid	1	2	0
	ENT	Entopterygoid	0	0	\
	HYO	Hyomandibular	0	0	0
	INT	Interopercular	0	0	0
	MAX	Maxilla	1	0	0
	OP	Opercular	0	1	1
	OT	Otolith	0	0	0
	PA	Palatine	0	0	\
	PAR	Parasphenoid	0	0	0
	PRE	Preopercular	1	1	0
	PX	Premaxilla	0	0	\
	Q	Quadrate	1	1	1
	SUB	Subopercular	1	0	1
	VOM	Vomer	1	2	0
II	**CE**	Ceratohyal	0	0	0
	EHY	Epihyal	1	1	0
	URO	Urohyal	0	1	\
III	**BAP**	Basipterygium	0	1	\
	CL	Cleithrum	0	0	0
	CO	Coracoid	1	0	\
	PSC	Postcleithrum	0	0	\
	PST	Posttemporal	0	0	\
	S	Scapula	0	0	\
	SUP	Supracleithrum	0	2	0
IV	**PCV1 (PCV2)**	1st (2nd) precaudal vertebra	4	1	2
	AAV	Anterior abdominal vertebra	3	2	2
	PAV	Posterior abdominal vertebra	2	1	4
V	**CV**	Caudal vertebra	2	2	3
	LC	Last caudal vertebra	0	0	\
VI	**VC**	Vertebral body (centrum)	0	0	1

Table 5.8.9: Anatomical element distribution (MAU) by period for main taxa, for fine-sieved (FS: 1 mm) material. Group I = Head elements (Minus II): Neurocranium, jaws, gill arches, gill covers; Group II = Head elements: Outer branchial skeleton; Group III = Pectoral and pelvic skeleton; Group IV = Precaudal vertebra; Group V = Caudal vertebrae; Group VI = undefined vertebrae. \ = missing/undeveloped or unidentified anatomical elements for eel (Methods, Chapter 4).

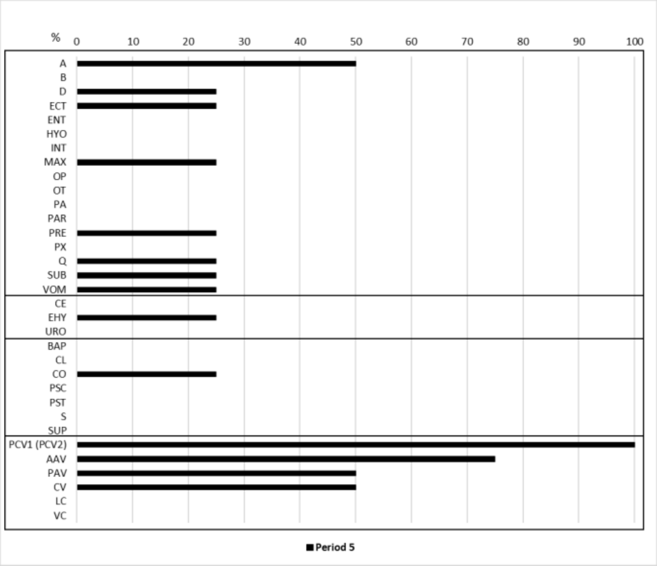


Fig. 5.8.10: Frequencies of anatomical element distribution (MAU) for *Clupea harengus*, **Period 5**, for fine-sieved material (FS: mesh 1 mm). Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

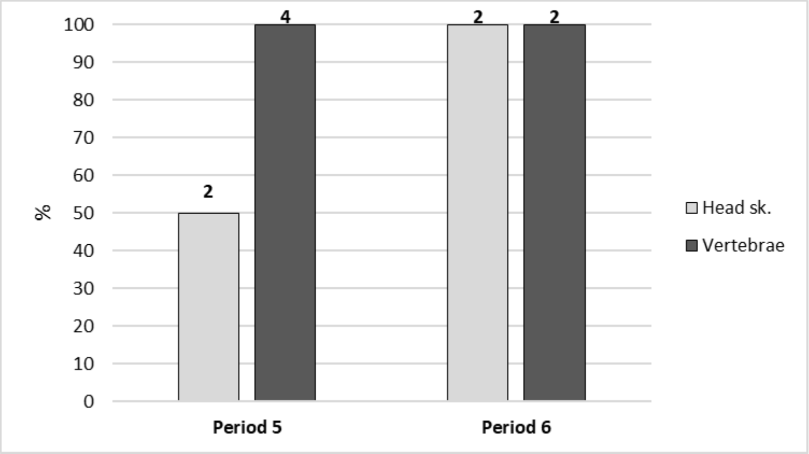


Fig. 5.8.11: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Clupea harengus* by period, for fine-sieved material (FS: mesh 1 mm).

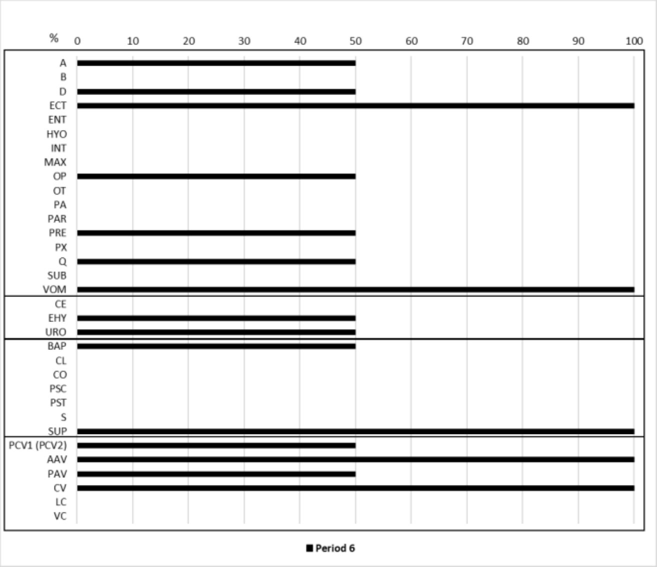


Fig. 5.8.12: Frequencies of anatomical element distribution (MAU) for *Clupea harengus*, **Period 6**, for fine-sieved material (FS: mesh 1 mm). Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

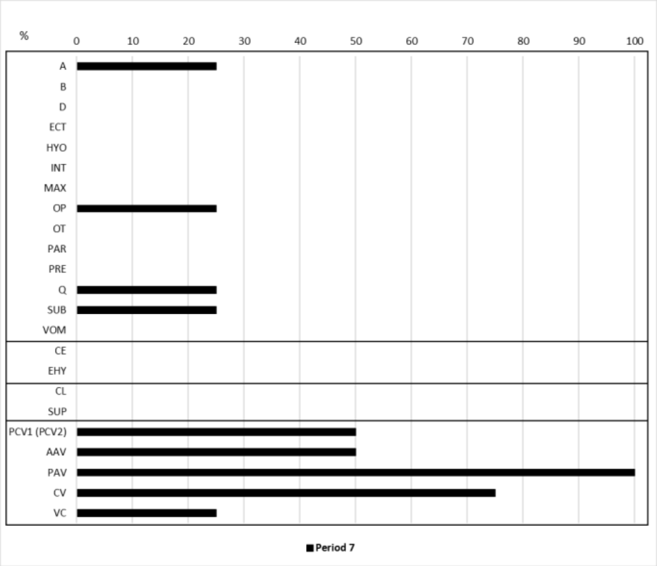


Fig. 5.8.13: Frequencies of anatomical element distribution (MAU) for *Anguilla anguilla*, **Period 7**, for fine-sieved material (FS: mesh 1 mm). Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

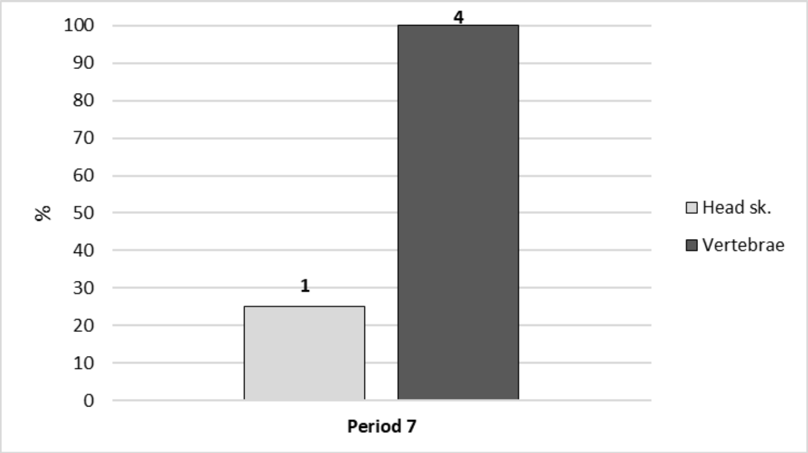


Fig. 5.8.14: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae skeleton in *Anguilla anguilla* for **Period 7**, for fine-sieved material (FS: mesh 1 mm).

TAXA	*Clupea harengus*	Pleuronectidae	**TOT**
Burning			
Burned	1	0	1
Tot burned			1 (0.2%)
Other modifications			
Crushed	0	1	1
Tot modified			1 (0.2%)

Table 5.8.10: Taphonomic modifications for **Period 6** material, total NISP 428, all recovery methods.

TAXA	*Anguilla anguilla*	*Osmerus eperlanus*	Pleuronectidae	Cyprinidae	**TOT**
Other modifications					
Crushed	29	3	1	1	34
Tot modified					34 (6%)
Butchery marks					
Chop	1	0	0	0	1
Tot butchered					1 (0.2%)

Table 5.8.11: Taphonomic modifications for **Period 7** material, total NISP 550, all recovery methods.

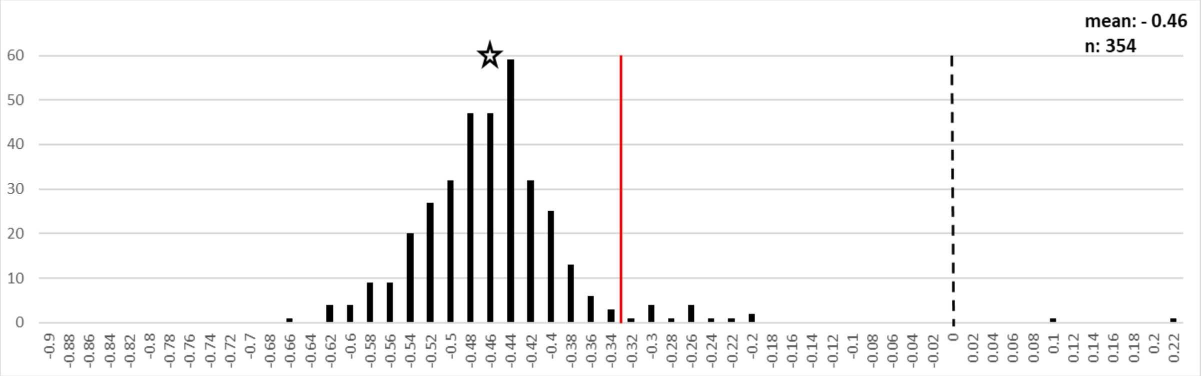


Fig. 5.8.15: Size distribution for all anatomical elements for *Anguilla anguilla*, **Period 7**. The star indicates the mean (-0.46). The standard set of values is represented by the value 0 (TL: 960 mm). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 124; n measures: 354.

5.9 Trig Lane, City of London

The excavation of the waterfront site of Trig Lane revealed a series of timber and stone revetments on the medieval foreshore, part of the reclamation of the riverfront carried out between the mid-13th c. and the late 15th c. Several publications describe the nature of the site, but most of the following information was extracted from Milne & Milne (1978).

5.9.1 The site: Trig Lane (TL74)

The site lies on the west side of Trig Lane, an alley which connects Thames Street to the river, about 800 m upstream the London Bridge in the City of London (Fig. 5.9.1). Trig Lane was named during the 14th c. after a family of fishmongers, owning a propriety in the area.

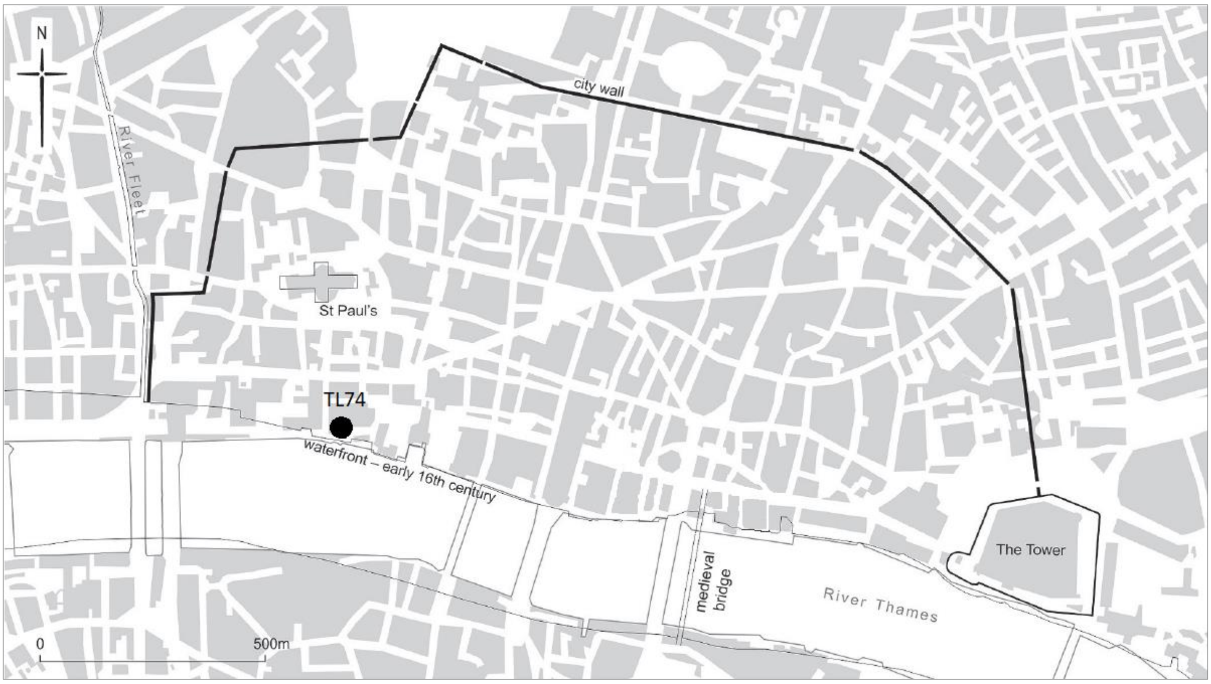


Fig. 5.9.1: Location of the site (Trig Lane-TL74) within the City of London (modified by Schofield *et al.* 2018, 1).

The river Thames, through centuries, kept rising and reached its maximum peak and width by the end of the Saxon period. The river kept advancing inland and eroding the south face of the pre-existing Roman riverside wall. From the 12th to the 16th c. a gradual reclamation of the land started, from the Tower to Blackfriars, by erecting timber and/or stone revetments. The space between the revetments and the wall was infilled with rubbish and sealed with stone or gravel; this practice resulted particularly convenient after the 13th c., when the use of rubbish pits had become less frequent as the city was by then so densely inhabited that it was difficult to find suitable places where to dig them (Milne & Milne 1982, 87).

The reclamation and maintenance of the river front was the right and duty of the owner of the plot adjacent to the river and this explains the variety in the typology of the revetments (Milne 1979); in particular stone buildings were believed to belong to the wealthier owners of properties on the river.

5.9.1.1 Excavations and zooarchaeological studies

In 1973 the Department of Urban Archaeology (Museum of London) started a program of excavation and research with the aim of stressing the importance of the river waterfront in the history of the city of London. The objective of the project was to contrast the destruction of the riverfront areas, which was at that point already irremediably damaged by redevelopment schemes. During the excavation, a number of Roman water structures and Saxon-time features were revealed along the Thames; remnants of the Middle Ages also emerged, including Trig Lane.

The excavations at Trig Lane started in 1974 (TL74), under the supervision of Mark Harrison, and ended in 1976 with a total excavated area of 500 m^2.

Over 3,000 features and contexts were recorded, representing structures built on the foreshore as part of the riverfront, and divided into groups G1-18 (Table 5.9.1).

Period	**Chronology**	**Groups**
I	pre-c. 1250	pre-G1
II	c. 1250-1270	G1
III	c. 1270-1330	G2, G3, G4, G5, G6
IV	c. 1330-1385	G7, G8, G9, G10, G13
V	c. 1385-1485	G11, G12, G13
VI	c. 1485-?1600	G15, G17
VII	c. 1600-?	/

Table. 5.9.1: Summary of the phasing for the excavated area of TL74 (after unpublished report held at the Museum of London Archive).

The earliest evidence of the reclamation of the river front consisted in the construction of a revetment (G2) possibly around the third quarter of the 13th c.

In the late 13th-early 14th c. the old revetment was replaced by two new timber revetments (Group 3-4) functioning together. In the 14th c. the frontage was repaired at least twice (Group 5-6) and by c. 1350 the waterfront was further stretched in the eastern part, with the construction of revetment Group 7, behind which refuse was tipped. This act of reclamation was associated with the construction of a large building and interpreted by the archaeologists as a sign of increased prosperity of the owner.

Around 1330, the holder of the propriety at the far west side of the site built his frontage in stone (Group 8). From this point onwards a number of renovations happened (e.g. Group 10, 11). By the c.1500 the frontage saw the construction of a river wall (G15) 2.50 m high and extended over 24 m in length. As mentioned above, the dumping of contemporary waste was frequent within the area of the frontage and the wall; one example of rubbish dumping was found between wall G15 and frontage G10-11. The rubbish dumped in the infillings and the near foreshore was made of a mix of domestic and industrial waste. Amongst the waste, a number of fishing tools were found; these included hooks, net weights, net mending tools, barrels, and wooden sticks to hang and dry the fish (Milne & Milne 1982, 88-89).

Animal bones and molluscs were also found but, unfortunately, no faunal report was ever produced or, if it was, could not be accessed from the archives. However, the fish remains report for TL74 was available and produced by Locker (Unpublished); this study was part of a larger project on the City of London fish exploitation (Orton *et al.* 2016).

5.9.2 Material and recording methods

Fish bones were collected from various areas of the site dating from the 13th to 17th c., but for the purpose of this research only material dated late 13th-late 15th c. (Groups 2-3, 6-8, 10-13, 15) will be considered. Unfortunately, some fish remains were recovered from contexts with unclear phasing, therefore they were excluded from the analysis.

Fish remains were collected from different deposits, the largest samples coming from Group 2 (c. 1270-1330) and Group 7 (c. 1330-1385), some representing the infills between revetments and river walls or foreshore deposits in front of them. The nature of these deposits is unknown as they could represent industrial activities, waste from fishmongers, or domestic rubbish dumps. Because of the uncertainty in the interpretations of the deposits and in order to increase the sample size, fish remains were grouped by chronological periods rather than structural Groups. In particular, three period were considered: **Period III (c. 1270-1330)**, **Period IV (c. 1330-1385)** and **Period V (c. 1385-1485)**. Following this sub-division, only **Period III** sample was large enough to proceed with further analysis (total NISP ≥ 100); the other two samples will be nonetheless represented in the tables but mentioned only when relevant.

Unfortunately, no information about recovery was available, but the size of the bones and the species recovered largely suggest hand-collection; this was assumed also by Locker in her report (Unpublished). This inevitably means a bias against smaller species, which needs to be considered in the interpretation of the data.

By comparing the results with Locker's report, it emerged that some contexts with relevant chronology where missing in this study, which raises some questions about the nature of the material available. Luckily, the only relevant species recorded by Locker and missing from this research was one vertebra of Salmonidae from **Period VI (c. 1330-1385).**

5.9.3 Results

For the small selected assemblage, a total of 328 bones were counted, 214 of these were identified at various taxonomic levels and 208 recorded as countable specimens.

No scales were collected, supporting the hypothesis that most of the material was hand-collected.

For the **Period III (c. 1270-1330)** sample the completeness of the bones was overall good, with more than 80% of the identified material more than 50% intact; the level of preservation of the bone surface was medium (Tables 5.9.2-3, Fig. 5.9.2-3). **Period IV** appears to have a relative higher percentage of bones that are less than 50% intact and some badly preserved bones. Conversely, the smallest sample, **Period V**, shares similar completeness and preservation with Period IV.

5.9.3.1 Taxonomic frequencies

Unknown recovery material

The NISP for **Period III (c. 1270-1330)** shows an assemblage (Table 5.9.4, Fig. 5.9.4) dominated by large Gadiformes, in particular cod (66%) and ling (15%). These are followed by Rajidae (7%), other Gadiformes (3%), among which one remain was attributed to whiting, conger (2%), and Salmonidae, plaice/flounder and eel, all with one remain. Plaice appears in the assemblage with an uncountable remain, and that is also the case for sturgeon (Acipenseridae), with a fragment of the skull which unfortunately was too small to be assigned to species (*Acipenser sturio*/*Acipenser oxyrinchus*).

No species reached the threshold for MNI calculation; habitat distribution for the period (Table 5.9.5, Fig. 5.9.5), shows an assemblage almost entirely represented by marine taxa (98%), with a minimal presence of migratory (2%) fish.

In **Period IV (c. 1330-1385)** and **Period V (c. 1385-1485)** the most common species is cod and the assemblages are almost all represented by marine taxa. In **Period IV (c. 1330-1385)** the occurrence of pike, flounder and the prestigious halibut (*Hippoglossus hippoglossus*) is worth mentioning. Another skull fragment of sturgeon (*Acipenser sturio*/*Acipenser oxyrinchus*) was recovered from **Period V (c. 1385-1485)**. Salmonidae bones are present in both periods.

5.9.3.2 Anatomical element distribution

No taxa reach the threshold for the calculation of the MAU and consequently no analysis of anatomical element distribution was possible. However, it is worth pointing out that, within the three selected samples, cod is entirely represented by vertebrae and bones from the shoulder girdle.

5.9.3.3 Taphonomic alterations

The taphonomic evidence is scanty, reflecting the small size of the samples, and it is summarised in Table 5.9.6.

The only traces of taphonomic alteration were found on cod bones from **Period IV (c. 1330-1385)**, with one burned bone and chops recorded on two vertebrae and one cleithrum belonging to individuals larger than 75 cm of total length.

5.9.3.4 Biometrical analysis

Measurements for pike and eel were too few to produce log ratio histograms. The only pike bone found from **Period IV (c. 1330-1385)** probably belonged to an adult pike of around 50 cm of total length, while the eel bone from **Period III (c. 1270-1330)** belonged to an individual smaller than 49 cm of total length.

5.9.4 Discussion

As mentioned above, the level of information that is possible to gain from the assemblage is limited because of the apparent lack of sieving and the small size of the sample.

Overall, the assemblage suggests the exploitation of large marine species, namely cod, ling and conger. Considering the small size of the sample, a relatively large variety of marine species is present; other species identified include rays, mackerel, gurnards, whiting, sole and halibut. The wide range and rarity of some of these species, together with the easy accessibility of the coast, indicates that fish was probably bought on an *ad hoc* basis and mostly consumed fresh, rather than in a bulk or preserved form. Typically, it would have been purchased from a fish market or individual fishmongers, where a large array of fresh species was available. Ling and halibut, because of their northern distributions (Camphuysen & Henderson 2017, 128), may have been taken to the market in a preserved form.

The Thames river would have provided pike, salmon/trout and eel, while the Thames estuary would have provided plaice, flounder and possibly the smallest eel, which, depending on their stage of life, could be fished from both the river and the estuary (Chapter 1). Flounder can also swim several kilometres upriver so it may have been as well fished in the Thames (Chapter 1). Pike and salmon/trout would be eaten fresh, so as flatfish considered the closeness of the fishing source. Eel was typically eaten both fresh and preserved (e.g. smoked, salted).

Sturgeon, as an anadromous species, could have been fished both from the estuary/costal area or the river; this species had an high social/economic value in medieval England, especially after the 12th c., when it became rarer due to fishing pressure and human modification of its habitat (Hoffmann 2005, 2008; Chapter 2); together with halibut, another prestigious species, sturgeon would have been eaten fresh and represent a festive meal or the dinner of a rich dweller of the area.

In all periods, most of the cod was represented by large individuals over 75 cm of total length, some definitively larger than 1 m (maximum total length found by Locker is 1.25 m). The presence of butchery marks on cod vertebrae and the cleithrum could represent beheading of the fish. All the above evidence, together with a clear prevalence of vertebrae and bones from the shoulder girdle, suggests that most of the cod was consumed beheaded in a preserved form (i.e. stockfish).

The single cod burned bone could represent accidental or intentional disposal of kitchen and/or meal waste into the fire.

In conclusion, it appears that the assemblage probably derives from the combination of kitchen/table and cesspit refuse as suggested by the few cut marks, a burned bone and the presence of edible specie. The variety and quality of species also confirms the identification of the deposit as domestic refuse.

Completeness	c. 1270-1330	c. 1330-1385	c. 1385-1485
> 75% present	8	3	2
75-50% present	77	40	29
50-25% present	9	13	5
< 25% present	7	11	4

Table 5.9.2: Bone completeness by chronology, all recovery methods.

Preservation	c. 1270-1330	c. 1330-1385	c. 1385-1485
Excellent	0	0	0
Good	4	3	3
Medium	97	57	37
Bad	0	7	0
Awful	0	0	0

Table 5.9.3: Bone preservation by chronology, all recovery methods.

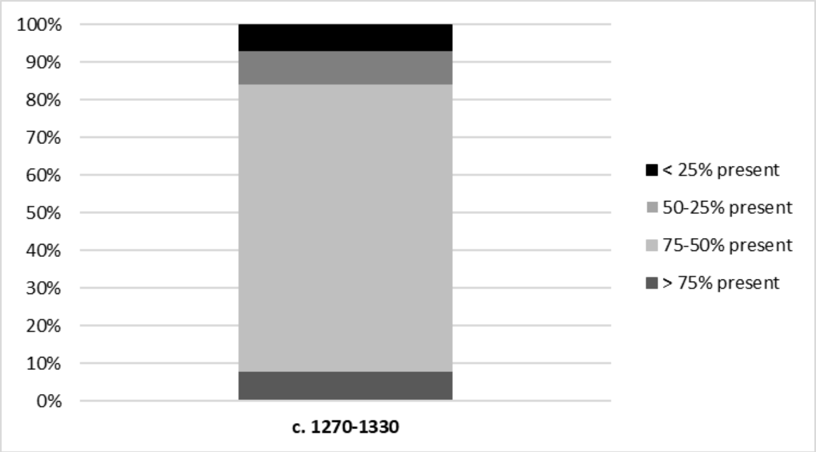


Fig. 5.9.2: Percentage of bone completeness for **c. 1270-1330** (NISP: 101), all recovery methods.

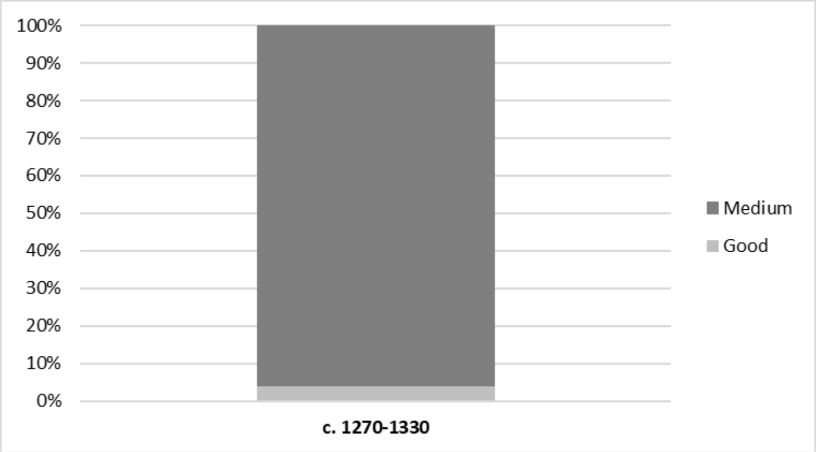


Fig. 5.9.3: Percentage of bone preservation for **c. 1270-1330** (NISP: 101), all recovery methods.

TAXA		**c. 1270-1330**	**c. 1330-1385**	**c. 1385-1485**	**TOT**
Latin name	**Common name**	**ND**	**ND**	**ND**	
Gadus morhua	Atlantic cod	67	48	28	143
Molva molva	Ling	16	2	0	18
Conger conger	European conger	3	3	4	10
Rajidae	-	8	0	0	8
Gadiformes	-	3	2	2	7
Pleuronectiformes	-	0	3	1	4
Salmonidae	-	1	1	2	4
Solea solea	Common sole	0	2	2	4
Merlangius merlangus	Whiting	1	1	0	2
Scomber scombrus	Atlantic mackerel	0	2	0	2
Clupea harengus	Atlantic herring	0	1	0	1
Anguilla anguilla	European eel	1	0	0	1
Pleuronectes platessa/Platichtys flesus	European plaice/flounder	1	0	0	1
Esox lucius	Northern pike	0	1	0	1
Hippoglossus hippoglossus	Atlantic halibut	0	1	0	1
Triglidae	-	0	0	1	1
Acipenseridae*	-	*	0	*	0
*Pleuronectes platessa**	European plaice	*	0	0	0
*Platichthys flesus**	European flounder	0	*	0	0
	TOTAL	101	67	40	208

Table 5.9.4: NISP of taxa by chronology based on diagnostic elements (other records noted as *) for unknown recovery material (ND). Acipenseridae* is represented by parts of the cranium, *Pleuronectes platessa* and *Platichthys flesus* are represented by interhaemal spines (os anale).

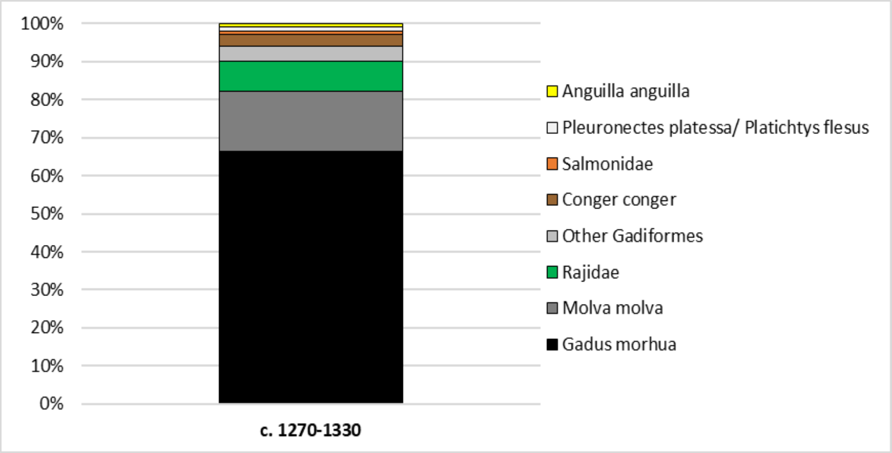


Fig. 5.9.4: Frequencies for the 8 most common taxa for **c. 1270-1330** (NISP: 101) for unknown recovery material (ND). Threshold by phase: tot NISP ≥ 100.

HABITAT	c. 1270-1330	c. 1330-1385	c. 1385-1485
Freshwater	0	1	0
Marine	98	62	37
Migratory	2	1	2
Other	1	3	1

Table 5.9.5: Taxa habitat distribution by chronology, for unknown recovery material (ND).

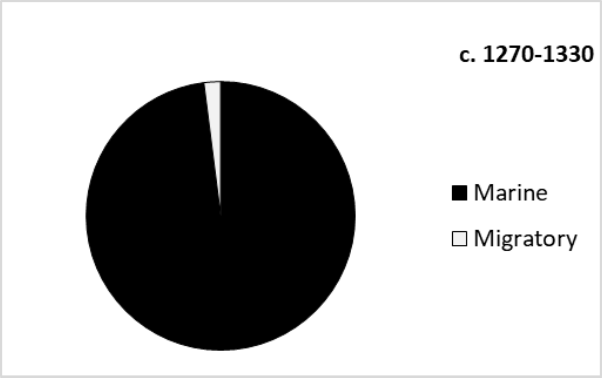


Fig. 5.9.5: Frequencies of habitat distribution for **c. 1270-1330** (NISP: 100) for unknown recovery material (ND). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

TAXA	*Gadus morhua*	**TOT**
Burning		
Burned	1	1
Tot burned		1 (1%)
Butchery marks		
Chop	3	3
Tot butchered		3 (4%)

Table 5.9.6: Taphonomic modifications for **c. 1330-1385**, total NISP 67, all recovery methods.

5.10 Billingsgate, City of London

The excavation of Billingsgate was part of a large project aimed to study the development of the waterfront of the City of London by bringing together the archaeological and documentary evidence from a number of sites excavated by the Museum of London, from 1974 to 1984. Part of this project was published in 2018 (Schofield *et al.* 2018); unless otherwise stated, the following information is extracted from this work.

5.10.1 The site: Billingsgate (BIG82)

The site of Billingsgate "Lorry Park" is located south of Thames Street and east of London Bridge between the New Fresh Wharf site and the old Billingsgate Fishmarket, today Northern and Shell building (Fig. 5.10.1).

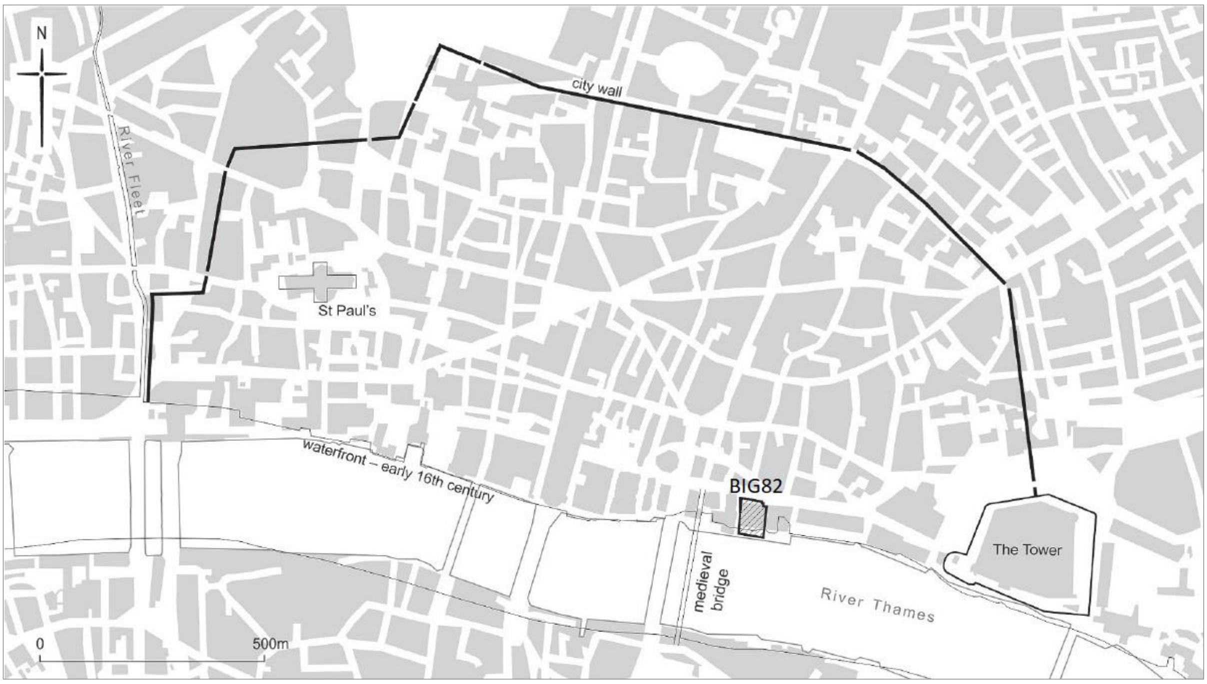


Fig. 5.10.1: Location of the site (Billingsgate-BIG82) within the City of London (modified by Schofield *et al.* 2018, 1).

As previously mentioned (VAL88), the advancement of the river Thames was constrained by the erection of timber and/or stone walls from the 12th to the 16th c.; this resulted in the creation of new land, with the consequent expansion of private proprieties, but also of indented inlets or docks for ships. In particular, in the area of Billingsgate the advancement of the 11th and 12th c. waterfront was characterised by a series of front-braced revetments, prefabricated by using timber from buildings and boats. A strip of land was created in this way towards the river, the

Botolph Wharf, which, being close to the only contemporary bridge over the Thames, represented a key point of commerce and travel for London. In particular, Billingsgate was well known, at least from the 14th c., as the main wharf for fish and became one of the most famous London covered fish markets in 1674 (Locker 2000, 91).

From the 13th c. a number of buildings was erected on the site, including private proprieties, warehouses, but also the parish church of St. Botolph, first mentioned around 1140 and destroyed by the Great Fire (1666). Archaeological evidence testifies that in medieval times St. Botolph was a wealthy parish, which is confirmed by the fact that the mayor of London, John Reynewell, (1426-7) was buried there. Together with the mayor, a large number of high-status burials were found beneath the floor of a private chapel at St. Botolph, dated between the mid-15th to the 17th c.

5.10.1.1 Excavations and zooarchaeological studies

The site was excavated by the Department of Urban Archaeology (Museum of London) under the direction of Steve Roskams. The 11-month excavations took place in 1982 (BIG82), prior redevelopment of the 1875 building and of a lorry park over the site. They uncovered several chronological features, from Roman times until the mid-18th c., though they particularly focused on the Roman and Saxon waterfronts, the medieval buildings of Botolph Wharf, and the parish church of St. Botolph.

The animal bones were studied by Rebecca Gordon but the unpublished report is not available, while the fish remains were studied by Locker (1992b) and were part of a larger project on the City of London fish exploitation (Orton *et al.* 2016).

5.10.2 Material and recording methods

Some problems emerged during the recording of the material, which are related to the existence of gaps in the contextual information and recovery methods.

Fish remains were recovered from deposits dated from Roman to Post-Medieval times, but for the purpose of this research only material coming from contexts dated from **11th** to **15th c.** are discussed. Within this time range, earlier contexts were connected with the river waterfront, in particular with dump and foreshore deposits, while several contexts from the 14th c. are linked to the St. Botolph church.

From Locker's report (1992b), it appears that fish remains where both hand-collected and sieved through a 1 mm mesh. Recovery information was, however, not always indicated on the bags containing the material, so it was necessary to cross information from Locker's report with relevant observations made during the recording process. Nevertheless, in many cases it was impossible to identify the recovery method and it also seems that hand-collected and sieved material were, in some cases, combined. This seems, for instance, the case when large cod bones were found alongside much smaller bones of species such as smelt and sprat; however, whole earth sampling could also explain this pattern. Consequently, two recovery categories were created: fine-sieved material (1 mm mesh) and mixed recovery material (fine-sieved and hand-collected).

5.10.3 Results

A grand total of 8,657 fish elements were counted. Of these, 2,351 were identified taxonomically (with various degrees of precision) and 2,233 were recorded as countable elements.

Such a high number of unidentified bones, which was mostly represented by undiagnostic fin rays, ribs and bone fragments, can be explained with the high degree of recovery. No scale was observed in the assemblage, possibly as consequence of the lack of flotation. Around 70 dermal denticles were recovered from all periods, belonging to Rajidae, including thornback ray (*Raja clavata*), but these were left out of quantifications, following the indications of the recording protocol.

In general, completeness of the bones was good, with over 80% of the remains represented by more than 50% of the relevant anatomical part (Table 5.10.1, Fig. 5.10.2) and a medium level of preservation of the bone surface (Table 5.10.2, Fig. 5.10.3).

5.10.3.1 Taxonomic frequencies

Fine-sieved material (1 mm)

NISP calculation for the fine-sieved sample from the **11th c.** (Table 5.10.3, Fig. 5.10.4) shows three major taxa dominating the assemblage, herring (24%), whiting (22%) and Pleuronectiformes (20%); these last are represented mostly by Pleuronectidae remains, but plaice/flounder and sole have been identified. Among other Gadiformes (15%), cod, haddock and possibly poor cod were recorded. Other identified taxa include eel (5%), smelt (5%) and Rajidae (3%). Among other Clupeidae (2%) one bone has been attributed to sprat/shad (*Alosa alosa*/*Alosa fallax*). Other taxa are sparsely represented, but it is worth mentioning the presence of the freshwater Cyprinidae with one unidentified bone and one pharyngeal bone attributed to roach (Table 5.10.4).

No taxa reached the threshold for MNI calculation and, overall, the sample is mostly represented by marine taxa (Table 5.10.5).

For the **12th c.** sample (Table 5.10.3, Fig. 5.10.5) the range of taxa is similar to the previous period, but with different proportions. Herring (46%) is the most common species, followed by Pleuronectiformes (10%; includes plaice and plaice/flounder), and whiting (10%). Among other Clupeidae (9%), again sprat/shad (*Alosa alosa*/*Alosa fallax*) occurs. Migratory eel (6%), smelt (5%) and other Gadiformes (5%), including cod and haddock, are also present. No Cyprinidae species was identified (Table 5.10.4).

As in the previous period, no taxa reached the threshold for MNI calculation and habitat distribution for the **12th c.** sample (Table 5.10.5, Fig. 5.10.6) shows marine taxa (79%) dominating the assemblage, followed by migratory (16%) and freshwater (6%) fish.

The **13th- early 14th c.** sample is the largest of the fine-sieved fraction (Table 5.10.3, Fig. 5.10.7); herring (47%) is still the most common species, followed by Pleuronectiformes (12%), which include plaice/flounder, plaice and sole. A larger proportion of sprat (11%) was identified from this phase, followed by whiting (10%), other Gadiformes (with cod and haddock identified) and other Clupeidae (with shad (*Alosa alosa*/*Alosa fallax*) identified), both covering around 5% of the identified material. Except for eel (4%) and smelt (2%), no other relevant species for the research was recovered.

Only herring reaches the threshold for MNI calculation and is represented by three individuals (Table 5.10.6).

Overall, the sample is almost entirely represented by marine taxa (92%), while no freshwater species was recovered (Table 5.10.5, Fig. 5.10.8). Migratory fish represents only 8% of the sample.

A similar range of taxa is present in the **14th c.** fine-sieved fraction (Table 5.10.3, Fig. 5.10.9), where herring (56%) is still the dominant species, followed by Pleuronectiformes (15%), with sole, plaice/flounder and plaice identified. Other Gadiformes (14%) have higher percentages in this period, with cod, haddock and ling identified. Other taxa include sprat (4%), eel (3%), smelt (3%) and other Clupeidae (1%), among which shad (*Alosa alosa*/*Alosa fallax*) has been identified. The only freshwater species is represented by one remain belonging to

Plate 5.10.1: Opercular attributed to the American Atlantic sturgeon (*Acipenser oxyrinchus*).

unidentified Cyprinidae (Table 5.10.4). Other taxa are negligible, with the exception of one large opercular (Plate 5.10.1) attributed to the American Atlantic sturgeon (*Acipenser oxyrinchus*); a note accompanying the bone, suggests that the identification was confirmed through DNA analysis by Els Thieren (23/04/2012).

Herring (two individuals) is the only taxa reaching the threshold for MNI calculation (Table 5.10.6).

Habitat distribution for this period (Table 5.10.5, Fig. 5.10.10) varies little from the **13th- early 14th c.** sample, with marine taxa (91%) dominating the assemblage, followed by migratory (9%) fish; freshwater fish (0.4%) is barely represented.

Mixed recovery material, hand-collected and fine-sieved (1 mm)

NISP calculation for the mixed recovery sample from the **11th c.** (Table 5.10.3, Fig. 5.10.11) shows a range of taxa largely similar to the fine-sieved sample for the same period. It appears though that herring (45%) is more frequent from this fraction, to the detriment of Pleuronectiformes (14%) and whiting (12%). The only freshwater species present are Cyprinidae with four bones unidentified and one pharyngeal bone attributed to dace (Table 5.10.7). No taxa reached the threshold for MNI calculation.

Like the fine-sieved sample, marine taxa (86%) dominate the assemblage, followed by migratory taxa (13%) and very small percentages of freshwater fish (2%) (Table 5.10.8, Fig. 5.10.12).

The **12th c.** mixed recovery sample (Tables 5.10.3, 5.10.8) is very small and entirely represented by marine taxa, in particular cod and herring.

Conversely, the **13th- early 14th c.** sample is the largest (Table 5.10.3, Fig. 5.10.13). Compared to the fine-sieved material, there is a higher percentage of herring (43%), but a larger presence of Gadiformes, in particular cod and whiting, together with haddock, ling, pollack and probably poor cod. Two cleithra of haddock showed hyperostosis, with the typical swelling and enlarged porosity of the bone tissue (von den Driesch 1994).

Plate 5.10.2: Supracleithrum attributed to sturgeon (possible American Atlantic sturgeon, *Acipenser oxyrinchus*).

In general, there is greater taxonomic variety, particularly of marine species. Pleuronectiformes are present in a similar proportion to the fine sieved fraction. A few Cyprinidae (1%), with two pharyngeal bones attributed to roach, Salmonidae and perch were recovered from this fraction. Three specimens were attributed to Acipenseridae, one of which (Plate 5.10.2) has a similar surface pattern to the American Atlantic sturgeon (*Acipenser oxyrinchus*). One of the specimens was sampled for DNA analysis (Els Thieren, 23/04/2012), but the only label provided makes reference to a generic "sturgeon".

MNI value broadly support NISP calculations, with herring represented by 5 individuals and large Gadiformes by 2 (Table 5.10.9).

Overall, habitat distribution shows marine taxa (89%) dominating the assemblage, followed by migratory fish (10%); unlike the fine-sieved sample, freshwater fish is present but only with 1% of the identified material (Table 5.10.8, Fig. 5.10.14).

In the **14th c.** mixed recovery sample, Gadiformes increase in frequency (Table 5.10.3, Fig. 5.10.15). Cod (31%) is the most common species, followed by herring (26%) and Pleuronectiformes (16%), which include plaice/flounder, flounder, plaice, sole and Scophthalmidae. Also present are whiting (10%), ling (4%), other Gadiformes (4%, mostly haddock) and shad (3%, *Alosa alosa*/*Alosa fallax*). Among Cyprinidae (2%), one bone was attributed to barbel and one to roach (Table 5.10.7). Other taxa are of limited interest, with the exception of one bone belonging to Salmonidae and two fragments belonging to Acipenseridae, which are too fragmented to be attributed to species (*Acipenser sturio*/*Acipenser oxyrinchus*); one of the specimens was sampled for DNA analysis (Els Thieren, 23/04/2012), but the results are unreported.

No taxa reached the thresholds for MNI calculations, while habitat distribution (Table 5.10.8, Fig. 5.10.16) shows that the **14th c**. assemblage is once again largely dominated by marine taxa (90%); a little more freshwater fish (3%) is present compared to the fine-sieved fraction, to the detriment of migratory fish (7%).

Only 8 remains were recovered from the **15th c.** mixed recovery fraction (Tables 5.10.3, 5.10.8), six belonging to cod and two to shad (*Alosa alosa*/*Alosa fallax*).

5.10.3.2 Anatomical element distribution

The analysis of anatomical element distribution was performed only for the two most common taxa, herring and Large Gadiformes (Tables 5.10.10-11).

For the **13th- early 14th c.**, both fine-sieved and mixed recovery material, and the **14th c.** fine-sieved samples, herring is primarily represented by vertebrae; head elements are less common, in particular from the fine sieved samples, where Group III elements are completely missing (Fig. 5.10.17-21).

Large Gadiformes from the **13th- early 14th c.** sample are also mostly represented by vertebrae (Fig. 5.10.22), as confirmed by MAU comparison of head elements vs vertebrae, where the latter are more abundant (Fig. 5.10.23).

5.10.3.3 Taphonomic alterations

The taphonomic evidence recorded from the **11th** and **12th c.** sample is scanty (Tables 5.10.12-13), with only two burned bones and two chop marks recorded on a parasphenoid and a posterior-abdominal vertebra belonging to a cod of 75-100 cm of total length.

Even in the larger **13th- early 14th c.** sample (Table 5.10.14), taphonomic traces were not common; around 0.6% of the identified bones showed burning and around 1% showed crushing. Four chop marks were recorded on a supracleithrum and three posterior-abdominal vertebrae of c. 1 m long cods.

In the **14th c.** sample only one bone was calcined and less than 1% of the bones were crushed; six chop marks were recorded on posttemporals, anterior- and posterior-abdominal vertebrae of c. 1 m long cods, and on a ling supracleithrum and cleithrum (Table 5.10.15).

5.10.3.4 Biometrical analysis

Only 31 Cyprinidae measurements were recorded in all periods, mostly belonging to individuals larger than a modern roach of 19 cm of total length, but probably no longer than 25-30 cm.

Measurements for eel are also scanty for the **11th**, **12th**, **14th c.** samples and they mostly belong to individuals smaller than 49 cm of total length, with the exception of one bone from the **11th c.** sample belonging to a large individual, with size comparable to a modern eel of 96 cm of total length.

For the **13th- early 14th c.** a greater number of eel measurements allowed to produce a log ratio histogram (Fig. 5.10.24). The measurements are roughly bimodally distributed around the 49 cm marker (red line). Only one measure approaches the standard value (0) of 96 cm of total length. Some small eels are present (considering that the size of a modern unsexed eel has a mean value of 35-60 cm; Tesch 2003, 168). This wide distribution of sizes represents different maturation stages of eel (Chapter 1), possibly ranging from the smallest glass eel (below 8 cm of total length; *ibid.*, 137) to yellow/silver eel (over 30 cm of total length; *ibid.*, 150).

5.10.4 Discussion

In the early phases, herring, whiting and Pleuronectiformes were the most consumed fish; from the **13th- early 14th c.**, there is, however, an increased interest in Gadiformes, especially large cod. There is also a slight increase in marine species to the detriment of migratory species, while freshwater species remain scarce. These two trends could be read as a possible expansion of fishing towards offshore areas, where larger fish tend to live their adult lives. However, contextual differences, as well as recovery bias, may also account for such trend.

The large variety of marine taxa, such as herring, sprat, cod, whiting, haddock, pollack, mackerel, rays, gurnards, sole, conger, garfish, is likely to reflect the position of the site near the coast; all these fish would have been available at the London market and sourced from the coastal areas near the Thames estuary. Considering the wide range of species and the easy accessibility to the coast, it is likely that some of the fish was purchased and consumed fresh. However, ling tends to have a northern habitat range (Camphuysen & Henderson 2017, 128), so it is possible that it was imported to the London market in a preserved form.

The Thames would have provided eel, Cyprinidae, salmon/trout and possibly flounder and sturgeon; sturgeon, as an anadromous species, could have been fished both from the estuary/costal area and the river. Except eel, all fish coming from the river was probably consumed fresh.

The Thames estuary, which would have provided plaice/flounder, the seasonal smelt, and possibly the smallest eel, was probably heavily exploited. As mentioned for previous sites, smelt is a common fish in London assemblages because there was a prolific smelt fishery on the tidal Thames, especially productive in winter and early spring (Wheeler 1979b, 48; Locker 1992a, 1). Wheeler (1979b) refers also to a seasonal catch of white bait (juvenile herring, sprats) from the Thames estuary, where the relative abundance of herring and sprat would depend on the season (i.e. sprat was more abundant from February to April). Eel could also had been sourced from the estuary. Individuals at the stage of yellow/silver eel tend to be fished in rivers, but at the stage of glass eel/elvers they can be caught in estuaries (Chapter 1). The large and scattered variety of eel sizes for the **13th- early 14th c.** suggests occasional fishing possibly from different sources; this reflects the fact that eel was not the focus of the fish diet at Billingsgate. The larger specimens of eel from **11th** and **13th- early 14th c.** were probably sexually mature females, caught on the autumnal seaward migration towards the spawning ground, the Sargasso Sea (see species overview in Chapter 1). Smaller eel was typically consumed both fresh and preserved (e.g. salted, smoked), but these larger specimens would have probably represented some special/prestigious meal and they would have been served fresh. Sturgeon would also be consumed fresh during a festive meal, being considered a species with a very high social/economic value (Hoffmann 2005, 2008; Chapter 2). As mentioned above, St. Botolph was quite a wealthy parish so it is reasonable to think that sturgeon, especially that from the **14th c.** deposits, represented a luxurious treat for members of the clergy or some wealthy dwellers of the area. As stated in the case of the Fleet Valley site (VAL88), Locker (1994, 3) observed that a frequent recovery of sturgeon remains from London assemblages may suggest that the fish was sold on the open market and not only reserved to the nobility.

The anatomical element distribution for herring for the **13th- early 14th c.** and **14th c.** suggests that the fish was probably eaten whole, possibly gutted, as the lower proportion of head elements is likely a consequence of taphonomic bias, due to the greater fragility of the head bones. Nevertheless, there is ethnographic evidence of the removal of the gill region before salting and packing herrings into barrels (Enghoff 1997). In this perspective, the dearth of bones, in particular for the **13th- early 14th c.** sample, of the pectoral and pelvic skeleton could also represent a preparation technique, where gills and fins of the fish were removed. Considering the large quantity of herring consumed at the site, it is likely that many had been preserved (e.g. smoked, salted, pickled). The proximity of the coast would, however, provide the opportunity for some fish to be consumed fresh.

Large Gadiformes are represented by all parts of the skeleton, indicating that these were not introduced to the site as beheaded stockfish. There is an increase in the occurrence of large cods in the **13th- early 14th c.**, again possibly testifying an increase towards fishing in offshore areas.

The few calcined and burned bones are likely to represent accidental or intentional disposal of kitchen and/or meal waste into the fire. Bone deformation recorded on small species, such as herring, eel, smelt and shad, represents the consequence of damage from human consumption and digestion (Jones 1984, 1986), which, in turn, indicates a cess pit context. The crushing of bones of larger species, such as Pleuronectiformes or large Gadiformes, could be a consequence of trampling or cooking. For instance, the compression of the body of the fish with a weight in the preparation of pressed fish or the hammering of the carcass to release the flavour from the flesh or to break the fibres of the stockfish (Wubs-Mrozewicz 2009; Davidson 2012) could produce crushed bones.

Butchery evidence is scarce; chops on cod vertebrae could indicate the severing of the vertebral column into pieces or its longitudinal splitting. Chops on ling supracleithrum and cleithrum could represent beheading. This pattern, together with a dearth of ling head elements, suggests that this species, unlike cod, was imported as stockfish in a beheaded form.

Overall, despite the limitations concerning the insufficient contextual information, the variety and type of species indicates that we are probably dealing with kitchen refuse and table waste, alongside some cesspit refuse. The predominance of marine fish, probably obtained from local markets, is indicative of ordinary urban consumption, though the occurrence of the occasional large eel and sturgeon suggests that some expensive meals also took place, but these must have been special occasions.

Completeness	11th c.	12th c.	13th- early 14th c.	14th c.	15th c.
> 75% present	80	40	311	108	1
75-50% present	243	84	646	340	2
50-25% present	37	18	176	51	5
< 25% present	21	2	40	28	0

Table 5.10.1: Bone completeness by chronology, all recovery methods.

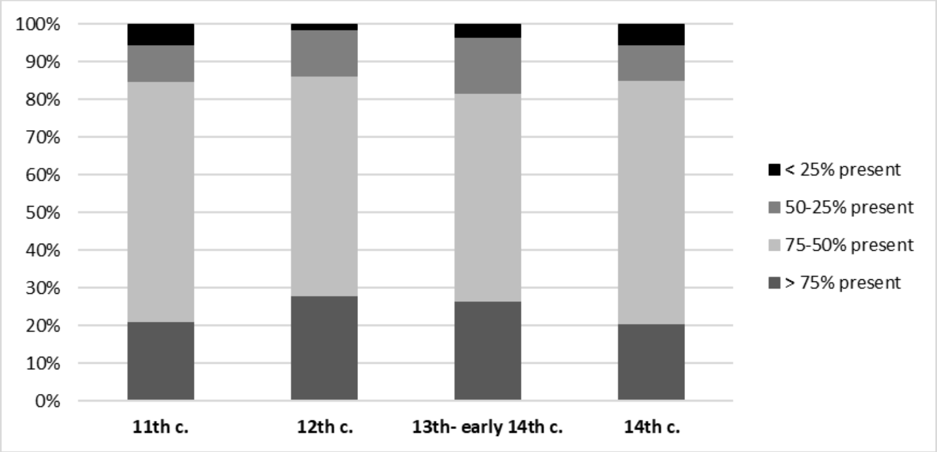


Fig. 5.10.2: Percentage of bone completeness by chronology (**11th c.**, NISP: 381; **12th c.**, NISP: 144; **13th-early 14th c.**, NISP: 1173; **14th c.**, NISP: 527;), all recovery methods.

Preservation	11th c.	12th c.	13th- early 14th c.	14th c.	15th c.
Excellent	0	0	0	0	0
Good	4	24	170	110	1
Medium	332	106	933	404	6
Bad	45	14	70	13	1
Awful	0	0	0	0	0

Table 5.10.2: Bone preservation by chronology, all recovery methods.

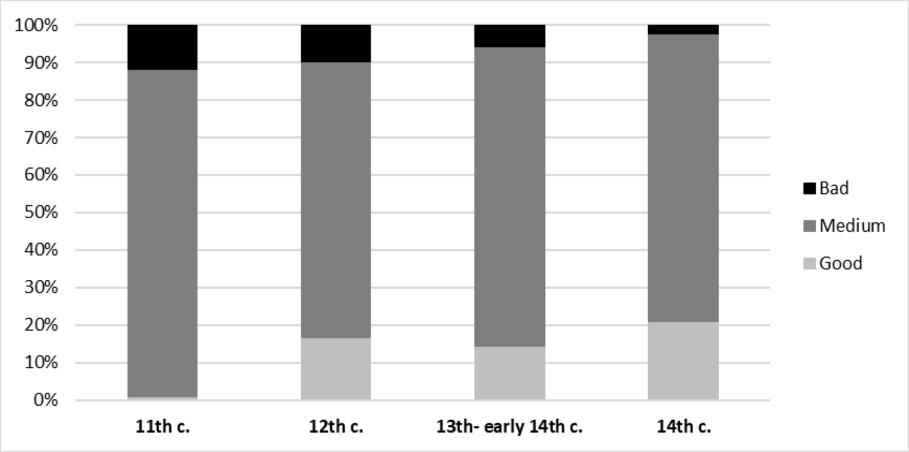


Fig. 5.10.3: Percentage of bone preservation by chronology (**11th c.**, NISP: 381; **12th c.**, NISP: 144; **13th-early 14th c.**, NISP: 1173; **14th c.**, NISP: 527), all recovery methods.

TAXA		11th c.		12th c.		13th- early 14th c.		14th c.		15th c.	TOT
Latin name	**Common name**	**FS**	**MIX**	**FS**	**MIX**	**FS**	**MIX**	**FS**	**MIX**	**MIX**	
Clupea harengus	Atlantic herring	27	111	56	7	139	373	131	72	0	916
Pleuronectiformes	-	18	26	10	0	33	84	29	32	0	232
Merlangius merlangus	Whiting	25	32	12	5	32	72	10	29	0	217
Gadus morhua	Atlantic cod	3	21	3	10	7	78	4	84	6	216
Gadiformes	-	11	11	1	0	8	52	7	7	0	97
Anguilla anguilla	European eel	6	11	8	0	12	32	9	4	0	82
Sprattus sprattus	European sprat	1	6	4	1	33	18	10	0	0	73
Osmerus eperlanus	European smelt	6	18	7	0	7	20	7	0	0	65
Clupeidae	-	1	2	5	0	13	29	3	1	0	54
Alosa sp.	-	1	1	2	0	3	15	1	10	2	35
Molva molva	Ling	0	1	0	0	0	9	11	12	0	33
Cyprinidae	-	1	4	6	0	0	11	1	7	0	30
Pleuronectes platessa/Platichtys flesus	European plaice/flounder	3	3	1	0	3	14	2	4	0	30
Melanogrammus aeglefinus	Haddock	1	1	3	1	2	13	2	4	0	27
Solea solea	Common sole	1	6	0	0	1	10	3	4	0	25
Rajidae	-	4	2	0	0	3	8	1	2	0	20
Scomber scombrus	Atlantic mackerel	0	4	0	0	2	6	1	1	0	14
Pleuronectes platessa	European plaice	0	1	2	0	1	5	1	3	0	13
Triglidae	-	0	2	0	0	0	1	1	4	0	8
Conger conger	European conger	0	0	0	0	0	4	0	4	0	8
Salmonidae	-	0	0	0	0	0	5	0	1	0	6
Labridae	-	0	0	0	0	0	4	0	1	0	5
Belone belone	Garfish	0	3	0	0	0	0	0	0	0	3

cfr. *Trisopterus minutus*	Poor cod	2	0	0	0	0	1	0	0	0	3
Scophthalmidae	-	0	0	0	0	0	1	0	2	0	3
Chelidonichthys lucerna	Tub gurnard	0	0	0	0	0	2	0	1	0	3
Platichtys flesus	European flounder	0	0	0	0	0	1	0	1	0	2
Pollachius pollachius	Pollack	0	0	0	0	0	2	0	0	0	2
Acipenseridae	-	0	0	0	0	0	1	0	1	0	2
Pagellus sp.	-	2	0	0	0	0	0	0	0	0	2
Myoxocephalus scorpius	Shorthorn sculpin	0	1	0	0	0	0	0	0	0	1
Perca fluviatilis	European perch	0	0	0	0	0	1	0	0	0	1
Trachurus trachurus	Atlantic horse mackerel	0	0	0	0	0	1	0	0	0	1
Sparidae	-	0	1	0	0	0	0	0	0	0	1
Barbus barbus	Barbel	0	0	0	0	0	0	0	1	0	1
Acipenser oxyrinchus	American Atlantic sturgeon	0	0	0	0	0	0	1	0	0	1
Ammodytae tobianus	Small sandeel	0	0	0	0	0	1	0	0	0	1
*Raja clavata**	Thornback ray	0	*	0	*	*	*	0	*	0	0
*Rutilus rutilus**	Roach	*	0	0	0	0	*	0	*	0	0
*Leuciscus leuciscus**	Common dace	0	*	0	0	0	0	0	0	0	0
	RESULTS	381		144		1173		527		8	2233

Table 5.10.3: NISP of taxa by chronology based on diagnostic elements (other records noted as *) for fine-sieved (FS: 1 mm), and possible mixed recovery (MIX) material. *Raja clavata** is represented by dermal denticles, *Rutilus rutilus** and *Leuciscus leuciscus** are represented by pharyngeal plates.

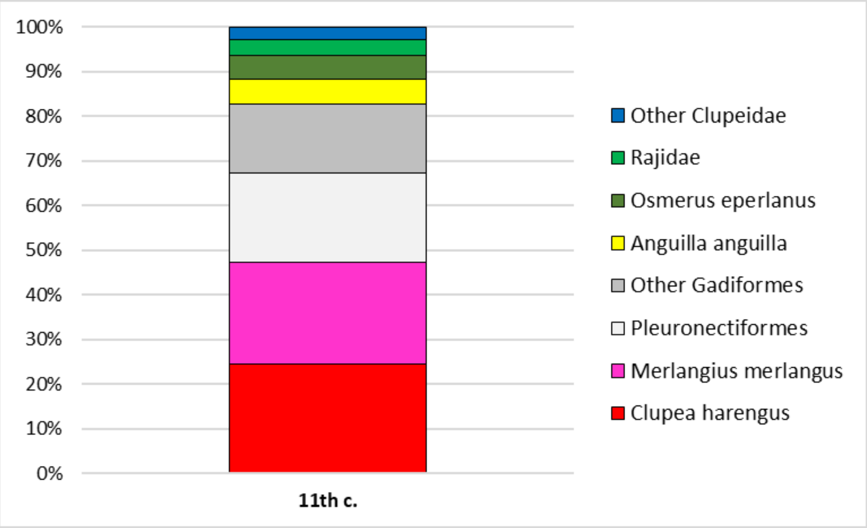


Fig. 5.10.4: Frequencies for the 8 most common taxa for **11th c.** (NISP: 110), for fine-sieved material (FS: 1 mm). Threshold by phase: tot NISP ≥ 100.

TAXA	11th c.	12th c.	14th c.
Rutilus rutilus	1	0	0
Cyprinidae unid.	1	6	1

Table 5.10.4: NISP for the Cyprinidae family by chronology for fine-sieved material (FS: 1 mm) based on all counted specimens and pharyngeal bones; although regarded as not countable, pharyngeal bones will be represented in this table because they have been consistently recorded for all Cyprinidae.

HABITAT	11th c.	12th c.	13th- early 14th c.	14th c.
Freshwater	1	6	0	1
Marine	78	86	240	185
Migratory	13	17	22	18
Other	21	11	37	31

Table 5.10.5: Taxa habitat distribution by chronology, for fine-sieved material (FS: 1 mm).

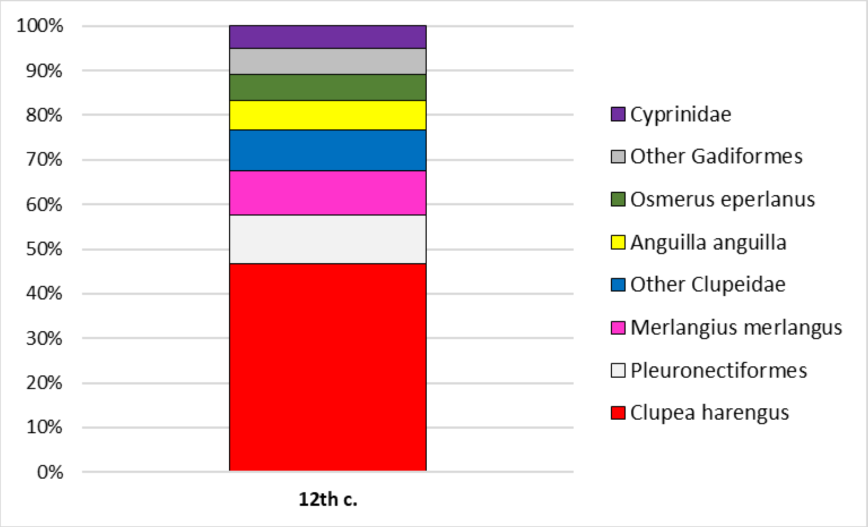


Fig. 5.10.5: Frequencies for the 8 most common taxa for **12th c.** (NISP: 120), for fine-sieved material (FS: 1 mm). Threshold by phase: tot NISP ≥ 100.

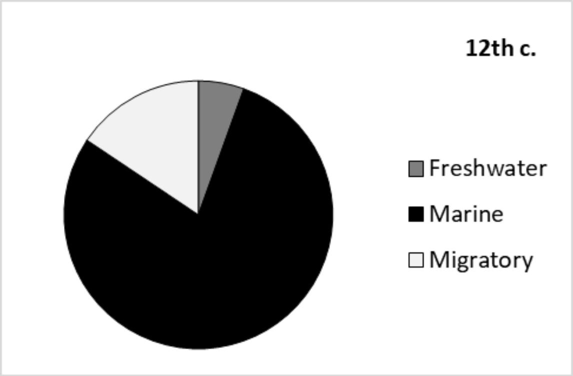


Fig. 5.10.6: Frequencies of habitat distribution for **12th c.** (NISP: 109) for fine-sieved material (FS: 1 mm). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

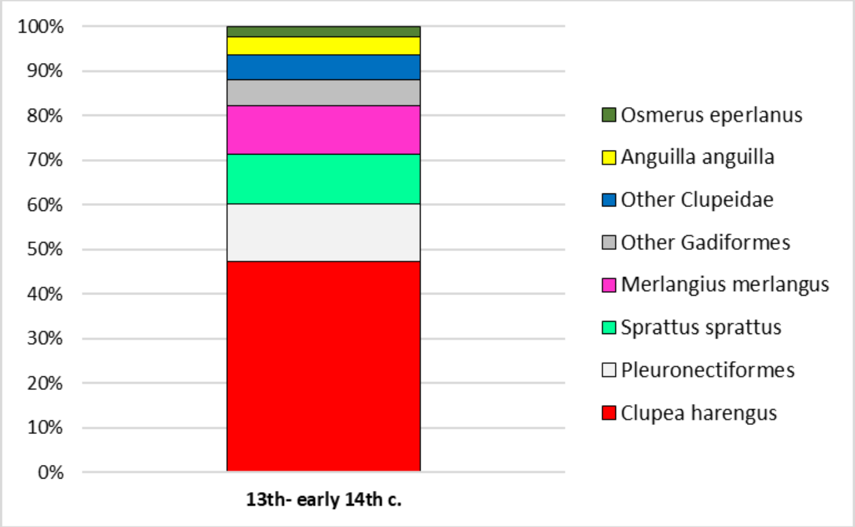


Fig. 5.10.7: Frequencies for the 8 most common taxa for **13th- early 14th c.** (NISP: 296), for fine-sieved material (FS: 1 mm). Threshold by phase: tot NISP ≥ 100.

TAXA	13th- early 14th c.	An.E.	14th c.	An.E.
Clupea harengus	3	vertebrae	2	MAX

Table 5.10.6: MNI by chronology for *Clupea harengus* for fine-sieved material (FS: 1 mm). Threshold by phase: taxa NISP ≥ 100. An.E. is the anatomical element used for MNI calculation. MAX: maxilla.

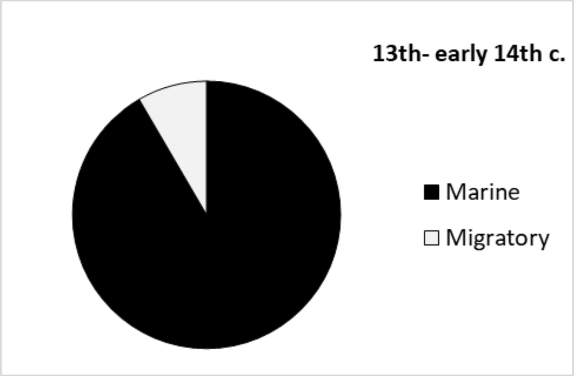


Fig. 5.10.8: Frequencies of habitat distribution for **13th- early 14th c.** (NISP: 262) for fine-sieved material (FS: 1 mm). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

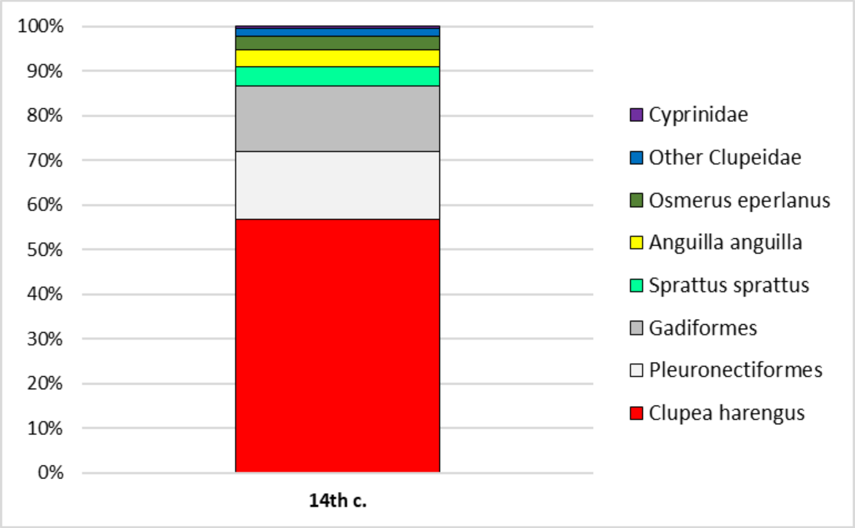


Fig. 5.10.9: Frequencies for the 8 most common taxa for **14th c.** (NISP: 231), for fine-sieved material (FS: 1 mm). Threshold by phase: tot NISP ≥ 100.

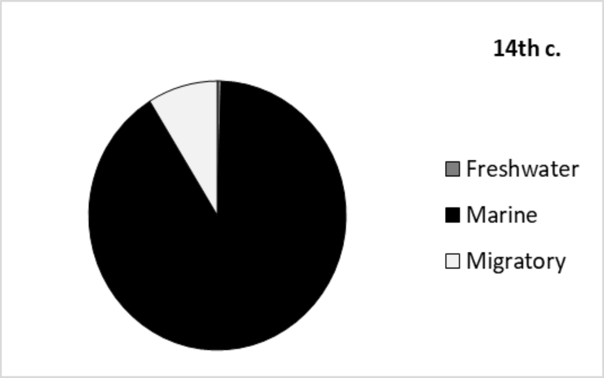


Fig. 5.10.10: Frequencies of habitat distribution for **14th c.** (NISP: 204) for fine-sieved material (FS: 1 mm). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

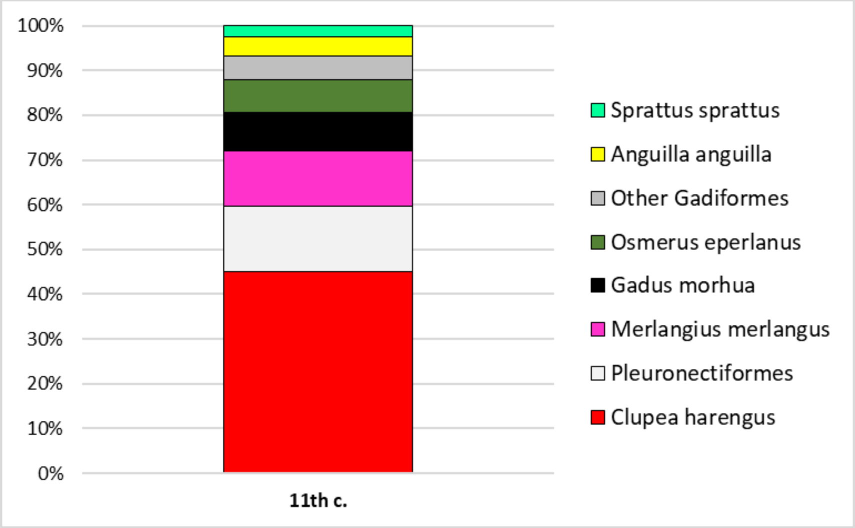


Fig. 5.10.11: Frequencies for the 8 most common taxa for **11th c.** (NISP: 246), for mixed recovery material (MIX). Threshold by phase: tot NISP ≥ 100.

TAXA	11th c.	13th- early 14th c.	14th c.
Leuciscus leuciscus	1	0	0
Barbus barbus	0	0	1
Rutilus rutilus	0	2	1
Cyprinidae unid.	4	11	7

Table 5.10.7: NISP for the Cyprinidae family by chronology for mixed recovery material (MIX) based on all counted specimens and pharyngeal bones; although regarded as not countable, pharyngeal bones will be represented in this table because they have been consistently recorded for all Cyprinidae.

HABITAT	11th c.	12th c.	13th- early 14th c.	14th c.	15th c.
Freshwater	4	0	12	8	0
Marine	205	24	687	231	6
Migratory	30	0	74	17	2
Other	29	0	101	36	0

Table 5.10.8: Taxa habitat distribution by chronology, for mixed recovery material (MIX).

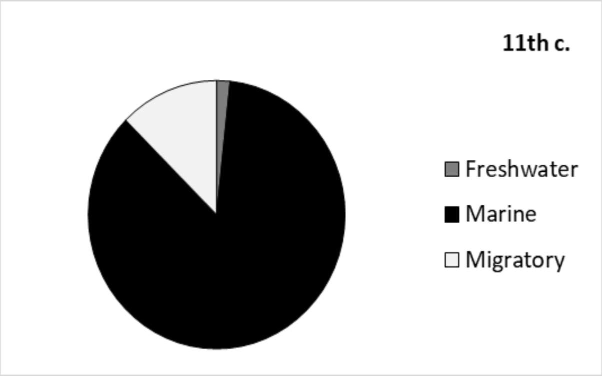


Fig. 5.10.12: Frequencies of habitat distribution for **11th c.** (NISP: 239) for mixed recovery material (MIX). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

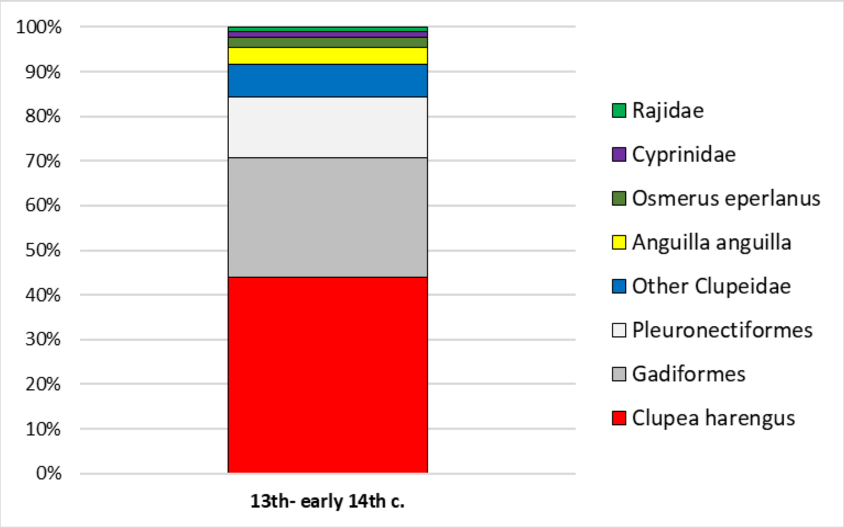


Fig. 5.10.13: Frequencies for the 8 most common taxa for **13th-early 14th c.** (NISP: 849), for mixed recovery material (MIX). Threshold by phase: tot NISP ≥ 100.

TAXA	13th- early 14th c.	An.E.
Clupea harengus	5	vertebrae
Large Gadiformes	2	various

Table 5.10.9: MNI for **13th-early 14th c.** for main taxa for mixed recovery material (MIX). Within Large Gadiformes, *Merlangius merlangus* and cfr. *Trisopterus minutus* are excluded. Threshold by phase: taxa NISP ≥ 100. **An.E.** is the anatomical element used for MNI calculation.

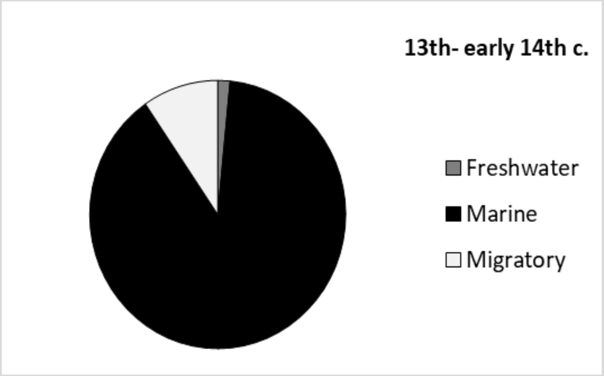


Fig. 5.10.14: Frequencies of habitat distribution for **13th-early 14th c.** (NISP: 773) for mixed recovery material (MIX). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

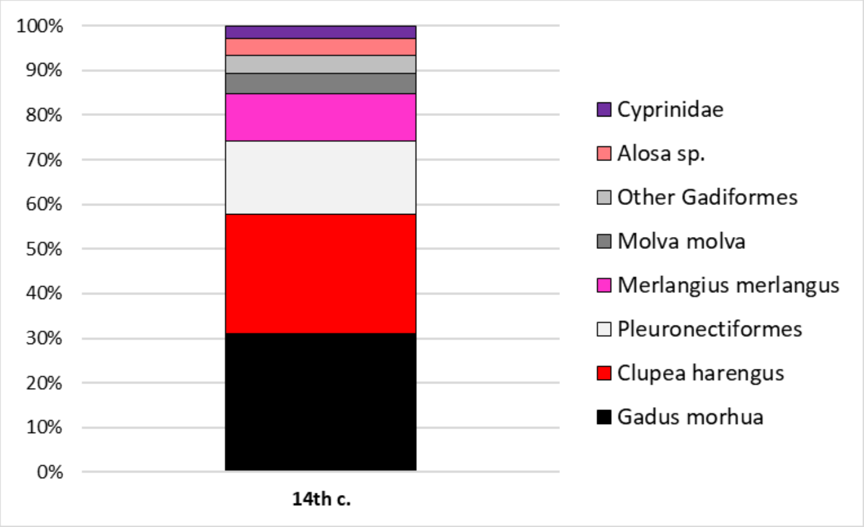


Fig. 5.10.15: Frequencies for the 8 most common taxa for **14th c.** (NISP: 270), for mixed recovery material (MIX). Threshold by phase: tot NISP ≥ 100.

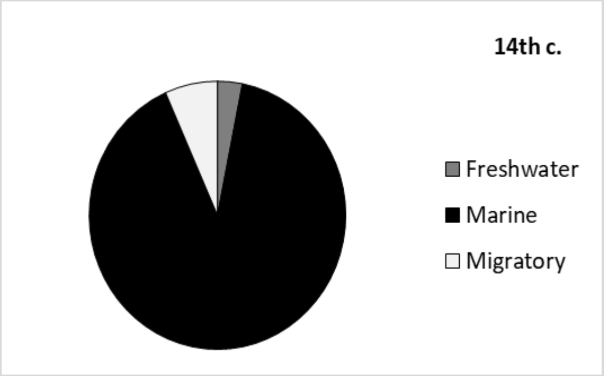


Fig. 5.10.16: Frequencies of habitat distribution for **14th c.** (NISP: 256) for mixed recovery material (MIX). "Other" excluded. Threshold by phase: tot NISP ≥ 100.

GROUP	**Element**		*Clupea harengus*	
			13th- early 14th c.	**14th c.**
I	**A**	Articular	0	1
	B	Basioccipital	0	0
	D	Dentary	0	0
	ECT	Ectopterygoid	0	0
	ENT	Entopterygoid	0	0
	HYO	Hyomandibular	0	0
	INT	Interopercular	0	0
	MAX	Maxilla	1	2
	OP	Opercular	0	0
	OT	Otolith	0	0
	PA	Palatine	0	0
	PAR	Parasphenoid	0	1
	PRE	Preopercular	0	0
	PX	Premaxilla	0	0
	Q	Quadrate	0	0
	SUB	Subopercular	0	0
	VOM	Vomer	0	0
II	**CE**	Ceratohyal	0	0
	EHY	Epihyal	1	0
	URO	Urohyal	0	1
III	**BAP**	Basipterygium	0	0
	CL	Cleithrum	0	0
	CO	Coracoid	0	0
	PSC	Postcleithrum	0	0
	PST	Posttemporal	0	0
	S	Scapula	0	0
	SUP	Supracleithrum	0	0
IV	**PCV1 (PCV2)**	1st (2nd) precaudal vertebra	3	4
	AAV	Anterior abdominal vertebra	3	2
	PAV	Posterior abdominal vertebra	3	2
V	**CV**	Caudal vertebra	2	3
	LC	Last caudal vertebra	2	4
VI	**VC**	Vertebral body (centrum)	0	0

Table 5.10.10: Anatomical element distribution (MAU) by chronology for *Clupea harengus*, for fine-sieved material (FS: 1 mm). Group I = Head elements (Minus II): Neurocranium, jaws, gill arches, gill covers; Group II = Head elements: Outer branchial skeleton; Group III = Pectoral and pelvic skeleton; Group IV = Precaudal vertebra; Group V = Caudal vertebrae; Group VI = undefined vertebrae.

GROUP	Element		*Clupea harengus*	Large Gadiformes
			13th- early 14th c.	**13th- early 14th c.**
I	**A**	Articular	3	2
	B	Basioccipital	0	1
	D	Dentary	1	0
	ECT	Ectopterygoid	1	1
	ENT	Entopterygoid	0	0
	HYO	Hyomandibular	1	1
	INT	Interopercular	0	0
	MAX	Maxilla	1	1
	OP	Opercular	1	0
	OT	Otolith	0	2
	PA	Palatine	0	0
	PAR	Parasphenoid	1	0
	PRE	Preopercular	1	0
	PX	Premaxilla	1	2
	Q	Quadrate	1	2
	SUB	Subopercular	1	0
	VOM	Vomer	0	1
II	**CE**	Ceratohyal	1	0
	EHY	Epihyal	3	0
	URO	Urohyal	4	0
III	**BAP**	Basipterygium	0	0
	CL	Cleithrum	0	1
	CO	Coracoid	0	0
	PSC	Postcleithrum	0	0
	PST	Posttemporal	0	0
	S	Scapula	0	0
	SUP	Supracleithrum	1	2
IV	**PCV1 (PCV2)**	1st (2nd) precaudal vertebra	6	0
	AAV	Anterior abdominal vertebra	7	3
	PAV	Posterior abdominal vertebra	4	3
V	**CV**	Caudal vertebra	5	2
	LC	Last caudal vertebra	7	1
VI	**VC**	Vertebral body (centrum)	0	0

Table 5.10.11: Anatomical element distribution (MAU) for **13th-early 14th c.** for main taxa, for mixed recovery material (MIX). Within Large Gadiformes, *Merlangius merlangus* and cfr. *Trisopterus minutus* are excluded. Group I = Head elements (Minus II): Neurocranium, jaws, gill arches, gill covers; Group II = Head elements: Outer branchial skeleton; Group III = Pectoral and pelvic skeleton; Group IV = Precaudal vertebra; Group V = Caudal vertebrae; Group VI = undefined vertebrae.

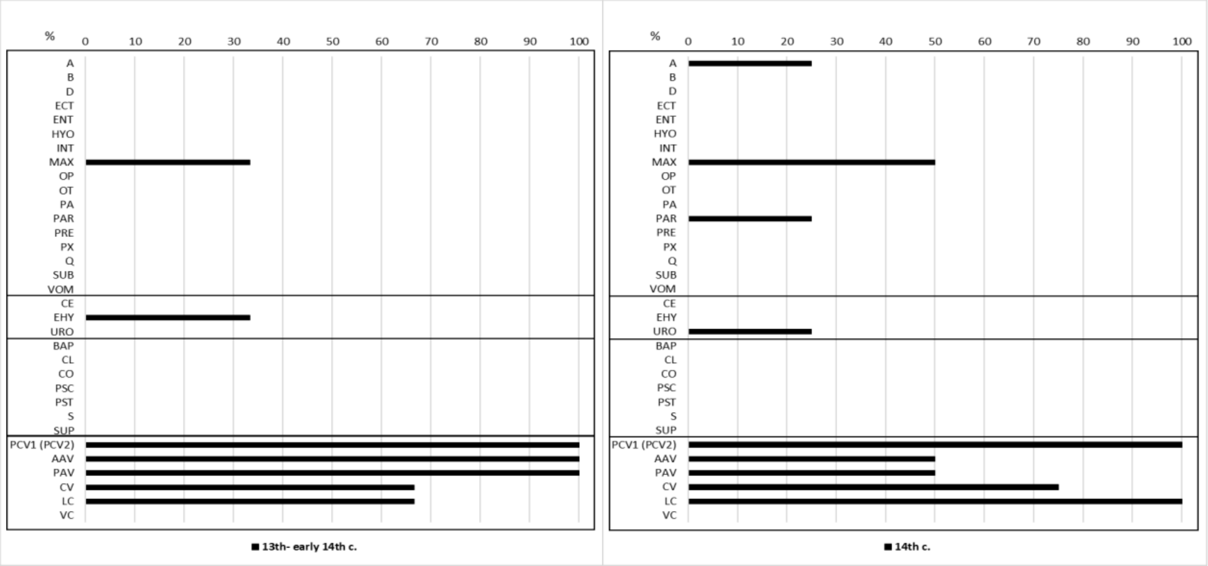


Fig. 5.10.17-18: Frequencies of anatomical element distribution (MAU) for *Clupea harengus*, **13th-early 14th c.** and **14th c.,** for fine-sieved material (FS: 1 mm). Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

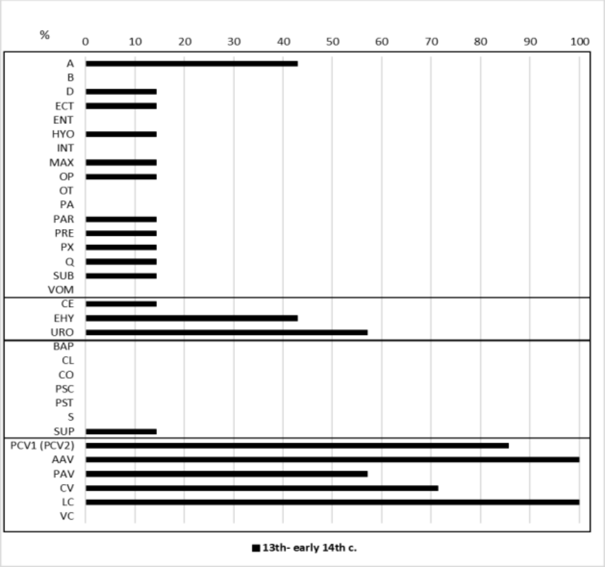


Fig. 5.10.19: Frequencies of anatomical element distribution (MAU) for *Clupea harengus*, **13th- early 14th c.**, for mixed recovery material (MIX). Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

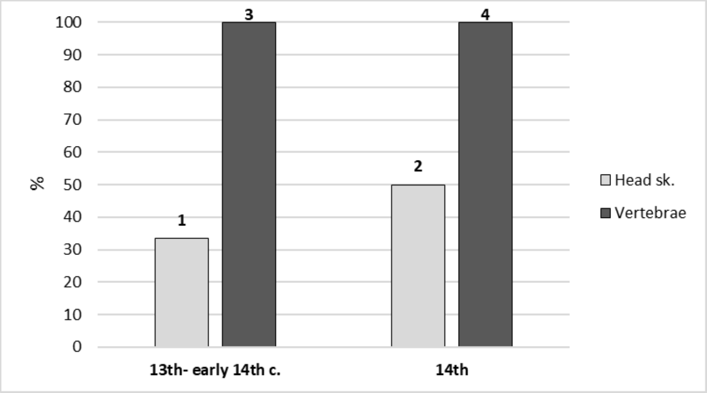


Fig. 5.10.20: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Clupea harengus* by chronology, for fine-sieved material (FS: 1 mm).

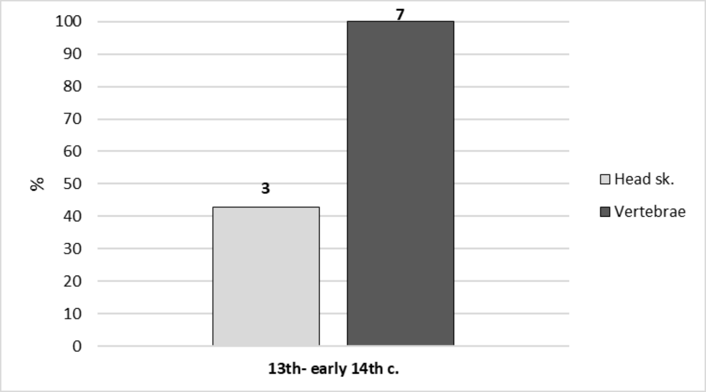


Fig. 5.10.21: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Clupea harengus* for **13th-early 14th c.**, for mixed recovery material (MIX).

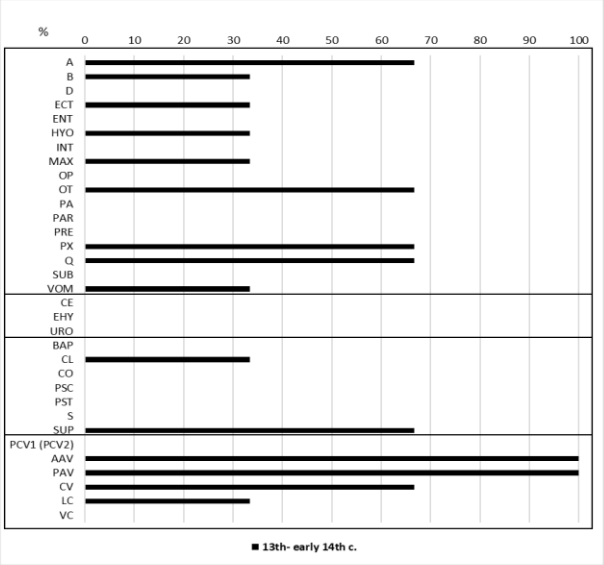


Fig. 5.10.22: Frequencies of anatomical element distribution (MAU) for large Gadiformes *(Merlangius merlangus,* cfr. *Trisopterus minutus* excluded*)*, **13th-early 14th c.,** for mixed recovery material (MIX). Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

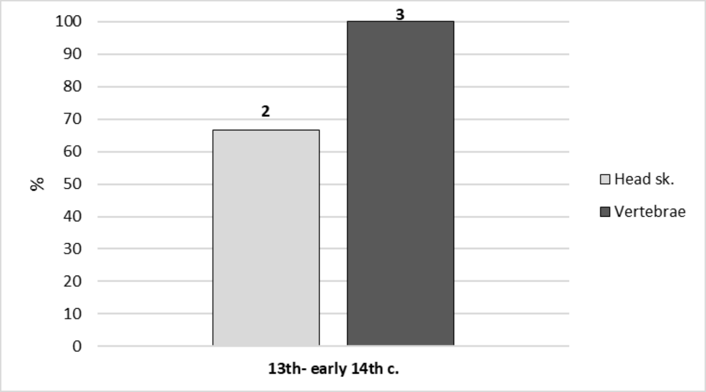


Fig. 5.10.23: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae for large Gadiformes (*Merlangius merlangus,* cfr. *Trisopterus minutus* excluded) for **13th-early 14th c.**, for mixed recovery material (MIX).

TAXA **Burning**	*Merlangius merlangus*	**TOT**
Burned	1	1
Tot burned		1 (0.2%)

Table 5.10.12: Taphonomic modifications for **11th c.** material, total NISP 381, all recovery methods.

TAXA	*Gadus morhua*	*Clupea harengus*	**TOT**
Burning			
Burned	0	1	1
Tot burned			1 (0.6%)
Butchery marks			
Chop	2		2
Tot butchered			2 (1%)

Table 5.10.13: Taphonomic modifications for **12th c.** material, total NISP 144, all recovery methods.

TAXA	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	**TOT**
Burning												
Burned	0	1	0	1	1	0	0	0	0	1	0	4
Calcined	0	1	0	2	0	0	0	0	0	0	0	3
Tot burned	0	2	0	3	1	0	0	0	0	1	0	7 (0.6%)
Other modifications												
Crushed	0	2	4	0	1	2	2	1	1	0	1	14
Tot modified												14 (1%)
Butchery marks												
Chop	4	0	0	0	0	0	0	0	0	0	0	4
Tot butchered												4 (0.3%)

Table 5.10.14: Taphonomic modifications for **13th-early 14th c.** material, total NISP 1173, all recovery methods. ***1)*** *Gadus morhua*, ***2)*** *Clupea harengus*, ***3)*** Pleuronectidae, ***4)*** *Melanogrammus aeglefinus*, ***5)*** Gadiformes, ***6)*** *Anguilla anguilla*, ***7)*** Clupeidae, ***8)*** *Osmerus eperlanus*, ***9)*** *Merlangius merlangus*, ***10)*** *Pleuronectes platessa/ Platichtys flesus*, ***11)*** *Alosa* sp.

TAXA	*Gadus morhua*	*Molva molva*	*Clupea harengus*	*Merlangius merlangus*	*Scomber scombrus*	**TOT**
Burning						
Calcined	0	0	0	1	0	1
Tot burned						1 (0.2%)
Other modifications						
Crushed	0	0	3	0	1	4
Tot modified						4 (0.7%)
Butchery marks						
Chop	4	2	0	0	0	6
Tot butchered						6 (1%)

Table 5.10.15: Taphonomic modifications for **14th c.** material, total NISP 527, all recovery methods.

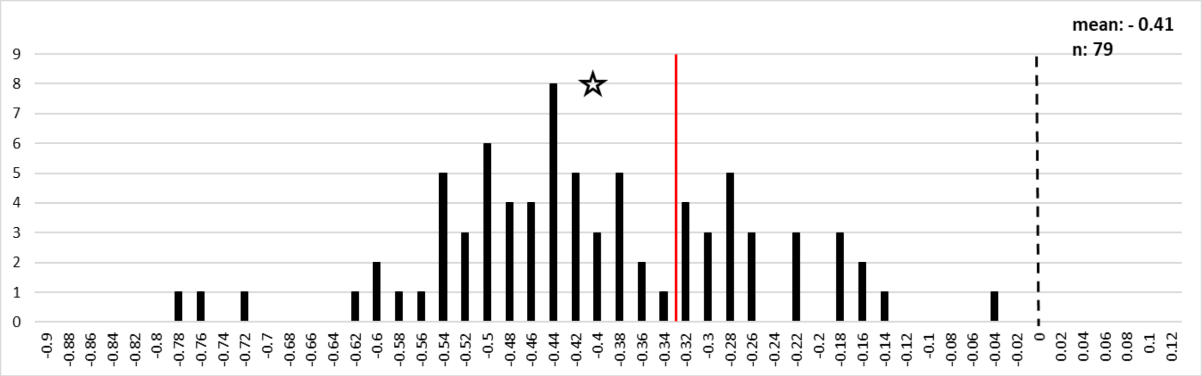


Fig. 5.10.24: Size distribution for all anatomical elements for *Anguilla anguilla*, **13th-early 14th c**. The star indicates the mean (-0.41). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 29; n measures: 79.

5.11 Milk Street, City of London

The analysis of the archaeological evidence from Milk Street is part of a project combining four different excavations (1976-1980) on four streets leading to Cheapside, the most important commercial street of the medieval City of London. Unless otherwise indicated, the following information about the site is extracted from the publication of these excavations (Schofield *et al.* 1990).

5.11.1 The site: Milk Street (MLK76)

The site of 1-6 Milk Street is located on the eastern side of the modern Milk Street, a lane running north of the famous Cheapside, London (Fig. 5.11.1).

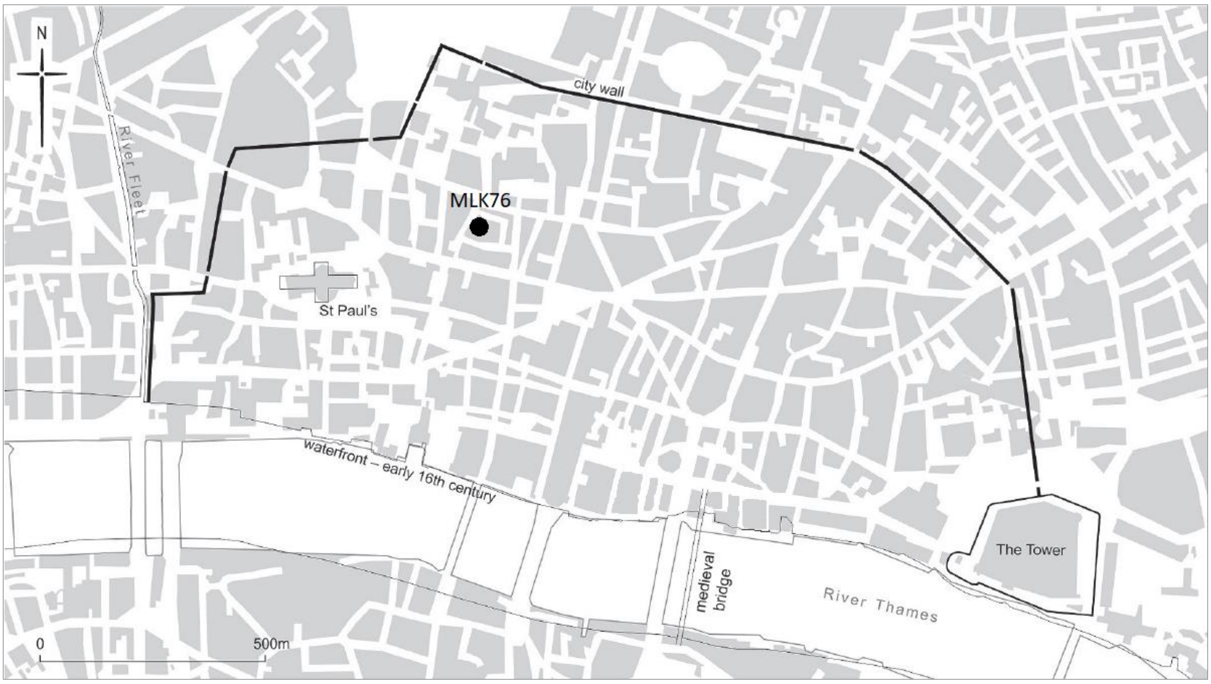


Fig. 5.11.1: Location of the site (Milk Street-MLK76) within the City of London (modified by Schofield *et al.* 2018, 1).

In this area, documentary sources indicate a high degree of occupational specialisation and social stratification in medieval times. The street frontages and the back lands were used as residences, but also for trading (generally as shops on the frontage of the street) and for artisanal activities and manufacturing. Consequently, wealthy merchants lived alongside craftsmen, shopkeepers and people of lower status. Milk Street was probably mostly a residential area; some of the building belonged to particularly rich owners, including members of the Crown and, from the 13th c., a small Jewish community was established in the area. Those involved in trade were wealthy merchants, such as mercers, drapers, tailors, pepperers, grocers and goldsmiths. In some phases the properties belonged to the nearby church of St. Magdalene and rented out to increase the income of the parish.

5.11.1.1 Excavations and zooarchaeological studies

The first excavation of the site was carried out in 1972 by the City of London Archaeological Society, prior redevelopments.

Further archaeological investigations were performed by the Department of Urban Archaeology (Museum of London) in 1976 and funded by the Department of the Environment and Wates Development Ltd.

The excavations revealed a long archaeological sequence spanning from Roman to post-medieval times; at the main site (MLK76), four medieval properties (Tenements 2-5) were uncovered on the east side of the street. A further Tenement 6 was later identified from the previous 1972 excavation.

Animal bones have been studied by Gordon (Gordon & Schofield in prep.), while fish remains were studied by Locker (1985) and were part of a larger project on fish exploitation in the City of London (Orton *et al.* 2016).

5.11.2 Material and recording methods

Fish remains were recovered from various Roman to post-medieval contexts. For the purpose of this research, only material dated from the **mid-11th c.** to the late **14th c.** has been analysed. The relevant contexts are represented by features associated with the main buildings, such as pits, cesspits and occupation layers. Prominent contexts include pit 116 (dated 1230-1270), a stone-lined cesspit connected with the stone house Tenement I, which contained fish bones, wooden items and other food remains. Pit 117 was another stone-lined cesspit connected with Tenement 4, containing fish bones and material dated to the late 14th c. (most notably a papal bull). Pit 5 was used as a hearth, which subsided into an underlying cesspit on the north of Tenement 3.

Unfortunately, the nature and chronology of some contexts could not be tracked down, and they had to be excluded from the research.

Locker (1985) states that the fish remains were recovered both by hand-collection and sieving. Information about mesh size is unreported, and also not specified on the bags containing the material, with the exception of nine bones retrieved from a 1 mm fraction. It is also possible that hand-collected and sieved material was in some cases combined as large and very small bones could be found in the same bags; this, however, could also be the consequence of whole hearth sampling. Consequently, two categories of material were established: sieved and mixed.

The material was further grouped by chronological periods (**mid-late 11th c.**, **12th c.**, **mid-late 13th c.**, **mid-late 14th c**.), but not by area, due to the lack of contextual information in some cases but also because further subdivision of the material would have drastically decreased the sample size. Material generically date to the **mid-11th -late 12th c.** was included in some aspects of the analysis but taking care of not compromising the chronological integrity of the more tightly dated **mid-late 11th** and **12th c.** periods.

5.11.3 Results

A grand total of 3,083 fish remains were counted; of these, 1,558 were identified taxonomically (with various degrees of precision) and 1,492 were recorded as countable specimens.

Only one scale was identified from pit 116 and the dearth of this anatomical element may be a consequence of the lack of flotation; around 15 dermal denticles were recovered from various contexts belonging to Rajidae. Neither scales nor dermal denticles were included in the quantification of the data (see Methods Chapter).

In general, completeness of the bones was good, with nearly 90% of the elements represented by more than 50% of their original size (Table 5.11.1, Fig. 5.11.2) and a medium level of preservation of the bone surface (Table 5.11.2, Fig. 5.11.3); the best preserved assemblage is the one from the **12th c**.

5.11.3.1 Taxonomic frequencies

Sieved material

Only one bone belonging to Gadiformes and two to eel were recovered from the **mid- late 11th c.** sieved samples (Tables 5.11.3-4).

The sieved assemblage for the **12th c.** was larger (Table 5.11.2, Fig. 5.11.4) and was represented for 45% by Clupeidae. Most Clupeidae were identified as herring, but sprat was present; the other unidentified Clupeidae bones were mostly small vertebrae probably belonging to herring, but not easily distinguishable from sprat. The next most common taxon is represented by Cyprinidae (22%), mostly unidentified, though one pharyngeal bone matched minnow morphology well (Table 5.11.5). Other common taxa include smelt (21%), eel (5%), and Pleuronectiformes (2%), among which plaice and plaice/flounder were identified. Less common taxa are represented by Gadiformes (1%), with one withing identified, and Salmonidae (0.5%). No taxa reached the threshold for MNI calculation.

Habitat distribution shows that the sieved fraction is mostly represented by marine taxa (48%), but migratory (28%) and freshwater (23%) fish are also well represented (Table 5.11.4, Fig. 5.11.5).

Mixed recovery material, hand-collected and sieved

NISP calculation for the mixed recovery sample from the **mid- late 11th c.** (Table 5.11.3, Fig. 5.11.6) shows again Clupeidae dominating the assemblage, in particular herring (30%); other Clupeidae (16%) include shad (*Alosa alosa*/*Alosa fallax*), but most specimens identified at family level are probably represented by small herrings. Also well represented are withing (14%) and Pleuronectiformes (11%), mostly Pleuronectidae, though sole, plaice and flounder have also been recorded. Other taxa include eel (10%), mackerel (7%) cod (6%) and other Gadiformes (2%), among which haddock was identified. Other species are present in negligible numbers, but the presence of smelt is worth noticing. No taxa reached the threshold for MNI calculation.

The assemblage is mostly represented by marine fish (80%), the rest being migratory (20%), while freshwater taxa were completely absent (Table 5.11.6, Fig. 5.11.7).

The **12th c.** mixed recovery sample is the largest (Table 5.11.3, Fig. 5.11.8) and shows a frequency of taxa that is more similar to the previous periods than the contemporary sieved sample. The three most common taxa are herring (51%), followed by Pleuronectiformes (16%) and withing (11%). Among the Pleuronectiformes, plaice, plaice/flounder, sole and dab have been identified. Cod is represented by 7% of the identified material, eel 5% and other Gadiformes, which include haddock, by 3%. The Cyprinidae (2%) could only be identified at family level (Table 5.11.5) and a few remains of smelt (1%) were recovered. Other taxa are uncommon, but it is worth mentioning the presence of pike and Salmonidae.

The MNI calculation shows herring represented by six individuals (Table 5.11.7).

Most of the assemblage is represented by marine taxa (87%), with the rest split between migratory (9%) and freshwater (4%) fish (Table 5.11.6, Fig. 5.11.9).

No major changes occur in the **mid-11th -late 12th c.** material (Table 5.11.3, Fig. 5.11.10), which is once again dominated by herring, Pleuronectiformes and withing. Freshwater taxa, which were absent in the previous period, are represented by Cyprinidae (3%), with one pharyngeal bone attributed to roach (Table 5.11.5), and pike. Nonetheless, marine taxa still dominate the assemblage (Table 5.11.6, Fig. 5.11.11).

Sample size is small in the mixed recovery assemblages from the **mid- late 13th c.** and **mid- late 14th c.**, which include no freshwater taxa (Tables 5.11.3, 5.11.6).

5.11.3.2 Anatomical element distribution

The analysis of anatomical element distribution, following the thresholds established by the recording protocol, was only possible for herring recovered from the **12th c.** mixed recovery sample (Table 5.11.8). The species is primarily represented by vertebrae, in particular anterior-abdominal vertebrae (Fig. 5.11.12). The MAU comparison of heads versus vertebrae shows a prevalence of the latter, though head elements are reasonably well-represented (Fig. 5.11.13).

5.11.3.3 Taphonomic alterations

Taphonomic evidence for **mid- late 11th c.** and **mid-11th -late 12th c.** is scarce (Tables 5.11.9-10), with only a few bones calcined and crushed (mechanical and/or chemical bone deformation, Chapter 4).

Even in the larger **12th c.** sample (Table 5.11.11), taphonomic alterations were not common; only about 3% of the identified bones showed evidence of burning and less than 1% showed crushing and butchery marks. A variety of species was affected, but most taphonomic modifications were observed on herring bones, reflecting the abundance of this species in the assemblage. The only chop mark was observed on the parasphenoid of a cod of 75-100 cm of total length; furthermore, five cuts were recorded on a cleithrum belonging to a cod of approximately 50-75 cm of total length.

5.11.3.4 Biometrical analysis

Only 5 bones could be measured for pike recovered from the **mid-11th -late 12th c.** and **12th c.** samples, mostly belonging to individuals around 30-40 cm of total length. Furthermore, a broken dentary belonged to an individual smaller than a modern pike of 15 cm of total length.

Measurements for Cyprinidae are scanty but sufficient to produce a log ratio histogram for the **12th c.** sample (Fig. 5.11.14). These appear to be widely and heterogeneously distributed around the mean value, which is smaller than the standard represented by a modern roach of 19 cm of total length. This broad distribution of values is expected as it reflects the likely occurrence of different species.

A Cyprinidae caudal vertebra, which is not included in the log ratio diagram (see Chapter 4), was more than twice as large as the first caudal vertebra of the standard value.

The few measurements available for Cyprinidae from **mid-11th -late 12th c.** representing individuals of approximately the same size as the standard.

Eel measurements for **mid- late 11th c.** are also scanty and represent mostly individuals smaller than 49 cm of total length; some very small eels were probably only a few centimetres long.

For the **12th c.** a greater number of eel measurements allowed to produce a log ratio histogram (Fig. 5.11.15). These are heterogeneously distributed around the mean value and, on average, smaller than the marker of 49 cm of total length (red line). Only a few measurements are larger than the marker, but none approach the standard value (0) of 96 cm of total length. One broken vomer from this sample belonged to an individual of over 1 m of total length, likely representing a female silver eel (considering that males rarely grow beyond 54 cm of total length; Tesch 2003, 168).

The distribution of eel measurements for the **mid-11-late 12th c.** (Fig. 5.11.16) is largely similar to the 12th c. sample, though more homogeneous.

A few measurements for eel from the **mid- late 14th c.** sample represent individuals with similar sizes to the earlier samples, i.e., on average, slightly smaller than the marker of 49 cm of total length (red line).

5.11.4 Discussion

When comparing data from different periods it is essential to consider sample size differences and comparability of recovery methods; in this regard, the largest sample with better recovery is from the **12th c.** and, to a lesser extent, from the **mid- late 11th c.**, so the discussion will focus on diachronic changes between these two phases.

In all periods, herring is the most common species, with the exception of the small sample from the **mid-late 14th c.** Considering the herring small size, its abundance in the mixed recovery samples is indicative of the presence of a significant quantity of sieved material, especially from the **12th c.** sample.

The frequency rank of herring (and in general Clupeidae), withing and Pleuronectiformes is constant throughout the chronological sequence; however, in the **12th c.** assemblage there is a higher proportion of Pleuronectiformes and a higher focus on large Gadiformes, especially cod, which is partially confirmed also by the overlapping **mid-11-late 12th c.** sample. In the **12th c.** there is a larger variety of species, particularly marine, which reflect the larger sample size. Again, this is to some extent confirmed by the **mid-11-late 12th c. assemblage**.

Freshwater fish appears in the assemblage only in the **12th c.** and in the **mid-11-late 12th c.** material. The sieved **12th c.** sample shows a very different range of taxa from the mixed recovery samples, unsurprisingly more focused on smaller species, a greater frequency of freshwater fish. Nevertheless, there can be no question about the fact that in all periods the fish diet was largely based on marine species. Such a large variety of marine dish, such as herring, sprat, cod, whiting, haddock, mackerel, rays, gurnards, sole, conger, garfish, is probably a consequence of the location of the site, which is close to the coast, and the large availability of species on the London market. These would have been sourced from the coastal area and sea near the Thames estuary, with the exception perhaps of the larger Gadiformes, such as adult cod, which would have been fished offshore. Considering the wide range of taxa, the rarity of some of the species, and the easy accessibility of the coast, it is likely that some of the fish was purchased and consumed fresh.

Freshwater and migratory fish would have probably also been purchased at the market, while the river would have provided eel, Cyprinidae, pike, salmon/trout and possibly flounder. All the species mentioned above were typically consumed fresh, with the exception of eel which was consumed both fresh and preserved (e.g. salted, smoked). The smallest Cyprinidae (e.g. minnow or juvenile individuals) could represent an accidental catch or the gut content of larger predators, such as pike, though no particularly large pike was found. There is no reason to think that these small individuals would not be eaten, as, in medieval times, small freshwater species were often consumed fresh in soups, pies, pastries or preserved as pickles (e.g. Klemettilä 2012; Locker 2018b). The distribution of Cyprinidae size does not suggest methodical and managed fishing, but rather the bycatch of other targeted species, such as eel. The rarity and small size of pike also suggest that the fish was an occasional catch. Salmon/trout tend to be underrepresented in the archaeological record as their bones are particularly susceptible to taphonomic destruction (Hamilton-Dyer 2007, 181), though Wheeler (1979a, 22) suggests that salmon may have been scarce in the Thames in medieval times.

There was intensive exploitation of the Thames estuary, which could have provided plaice/flounder, the seasonal smelt and shad, and possibly the smallest eel. Most eels live the first part of their lives (glass eel stage) in costal and estuarine areas and start to colonise rivers at the stage of elvers (from roughly 7-8 cm of total length; Churchward 1996 in Tesch 2003, 137). Most individuals found at Milk Street are around the size range of elvers and yellow/silver eel, which is when they live in rivers. However, the smallest individuals, possibly at the stage of glass eel, could have also been caught in the estuary. The large eel specimen from the **12th c.** was probably a sexually mature female caught on the autumnal seaward migration towards the spawning ground, the Sargasso Sea (see species overview in Chapter 1). The large fish would typically represent some special/prestigious meal. Eel size distribution for the **12th c.** is difficult to interpret; the wide range of sizes represents different stages of life of the fish and could suggest the availability of eel in different seasons; however, the diversity of measurements could indicate that eel was fished occasionally or from different sources.

As mentioned for other sites, smelt tends to be generally rare in medieval fish assemblages; London sites are an exception, as there was an important smelt fishery on the tidal Thames, which would follow the seasonal migrations of the fish (more productive in winter and early spring; Wheeler 1979b, 48; Locker 1992b, 1). Wheeler (1979b) refers also to the seasonal catching of white bait (juvenile herring, sprats) from the Thames estuary, where the proportion between herring and sprat would depend on the season (e.g. sprat was more abundant from February to April).

The anatomical element distribution for herring shows how the fish was probably eaten whole. A prevalence of vertebrae is noticeable, but this is likely to be the result of taphonomic bias, considering that head bones are particularly fragile and difficult to identify when highly fragmented. Herring was likely to be consumed in a preserved form (e.g. pickled, dried or salted), with gutting being the only preparatory action. Considering the relative short distance of the site from the coast, there could have been occasions when herring was consumed fresh and it cannot be excluded that some were beheaded prior cooking. Furthermore, Locker (1985, 2) has pointed out that the practice of smoking herring did not start until the late 13th c., and therefore this fish would be likely to have been marketed as pickled.

The few calcined bones could represent accidental or intentional disposal of kitchen and/or meal waste into the fire. Bone deformation recorded on small species, such as eel, smelt and Clupeidae, likely represents damage generated by human consumption and digestion (Jones 1984, 1986), thus demonstrating the occurrence of cess pit filling.

Cut and chop marks on large cod parasphenoid and cleithrum could represent decapitation of the fish, though head elements are sufficiently well-represented to rule out the possibility that cured, headless, cods were regularly introduced to the site.

Overall, the variability of the contexts containing fish remains is typical e of urban assemblages representing households of different status, as well as cultural and religious affiliation. The bulk of the fish diet was covered by marine fish, especially herring, which would have been eaten as preserved or fresh. Some use of local freshwater resources is attested, particularly from the **12th c.**, but there is very limited evidence of the occurrence of typical high status species.

Completeness	mid- late 11th c.	mid-11th -late 12th c.	12th c.	mid- late 13th c.	mid- late 14th c.
> 75% present	63	74	272	16	3
75-50% present	175	195	515	9	5
50-25% present	21	32	68	0	1
< 25% present	7	6	30	0	0

Table 5.11.1: Bone completeness by chronology, all recovery methods.

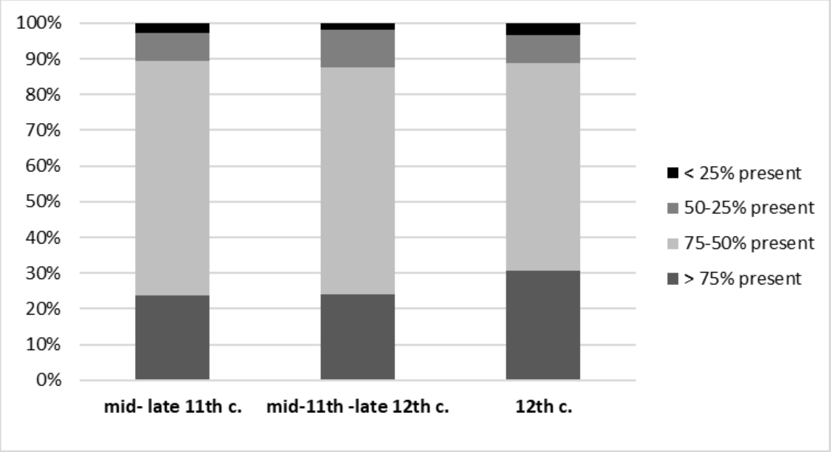


Fig. 5.11.2: Percentage of bone completeness by chronology (**mid- late 11th c.**, NISP: 266; **mid-11th -late 12th c.**, NISP: 307; **12th c.**, NISP: 885), all recovery methods.

Preservation	mid- late 11th c.	mid-11th -late 12th c.	12th c.	mid- late 13th c.	mid- late 14th c.
Excellent	2	4	111	0	0
Good	31	18	103	9	3
Medium	225	280	655	16	6
Bad	8	5	16	0	0
Awful	0	0	0	0	0

Table 5.11.2: Bone preservation by chronology, all recovery methods.

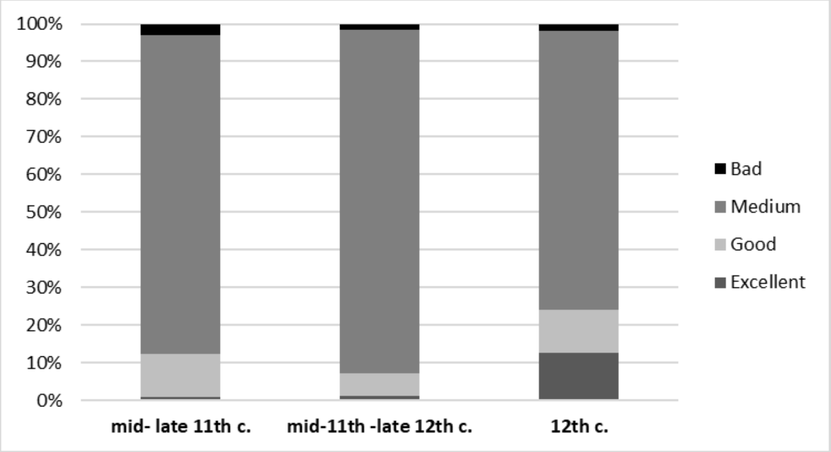


Fig. 5.11.3: Percentage of bone preservation by chronology (**mid- late 11th c.**, NISP: 266; **mid-11th -late 12th c.**, NISP: 307; **12th c.**, NISP: 885), all recovery methods.

TAXA		**mid- late 11th c.**		**mid-11th -late 12th c.**	**12th c.**		**mid- late 13th c.**	**mid-late 14th c.**	**TOT**
Latin name	**Common name**	**S**	**MIX**	**MIX**	**S**	**MIX**	**MIX**	**MIX**	
Clupea harengus	Atlantic herring	0	79	105	40	347	11	3	585
Merlangius merlangus	Whiting	0	37	43	1	78	5	0	164
Pleuronectiformes	-	0	25	40	3	82	3	1	154
Anguilla anguilla	European eel	2	27	28	10	35	1	4	107
Gadus morhua	Atlantic cod	0	18	25	0	50	1	0	94
Cyprinidae	-	0	0	9	42	19	0	0	70
Clupeidae	-	0	25	0	34	4	0	0	63
Osmerus eperlanus	European smelt	0	1	1	40	9	0	0	51
Alosa sp.	-	0	19	16	0	5	0	0	40
Scomber scombrus	Atlantic mackerel	0	19	12	0	7	1	0	39
Gadiformes	-	1	5	5	2	14	0	0	27
Pleuronectes platessa	European plaice	0	1	6	0	16	3	0	26
Pleuronectes platessa/Platichtys flesus	European plaice/flounder	0	0	10	1	8	0	0	19
Sprattus sprattus	European sprat	0	0	0	10	0	0	0	10
Melanogrammus aeglefinus	Haddock	0	3	0	0	6	0	1	10
Salmonidae	-	0	0	1	1	7	0	0	9
Solea solea	Common sole	0	3	1	0	2	0	0	6
Esox lucius	Northern pike	0	0	2	0	5	0	0	7
Belone belone	Garfish	0	0	1	0	3	0	0	4
Conger conger	European conger	0	0	1	0	1	0	0	2
Rajidae	-	0	1	1	0	0	0	0	2
Mugilidae	-	0	0	0	0	1	0	0	1
Triglidae	-	0	0	0	0	1	0	0	1
Limanda limanda	Common dab	0	0	0	0	1	0	0	1
*Platichthys flesus**	European flounder	0	*	0	0	0	0	0	0
*Raja clavata**	Thornback ray	0	*	*	0	*	0	0	0
*Rutilus rutilus**	Roach	0	0	*	0	0	0	0	0
*cfr. Phoxinus phoxinus**	cfr. Eurasian minnow	0	0	0	*	0	0	0	0
	TOTAL	266		307	885		25	9	1492

Table 5.11.3: NISP of taxa by chronology based on diagnostic elements (other records noted as *) for sieved (S) and possible mixed recovery (MIX) material. *Platichthys flesus** is represented by interhaemal spines (os anale), *Raja clavata** is represented by dermal denticles, *Rutilus rutilus** and cfr. *Phoxinus phoxinus** are represented by pharyngeal plates.

HABITAT	mid- late 11th c.	12th c.
Freshwater	0	42
Marine	1	87
Migratory	2	51
Other	0	4

Table 5.11.4: Taxa habitat distribution by chronology, for sieved material.

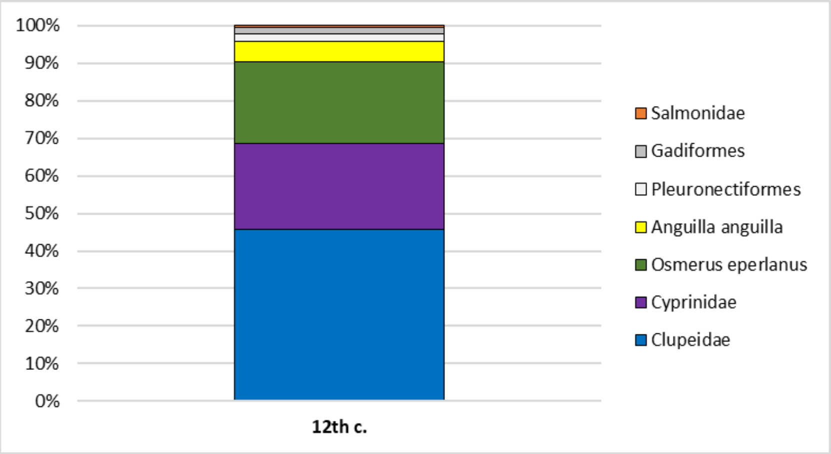


Fig. 5.11.4: Frequencies for the main taxa for **12th c.** (NISP: 184) for sieved material. Threshold by phase: tot NISP ≥ 100.

TAXA	mid-11th -late 12th c.	12th c.	
	MIX	S	MIX
cfr. Phoxinus phoxinus	0	1	0
Rutilus rutilus	1	0	0
Cyprinidae unid.	10	42	22

Table 5.11.5: NISP for the Cyprinidae family by chronology based on all counted specimens and pharyngeal bones; although regarded as not countable, pharyngeal bones will be represented in this table because they have been consistently recorded for all Cyprinidae.

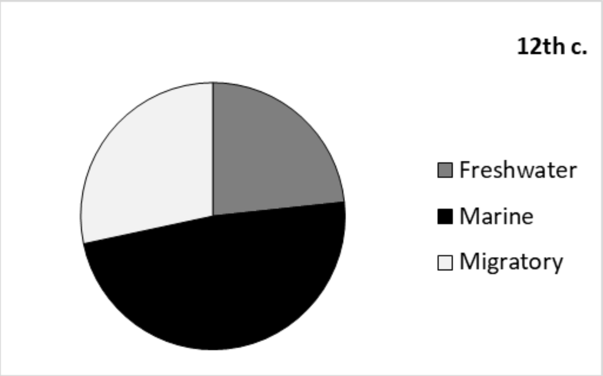


Fig. 5.11.5: Frequencies of habitat distribution for **12th c.** (NISP: 180) for sieved material. "Other" excluded. Threshold by phase: tot NISP ≥ 100.

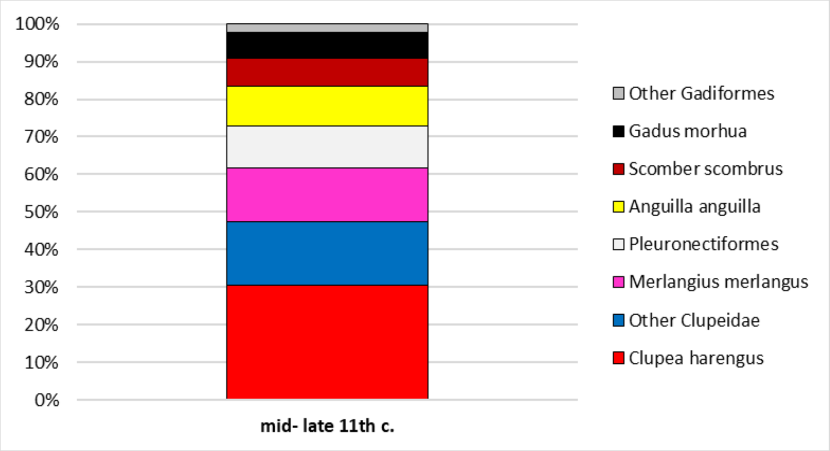


Fig. 5.11.6: Frequencies for the 8 most common taxa for **mid- late 11th c.** (NISP: 259) for mixed recovery material. Threshold by phase: tot NISP ≥ 100.

HABITAT	mid- late 11th c.	mid-11th -late 12th c.	12th c.	mid- late 13th c.	mid- late 14th c.
Freshwater	0	11	24	0	0
Marine	187	200	530	21	4
Migratory	47	46	57	1	4
Other	29	50	90	3	1

Table 5.11.6: Taxa habitat distribution by chronology, for mixed recovery material.

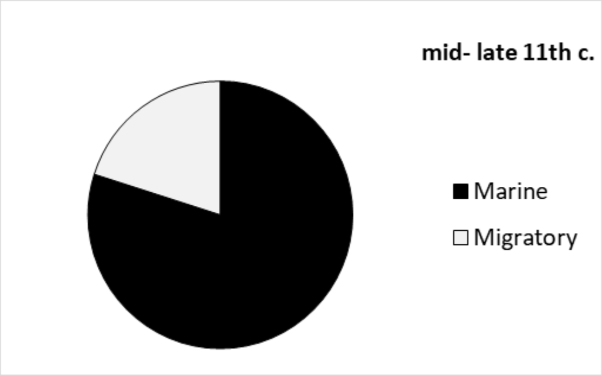


Fig. 5.11.7: Frequencies of habitat distribution for **mid- late 11th c.** (NISP: 234) for mixed recovery material. "Other" excluded. Threshold by phase: tot NISP ≥ 100.

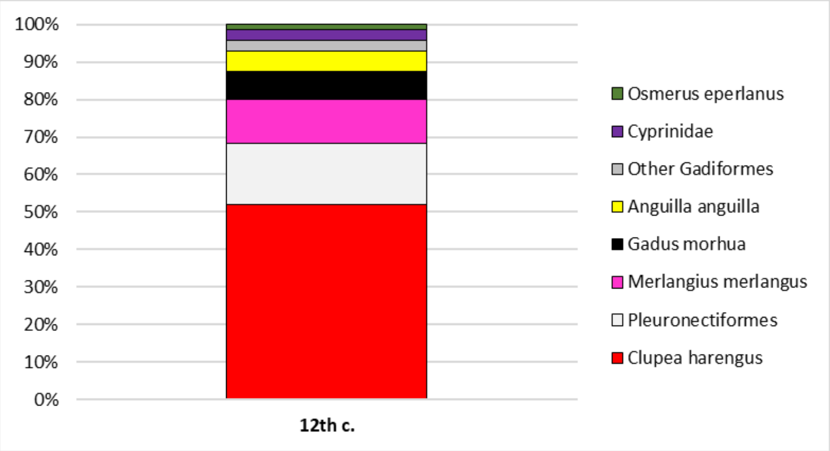


Fig. 5.11.8: Frequencies for the 8 most common taxa for **12th c.** (NISP: 667) for mixed recovery material. Threshold by phase: tot NISP ≥ 100.

TAXA	12th c.	An.E.
Clupea harengus	6	vertebrae

Table 5.11.7: MNI for **12th c.** period for *Clupea harengus*, for mixed recovery material. Threshold by phase: taxa NISP ≥ 100. **An.E.** is the anatomical element used for MNI calculation.

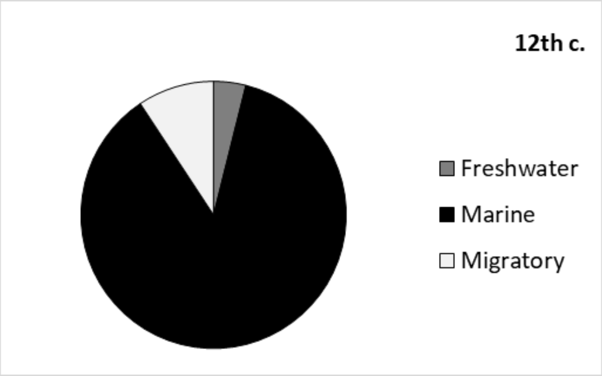


Fig. 5.11.9: Frequencies of habitat distribution for **12th c.** (NISP: 611) for mixed recovery material. "Other" excluded. Threshold by phase: tot NISP ≥ 100.

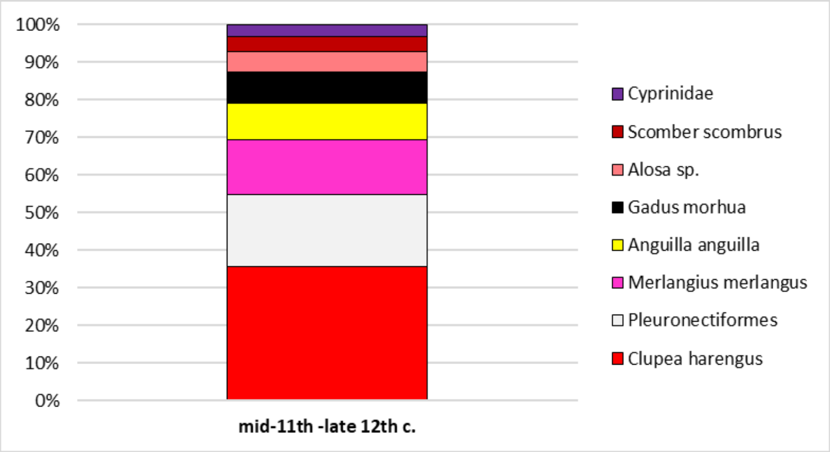


Fig. 5.11.10: Frequencies for the 8 most common taxa for **mid-11th -late 12th c.** (NISP: 295) for mixed recovery material. Threshold by phase: tot NISP ≥ 100.

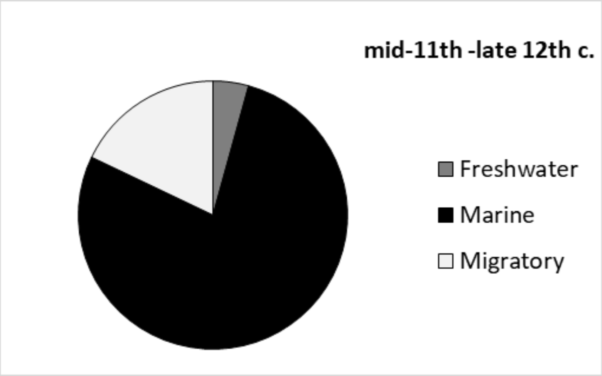


Fig. 5.11.11: Frequencies of habitat distribution for **mid-11th -late 12th c.** (NISP: 257) for mixed recovery material. "Other" excluded. Threshold by phase: tot NISP ≥ 100.

GROUP	Element		*Clupea harengus*
			12th c.
I	**A**	Articular	0
	B	Basioccipital	0
	D	Dentary	1
	ECT	Ectopterygoid	0
	ENT	Entopterygoid	1
	HYO	Hyomandibular	1
	INT	Interopercular	0
	MAX	Maxilla	4
	OP	Opercular	1
	OT	Otolith	0
	PA	Palatine	0
	PAR	Parasphenoid	2
	PRE	Preopercular	1
	PX	Premaxilla	0
	Q	Quadrate	1
	SUB	Subopercular	0
	VOM	Vomer	0
II	**CE**	Ceratohyal	3
	EHY	Epihyal	0
	URO	Urohyal	2
III	**BAP**	Basipterygium	0
	CL	Cleithrum	2
	CO	Coracoid	0
	PSC	Postcleithrum	0
	PST	Posttemporal	0
	S	Scapula	0
	SUP	Supracleithrum	1
IV	**PCV1 (PCV2)**	1st (2nd) precaudal vertebra	3
	AAV	Anterior abdominal vertebra	7
	PAV	Posterior abdominal vertebra	5
V	**CV**	Caudal vertebra	5
	LC	Last caudal vertebra	4
VI	**VC**	Vertebral body (centrum)	0

Table 5.11.8: Anatomical element distribution (MAU) **12th c.** for C*lupea harengus*, for mixed recovery material. Group I = Head elements (Minus II): Neurocranium, jaws, gill arches, gill covers; Group II = Head elements: Outer branchial skeleton; Group III = Pectoral and pelvic skeleton; Group IV = Precaudal vertebra; Group V = Caudal vertebrae; Group VI = undefined vertebrae.

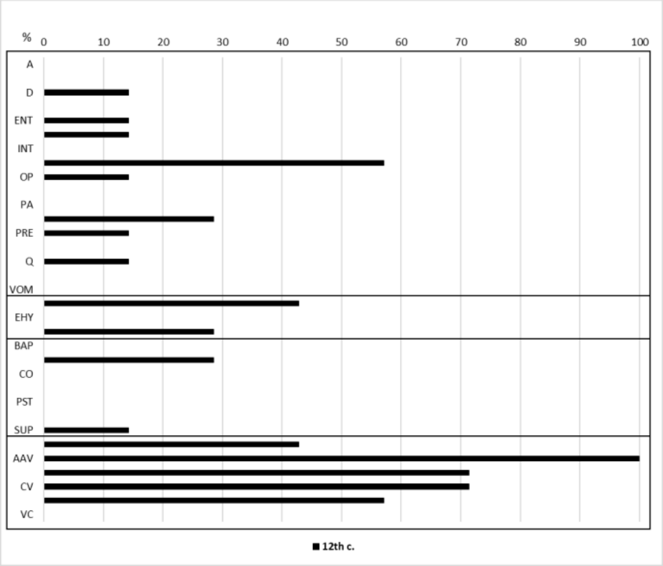


Fig. 5.11.12: Frequencies of anatomical element distribution (MAU) for *Clupea harengus*, **12th c.**, for mixed recovery material. Horizontal lines separate the different anatomical areas. Percentages are calculated out of the most common element; threshold by phase: taxa NISP ≥ 100 specimens.

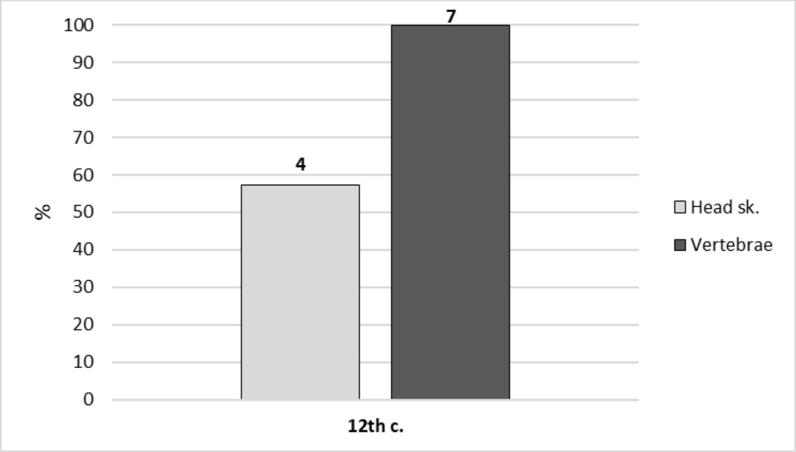


Fig. 5.11.13: Frequencies (MAU) of bones from the head skeleton *vs* vertebrae in *Clupea harengus* for **12th c.**, for mixed recovery material.

TAXA **Burning**	Clupeidae	*Anguilla anguilla*	*Clupea harengus*	*Gadus morhua*	**TOT**
Calcined	0	0	1	1	2
Tot burned					2 (0.7%)
Other modifications					
Crushed	2	2	0	0	4
Tot modified					4 (1%)

Table 5.11.9: Taphonomic modifications for **mid- late 11th c.** material by taxa, total NISP 266, all recovery methods.

TAXA	*Anguilla anguilla*	Gadiformes	TOT
Burning			
Calcined	1	1	2
Tot burned			2 (0.6%)
Other modifications			
Crushed	2	0	2
Tot modified			2 (0.6%)

Table 5.11.10: Taphonomic modifications for **mid-11th -late 12th c.** material by taxa, total NISP 307, all recovery methods.

TAXA	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	TOT
Burning											
Burned	12	0	0	0	0	0	1	0	1	0	14
Calcined	14	0	2	0	0	0	1	1	0	1	19
Tot burned											33 (3%)
Other modifications											
Crushed	0	0	0	2	2	2	0	0	0	0	6
Tot modified											6 (0.6%)
Butchery marks											
Chop	0	1	0	0	0	0	0	0	0	0	1
Cut	0	1	0	0	0	0	0	0	0	0	1
Tot butchered	0	2	0	0	0	0	0	0	0	0	2 (0.2%)

Table 5.11.11: Taphonomic modifications for **12th c.** material by taxa, total NISP 885, all recovery methods. *1) Clupea harengus, 2) Gadus morhua, 3)* Pleuronectidae*, 4) Osmerus eperlanus, 5) Anguilla Anguilla, 6)* Cyprinidae*, 7) Merlangius merlangus, 8)* Clupeidae*, 9)* Gadiformes*, 10) Esox lucius.*

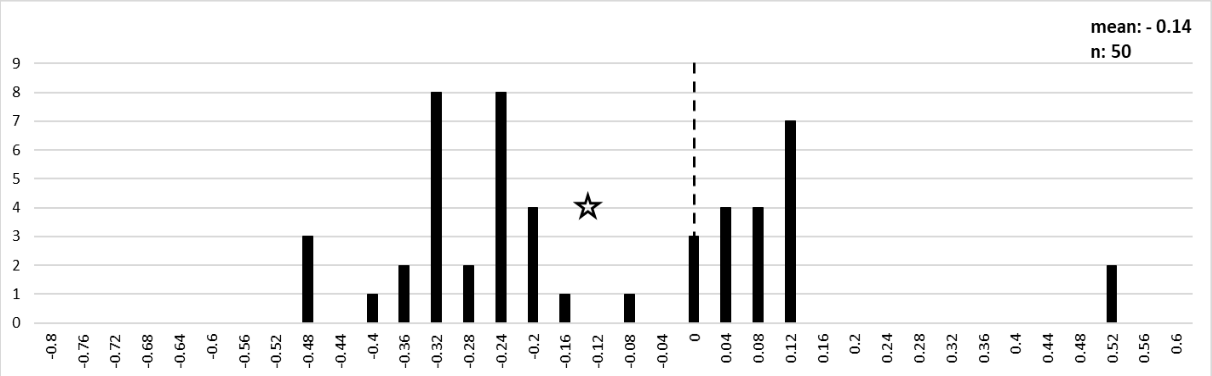


Fig. 5.11.14: Size distribution for all anatomical elements for Cyprinidae family, **12th c.** The star indicates the mean (- 0.14). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 18; n measures: 50.

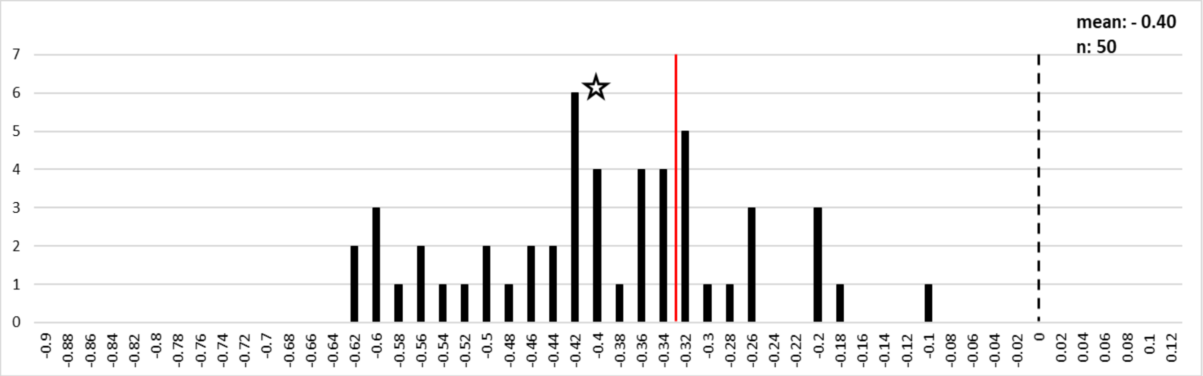


Fig. 5.11.15: Size distribution for all anatomical elements for *Anguilla anguilla*, **12th c**. The star indicates the mean (-0.40). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 20; n measures: 50.

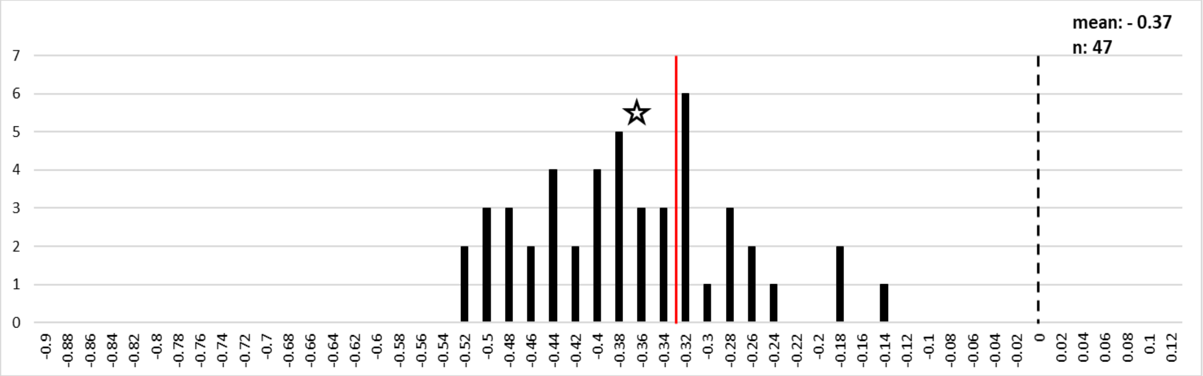


Fig. 5.11.16: Size distribution for all anatomical elements for *Anguilla anguilla*, **mid-11-late 12th c.** The star indicates the mean (-0.37). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 19; n measures: 47.

Chapter 6. Discussion

This chapter will discuss the archaeological evidence collected from the study of the 11 fish bone assemblages analysed as part of this research. The discussion will consider individual assemblages but also groups of sites, arranged by type, location and status. The two castles, Stafford and Windsor, as well as Eynsham Abbey, are of the highest status, followed by the other two religious establishments, St. Mary Graces and St. Gregory's Priory (the latter possibly the less wealthy of the two). Urban assemblages are potentially representative of a mixture of status conditions and households but, on average, they are likely to reflect less wealth than the other sites here discussed. In our interpretation, we must consider that the richer establishments owned fishponds and mills and had access to river fisheries; hence they could be self-sufficient in terms of their freshwater fish supply. Conversely, towns were generally unable to produce their sustenance and most of the food was sourced from the countryside or was imported through trade and sold at the market (Albarella 2005, 140; Van Neer *et al.* 2009). Despite the presence of rich dwellers within towns, most inhabitants would not own fishing rights and they would rely mostly on cheaper imported preserved marine fish; any purchase of freshwater fish was probably expensive (Van Neer *et al.* 2009).

To facilitate the reading of this chapter, chronology and recovery method for each site are summarised in Table 6.1. The focus of the interpretation will be on status rather than chronology, which is why most considerations will be applied to the medieval period (11th to 15th c.) as a whole. Material collected with different recovery methods (i.e. sieving and hand-collection) will be also combined, and the consequences discussed where relevant (referring to the interpretation already provided in the chapters about individual sites). This chapter will also make use of common, rather than Latin, names of the British species, to make it more accessible to the general reader. Equivalences of common and Latin names can be found in the Introduction Chapter.

Site	Type	Chronology					Recovery					
		11th c.	12th c.	13th c.	14th c.	15th c.	FS	CS	S	H-C	MIX	ND
Stafford Castle	castle	X	X	X	X	X			X	X		
Windsor Castle	castle	X	X	X	X		X	X		X		
Eynsham Abbey	religious	X	X	X	X	X	X	X	X	X		
St. Mary Graces	religious					X					X	
St. Gregory's Priory	religious				X	X	X					
Stert Street	urban			X	X	X		X		X		
Orchard Lane	urban	X	X				X					
Fleet Valley	urban		X	X	X	X	X	X		X		
Billingsgate	urban	X	X	X	X	X	X				X	
Trig Lane	urban			X	X	X						X
Milk Street	urban	X	X	X	X				X		X	

Table 6.1 List of sites included in this research and further discussed. Recovery = FS: fine-sieved material with mesh ≤ 2 mm; CS: coarse-sieved material, with mesh > 2 mm; S: sieved material, with no indication of mesh size; H-C: hand-collected material; MIX: sieved material and hand-collected material mixed after collection; ND: no information about recovery methods is available (Chapter 4).

The first part of the discussion will be dedicated to the comparison of the results collected from the 11 sites given the research questions raised in the first chapters of the thesis; in particular this first section will focus on the relative distribution of freshwater fish compared to marine\migratory taxa, followed by a review of the frequencies of species relevant for this research, intertwined with biometrical data. In the second section, this evidence will be interpreted from the perspective of the typology of sites and status, where medieval northern Europe will be also used as comparative ground. The third part of the discussion will tackle the pros and cons of the use of freshwater fish as an indicator of status.

6.1 Interpreting the results: freshwater fish distribution and size

One of the main goals of this research was to explore freshwater fish frequencies and whether the consumption of this type fish was more frequent in high status sites. The results have indicated that the consumption of freshwater fish was indeed generally more frequent in high status sites (Table 6.2, Fig. 6.1-6.3). The assemblages recovered from the two high status **castles** have higher proportions of freshwater fish compared to the other sites. Despite both castles having ponds, and therefore ready access to freshwater fish, its consumption was noticeably lower at Windsor. This can probably be explained by the fact that the Royal family only visited the castle occasionally, therefore, the animal remains largely derive from the meals of people of lower status. Furthermore, the location of Windsor Castle near London meant easy access to markets where marine fish was readily available, making the fish diet more mixed than it would have been if there had been exclusive reliance on local sources. We have seen other examples of high status diet based on a large variety of taxa (especially marine) in Launceston Castle assemblage (Chapter 3). A high number of taxa could be well representative of a higher status establishment, indicating a large accessibility to species. Forty fish taxa were identified at Windsor Castle, mostly marine but with a higher number of freshwater taxa compared to the other sites analysed in this thesis (Table 6.3). The number of identified freshwater taxa was even higher than at Stafford Castle, where the household was definitively relying more on local sources. In general, the disproportion in the number of freshwater and marine taxa, which is typical of many sites (and in favour of the latter), tends to be less pronounced at castle sites (Fig. 6.4-6.5). Similarly, at the rich manor of Little Pickle in Surrey (Bullock 1994; Chapter 3), the large range of species from different habitats was explained with the high status of the aristocratic household; the variety of freshwater taxa and the presence of large Gadiformes (probably consumed in a preserved form) was evidence of the variety of water sources accessible to the lords of the manor.

Freshwater fish was consumed more frequently in towns than in **religious establishments**, when we consider, collectively, the sites discussed in this thesis. However, Eynsham Abbey and St. Mary Graces have higher freshwater fish proportions than the urban sites. This may be associated with their substantial wealth. Interestingly, St. Mary Graces has freshwater fish proportions that are lower than Eynsham Abbey but higher than St. Gregory's Priory, though more similar to the former. This probably reflects its intermediate status. St. Gregory's Priory, which has lower freshwater fish proportions, was possibly the less wealthy religious establishment among the three and was also located near the coast, therefore having greater access to marine fish. As seen in Chapter 3, several fish assemblages from different types of sites in the Norwich area and Canterbury are also characterised by a high frequency of marine species, in particular herring. Their coastal location and the importance of the East Anglian fisheries can explain this trend. Similarly, other zooarchaeological evidence from St. Gregor's Priory show how the diet of the monks was not commonly characterised by luxurious food as we observe scanty remains of species associated with the highest status (e.g. deer, large wild birds); however, some pattern (high proportion of mutton, lamb and pork, including some suckling pig, and small wild birds) suggested some wealth (Powell *et al.* 2001).

Among the analysed sites, **towns** have the lowest frequency and taxonomic variation of freshwater fish. In London, the high variability of marine taxa is probably associated with their wide availability on the urban market. Urban sites also have the highest proportion of migratory taxa, represented largely by eel. A noticeable high incidence of freshwater taxa is visible at Orchard Lane and, to a lesser extent, Stert Street. This can partly be explained by the inland location of the sites and their position near rivers (and the Fens in the case of Orchard Lane). The small Orchard Lane assemblage is probably affected by recovery bias, as only fine-sieved remains from one single context were collected; however, the assemblage shows a substantial reliance on the local river, which was exploited for eel and, in a lower proportion, Cyprinidae; these, due to their small size, were interpreted as possible by-catch. Another sieved assemblage associated with the city of Huntington (Locker 1996), was largely represented by herring and low percentages of migratory and, even lower, freshwater fish. Hence, Orchard Lane is unusual. A similar predominance of eel was, however, recorded for Stert Street.

In sum, the results show how freshwater fish was consumed more at high status sites, in particular the two castles, but the location of the sites certainly also had a major impact on the type of fish that was eaten. This partially supports Locker (2018b; Chapter 3)’s view regarding the importance of site location in determining the relative proportions of marine, migratory and freshwater fish.

Next step would be to move on and review the resulting data related to taxa specifically object of this research. In this regard, it is interesting to explore to what extent some particularly valued species may have featured more prominently at the higher status sites and weather the size of these species may add information to the discussion.

One such species is the **pike**. As already observed by Serjeantson and Woolgar (2006), this species is present in different site types. When comparing the relative frequencies of pike versus herring/cod/eel (Fig. 6.6) for the analysed sites, it is clear that pike is well represented only in a few assemblages, mainly Stafford Castle, followed by Eynsham Abbey and St. Mary Graces. When we combine the sites by type, pike results to be more abundant at castles, followed by religious establishments and urban sites (Fig. 6.7-6.8). If we disregard the priory close to the coast, the frequency of pike nearly doubles at ecclesiastic sites. The presence of pike in the urban environment is unsurprising, as historical sources tell us that small size pikes (pickerels), were sold cheaply at the market. Nonetheless, pike was more common at higher status sites and a connection can be drawn between the status of the sites, the property of private freshwater sources (e.g. river fisheries, fishponds, water mills) and the frequency of this species. The fish supply from fishponds, because of their low yield, has been suggested to have been insufficient to fulfil the yearly demand for fish in large establishments (Currie 1988; Bond 1992). Therefore it is reasonable to think that a substantial part of freshwater fish was sourced from riverine fisheries (Bond 2016b, 162). However, from an archaeological perspective, the presence of fishponds would certainly enhance the frequency of pike bones.

Additional evidence could be gathered from the application of biometrical analysis on pike specimens (Appendix 1-3: Fig. 6.9-6.11). The largest pikes are generally found in castles and the smallest in religious establishments, particularly Eynsham Abbey, while in urban sites they tend to be of intermediate size. The greater variation of measurements in castles and in religious establishments suggests a managed and regular supply of pike throughout the year. In urban sites, the distribution of measurements through discrete peaks of size abundance could indicate that fishing for pike was done sporadically/seasonally, but this distribution may be less reliable due to the smaller size of the sample. As mentioned above, we know through documentary evidence that the three higher status sites (the two castles and Eynsham Abbey) owned fishponds locally and around the country (at least in the case of Windsor Castle). The fairly homogeneous distribution of pike sizes at these three establishments is probably connected with the presence of managed freshwater sources. In fishponds, the fish would be let to grow to an optimal or desired weight/size before being culled and this would be reflected in an average larger size of the fish. The very largest specimens would still be sourced from rivers, due to the already mentioned problem of large pike management in fishponds. It is impossible to determine with certainty which is the upper size limit of pikes to be kept in ponds, as this would depend on several factors, such as the size of the pond, the temperature of the water, and the size of other fish kept in the pond. However, Locker (*et al.* 2003, 400) suggests that the typical size for pike to be kept in ponds was up to 40 cm; information about modern pond management suggests that pikes will prey on fish up to 1/3, 1/4 of their size. On this basis, it seems that at the two castles, where the average pike size is around 40-50 cm of total length and the potential prey (perch, Cyprinidae) size is around 20 cm of total length, most of the pikes, whose bones were found during the excavation, could be still manageable in ponds. Furthermore, very small, juvenile pikes were typically kept (and protected) in specifically dedicated ponds (Roberts 1986; Chapter 2). This pattern is detectable for castles but not ecclesiastic sites, where pike size is generally smaller. A possible explanation for this smaller size could be a higher fish demand consequent to religious prescriptions. As seen in the York case (Harland *et al.* 2016), fishing pressure on a specific species can lead to a decrease in the average fish size, which could also explain the pattern observed at the religious sites discussed here (particularly Eynsham Abbey). Large-scale religious establishments had many monks to feed (up to 30 at Eynsham), putting further pressure on the body-size of the fish populations kept in ponds. Another factor to consider is that some of the religious establishment measurements in Fig 6.11 represent pike recovered from pre-13th c. contexts from Eynsham Abbey, thus before the construction of the fishponds. This pike was likely sourced from river fisheries, and of smaller size compared to pike connected with the later construction of the fishponds (see related Section 5.3).

Very large pike specimens, with a total length of 1 meter or over, were recovered from the three higher status sites. Large pike was highly-priced and was reserved for special occasions or special high-status consumers (e.g. Dyer 1994). These larger specimens would have been targeted from rivers (once again, large pike is unmanageable in ponds) and fished with a certain level of effort, which would have increased the value of the fish. A few larger pikes have also been found in urban contexts, and they are likely to represent meals of richer dwellers of the city. They were either granted fishing rights or were gifted the fish, probably in exchange for favours or loyalty to the countryside aristocracy.

Other fish identified by documentary sources as endowed with a high socio\economic value are sturgeon, Salmonidae and burbot (Chapter 2). The royal **sturgeon**, whose abundance is difficult to quantify due to the peculiarities of its skeletal anatomy (Chapter 4), has merely been recorded as present/absent. Many historians have pointed out the high price and rarity of sturgeon in medieval England (e.g. Hoffman 1996) and as confirmation of this, remains of this the fish were found at two of the highest status sites (Windsor Castle and Eynsham Abbey). However, sturgeon was present also in three London urban sites (Billingsgate, Trig Lane and at Fleet Valley it was identified by Locker (1994)). As attested by the presence of other highly regarded species (e.g. turbot at Fleet Valley, halibut at Trig Lane and the already discussed large pikes), it is not unusual to recover luxury items in urban contexts. It is worth reiterating that the typical characteristic of urban assemblages is its diversity, reflecting the wide range of people leaving in towns, in terms of ethnicity, religion, social status, wealth, etc. Locker (1994, 3) has suggested that the relatively frequent occurrence of sturgeon from medieval deposits in London may indicate that the fish was also available on the open market; however, if this is the case, the source of the fish to be sold is still unknown. The geographical location of the site could affect the availability of sturgeon, especially after the 12th c., when the fish had started becoming rarer (Hoffmann 2008). Specific habitat requirements of the species would make the fish more frequent in restricted areas and, considering the location of the sites where the fish was recovered, it appears that the Thames river was one of these selected areas. As for the case of large pikes, the presence of the sturgeon in urban environments could represent a gift from the countryside aristocracies. This mechanism of exchange of rare exotic (e.g. carp, peacock) or local wild animals (e.g. deer) in form of gifts among the richer end of the society to strengthen alliances or in exchange of favours was very common in medieval England (Dyer 1994; Albarella 2007). The rarity of the sturgeon in the studied assemblages reflects the gradual disappearance of the species from European waters; from the 8th to the 12th-13th c. the presence of sturgeon declined from 70% to 10% at 17 Baltic sites (Benecke 1986 in Hoffmann 1995). In the 13th c. sturgeon was legally reserved to the king in England and France (Richardson & Sayles 1955 in Hoffmann 1995) and one century later cookbooks instruct on how to "make sturgeon" from veal (Hieatt & Butler 1985 in Hoffmann 1995), showing how prestige was still attached to a fish that was gradually disappearing (Hoffmann 1995, 64).

Zooarchaeological evidence shows how **Salmonidae** used to be rare in medieval England (Serjeantson & Woolgar 2006) and this trend is confirmed by the 11 sites analysed here. Salmonidae are more frequent at Windsor Castle and the London urban site of Fleet Valley (Fig 6.12), possibly indicating the availability of salmon/trout in the Thames river. Salmonidae were more commonly consumed at castle sites, while approximately similar proportions occur in religious establishments and urban sites (Fig. 6.13-6.14). It is, however, worth bearing in mind that in Salmonidae the preservation of the bones is strongly subjected to taphonomic processes (Chapter 4), which can thus vary substantially from site to site. Additionally, Salmonidae are particularly demanding in terms of flow and quality of the water, being highly sensitive to water pollution, eutrophication and changes of water temperature, thus the location of the site may have a substantial impact on their distribution. In religious sites, there is no positive correlation between status and Salmonidae consumption; conversely, they are more abundant at St. Gregory's Priory than Eynsham Abbey. Once again, preservation and natural distribution of the species may explain this pattern. The Salmonidae follow the trend of the other high status species in being more abundant at castle sites, but the interpretation of their occurrence and frequency is made problematic by taphonomic factors. This scarcity of Salmonidae appears to be a common phenomenon also in the rest of Europe (Hoffmann 1995). Documentary records for coastal rivers of lower Normandy show a decrease in the abundance of salmon from the 12th to the 13th c. and a further drop by the 14th c. to less than a third of the total catch (Halard 1983 in Hoffmann 1995).

Similarly, **burbot** was uncommon in the studied assemblages. The highest frequency of burbot is found in religious establishments, especially Eynsham Abbey (Fig. 6.15-6.17), though we must consider that these comparisons are based on small numbers. Burbot was present in the three highest status sites and at St. Mary Graces, while the only urban site where it occurred is Stert Street. This species is also very susceptible to water pollution, which is the reason why it became rarer in conjunction with the increasing urbanisation of medieval towns (O'Connor

1989). The location of the sites is likely to be one of the major factors behind the frequency of burbot in archaeological assemblages. However, there is also the possibility that the fish was traded. The remains of burbot found at Windsor Castle suggest that the species was present in the Thames or imported from the numerous fisheries owned around the country. Should the former be the case, the lack of burbot remains from the London urban sites may indicate that the species was not typically sold at the market, maybe because of its rarity and high value/price.

The role of **Cyprinidae**, as reported by documentary sources, is multifaceted; whilst their presence is often associated with fishponds and highly prized species, such as pike, very small Cyprinidae are often mentioned with the generic term of minnow (Bond 1988, 75; Dyer 1994, 106) and sometimes archaeologically dismissed as accidental catch. Small Cyprinidae, once caught, were consumed (Locker 2018b), but it is reasonable to think that they were not purposefully fished, especially for a wealthy table. When documentary sources mention Cyprinidae in the context of fishponds management or recipe books, the species that is most commonly referred to is the highly praised freshwater bream (*Abramis brama*). Nonetheless, this species is absent from the studied assemblages, except for one remain found at Eynsham Abbey. Locker (2018a) also found two bones of the species at Windsor Castle. The identifiability of Cyprinidae bones is limited to a reduced number of anatomical elements (Chapter 4), thus the freshwater bream may have been overlooked, though the rarity of this species is still noticeable compared to other Cyprinidae. The most common species found in all assemblages are those adaptable and easy to maintain, such as tench and roach, followed by the more sensitive dace and chub. All four species have been reported to have bred in ponds in medieval times (Bonow *et al.* 2016). As expected on the basis of the chronology of most sites (pre-15th c.), no carp (*Cyprinus carpio*) was identified, as this is a later import. Previous zooarchaeological reviews (Serjeantson & Woolgar 2006), show how Cyprinidae are found in different site types and they are relatively abundant compared to other ‘primary division’ freshwater taxa (see Chapter 1). This is the case for the studied assemblages too where, collectively, Cyprinidae are the most common freshwater fish in all sites, except Stafford Castle and Eynsham Abbey, where pike dominates. Pike is predominant also at Trig Lane, but this is likely to be a consequence of lack of sieving. Compared to species of roughly similar size, Cyprinidae are most abundant in castles (particularly Stafford), followed by urban sites and religious establishments (Fig. 6.18-6.20). A high frequency of Cyprinidae could be associated with the presence of ponds; this seems to be the case for the two castles, but it does not apply to Eynsham Abbey. At St. Mary Graces, the abundance of Cyprinidae could be linked to the tenure of water mills, where Cyprinidae could have been caught alongside eels. Among urban sites, the highest number of Cyprinidae remains is found at Orchard Lane, which also has abundant eel, probably sourced together.

The Cyprinidae size distribution indicates that the largest specimens were consumed in castles, followed by religious establishments, and then urban sites (Appendix 4-10: Fig. 6.21-6.23). Like for pike, the roughly unimodal distribution of measurements of Cyprinidae from the two castles, together with the wide range of sizes represented, may indicate managed fishing occurring all year round, namely that the fish were kept in fishponds. It is important to point out that the great diversity of Cyprinidae sizes is also representative of different species. As mentioned, it is unlikely that the smallest specimens were purposefully sourced from the ponds; it is more likely that they represent bycatch or the stomach content of large predators (e.g. pike). With a smaller average value but a similar distribution and range of sizes, Cyprinidae found in religious establishments could also be associated with fishponds. The presence of very large specimens (at Eynsham Abbey) may suggest the use of fishponds for Cyprinidae as these fish are unlikely to survive long in a natural environment. The Cyprinidae from castles and religious sites were also caught from rivers fisheries and water mills, in particular the smallest individual as bycatch. Indeed, in the specific case of Eynsham Abbey, not many fishponds would have been exclusively dedicated to the growth of Cyprinidae (rather, it has been suggested they were mostly dedicated to the breeding of pike and eel; Ayres *et al.* 2003). Like for pike, the smaller size of Cyprinidae in religious establishments compared to castles could also be a reflection of higher fishing pressure on freshwater resources, as a consequence of a higher demand for fish. In urban sites, Cyprinidae sizes are more heterogeneously distributed, possibly representing less organised fishing (e.g. occasional and/or from different sources) and accidental catches for the smallest specimens.

Another fish that we can associate with the presence of fishponds, thus rich establishments, is the **perch**. Perch is less frequently recorded in our assemblages than other typical pond’s fish (i.e. pike and Cyprinidae) and it appears to have been more often consumed in the two castles, followed by the religious establishments and the urban sites. Despite the limited sample size, it appears that larger perch were consumed at castles, followed by religious establishments and urban sites (Appendix 11-13; Fig. 6.24-6.25). The wide range of measurements from castles can be explained once again with managed fishing, but this trend is not apparent at religious establishments.

Another fish that was perceived to have had a dual value was the **eel**; a large eel was so highly regarded that used to be exchanged as a gift among aristocrats. Large quantities of smaller eels, consumed in one meal or gifted together, would have made a good impression too. At the same time, household accounts indicate that small eels were cheap (Dyer 1994). The frequency of eel is intertwined with that of herring, as zooarchaeological research shows that eel was dominant pre-Conquest, but was replaced by herring in the 11th c. (Barrett *et al.* 2004a; Serjeantson & Woolgar 2006). While the presence of eel seems to decrease in favour of herring after the Norman Conquest, the resilience of the species to pollution and human modification of the freshwater ecosystem made this species more durable than other freshwater species (e.g. sturgeon, Salmonidae) in England as in the rest of Europe (Hoffmann 1996). In the studied assemblages, eel is the most common species at two sites (Stert Street and Orchard Lane) and the second most important at the other three sites. However, herring is the most common species at eight out of the 11 sites discussed in this thesis. This trend is consistent with what observed in a number of regional reviews (e.g. Barrett et al 2004a; Serjeantson & Woolgar 2006; Holmes 2017; Albarella 2019), with herring typically being the most common species recovered from fish assemblages post-Norman Conquest, independently from the status and location of the site. This suggests also a good degree of recovery and preservation of the material, considering the small size of both species and the fragility of their bones (particularly herring). Trig Lane is the only site where cod, rather than eel or herring, is the most common species; this highlights the already-mentioned recovery bias affecting the assemblage from this site. Herring was a staple food in medieval times, especially in its preserved form. It is not surprising that it is also found at high status sites, due to the diversity of people who could use the site at different times. It is reasonable to assume that preserved herring would not be served at the table of the king or the abbot, but rather to people of lower status. Although herring bones are fairly ubiquitous at medieval sites, we should be careful not to overestimate the importance of this fish to the diet, due to its small size. For example, at Stafford Castle, herring, pike and eel are the most common species, with herring represented by a minimum number of individuals (MNI) of 43, which would provide much less food than 21 pikes or 39 eels (according to MNI).

Unsurprisingly, of the sites analysed for this thesis, the one with the highest herring proportions is St. Gregory's Priory, which is located near the coast. In general, however, the three ecclesiastic sites have more herring than the castles and urban sites, which may be explained by the more pressing demand for fish supplies coming from the monks (preserved herring would be readily available to be eaten throughout the year).

Conversely, eel is more common in urban sites, particularly Orchard Lane and Stert Street, which probably relied heavily on the economic exploitation of the rivers.

Nonetheless, the largest eels are found at the three highest status sites (Stafford Castle, Eynsham Abbey and Windsor Castle), while the smallest are from the other two religious establishments (St. Mary Graces and St. Gregory's) (Appendix 14-23). The small size of the St. Gregory's eels can probably be explained by fishing occurring mainly in the estuary and coastal area, where young glass eels and elvers typically live. Sites that had fishponds probably purposefully fattened some eels for special occasions, while the large eels found in towns are more likely to be the result of gifts from the elite to be served at the rich people's table. The unimodal distribution of eel size on a wide range of measurements for castles (Fig. 6.26) suggests again a managed catch, possibly throughout the year. The bimodal distribution from religious establishments (Fig. 6.27), represented mostly by the Eynsham Abbey's eels, may be explained with the exploitation of different sources (e.g. fishponds, river fisheries and mills), but sexual dimorphism may also be a factor. Eel size distribution from urban sites (Fig. 6.28) suggests a fishing strategy more focussed on smaller specimens compared to the other site types. This may represent fishing focused on a single water source (e.g. estuaries and coastal areas, where smaller specimens are found), reflecting possibly some fishing restrictions on locations and time (day, seasons), which were customary in medieval Europe (Hoffmann 1996, 653). Another possible explanation for the smaller size of eel in urban contexts is overexploitation. The smaller size of fish in urban environments has also been observed in medieval and post-medieval Belgian towns, where the decrease in the average size of freshwater fish was explained with increasing fishing pressure (Van Neer *et al.* 2009, 32).

6.2 Exploring freshwater fish consumption within different site types

After the Norman Conquest, the increased privatisation of fishing rights brought freshwater sources under the control of the elite (e.g. Dyer 1994; Hoffmann 1995). Freshly caught fish was preferred by the elite. From the 12th c. onwards freshwater ecosystems were managed to supply fresh fish to the aristocratic table; as a result of this process, fishponds became a status symbol (Hoffmann 1995, 66). Especially after the Black Death and the ensuing economic crisis, the leasing and rental of fishing rights became the norm, and freshwater fish started being sold at the market by specialised fishmongers (Hoffmann 1995). At the same time, public authorities enforced regulations to protect fish populations (e.g. minimum fish size limit, maximum number of individuals to be fished, the prohibition to fish during the spawning season) but the elite maintained the monopoly over freshwater resources (*ibid.*). High demand for fish put freshwater fisheries under stress and resulted in higher prices for locally sourced wild fish, increasing the perception of freshwater fish as high status food (Hoffmann 1996). In this context, documentary evidence from the 11th-15th c. shows high prices associated with selected freshwater species (e.g. Dyer 1994). As seen in Chapter 3, the zooarchaeological evidence is not as straightforward in showing a clear connection between freshwater fish consumption and high status sites (e.g. pike was consumed in different site types); this is probably a consequence of the scarcity of freshwater fish remains, which often prevent reliable comparisons between sites. Nonetheless, several assemblages showed the preferential consumption of highly regarded species at high status sites (e.g. Little Pickle, Westminster Abbey).

Overall, except for Stafford Castle, the results seem to confirm the general scarcity of freshwater fish among all site types already observed by other authors, paralleled by the increased incidence of marine species in British assemblages after the ‘fish event horizon’ of AD 1000 (Barrett *et al.* 2004a; 2004b; Serjeantson & Woolgar 2006; Harland *et al.* 2016; Holmes 2017; Albarella 2019). Despite the overall low frequency of freshwater fish remains recovered from the 11 sites, this research contributes to identify and characterise the link between high status diets and freshwater fish.

Such a link is proven, for example, by the higher frequency of freshwater fish from **castle sites**, as well as the occurrence of fish species that are known to have been especially priced. Even when we consider species with a dual perception, acquiring value either because of their large size (eel) or rearing in ponds (Cyprinidae), assemblages from castles fulfil the expectations of high status consumption. A similar situation was reported in a review of medieval and post-medieval fish assemblages of Belgian sites (Van Neer & Ervynck 1994), where at Londerzeel castle (later 13th-14th c.), the relative proportion of marine species (57%) was only slightly higher than that of freshwater and migratory species (43%), among which sturgeon was recorded in large quantities.

All fish taxa tend to be larger in assemblages recovered from castles. At these sites, the fish were mainly kept in controlled environments (fishponds) or caught from nearby rivers (especially pike). Since large freshwater species were used as a display of wealth, the fish was deliberately left to grow in fishponds. Large pikes were purposefully targeted in river fishing, particularly when a special occasion or guest required the appearance of a ‘luce’ on the table. Castles probably benefitted from the availability of fresh fish throughout the year, as demonstrated by the wide size range we see for many species (presumably linked to seasonal variation). The analysis of different consumption patterns in the city of Namur (Belgium) during the 11th – 15th c. showed a similar trend. A comparison between fish assemblages from the urban castle of Des Comtes, inhabited by both laic and religious folks, and middle-class houses at Grognon provided interesting information on the type and size of the fish consumed in relation to the status of the sites (Pigiére *et al.* 2014). Freshwater species predominated in both contexts (mainly Cyprinidae). However, a higher proportion of perch was detected for the castle, along with sturgeon and carp; the latter two species were completely absent at Grognon. As in medieval England, these three species were highly regarded. The higher status of the castle was represented not only by the presence or greater incidence of higher quality freshwater species but also by a wider taxonomic spectrum (including long-distance traded marine species) and the larger size of freshwater and migratory fish. Pike, perch and Salmonidae were consistently larger at the castle. At Grognon the middle-class occupants consumed mostly smaller and lower quality freshwater species, together with herring, while other marine species played virtually no role in their diet.

Religious and lay elites were deeply interrelated in medieval times (Chapter 2; Hoffmann 1995, 68); documentary sources testify how, by the 13th c., the monastic diet was in all respects a form of the upper-class diet, regarding both the quality and quantity of food consumed (Harvey 1993, 34). Zooarchaeological evidence for **religious establishments** has provided an insight into wealthy diets within ecclesiastical sites. For instance, the fish assemblage from Westminster Abbey (Locker 1995) shows a diet characterised by a wide variety of species consumed, which includes expensive ones (e.g. sturgeon, Salmonidae and pike). A similar trend has been detected in medieval France; at the Andlau Abbey (Alsace), for example, the higher frequency of pike recovered from 10th-12th c. deposits, together with other prestigious species such as sturgeon and possibly lamprey, was interpreted as an indicator of the wealth of the monks (Borvon 2019). At the St. Salvadors Benedectine Abbey in Belgium (Van Neer & Ervynck 1994; Ervynck 1997), fish remains from a kitchen deposit dated to the 16th c. included a fairly high variety of species. The diet included preserved marine fish (salted herring and stockfish) but was based predominantly on freshwater catches, mostly eel and carp. Expensive species were also identified, including sturgeon and turbot. Ervynck (1997) saw in the consumption of such a variety of species an attempt to escape the monotony of a diet regimented by religious rules and fasting.

In our study, the degree of similarity of assemblages from lay and religious high status sites was assessed. The results show how the evidence of high status for religious establishments is less straightforward compared to castles, probably reflecting the interplay of various potentially conflicting factors. Nonetheless, highly regarded species tend to be more frequent than in urban sites (except Cyprinidae) and specimens also tend to be larger (except pike).

The smaller size of fish from the three religious establishments compared to castles may be a consequence of a higher demand for fish coming from religious households and partially of the supply of pike from river fisheries (at Eynsham Abbey). As we have seen in Chapter 2, meat avoidance was compulsory for ecclesiastic people for many days of the year, following the food guidelines provided by the Rule of St. Benedict. This led to high demand for fish, causing potential overfishing of freshwater species available from private resources (ponds, mills, or fisheries) and an average smaller size of the specimens caught. Fish demand was not only fulfilled through the exploitation of private ponds and river fisheries but could be supplemented with the acquisition of herring, especially in their preserved form, which explains the lower frequency of freshwater fishes in ecclesiastic sites compared to castles. Moreover, herring, as observed by Van Dam (2009, 324, 328), was the ideal meal for fasting, while large fish, because particularly desirable, may have been forbidden and considered sinful by certain monastic orders.

Despite the average smaller size of fish from religious establishments, the similarity in fish size distribution with the two castles (wide range of sizes and mostly unimodally distributed), suggests the use of managed fishing sources (i.e. fishponds and river fisheries, at least in the case of Eynsham Abbey).

Variations in the diet of different Coenobitic orders could not be explored; in theory, the order that followed the Rule of St. Benedict more strictly was the Cistercians, represented by St. Mary Graces, while the more ‘liberal’ Benedictines and Augustinians lived at Eynsham Abbey and St. Gregory’s Priory. More analysed sites, however, are needed to try to identify differences between different orders. This was beyond the aims of this dissertation, but it could represent an interesting area for future study.

The results indicate that **urban sites** are generally characterised by lower frequencies of highly regarded species (except Cyprinidae) and the sporadic presence of a large pike or a sturgeon, reflecting the diversity of wealth occurring in towns. Similarly, in the above-mentioned Belgian review (Van Neer & Ervynck 1994) urban assemblages (13th -18th c.) were dominated by higher proportions of marine fish, especially Gadiformes, Pleuronectiformes and herring. Van Neer & Ervynck interpreted these higher frequencies as a practical need and economic limitation, reflecting the difficulties of obtaining freshwater fish in the urban context. Such reduced accessibility to freshwater fish was the result of the pollution of freshwater habitats, infrastructural works modifying the rivers' flow, and tax regulations on freshwater fishing. The authors concluded that castles (i.e. the above mentioned Londerzeel castle) and abbeys (i.e the above mentioned St. Salvadors Benedectine) probably relied more heavily on local resources than contemporary urban sites; highly regarded species, such as sturgeon and carp, were found in significant numbers only within castles and abbeys.

Another piece of evidence highlighted by our research project is that, except for pike, urban sites are characterised by the presence of smaller-sized fish. The smaller size of fish in urban environments has also been reported in a study by Heinrich (1994), where he compared the fish assemblages recovered from two medieval castles, Bodenteich (13th-18th c.) and Plesse (15th-17th c.), with that from an urban context (Höxter 16th-17th c.) from central-northern Germany. Except for Bodenteich's 17th-18th c. material, freshwater species predominated in all sites and phases; in particular, Cyprinidae (e.g. freshwater bream, roach, chub, carp), perch and pike were the most abundant species. In the urban deposits though, Cyprinidae and other freshwater specimens were the smallest (including gudgeon, Eurasian minnow, bullhead and juvenile individuals of larger species). Furthermore, the highly regarded carp was missing. The results suggested that the inhabitants of the town mostly relied on marine preserved fish; freshwater fish was mostly inaccessible, indicating the existence of restrictions on freshwater fisheries which only allowed to catch very small fish, probably used to prepare fish-soups. This example clearly shows the importance of biometrical analysis when interpreting species frequencies. Heinrich (1994, 215), in his interpretation of the data, did not exclude overexploitation as the reason behind the high frequency of small freshwater species; this concept leads to another interesting consideration. The small size of the freshwater fish analysed in our urban sites may be due to fishing restrictions on the catch, which were widespread in the Middle Ages (Hoffmann 1996, 653), but also overexploitation could be involved. In the urban context, we must consider the limited capacity of local freshwater resources to feed a large and dense population and the consequent potential pressure on such resources. We do not see this happening in castles, though. At these high status sites, fish consumption was more important as a marker of status than for its nutritional value, and it was, therefore, possible to let the fish grow to an optimal size. Fishponds with large fish could also have a decorative function in castle parks and gardens (e.g. Bonow *et al.* 2016).

The general scarcity of fish bones from **rural villages** already mentioned in Chapter 3 (Serjeantson & Woolgar 2006) is the reason why no assemblage from this type of site has been included in this research. Previous studies of the scanty fish bones from villages (e.g. Albarella

& Davis 1994, 2010) have noticed how fishing and hunting were subsidiary activities to rearing livestock and farming. This preference can be associated with the increasing restrictions on accessing freshwater sources after the Norman Conquest (Sykes 2007). At Wharram Percy (Barrett 2004) and West Cotton (Albarella & Davis 1994, 2010) the few collected fish bones mostly belong to marine taxa, despite the proximity of rivers at both sites. This suggests that the villagers would rather buy some cheap preserved fish at the market (mostly herring), probably because they had no right of access to the rivers. Even herring and other marine fish must have, however, been uncommon occurrences on the peasant table.

All in all, our evidence supports both historical (e.g. Dyer 1994) and zooarchaeological (e.g. Locker 2018b) suggestions that in medieval England freshwater fish was typically scarce and more often consumed in high status sites. The regulated access to freshwater sources is reflected in a lower occurrence of freshwater fish remains in urban sites and their smaller size. A similar trend has been highlighted by other authors (e.g. Dyer 1994; Serjeantson 1997; Albarella 2019), for wild birds and wild mammals; hunting and fowling rights, as much as fishing rights from freshwater sources, were restricted. For instance, the relatively high proportion of deer from faunal assemblages is typical of high status sites and the presence of private hunting parks (e.g. Ashby 2002). This can be exemplified by the assemblage of Launceston Castle, where wealthy dining is represented by a high frequency of deer bones from the hind limbs (the best meat cuts), and the presence of a variety of highly prised birds (e.g. crane, swan, partridge) (Albarella & Davis 1996). The rich could afford not to feel the pressure of food production, thus hunting animals for their prestige rather than nutritionally value (Ashby 2002). In high status assemblages, we find species, such as crane and manx shearwater, with limited nutritional value relative to the effort that must have required to source them (Albarella & Davis 1996). Similarly, fish production in fishponds was not intensive and could not sustain a large community. This was, however, of secondary importance as the ponds' main function (ornamentally and as food) was a status symbol (e.g. used for fattening selected species to be served to a relatively small household). Prestige was not necessarily associated with the gastronomic value of the item; for instance, peacocks, often used as a centrepiece of aristocratic tables, have notoriously tough meat (Hammond 1998) and the flesh of some freshwater species (e.g. carp, tench) is today disregarded as 'muddy' and tasteless. Like for fish, the size of birds served at the table may have had important social value, but at the expense of taste (Albarella & Thomas 2002). For instance, cranes, which are often found at castle sites, were regarded by the 15th c. documentary sources to be palatable only when very young but, of course, a fully grown bird would make a greater impression on the table (Albarella & Davis 1996).

Van Dam (2009) has made similar observations regarding the perception of fish as a luxury food in the medieval Netherlands. Similarly to England, highly regarded species include sturgeon, pike, eel, salmon, carp and freshwater bream; among the most popular sea-fish, there were fresh haddock and cod. Serving ‘schafteling’ (large eel) or large pike was a visible manifestation of wealth in the medieval Netherlands, while large sturgeon was reserved for highly distinguished people. Van Dam has observed that rarity may have had a role in the higher value of the fish, both in terms of exoticism (e.g. carp, like in England) and size of the animal; she observed that ‘large’ tends to be synonymous to ‘scarce’ in ecosystems where typically there are many small individuals and few larger ones. Thus the acquisition of these larger specimens would have been more demanding; this, however, would have been irrelevant in comparison to the social importance of being able to display large fish. Again, size appears to be a discriminant in the evaluation of fish. Van Dam defines small sea (herring and plaice), and freshwater species (e.g. small roach) as cheap and low status. As revealed by this study for England, in the Netherlands Cyprinidae were consumed by high and low status people alike, but small species and/or juvenile individuals appeared more frequently on the menu of the poorest households.

Another interesting issue is raised by Borvon (2012) in a study of the faunal material from the site of Montsoreau, Maine-et-Loire (France, 10th -12th c.). The author highlighted a possible correlation between status and hunting/fishing methods. While the capture of several individuals using nets (for ducks, small Passeriformes and most fish species) would have been more efficient, and therefore less prestigious, the hunting/fishing of single individuals was highly regarded and the catches reserved for the elite. As concerns fishing, this was not a common activity of the elite at least until the 15th c. (Hoffmann 1985), but, regardless of who was conducting the fishing activity, it is reasonable to think that the number of individuals captured would have also determined their value. Borvon referred to Cyprinidae and eel as typical examples of species that, when small, can be captured in large quantities with the use of nets. This could explain the high frequency of small Cyprinidae and eels in urban sites; these were fished using nets (often with a fine mesh, considering the very small size of some specimens), rather than the wicked baskets employed for catching larger eels or the hooks and nets designed for larger and rarer species such as pike and sturgeon. Again, size seems to be the discriminant in determining the value of fish, where prestige is connected with the meaning that acquiring a large specimen implies.

6.3 On the use of freshwater fish as an indicator of status

Barrett *et al.* (2004a, 2004b) observed archaeologically a decrease in the frequency of freshwater fish after the 10th c., while, from a historical point of view, Dyer (1994) has suggested that the rarity of freshwater species in medieval times made them surge to a symbol of social privilege. Following this premise, this research has highlighted the following six trends characterising high status sites:

- an average higher frequency of freshwater fish in comparison to migratory and marine fish;
- an average higher frequency of species with a high socio/economic value and/or connected with the presence of fishponds (e.g. pike, perch, Cyprinidae);
- the occasional occurrence of rare and highly prised freshwater/migratory species (e.g. sturgeon, Salmonidae, burbot);
- an average higher number of freshwater taxa;
- average larger size of some species (e.g. pike, perch, Cyprinidae, eel);
- for some species, a wide range of measurements coupled with a unimodal distribution, indicating managed fishing throughout the year and possibly also the presence of fishponds.

We must, however, be careful not to oversimplify the evidence. Although a correlation between high status and consumption of (often large) freshwater fish is fairly clear, there are additional factors affecting fish taxonomic frequencies that must be considered. One of them is taphonomy (Reitz & Wing 1999, Ashby 2002). Differential preservation of the bones and inconsistent sieving may have a major role in the range and frequency of taxa present in an assemblage. However, taxonomic representation of freshwater species was in this research compared with that of marine species, particularly herring. Herring bones are small and fragile and, thus, the absence or scarcity of small freshwater species has been regarded to be genuine when herring was abundant. We can, however, be less confident about the occurrence of Salmonidae as the bones of this family are especially prone to taphonomic destruction and therefore they are probably chronically underrepresented in archaeological sites.

Social status and wealth also run the risk of being misunderstood if we fail to consider site location, as the supply of freshwater and marine fish is also dependent on resource accessibility (including vicinity). At St. Gregory's Priory, for instance, a predominance of marine fish at an ecclesiastic site can be explained with the vicinity of the coast and the prolific activity of the East Anglian fisheries. Conversely, the inland site of Orchard Lane was in a prime position to exploit the Great Ouse river and the Fens. As observed by Albarella (2005), focussing on individual cases is probably not helpful in highlighting trends; the high frequency of freshwater taxa from high status sites is quite evident from the results, but it is a generalisation, and as such would have many exceptions. For instance, the site of Wharram Percy shows an opposite situation to Orchard Lane, as the inland rural site, despite the presence of fishponds within the site, was mostly reliant on preserved marine fish. The location is also key to the presence of rarer species sensitive to pollution and with a restricted geographic range (e.g. burbot, sturgeon, Salmonidae). The absence of these species, therefore, needs to be interpreted with care, as it may be associated with environmental degradation. For other species, with a wider distribution and high adaptability to variable environmental conditions, such as eel, the location of the site would play a lesser role. As discussed and previously highlighted by O'Connor (1989), access to markets can also affect the variety of available species (e.g. see the case of Billingsgate and the London markets).

The literature already warned about the use of species variability as an indicator of status because highly dependent on the size of the assemblage and on the recovery methods used (see for instance Reitz & Wing 1999, Ashby 2002). A further factor to consider is that not all freshwater species necessarily represent edible food or specifically targeted species. They may, for instance, represent the stomach content of large predators (e.g. pike). Consequently, species variability does not appear to be a convincing indicator of status; at least not when considered on its own.

As observed by Ashby (2002), the presence of a prestigious animal in an assemblage does not automatically boost the status of the site, as it may represent an occasional meal, where the resources of a family are stretched for a special festivity; this meal will not be representative of the daily consumption of the family nor of the wealth of the household. Additionally, there is always the possibility that the animal was poached (*ibid.*). Sturgeon was found in all three typologies of sites, supporting Ashby's viewpoint. This research, therefore, confirms the problematic use of the presence of rare luxury species as indicators of status, at least when analysed in isolation. It is in the everyday day eating that the social gaps between urban dwellers and high classes become evident, and this can be reflected in overall species frequencies, especially when our sample sizes are sufficiently large to give us confidence about such statistics.

About the use of fish size as a possible indicator of status, freshwater fish have proven to be consistently larger in castles, where fishponds were available. The odd large pike or eel specimen was present also in urban sites, but these findings can be interpreted similarly to the case of sturgeon, showing the presence of people in town who were important enough to receive a gift, pay for it, or have fishing rights granted for sections of the river. These larger outliers alone cannot be considered as indicators of a permanent condition of high status, but they may rather represent (occasional) availability of financial means. Conversely, a consistently large fish size represents more reliable evidence of high status.

All the indicators of status provided above apply to castles, but for religious sites, additional factors need to be considered.

Based on documentary sources, Harvey (1993) has suggested that, in medieval England, the monastic diet represented a form of upper-class diet. This is largely consistent with the archaeological evidence provided by this research as, considering the six indicators of status mentioned above, the results show similarities between assemblages recovered from religious sites and castles. However, it is also clear that hierarchies within religious establishments and roles, and differences in households' wealth had a major impact on the type of fish consumed. Indeed Harvey (1993) also pointed out that the diet ordinary monks and abbots, for instance, would have differ in quality.

The possibility that more fish than meat was eaten at religious sites in comparison to castles is hard to prove archaeologically, but the smaller size of freshwater and migratory fish and a higher reliance on preserved fish (herring) could support this hypothesis. Van Dam (2009, 331) observed for the medieval Netherlands that two types of eating systems emerged regarding fish consumption: the more or less rigorous religious eating regime dictated by the church and a flexible eating regime differentiated by socio-economic group. The ecclesiastical fish bone assemblages analysed for this research place religious diet between these two systems. Large fish was typically preferred by the secular elite but in religious sites, more fish was probably consumed and of better quality than on urban sites.

In conclusion, this research has highlighted several status indicators that can be applied to freshwater and migratory fish assemblages, but they need to be combined, as their individual use may be problematic and could lead to spurious interpretations. The stronger indicator of high status is represented by the combination of a high frequency of some key freshwater species (pike, perch, Cyprinidae) and their average large size. Such evidence can be associated with the occurrence of fishponds, attested to aristocratic households in England after the Norman Conquest, and in religious establishments after the 12th c. (Taylor 2000, Bonow *et al.* 2016, Locker 2018b). Another important indicator of status is represented by size distribution, which can be linked to the presence of tightly managed freshwater environments and the availability of fresh fish throughout the year. This latter indicator was especially obvious in ecclesiastic sites. Biometrical investigations played an important role in this study and represent an innovative part of this research, as biometry has been somewhat underused in archaeoichthyology and yet it has the potential to inform us about social as well as economic aspects of past societies. The use of the log ratio technique has allowed us to increase sample size therefore extending the number and diversity of datasets that could be used

HABITAT	Stafford Castle (11th-15th c.)	Windsor Castle (11th-14th c.)	Eynsham Abbey (11th-15th c.)	St. Mary Graces (15th-16th c.)	St. Gregory's Priory (14th-16th c.)	Stert Street (13th-16th c.)	Orchard Lane (10th-12th c.)	Fleet Valley (11th-15th c.)	Billingsgate (11th-15th c.)	Trig Lane (13th-15th c.)	Milk Street (11th-14th c.)
Freshwater	2276	1913	762	61	62	168	40	73	32	1	77
Marine	1510	8872	7029	727	8003	475	17	732	1742	197	1030
Migratory	1337	2522	1070	134	487	1554	139	442	193	5	208
TOT	5123	13307	8861	922	8552	2197	196	1247	1967	203	1315

Table 6.2: Taxa habitat distribution for all sites, combined chronology and recovery methods.

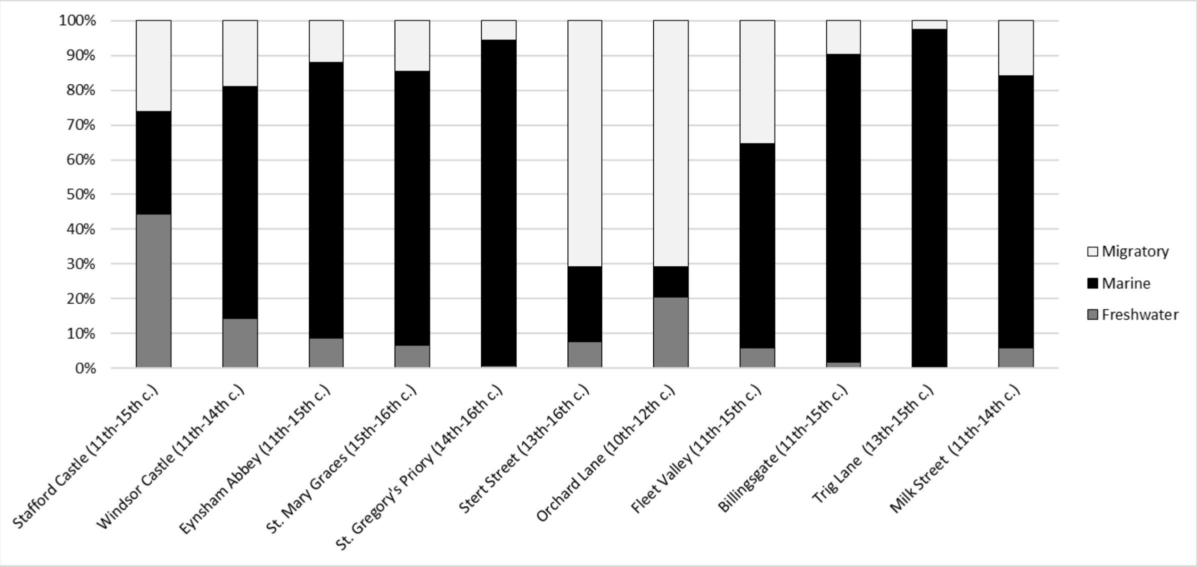


Fig. 6.1: Frequencies of habitat distribution for all sites, combined chronology and recovery methods.

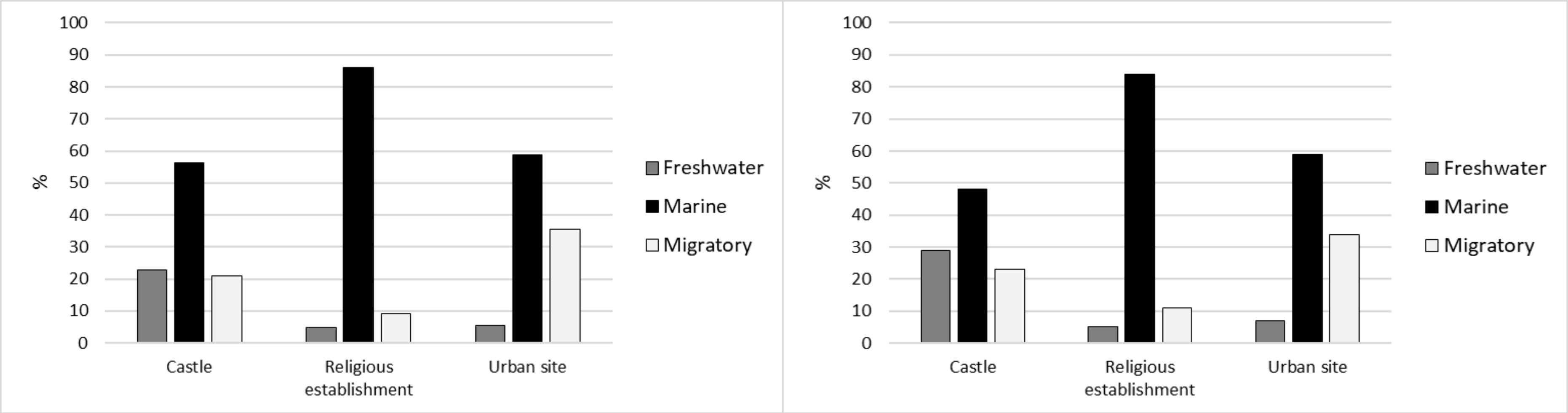


Fig. 6.2-3: Frequencies of habitat distribution by typology of sites, combined chronology and recovery methods. The first graph shows percentages calculated on the total NISP; the second graph shows percentages calculated as the average of the percentages for each site.

HABITAT	Stafford Castle (11th-15th c.)	Windsor Castle (11th-14th c.)	Eynsham Abbey (11th-15th c.)	St. Mary Graces (15th-16th c.)	St. Gregory's Priory (14th-16th c.)	Stert Street (13th-16th c.)	Orchard Lane (10th-12th c.)	Fleet Valley (11th-15th c.)	Billingsgate (11th-15th c.)	Trig Lane (13th-15th c.)	Milk Street (11th-14th c.)
Freshwater	11	13	13	8	5	13	7	6	5	1	4
Marine	8	19	16	13	26	17	1	18	26	12	17
Migratory	7	6	7	3	6	5	2	4	7	4	5
Other	3	2	2	2	2	2	0	2	2	2	2
TOT	29	40	38	26	39	37	9	30	40	19	28

Table 6.3: Number of taxa by habitat for all sites, combined chronology and recovery methods.

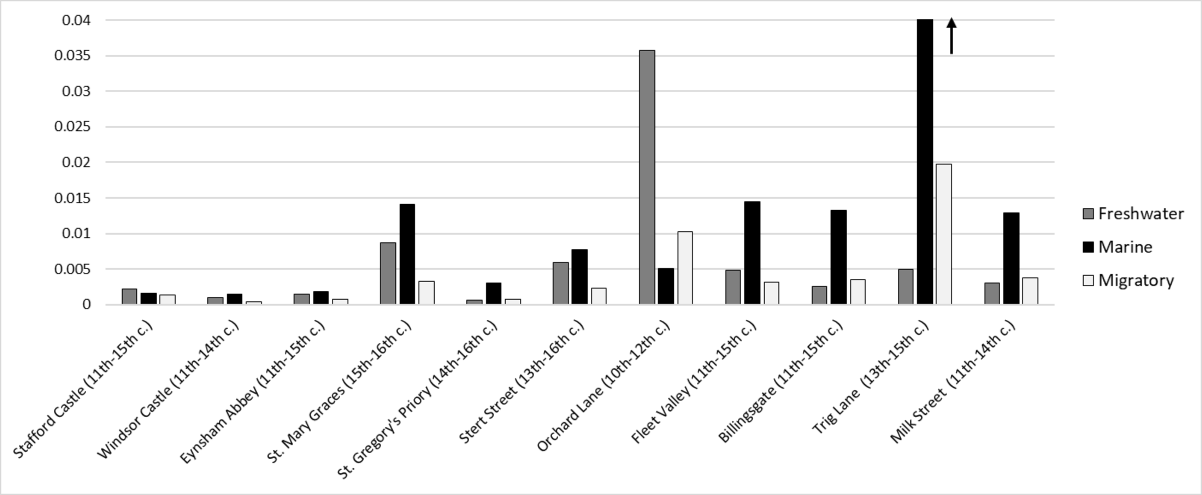


Fig. 6.4: Habitat index (n of taxa/tot NISP) for all sites, combined chronology and recovery methods.

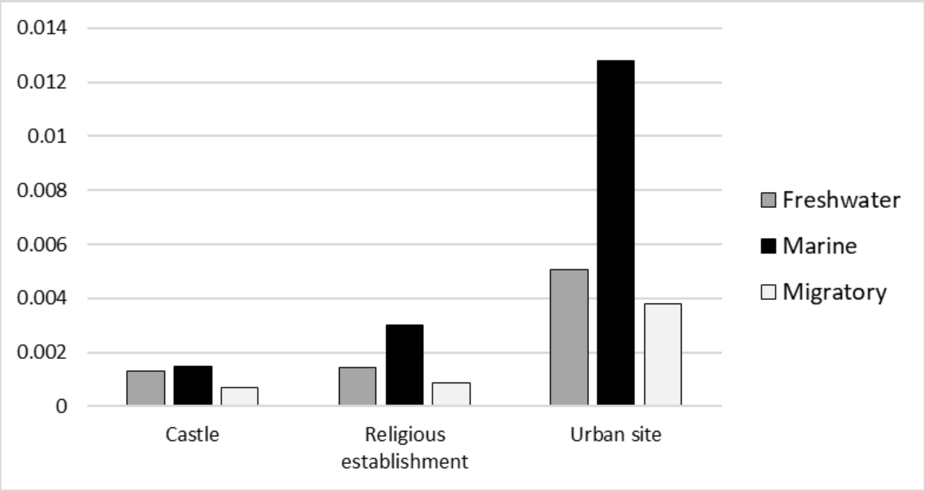


Fig. 6.5: Habitat index (n of taxa/tot NISP) by typology of sites, combined chronology and recovery methods.

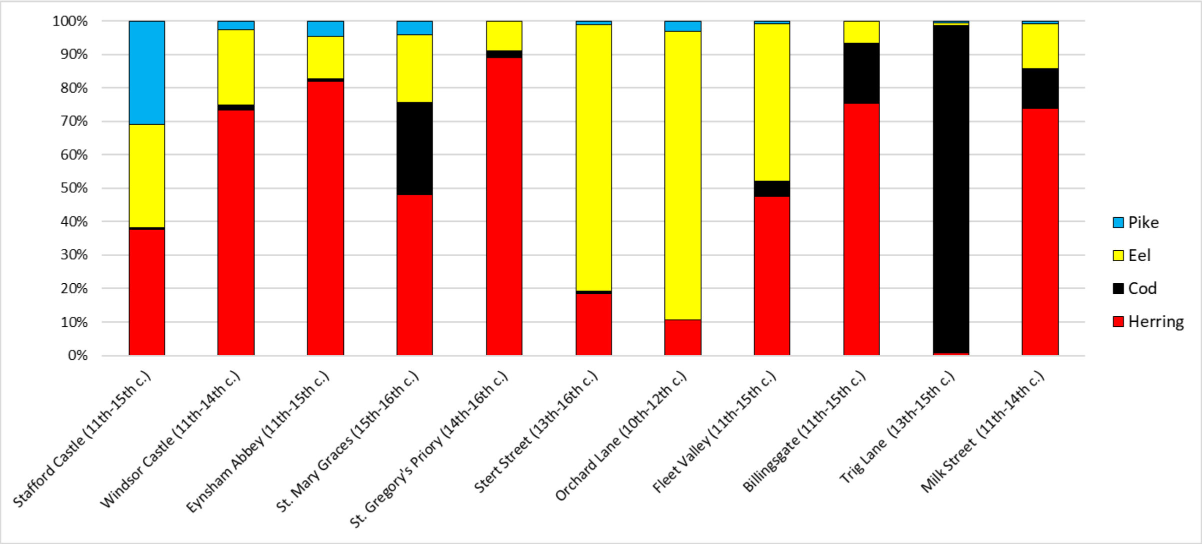


Fig. 6.6: Distribution of frequencies for pike versus three key species (Herring/Cod/Eel) for all sites, combined chronology and recovery methods.

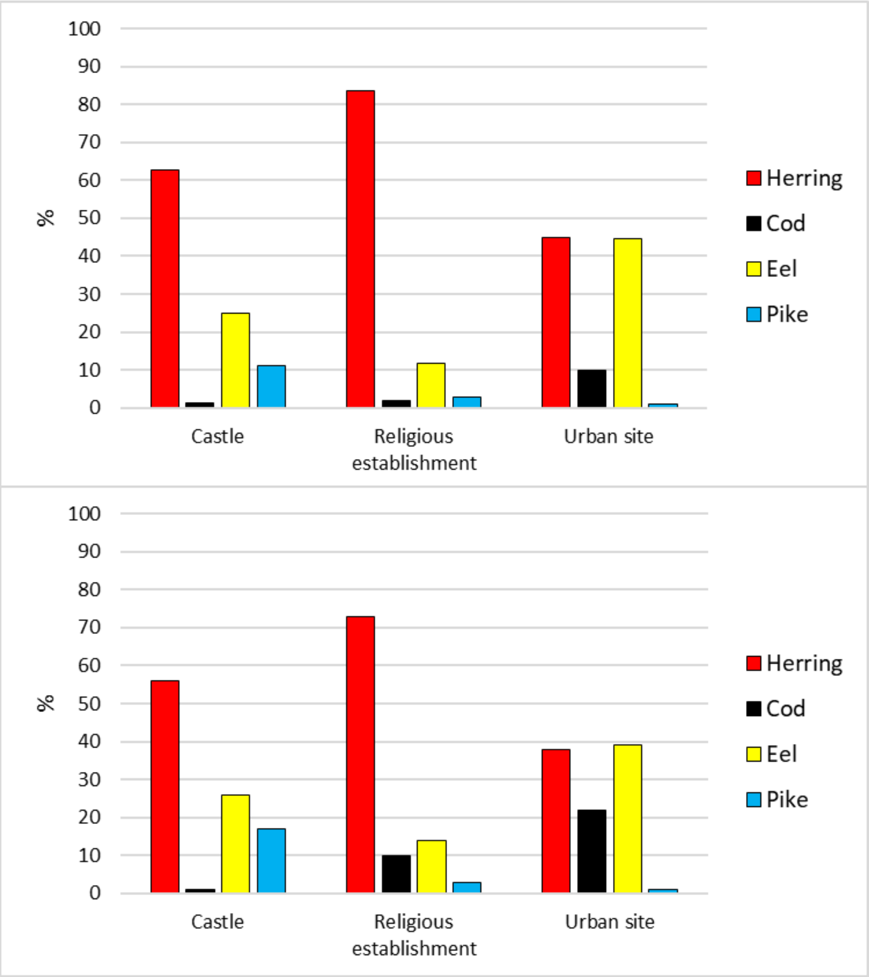


Fig. 6.7-8: Distribution of frequencies for pike versus three key species (Herring/Cod/Eel) by typology of sites, combined chronology and recovery methods. The first graph shows percentages calculated on the total NISP; the second graph shows percentages calculated as the average of the percentages for each site.

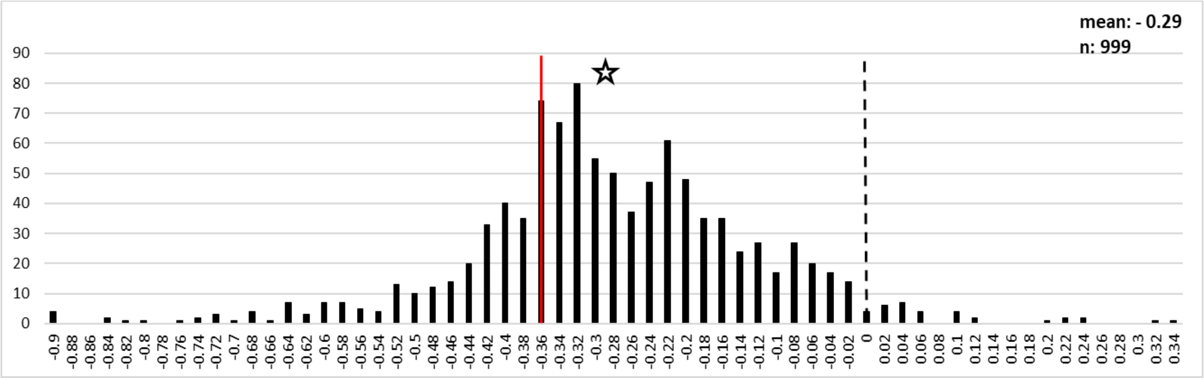


Fig. 6.9: Size distribution for all anatomical elements for pike, **castles (11th-15th c.)**. The star indicates the mean (-0.29), the red line marker represents a modern pike (origin: unknown) with TL of 340 mm and SL of 300 mm (mean: -0.36). The standard set of values is represented by the value 0 (TL: 715 mm, SL: 650 mm; modern individual, origin: France). Bones measured: 433; n measures: 999.

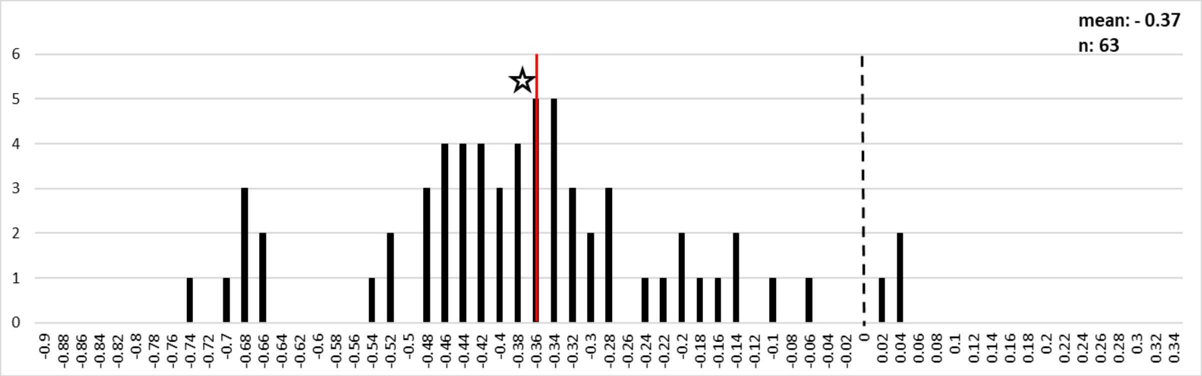


Fig. 6.10: Size distribution for all anatomical elements for pike, **urban sites (11th-15th c.)**. The star indicates the mean (-0.37), the red line marker represents a modern pike (origin: unknown) with TL of 340 mm and SL of 300 mm (mean: -0.36). The standard set of values is represented by the value 0 (TL: 715 mm, SL: 650 mm; modern individual, origin: France). Bones measured: 26; n measures: 63.

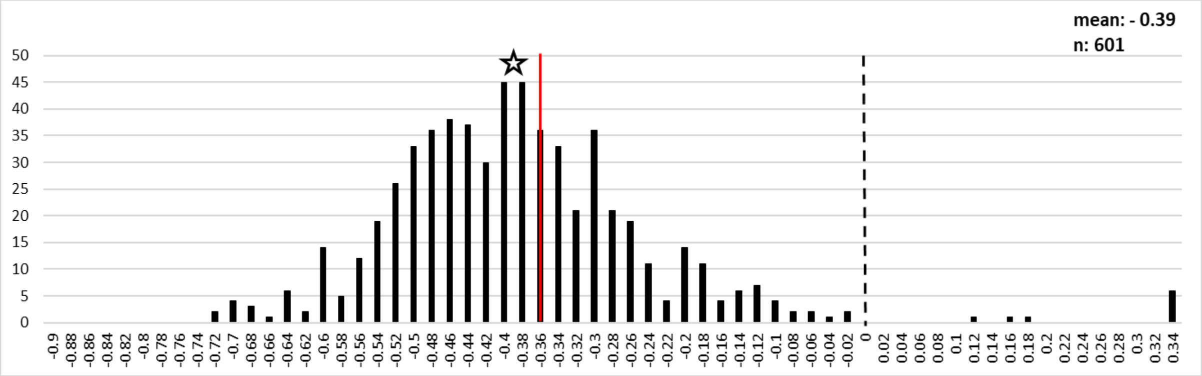


Fig. 6.11: Size distribution for all anatomical elements for pike, **religious establishments (11th-15th c.)**. The star indicates the mean (-0.39), the red line marker represents a modern pike (origin: unknown) with TL of 340 mm and SL of 300 mm (mean: -0.36). The standard set of values is represented by the value 0 (TL: 715 mm, SL: 650 mm; modern individual, origin: France). Bones measured: 210; n measures: 601.

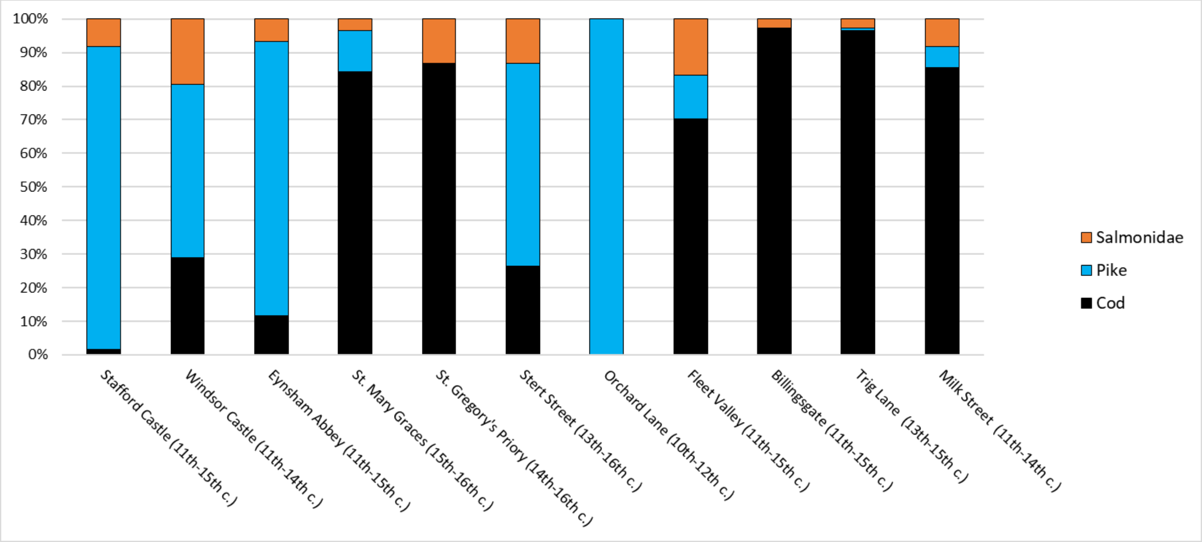


Figure 6.12: Distribution of frequencies for Salmonidae/pike/cod for all sites, combined chronology and recovery methods.

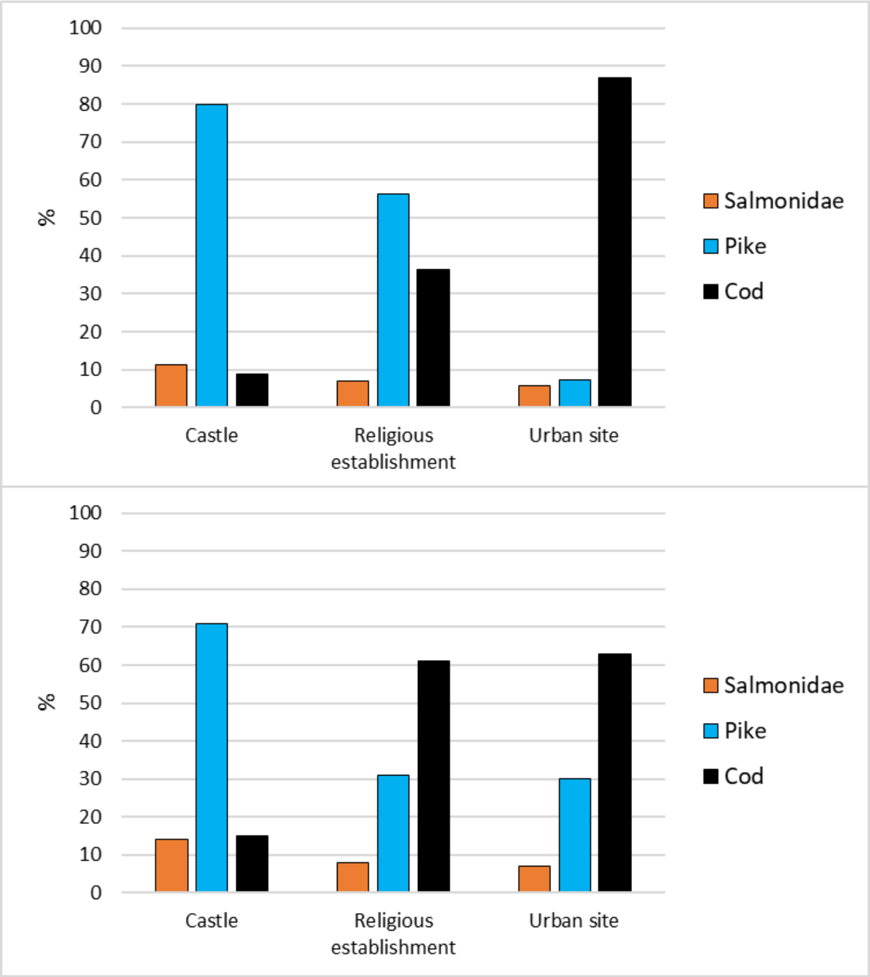


Fig. 6.13-14: Distribution of frequencies for Salmonidae/pike/cod by typology of sites, combined chronology and recovery methods. The first graph shows percentages calculated on the total NISP; the second graph shows percentages calculated as the average of the percentages for each site.

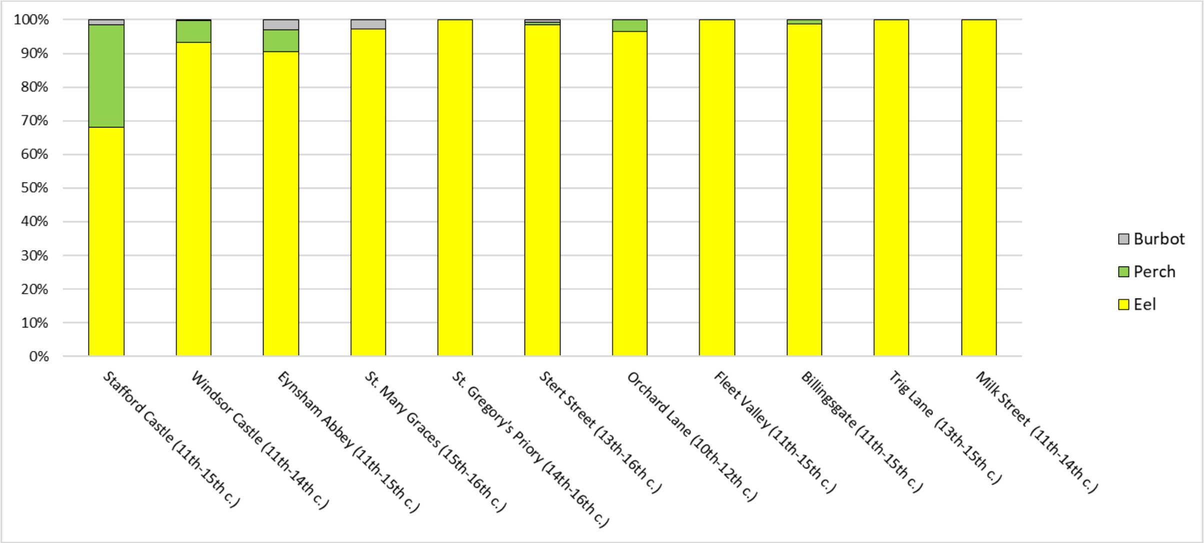


Fig. 6.15: Distribution of frequencies for burbot/perch/eel for all sites, combined chronology and recovery methods.

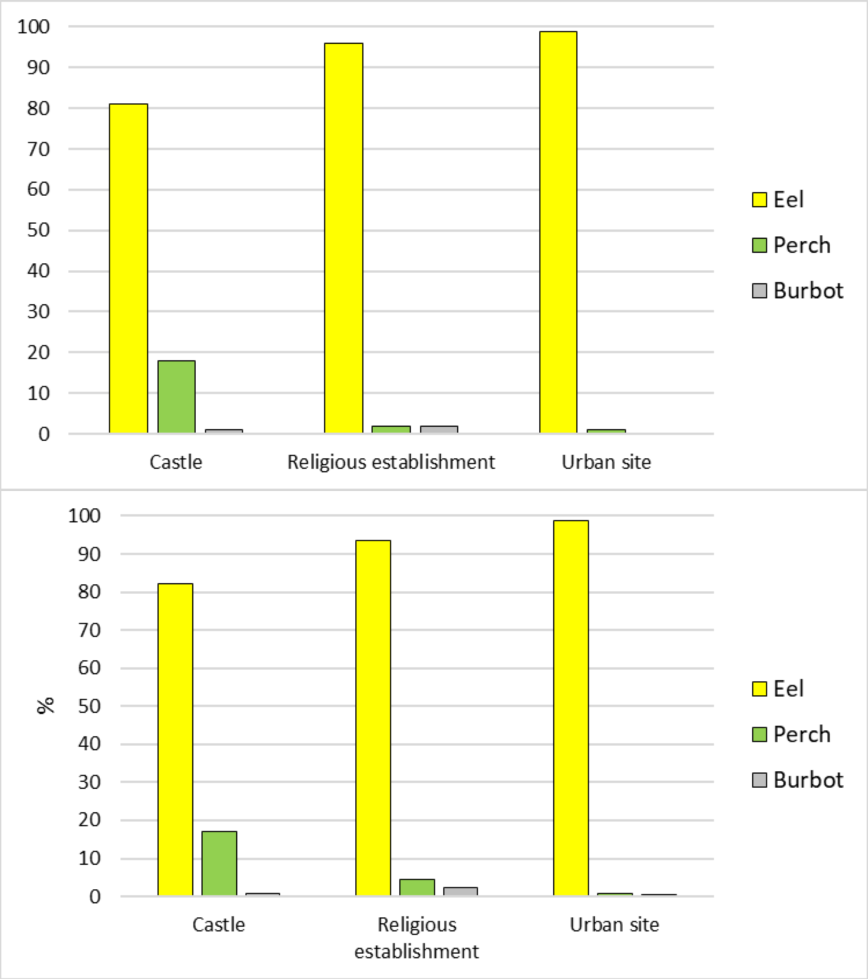


Fig. 6.16-17: Distribution of frequencies for burbot/perch/eel by typology of site, combined chronology and recovery methods. The first graph shows percentages calculated on the total NISP; the second graph shows percentages calculated as the average of the percentages for each site.

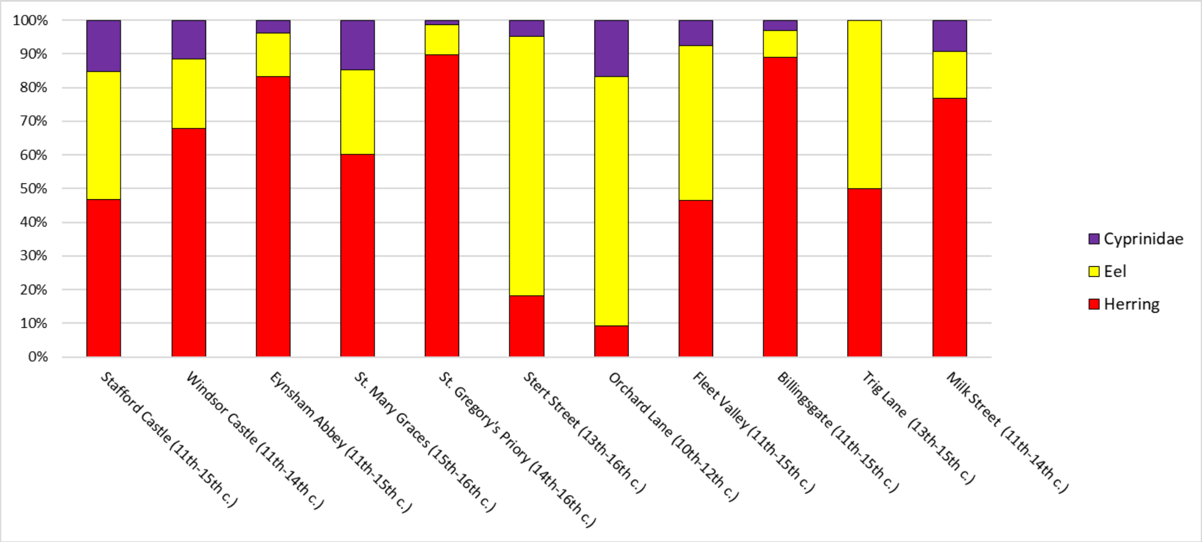


Fig. 6.18: Distribution of frequencies for Cyprinidae versus two key species (eel/herring) for all sites, combined chronology and recovery methods.

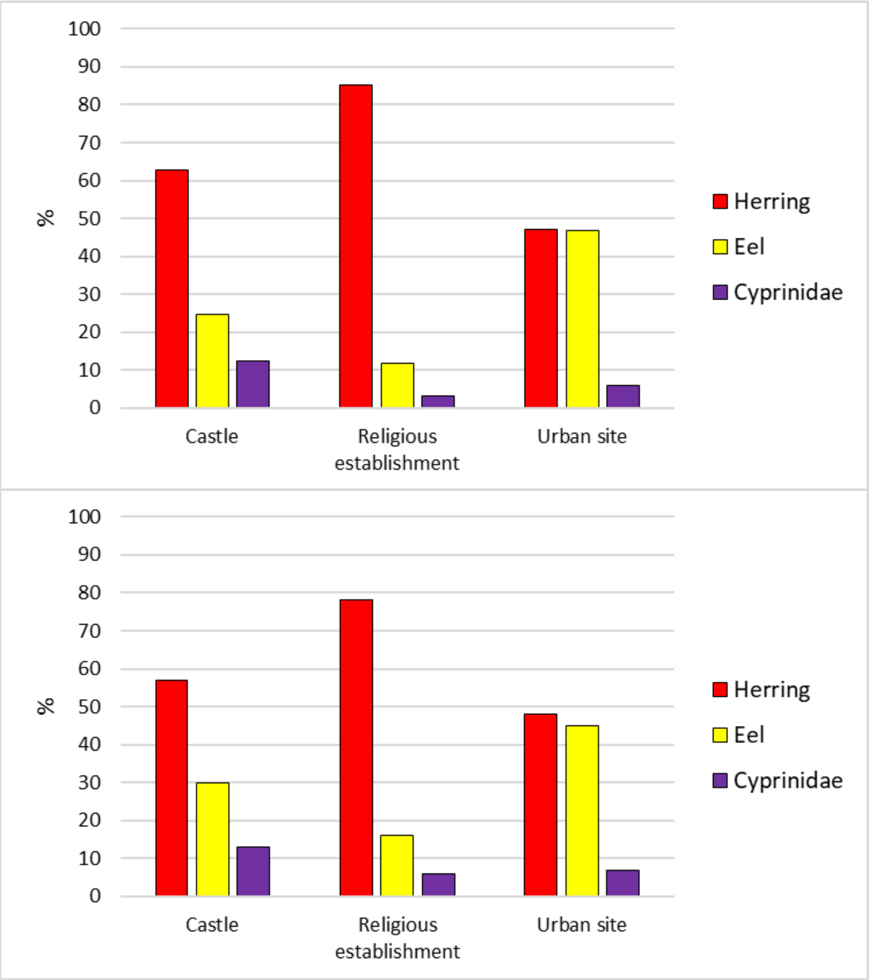


Fig. 6.19-20: Distribution of frequencies for Cyprinidae versus two key species (eel/herring) by typology of sites, combined chronology and recovery methods. The first graph shows percentages calculated on the total NISP; the second graph shows percentages calculated as the average of the percentages for each site.

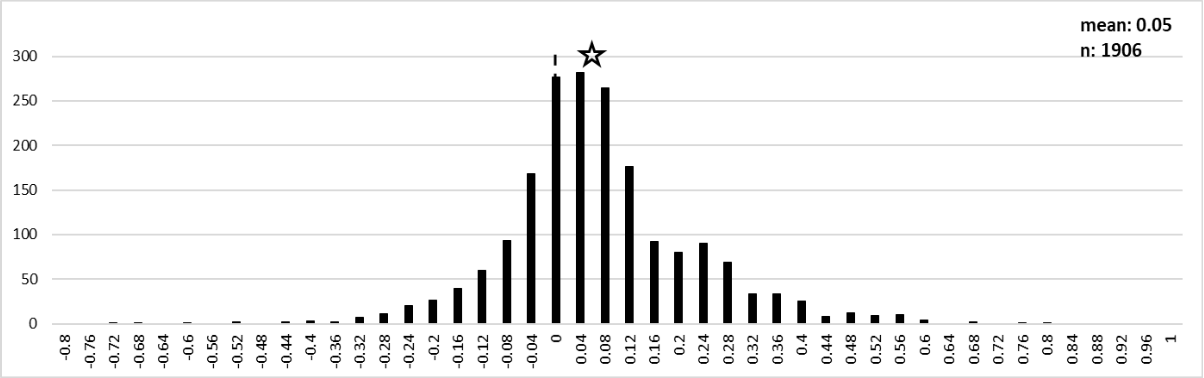


Fig. 6.21: Size distribution for all anatomical elements for Cyprinidae family, **castles (11th-15th c.)**. The star indicates the mean (0.05). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 753; n measures: 1906.

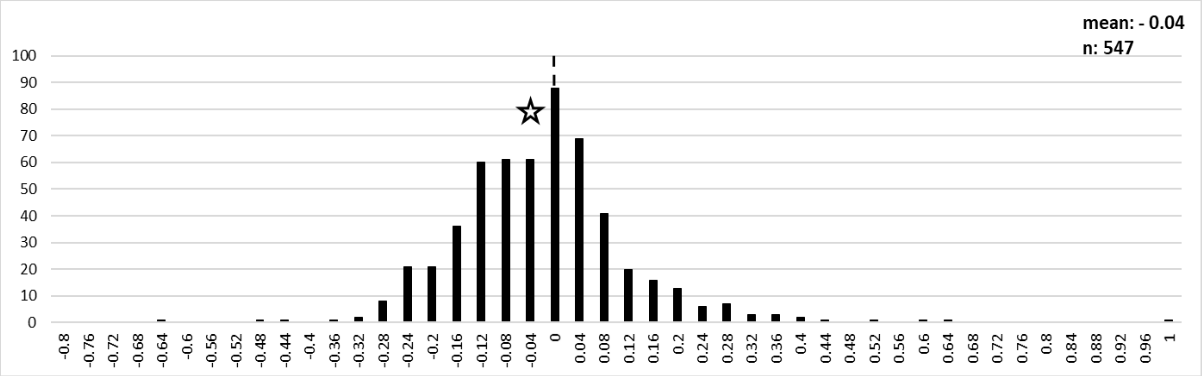


Fig. 6.22: Size distribution for all anatomical elements for Cyprinidae family, **religious establishments (11th-15th c.).** The star indicates the mean (- 0.04). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 197; n measures: 547.

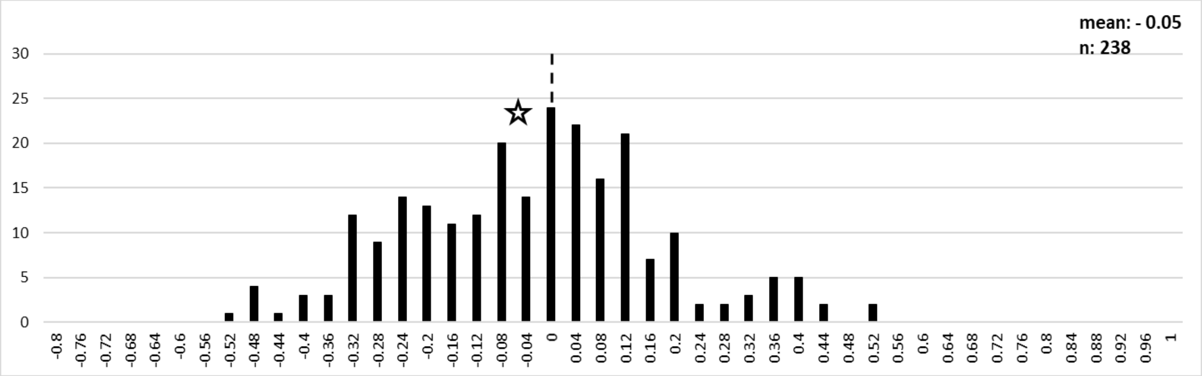


Fig. 6.23: Size distribution for all anatomical elements for Cyprinidae family, **urban sites (11th-15th c.)**. The star indicates the mean (- 0.05). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 125; n measures: 238.

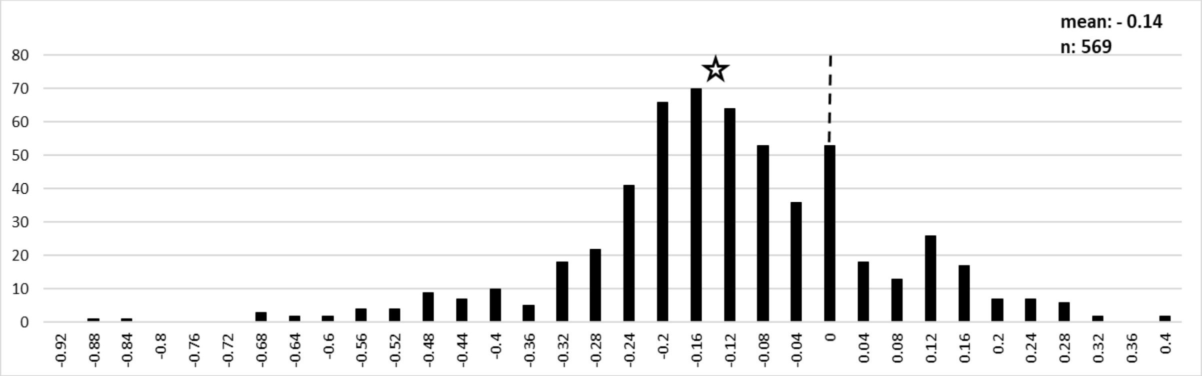


Figure 6.24: Size distribution for all anatomical elements for perch, **castles (11th-15th c.).** The star indicates the mean (- 0.14). The standard set of values is represented by the value 0 (TL: 275 mm, SL: 240 mm; modern individual, origin: Italy). Bones measured: 388; n measures: 569.

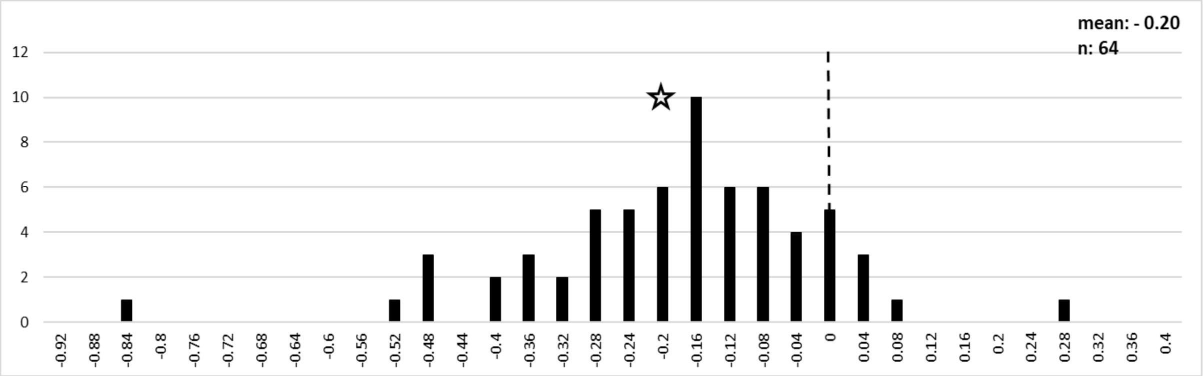


Fig. 6.25: Size distribution for all anatomical elements for perch, **religious establishments (11th-15th c.)**. The star indicates the mean (- 0.20). The standard set of values is represented by the value 0 (TL: 275 mm, SL: 240 mm; modern individual, origin: Italy). Bones measured: 31; n measures: 64.

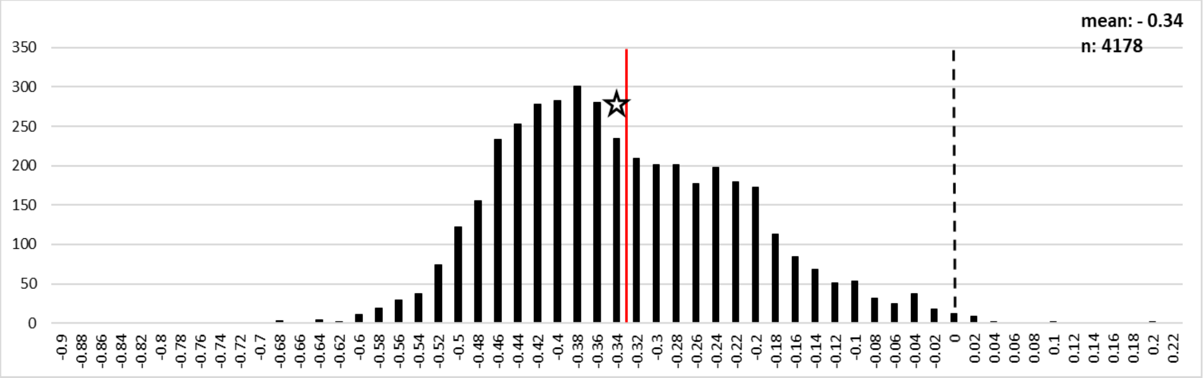


Fig. 6.26: Size distribution for all anatomical elements for eel, **castles (11th-15th c.)**. The star indicates the mean (-0.34). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 1651; n measures: 4178.

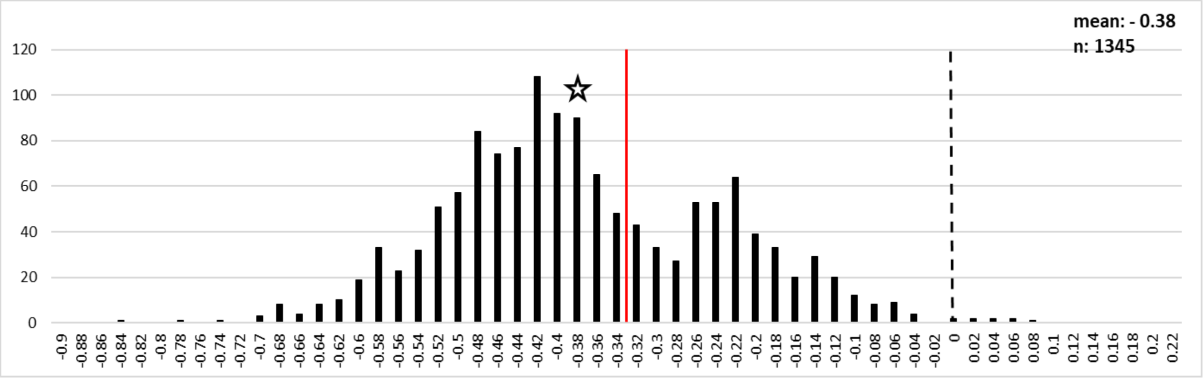


Fig. 6.27: Size distribution for all anatomical elements for eel, **religious establishments (11th-15th c.)**. The star indicates the mean (-0.38). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 494; n measures: 1345.

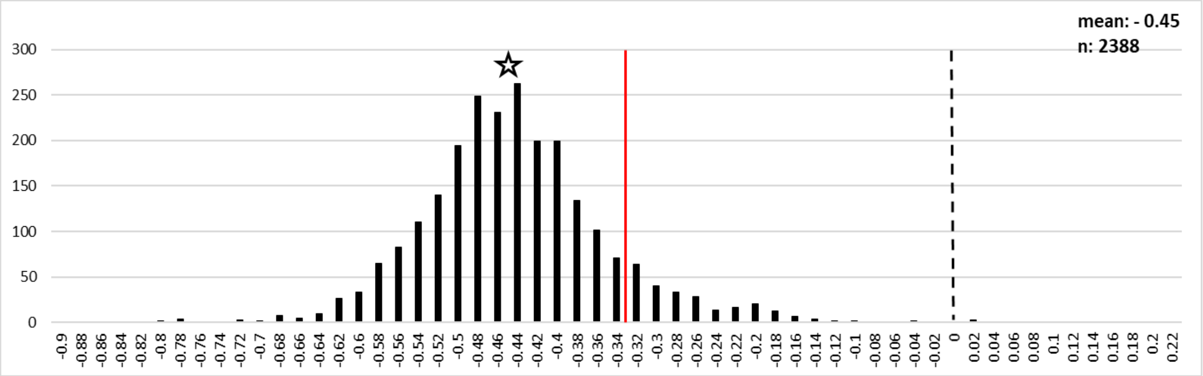


Fig. 6.28: Size distribution for all anatomical elements for eel, **urban sites (11th-15th c.)**. The star indicates the mean (-0.45). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 871; n measures: 2388.

Chapter 7. Conclusions

Documentary sources for 11th-15th c. England inform us of the prestige and high value associated with certain freshwater/migratory fish. Laws were specifically created to restrict access to such fish (e.g. the royal sturgeon) to the upper class. However, not all freshwater fish was of high status, as demonstrated by the fact that some species were featured in cookery books describing delicacies for the rich table, whereas others were sold cheaply at the market.

Given this historical evidence, the aim of the research was to investigate the role of freshwater fish from a zooarchaeological perspective. Several zooarchaeological reviews for medieval England (e.g. Barrett *et al.* 2004a; Serjeantson & Woolgar 2006; Harland *et al*. 2016; Holmes 2017; Albarella 2019) analyse the role that fish played in the medieval economy and society but, since freshwater fish tends to be less common than marine fish, it is generally not discussed in much depth. The reviews mention that several English assemblages associated with wealthy contexts show a preferential consumption for selected freshwater fish species. However, the main obstacle to the identification of clear status indicators is the scarcity of freshwater fish remains. This problem has proven to be especially acute for biometrical analysis, which requires reasonably large sample sizes and yet is a valuable tool for assessing social status, as the size of fish is correlated to its cost and value.

The innovative approach to the biometrical analysis used by this research has allowed overcoming some of these limitations. The use of the log-ratio technique has led to an increase in sample size, and therefore an extension of the number and diversity of datasets that could be used. With this new data available it has been possible to give a characterization of freshwater fish by type of site (castles, religious establishments, and urban sites) as discussed in the next few paragraphs.

A clear connection between fish sourced from freshwater environments and high-status sites has been demonstrated for the two **castles** discussed in this thesis. This correlation has emerged from several status indicators, among which the most reliable is the high frequency of some key freshwater species (pike, perch, Cyprinidae) combined with their average large size. The tenure of freshwater resources (fishponds, river fisheries, mills) by these high-status sites allowed for a substantial freshwater fish catch. Pike, perch, Cyprinidae, and eel are variable in their size but they also include some very large individuals, suggesting that fresh fish was available for most of the year and caught from reliable local sources. The occurrence of some larger fish shows that some individuals could be let to grow up to an optimal/desired size in controlled environments (i.e. fishponds). Fishponds were used to fatten selected species for the table.

The three **religious establishments** are variable in wealth and location and this is reflected in the composition of the freshwater fish assemblages. Fish consumption, especially at the richer Eynsham Abbey, shows similarities with secular rich establishments. This matches the evidence from documentary sources, which highlight the similarity of ecclesiastic and upper-class diets. The smaller average size of the fish and the high frequencies of ‘cheap’ herring (probably preserved) is indicative of the greater fish consumption demanded by religious regulations.

Freshwater fish recovered from the **urban contexts** analysed in this thesis reflects the lower status of the sites, in particular as concerns the lower percentage of freshwater species and their average smaller size. The multimodal distribution of measurements suggests fishing practices that were probably irregular in their occurrence and/or seasonal. The only species with a large variability of sizes represented, distributed in an unimodal manner, is the eel; species on which of these site types were highly relying upon. Overall, the small size of the fish probably reflects the restricted access to freshwater environments. This could be a consequence of restriction of fishing rights, which may have either forbidden fishing in some areas or heavily regulated fishing season and size of the catch. Overexploitation is also a possible explanation for the small fish size, as freshwater sources may have suffered the pressure of feeding the large urban population. Some more expensive fish (e.g. sturgeon, large pike) was also found in towns, highlighting the status diversity of the urban dwellers.

Unfortunately, the general scarcity of fish remains from **rural sites** (hamlets and villages) did not make it possible for them to be included as part of this research. However, previous studies associate a dearth of freshwater fish with the low status of these sites (e.g. Serjeantson & Woolgar 2006).

The overall evidence emerging from this research is that freshwater fish can indeed represent a valid indicator of high status in medieval England, but, to do so, ideally, taxonomic and biometrical evidence must be combined. The presence of some uncommon but highly-prized species (e.g. sturgeon, Salmonidae, burbot) is not, on its own, a valid indicator of status for a whole site. For instance, in towns, these fish are occasionally found and they may represent the result of gifts from the countryside aristocracy for selected people (e.g. a merchant or an administrator) but the area may have also been occupied by people of much lower status. Towns characteristically represent social diversity and will feature a variety of different diets.

This research has also evaluated the importance of fishponds and how they can affect the nature of fish bone assemblages. It is a subject, however, in need of further study. To confirm the patterns that have been suggested in this thesis, it is necessary to study a larger number of sites with historical and/or archaeological evidence of the occurrence of fish ponds and then analyse their fish assemblages in detail, especially as concerns taxonomic and biometric compositions.

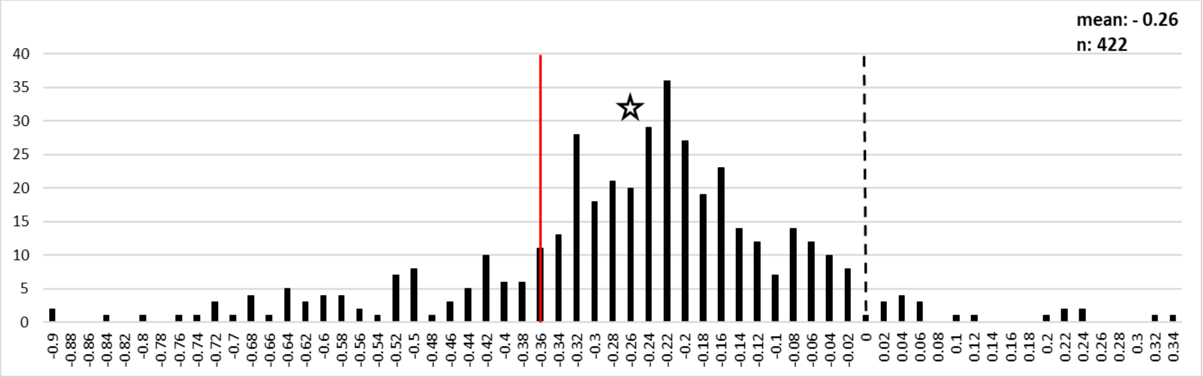
Future research could and, perhaps, should also explore the potential of other analytical techniques, such as ancient DNA or stable isotope analyses. These have been used in the past to explore fish exploitation and migratory routes (e.g. Yang *et al.* 2004; Barrett *et al.* 2011).

These analyses, however, are generally costly but, for taxonomic identification, an alternative may be represented by Zooarchaeology by Mass Spectrometry (ZooMS; Collins *et al.* 2009), which can be performed more cheaply, although it still requires dedicated laboratories. ZooMS can be especially useful to complement the macroscopic identification of species that are morphologically very similar (Orton 2016). The application of this methodology for targeted objectives (e.g. identification of different species of sturgeon or Cyprinidae) could add valuable information to the research questions discussed in this thesis.

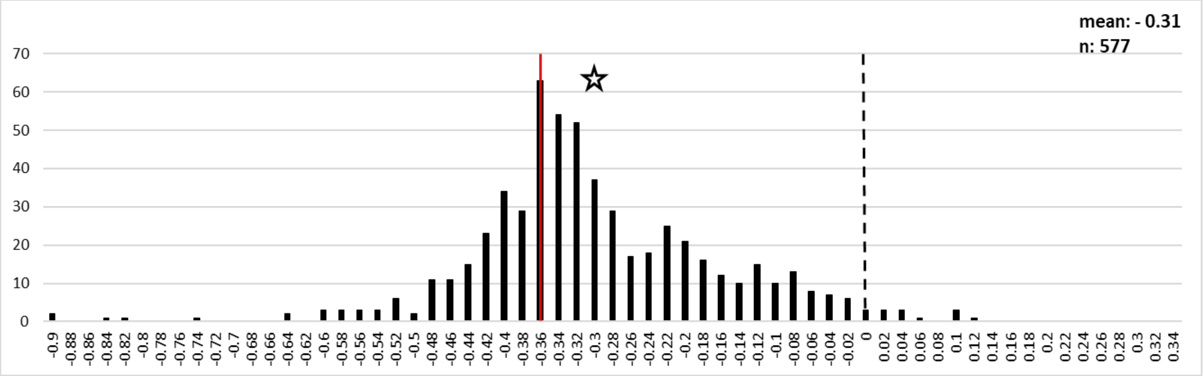
Finally, it is probably inevitable for every zooarchaeologist working on fish remains to make a plea for more extensive and systematic sampling and sieving of soil samples. Greater clarity on the adopted sieving strategies and methods than is generally available in published reports would also be very useful.

An important aspect of this research has been to enhance the value of biometry for the study of fish bones from archaeological sites. This has been demonstrated to be an important tool useful at addressing social as well as economic questions. It has contributed to understand and define the value of freshwater fish as markers of status. Species frequencies and habitat distributions have, of course, proven to be also important but the information they provide would have been incomplete, if not misleading, without the integration of biometric analysis. Future research will generate further data that will contribute to verify the hypotheses raised as part of this research. Hopefully, the evidence presented here has, however, demonstrated that freshwater, and not just marine, fish has sufficient potential to be analysed in-depth and provide important insights for our understanding of medieval societies.

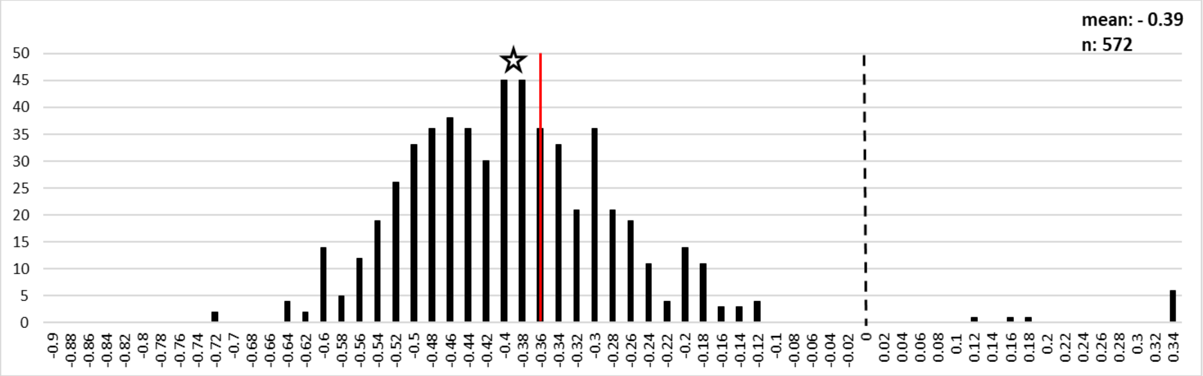
Appendices



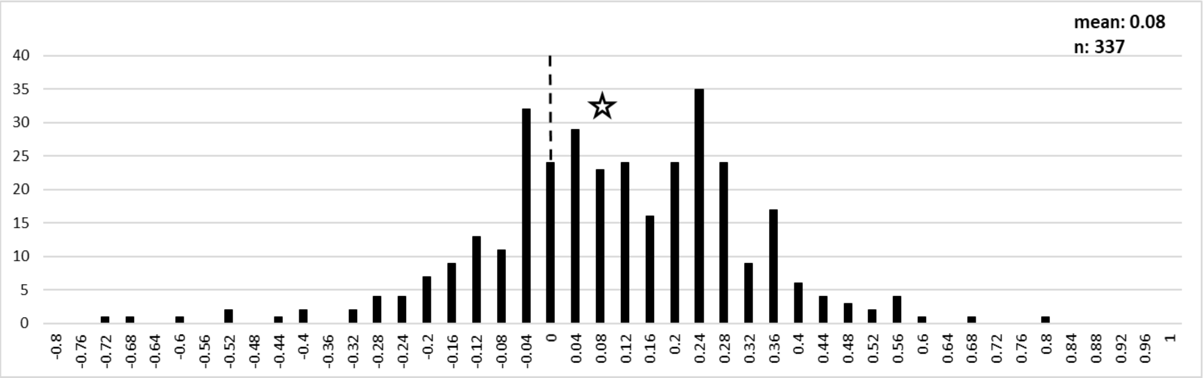
Appendix 1: Size distribution for all anatomical elements for *Esox lucius*, **Stafford Castle (11th-15th c.)**. The star indicates the mean (-0.26), the red line marker represents a modern pike (origin: unknown) with TL of 340 mm and SL of 300 mm (mean: -0.36). The standard set of values is represented by the value 0 (TL: 715 mm, SL: 650 mm; modern individual, origin: France). Bones measured: 198; n measures: 422.



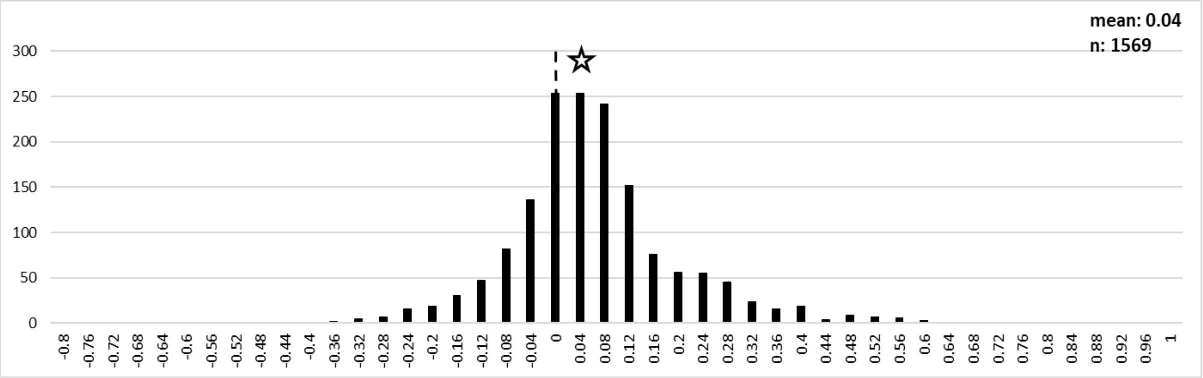
Appendix 2: Size distribution for all anatomical elements for *Esox lucius*, **Windsor Castle (11th-14th c.)**. The star indicates the mean (-0.31), the red line marker represents a modern pike (origin: unknown) with TL of 340 mm and SL of 300 mm (mean: -0.36). The standard set of values is represented by the value 0 (TL: 715 mm, SL: 650 mm; modern individual, origin: France). Bones measured: 235; n measures: 577.



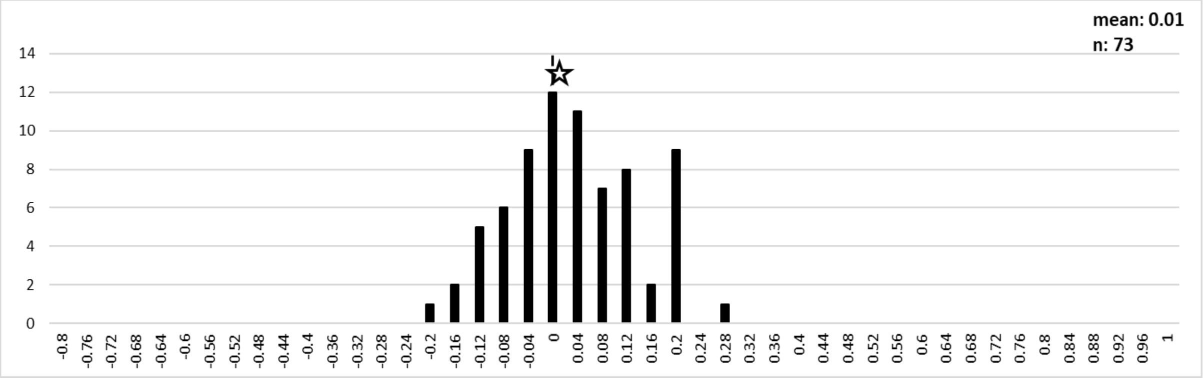
Appendix 3: Size distribution for all anatomical elements for *Esox lucius*, **Eynsham Abbey (11th-15th c.)**. The star indicates the mean (-0.39), the red line marker represents a modern pike (origin: unknown) with TL of 340 mm and SL of 300 mm (mean: -0.36). The standard set of values is represented by the value 0 (TL: 715 mm, SL: 650 mm; modern individual, origin: France). Bones measured: 200; n measures: 572.



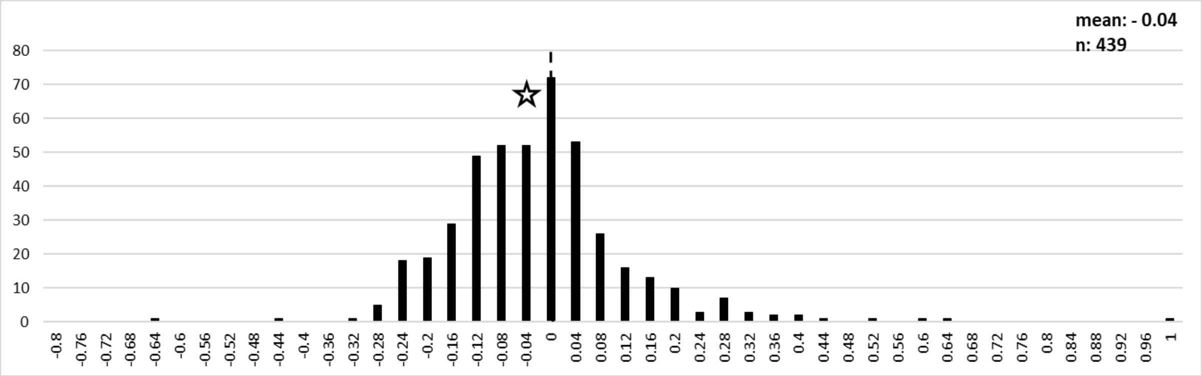
Appendix 4: Size distribution for all anatomical elements for Cyprinidae family, **Stafford Castle (11th-15th c.)**. The star indicates the mean (0.08). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 159; n measures: 337.



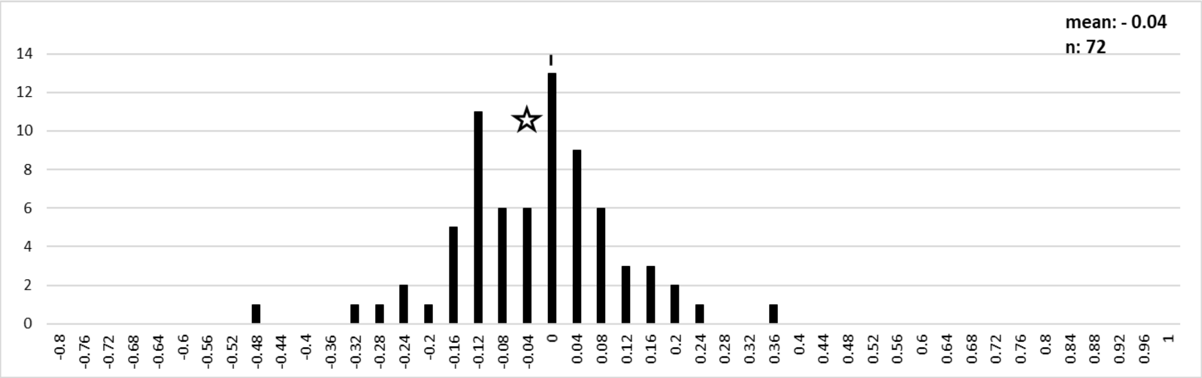
Appendix 5: Size distribution for all anatomical elements for Cyprinidae family, **Windsor Castle (11th-14th c.)**. The star indicates the mean (0.04). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 594; n measures: 1569.



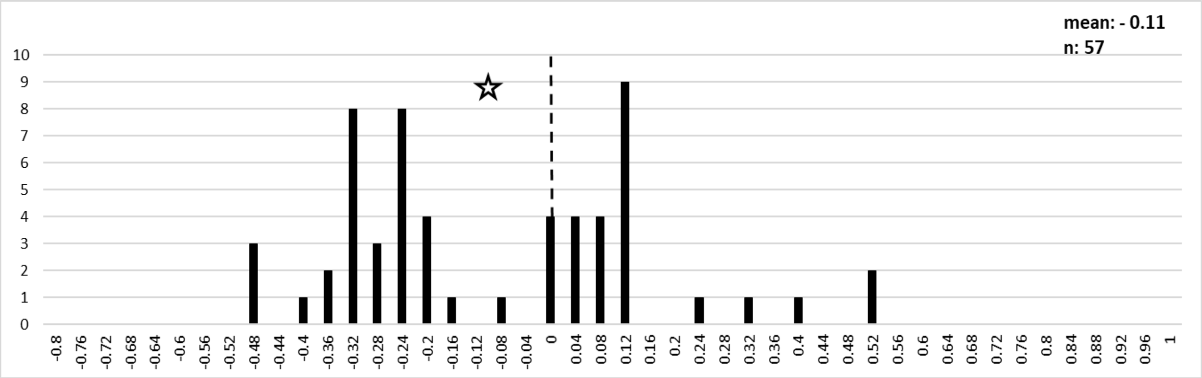
Appendix 6: Size distribution for all anatomical elements for Cyprinidae family, **Fleet Valley (12th-15th c.)**. The star indicates the mean (0.01). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 29; n measures: 73.



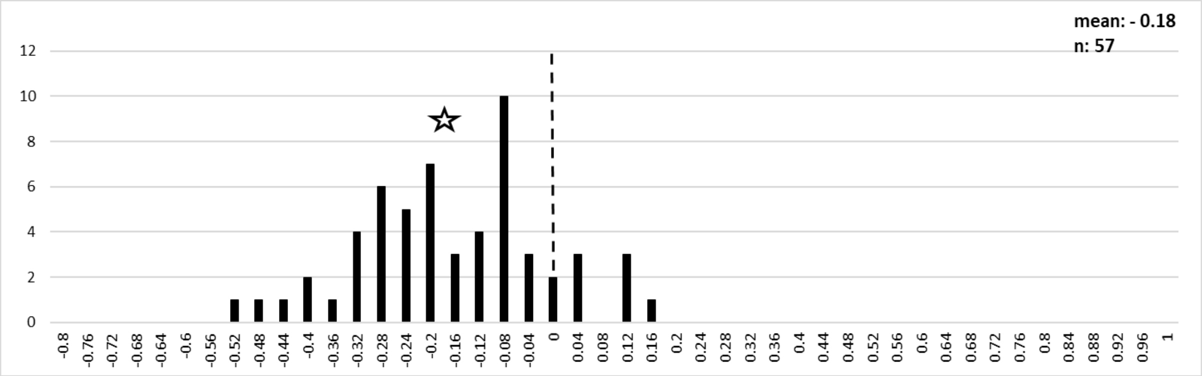
Appendix 7: Size distribution for all anatomical elements for Cyprinidae family, **Eynsham Abbey (11th-15th c.)**. The star indicates the mean (- 0.04). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 158; n measures: 439.



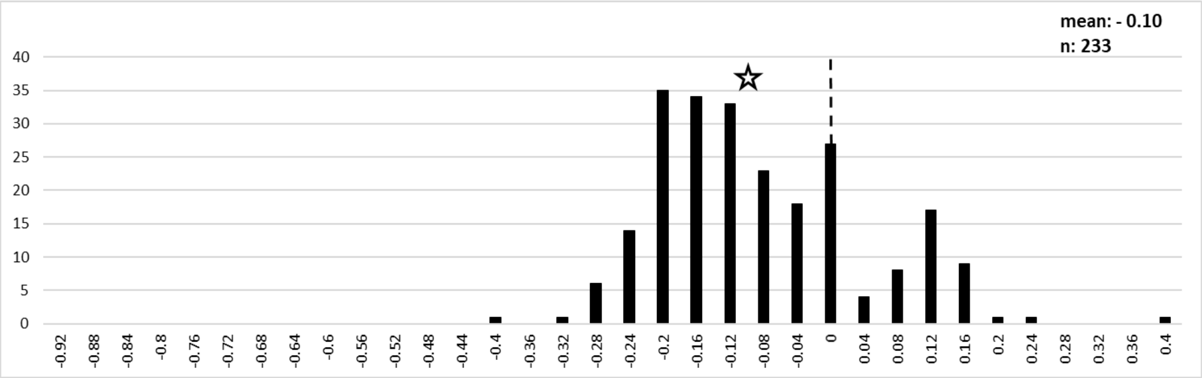
Appendix 8: Size distribution for all anatomical elements for Cyprinidae family, **St. Gregory's Priory (14th-15th c.)**. The star indicates the mean (- 0.04). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 26; n measures: 72.



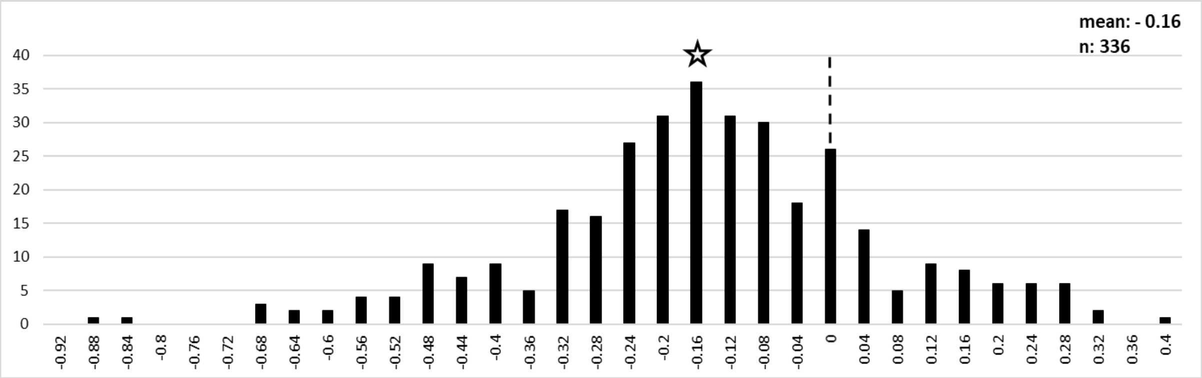
Appendix 9: Size distribution for all anatomical elements for Cyprinidae family, **Milk Street (11th-14th c.)**. The star indicates the mean (- 0.11). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 21; n measures: 57.



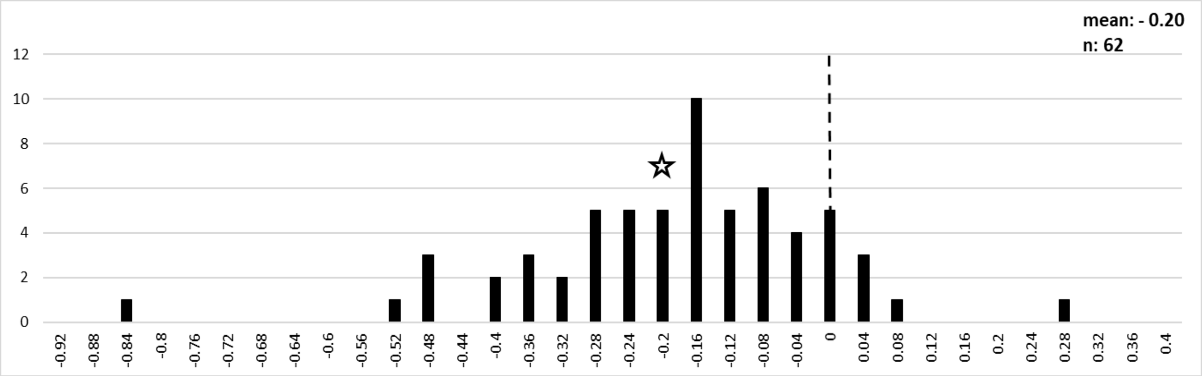
Appendix 10: Size distribution for all anatomical elements for Cyprinidae family, **Stert Street (13th-15th c.)**. The star indicates the mean (- 0.18). The standard set of values is represented by the value 0 (*Rutilus rutilus*, TL: 190 mm, SL: 150 mm; modern individual, origin: Italy). Bones measured: 25; n measures: 57.



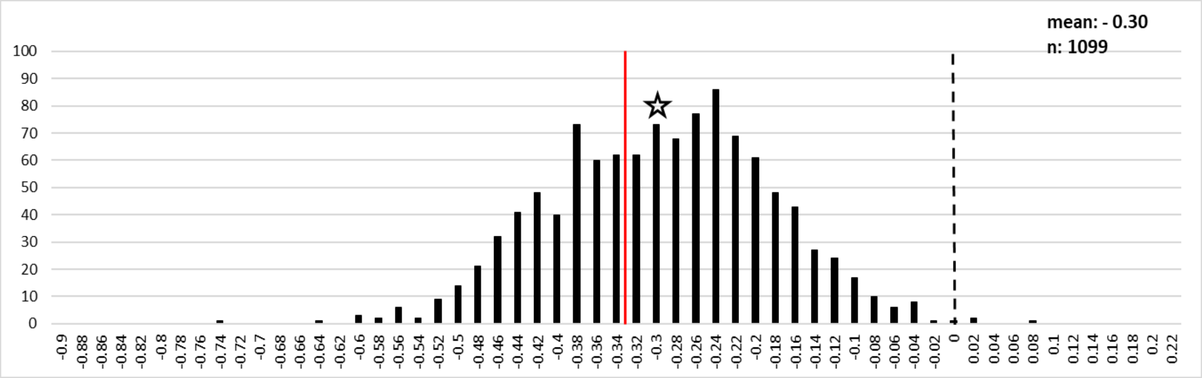
Appendix 11: Size distribution for all anatomical elements for *Perca fluviatilis*, **Windsor Castle (11th-14th c.)**. The star indicates the mean (-0.10). The standard set of values is represented by the value 0 (TL: 275 mm, SL: 240 mm; modern individual, origin: Italy). Bones measured: 107; n measures: 233.



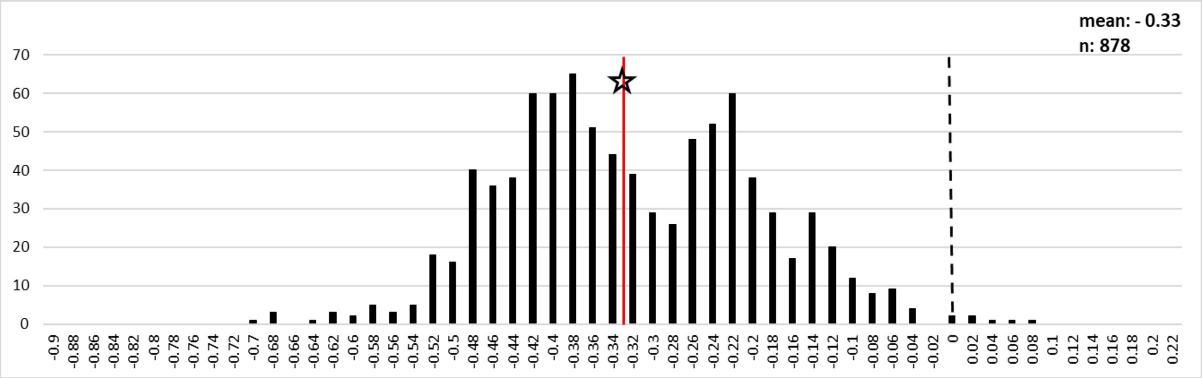
Appendix 12: Size distribution for all anatomical elements for *Perca fluviatilis*, **Stafford Castle (11th-15th c.)**. The star indicates the mean (-0.16). The standard set of values is represented by the value 0 (TL: 275 mm, SL: 240 mm; modern individual, origin: Italy). Bones measured: 281; n measures: 336.



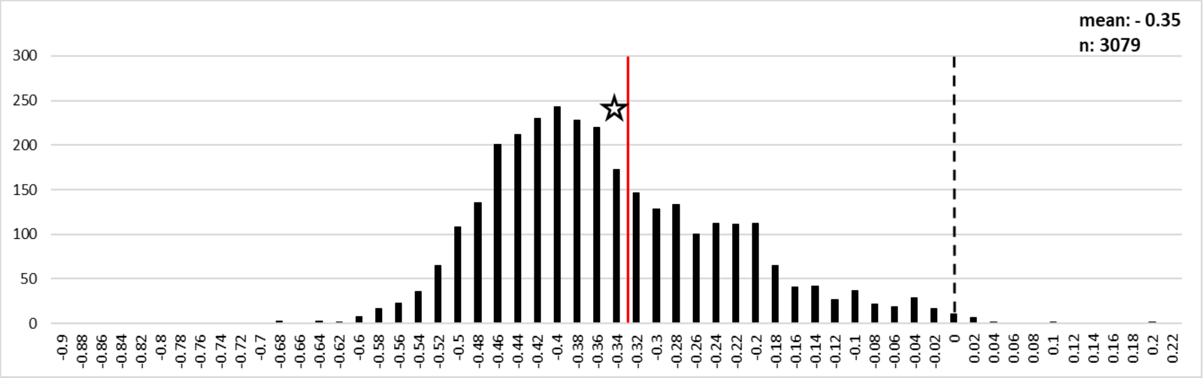
Appendix 13: Size distribution for all anatomical elements for *Perca fluviatilis*, **Eynsham Abbey (11th-15th c.)**. The star indicates the mean (-0.2). The standard set of values is represented by the value 0 (TL: 275 mm, SL: 240 mm; modern individual, origin: Italy). Bones measured: 30; n measures: 62.



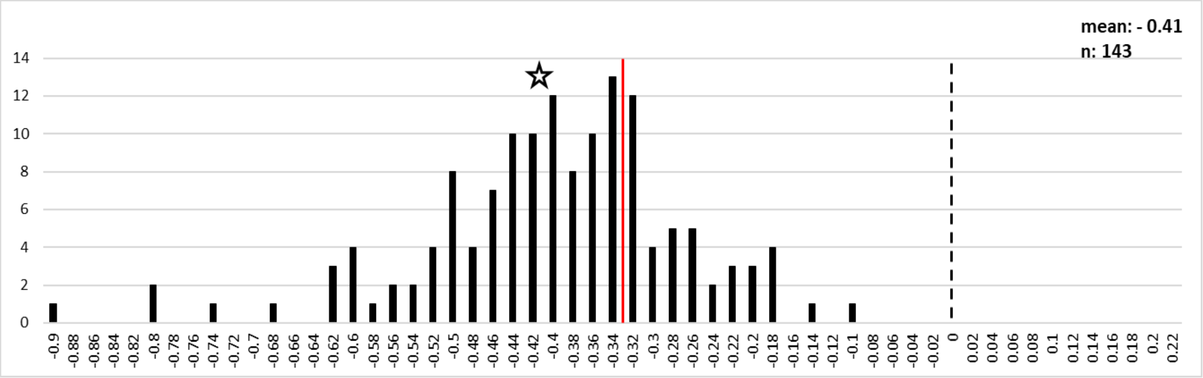
Appendix 14: Size distribution for all anatomical elements for *Anguilla anguilla*, **Stafford Castle (11th-15th c.)**. The star indicates the mean (-0.30). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 533; n measures: 1099.



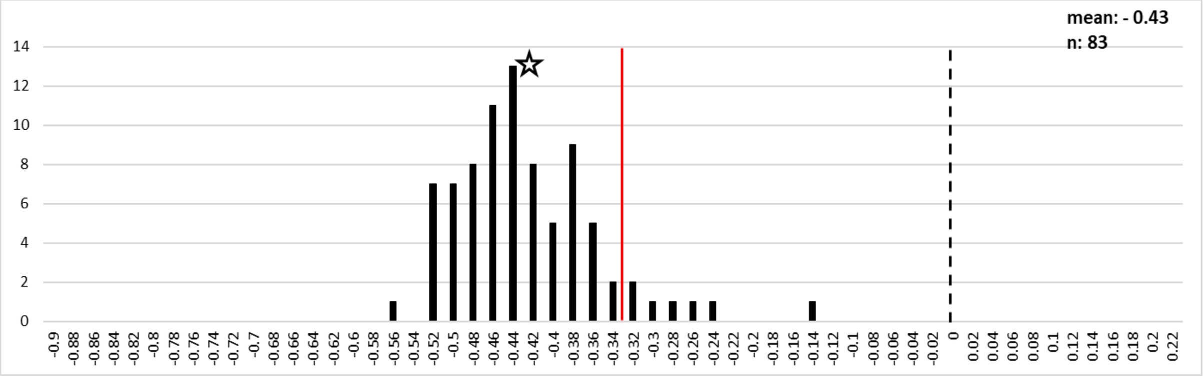
Appendix 15: Size distribution for all anatomical elements for *Anguilla anguilla*, **Eynsham Abbey (11th-15th c.)**. The star indicates the mean (-0.33). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 330; n measures: 878.



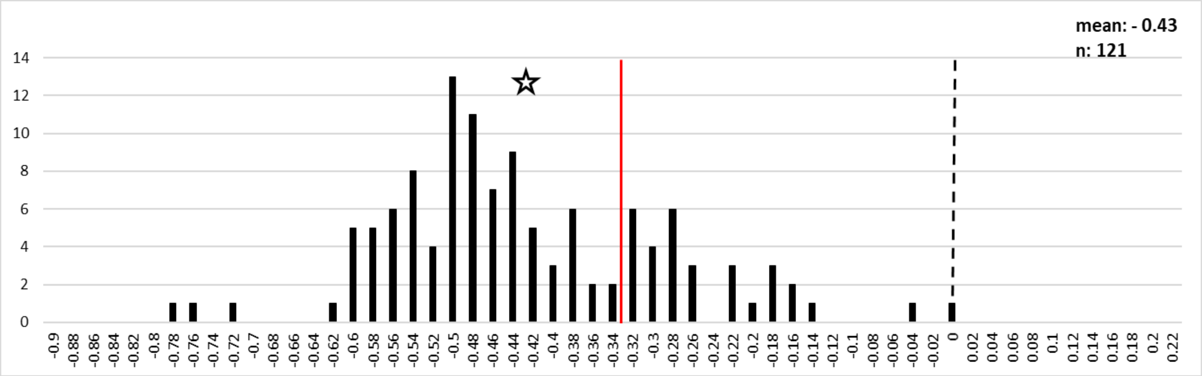
Appendix 16: Size distribution for all anatomical elements for *Anguilla anguilla*, **Windsor Castle (11th-14th c.)**. The star indicates the mean (-0.35). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 1118; n measures: 3079.



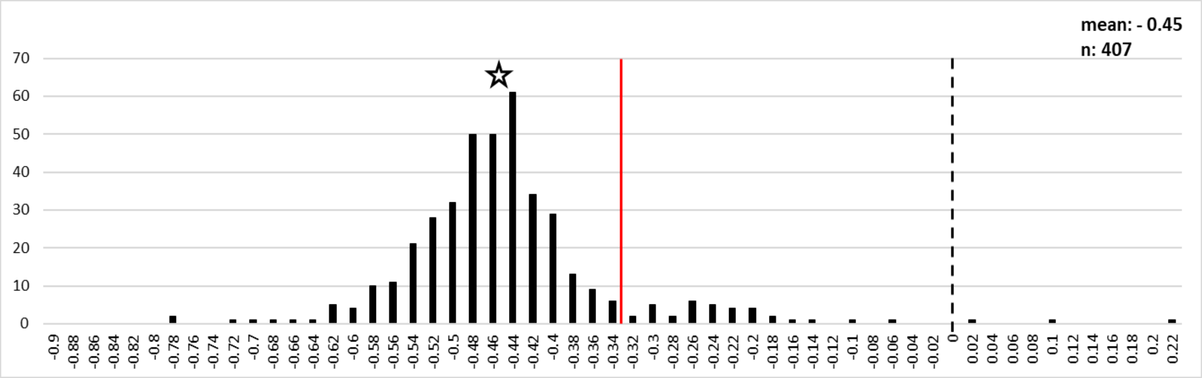
Appendix 17: Size distribution for all anatomical elements for *Anguilla anguilla*, **Milk Street (11th-14th c.)**. The star indicates the mean (- 0.41). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 56; n measures: 143.



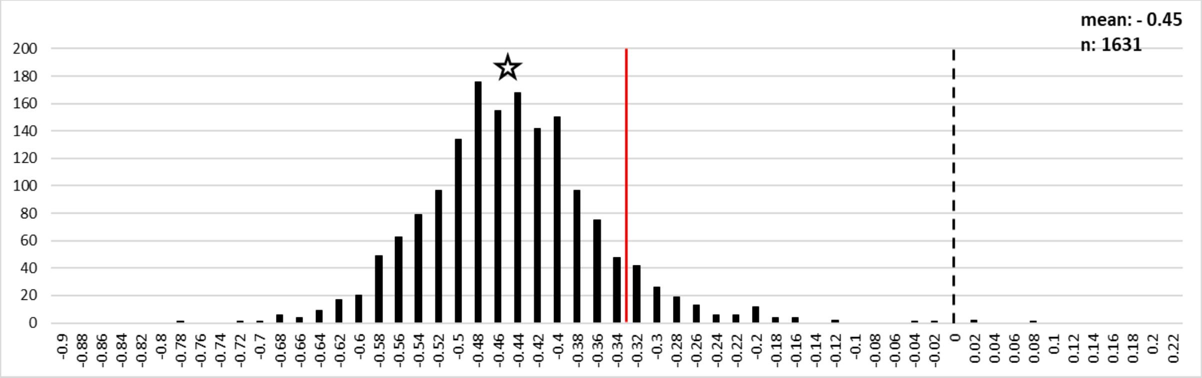
Appendix 18: Size distribution for all anatomical elements for *Anguilla anguilla*, **Orchard Lane (11th-12th c.)**. The star indicates the mean (- 0.43). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 30; n measures: 83.



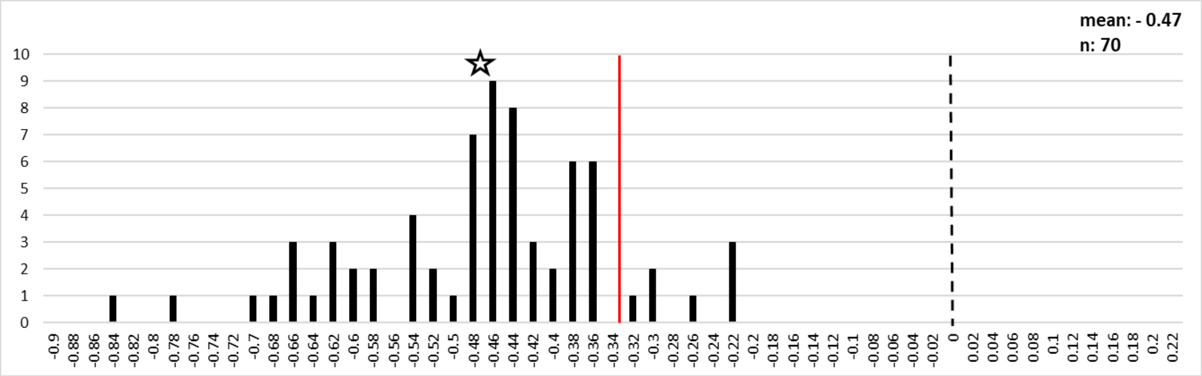
Appendix 19: Size distribution for all anatomical elements for *Anguilla anguilla*, **Billingsgate (11th-15th c.)**. The star indicates the mean (- 0.43). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 45; n measures: 121.



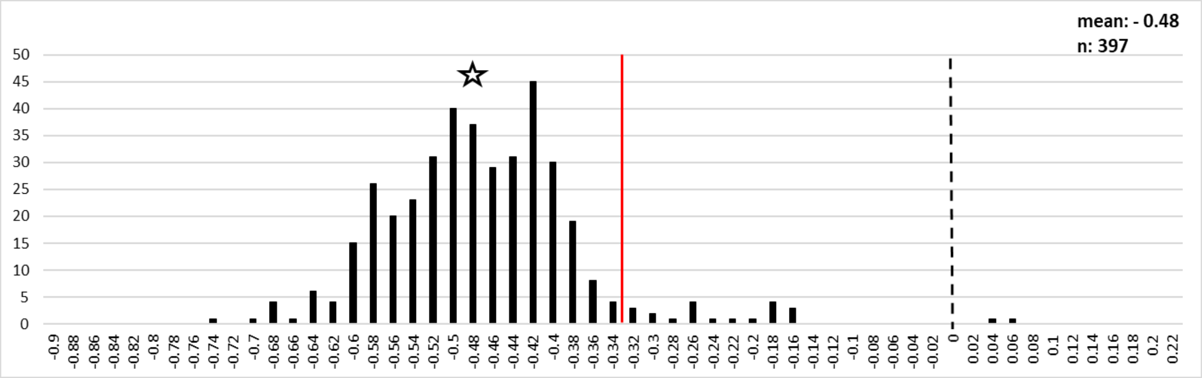
Appendix 20: Size distribution for all anatomical elements for *Anguilla anguilla*, **Fleet Valley (12th-15th c.)**. The star indicates the mean (- 0.45). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 143; n measures: 407.



Appendix 21: Size distribution for all anatomical elements for *Anguilla anguilla*, **Stert Street (13th-15th c.)**. The star indicates the mean (- 0.45). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 596; n measures: 1631.



Appendix 22: Size distribution for all anatomical elements for *Anguilla anguilla*, **St. Mary Graces (15th c.)**. The star indicates the mean (-0.47). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 25; n° measures: 70.



Appendix 23: Size distribution for all anatomical elements for *Anguilla anguilla*, **St. Gregory's Priory (14th-15th c.)**. The star indicates the mean (-0.48). The red line marker represents a modern eel (origin: unknown) with TL of 490 mm and SL of 465 mm (mean: -0.33). The standard set of values is represented by the value 0 (TL: 960 mm, SL: 940 mm; modern individual, origin: Italy). Bones measured: 139; n measures: 397.

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