COD AND HERRING

AN OFFPRINT FROM

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THE ARCHAEOLOGY AND HISTORY OF MEDIEVAL SEA FISHING

Edited by

JAMES H. BARRETT AND DAVID C. ORTON

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Front cover: Design by Katie Gabriel Allen using a woodcut image from *Historia de Gentibus Septentrionalibus* by Olaus Magnus (used by permission of University of Glasgow Library, Special Collections)
Back cover: Medieval fish bones from Blue Bridge Lane, York (Photo: James Barrett)

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Preface and Acknowledgements

The analysis of fish bones from archaeological sites is a highly specialised and painstaking task, requiring an abundance of the time that is so rarely available in either academic or commercial archaeology. Moreover, study of fish remains has seldom been at the top of archaeological research priorities. Nevertheless, over the last 40 years a few specialists across Europe have dedicated themselves to work of this kind, and thus to discovering the outlines of medieval fishing history around the North Atlantic, and the Irish, North and Baltic seas. Although mutually informed in terms of methodology, this fundamental research has often been carried out in the framework of national institutions and agendas. Concurrently, historians have independently striven to systematise and analyse complex corpora of textual evidence regarding medieval fishing and fish trade. Once again this work has sometimes occurred within national or regional schools of research. The results of these zooarchaeological and historical efforts have often proven surprising and important, revealing remarkable evidence of continuity and change. Archaeologists of medieval coastal settlements have also contributed much to our understanding of the relationship between people and the sea.

The present volume is an effort to enhance the value of this past work by crossing boundaries – between regions and between disciplines. It also emerges from a time when traditional zooarchaeology (the identification, quantification and interpretation of skeletal remains) has increasingly benefited from integration with biomolecular approaches, such as stable isotope analysis and the study of ancient DNA. These latter methods are not the main focus of the book – they are changing far too quickly for this to have been helpful. Nevertheless, they inform many of its chapters and Gundula Müldner has taken up the challenge of surveying the extant stable isotope evidence regarding human skeletal remains from medieval Britain. Even in the fields of zooarchaeology and history it is recognised, even hoped, that this volume will quickly become outdated. It is our aspiration that the collaborative process of consolidating what is known and unknown may already have accelerated the pace of current research on medieval sea fishing.

The idea behind the book emerged from an interdisciplinary conference organised by one of us (JHB) in Westray, Orkney, Scotland, in June of 2008. It was several years, however, before the groundwork could be laid – including finishing the analysis of major collections and the synthesis of decades of fish-bone and historical research. The initial practicalities were skilfully managed by Cluny Johnstone, then a postdoctoral research fellow on the 'Medieval Origins of Commercial Sea Fishing' project funded by the Leverhulme Trust. After a period of maternity leave Cluny decided to be a full-time parent and editing became our responsibility. DCO began the process while a postdoctoral research fellow on the Leverhulme Trust project 'Ancient DNA, Cod and the Origins of Commercial Trade in Medieval Europe'. JHB was then able to see it through to completion. This book is also based upon work from the COST Action Oceans Past Platform, supported by COST (European Cooperation in Science and Technology).

We are grateful to Julie Gardiner of Oxbow Books for her helpfulness and patience during the book's long gestation. Jennifer Harland (also a postdoctoral research fellow on the 'Medieval Origins of Commercial Sea Fishing' project) and Christine Harcus assisted with the original conference in Orkney, which was funded by the Leverhulme Trust, the McDonald Institute for Archaeological Research and the History of Marine Animal Populations project (supported by the Alfred P. Sloan Foundation). Many thanks are owed to Suzanne Needs-Howarth, who copy-edited the volume and helped compile Appendix 1.1, and to the McDonald Institute for Archaeological Research, which contributed to the cost of her work. Dora Kemp also kindly assisted with copy-editing. The cover was designed by Katie Gabriel Allen using a woodcut image from *Historia de Gentibus Septentrionalibus* by Olaus Magnus (used by permission of University of Glasgow Library, Special Collections) and a photograph of medieval fish bones from York taken by JHB. Other image credits are given in the figure captions, and each chapter includes its own acknowledgements section when appropriate. Most importantly, we thank the contributors to this volume for the many years of careful research that their chapters represent.

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Fish for London

David C. Orton, Alison Locker, James Morris and James H. Barrett

Introduction and background

Previous synthesis of zooarchaeological remains from English medieval sites has shown that marine fish consumption increased, from a very low baseline, around AD 1000, a phenomenon dubbed the fish event horizon (FEH) by Barrett *et al*. (2004a). This change appears initially to have been linked primarily to urban sites, with widespread marine fish consumption at inland rural settlements argued to be a slightly later development (Barrett *et al*. 2004b; but see also Chapter 17 regarding near-coastal elite settlements). That early towns and cities led the way in the expansion of marine resource use is perhaps unsurprising, given that urban settlements almost by definition involve a concentration of food consumers rather than producers and hence require a significant hinterland to meet demand. Turning to marine resources is one way to expand this resource base.

Stable isotope provenancing has shown that this FEH initially involved relatively locally caught fish, with imports from northern waters only becoming common during the thirteenth to fourteenth centuries (Barrett *et al*. 2011). To the extent that the shift towards marine resources was driven by demand from urban populations, one might also expect expanding cities to have been at the forefront of the eventual development of long-distance trade in fish. Apart from the increasing strain that must have been placed on local hinterlands (both terrestrial and marine) by growing cities such as London – whose population is estimated to have climbed from around 20,000 in the twelfth century to around 80,000 in the thirteenth century (Campbell *et al*. 1993, 24) – trade functions were in any case central to medieval urbanism (Astill 2009; Biddle 1976). Indeed, in this context it is worth noting that significant consumption of herring (*Clupea harengus*) seems to have pre-dated the FEH, specifically at early medieval proto-urban trading centres (Barrett *et al*. 2004b; see also Chapters 14–15).

London is thus a good case study through which to explore the onset and development of long-distance trade in fish to England, using cod (*Gadus morhua*) as our example. Apart from being one of the largest medieval cities in the kingdom, its historic core has also been subject to intensive, high-quality excavation over the past 40 years. Moreover, stable isotope provenancing results suggest that London came to rely on imported cod relatively early, within its southern North Sea context (Barrett *et al*. 2011), although sample size – and hence representativeness – is ultimately restricted by the practicalities of destructive laboratory analysis.

This chapter presents the results of a meta-analysis of cod remains from 95 sites across London, aimed at detecting changes over time in the contribution of imports, complementing and placing in context the isotopic results. It builds on an earlier publication (Orton *et al*. 2014), adding assessments of changes in fish preservation techniques and of the spatial distribution of the bone finds. Late and post-medieval trends are also given more attention in the present chapter than in the previous study.

Data and methods

The dataset used here is that of Orton *et al*. (2014), consisting of a total of 2827 reasonably well-dated cod remains from 95 excavation sites, along with associated context information and dating. Specimens with date ranges greater than 300 years were not used and are not included in this number. The vast majority of sites are in London's historic core, while a few from what is today known as Greater London can be considered part of the (post-)medieval city's wider economic catchment. Data were gathered from a range of published and unpublished sources, but principally the database of MOLA – a commercial excavation company that grew out of the Museum of London's field archaeology unit – and co-author

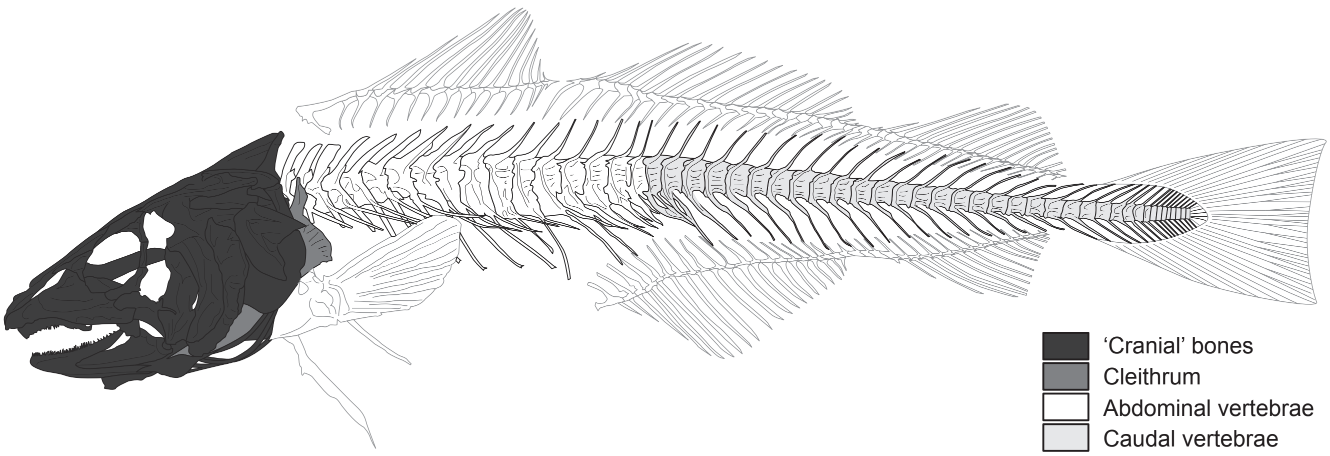

Figure 16.1. Skeleton of cod, showing anatomical categories used in this study. (Drawing: David Orton using a base image by Michel Coutureau and Benoît Clavel, ©ArchéoZoo.)

Alison Locker's personal archive. Further details can be found in the online supplementary information to Orton *et al*. (2014).

Our analysis relies on the assumption that, prior to the use of ice and/or refrigeration in modern times, cod were typically decapitated before drying and/or salting for long-distance transport (e.g. Barrett 1997; Candow 2009; Perdikaris and McGovern 2008). Thus cranial elements will usually represent relatively locally caught fish. Postcranial elements, by contrast, could derive either from local catches or from imports. There are exceptions to this rule, but they represent atypical examples (e.g. Bennema and Rijnsdorp 2015; Jonsson 1986). 'Cranial' is here defined to include the neurocranium, jaw apparatus, hyoid arch and gill covers, while postcranial refers to the cleithra (paired bones that support the pectoral fins, just behind the head) and the vertebrae. The vertebrae are subdivided into abdominal and caudal vertebrae where specified in the original data (Figure 16.1). Other postcranial bones, including supracleithra, postcleithra and scapulae, are excluded from analysis for the present purpose (leaving 2827 specimens for study, from an original total of 3034). The few known exceptions to the practice of decapitating cod prior to drying and/or salting may reduce the visibility of imports (that is, fish from some sources) but are unlikely to alter the overall picture.

Changes in the relative frequency of postcranial versus cranial bones can thus be used as a proxy for shifts in the contribution of imported cod. Moreover, because the inclusion of abdominal vertebrae in preserved cod varies according to technique and tradition, changes in relative frequencies *within* the postcranial category may reveal shifts in the types of products imported, and hence hint at shifts in the relative importance of different sources. For example, abdominal vertebrae and cleithra were left in *rundfisk*, one of the most common varieties of unsalted Norwegian stockfish (Chapter 18). Conversely, anterior vertebrae (but not cleithra) were typically removed during the production of *råskjær* (another variety of stockfish, made in Norway, Iceland and the Northern Isles of Scotland), and in the salted and dried products prepared, for example, in the early Newfoundland fishery (Candow 2009; Harland and Barrett 2012; Perdikaris and McGovern 2008; Chapter 18).

Relative frequencies of each bone category over time are compared using estimated frequency distributions, which are constructed using a simple, two-step procedure:

1. Divide the number of relevant specimens in each context by the length of that context's date range to create an estimated frequency density across that range. Note that this assumes a uniform probability distribution for the true date of deposition, within the limits provided by the context dating.
2. Sum the frequency density from all contexts at five-year intervals. This is effectively equivalent to calculating the aoristic sum with five-year bins (see Crema 2012).

In order to identify the sites and areas of London in which early imports seem to have been consumed and deposited, we also plot relative frequencies of cranial specimens, vertebrae, and cleithra by geographical location on a century-by-century basis, using the mid-points of each context's date range. Results are only plotted where 10 or more specimens from a given site fall within the relevant century.

Results

Figure 16.2 shows the estimated frequency distributions for all cod specimens over the course of the city's history. Changes through time should be treated with caution due to the possibility (indeed probability) of date-correlated biases in research intensity. Nonetheless, the near-total absence of cod specimens between the abandonment of the Roman city and *c*. AD 1000 is striking. The paucity of early medieval cod specimens is unlikely to represent research bias. Fish

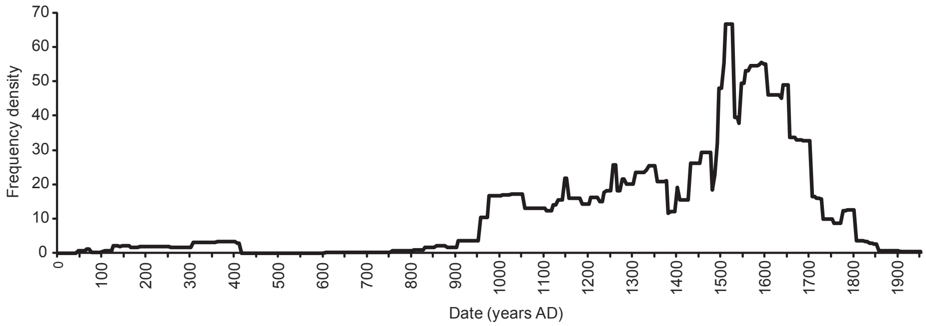

Figure 16.2. Estimated NISP frequency distribution for 3034 dated cod bones recovered from London (all anatomical elements). See text for explanation of methodology.

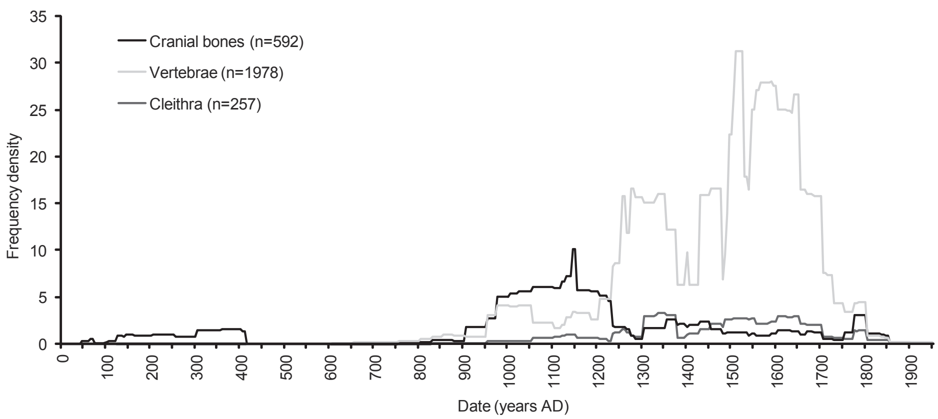

Figure 16.3. Estimated NISP frequency distributions for London cod by anatomical group.

remains from Saxon Lundenwic have certainly been studied, but they are mostly of species caught in fresh water, such as cyprinids (Cyprinidae), pike (*Esox lucius*) and eel (*Anguilla anguilla*) (e.g. Locker 1988).

Moving to the end of the sequence in the late seventeenth to nineteenth centuries, a marked decline in the frequency of cod specimens is less likely to represent a genuine fall-off in consumption. Rather, it may reflect a combination of changing depositional practices – reducing the chances of fish bones being deposited in well-dated urban contexts – and relatively limited archaeological interest. In ongoing work, these hypotheses are being tested by studying trends in the relationship between archaeological chronology and the number of environmental samples processed in London.

The estimated frequency distribution is broken down into the three main specimen types (cranial bones, cleithra and vertebrae) in Figure 16.3. Changes in the relative frequencies of different skeletal elements should be more robust than trends in overall frequencies, although possible sources of bias are considered below. Numerous small-scale fluctuations in relative frequency should probably be considered noise, emanating in large part from the vagaries of date brackets. Nevertheless, several clear trends are evident:

1. Specimens from Roman London are overwhelmingly cranial. This pattern is likely to represent an identification bias and is discussed below.
2. The re-appearance of cod specimens in the medieval city initially involves both cranial and postcranial bones in significant numbers, lending support to isotopic evidence for locally caught fish during this period.
3. This pattern changes in the early thirteenth century, when there is a sudden increase in vertebrae and a concurrent sharp decline in cranial specimens, suggesting the onset of a significant import trade in processed fish. The frequency of cleithra also starts to climb at this point, albeit more gradually. At this date the most likely product is stockfish from the North Atlantic, particularly Norway (see Chapters 4–5). Cranial specimens subsequently remain rare for the remainder of the sequence.
4. There is a marked dip in both vertebrae and cleithra in the decades around AD 1400, with no parallel for cranial elements, suggesting a temporary decline in imports. Given the timing, this might – tenuously – be linked to changes in consumption and trade resulting from the Black Death. Prices of Norwegian stockfish substantially increased and, based on English customs records, less stockfish was imported than in the early fourteenth century (Nedkvitne 2014; Chapter 5).
5. A recovery in the mid-fifteenth century and a dramatic increase in vertebrae at around AD 1500 suggest further rises in the contribution of imports. These shifts coincide with the historically documented growth of English fisheries and fish trade in Iceland (see Chapters 7–8), and ultimately in Newfoundland (Candow 2009). The extent

to which the early Newfoundland trade supplied English markets is a matter of debate. It appears to have been small; English vessels probably played a minor role in the Newfoundland fishery until the late sixteenth century (Starkey and Haines 2001, 8) and even then they primarily supplied continental Europe (Gray and Starkey 2000, 97). On the other hand, the Iceland fisheries did provide for English consumption (Childs 1995; Jones 2000).

Since the dataset includes both hand-collected specimens and bones recovered by the sieving of sediment samples, and since certain anatomical elements are larger and more robust than others, it is necessary to check for possible recovery biases. Figure 16.4 compares results between hand-collected specimens and those recovered by sieving. Whilst there are clear differences between Figures 16.4a and 16.4b, they are broadly consistent in terms of the temporal trends noted above. The most notable difference between the two is that the significant increase in vertebrae seen during the thirteenth century for the hand-collected bones – and for the combined dataset – is not apparent until around AD 1500 in the sieved dataset. Moreover, the hand-collected vertebrae show a marked trough at AD 1500 rather than a further increase to match their sieved counterparts.

The reasons for these inconsistencies become clear, however, when vertebrae are broken down into subgroups

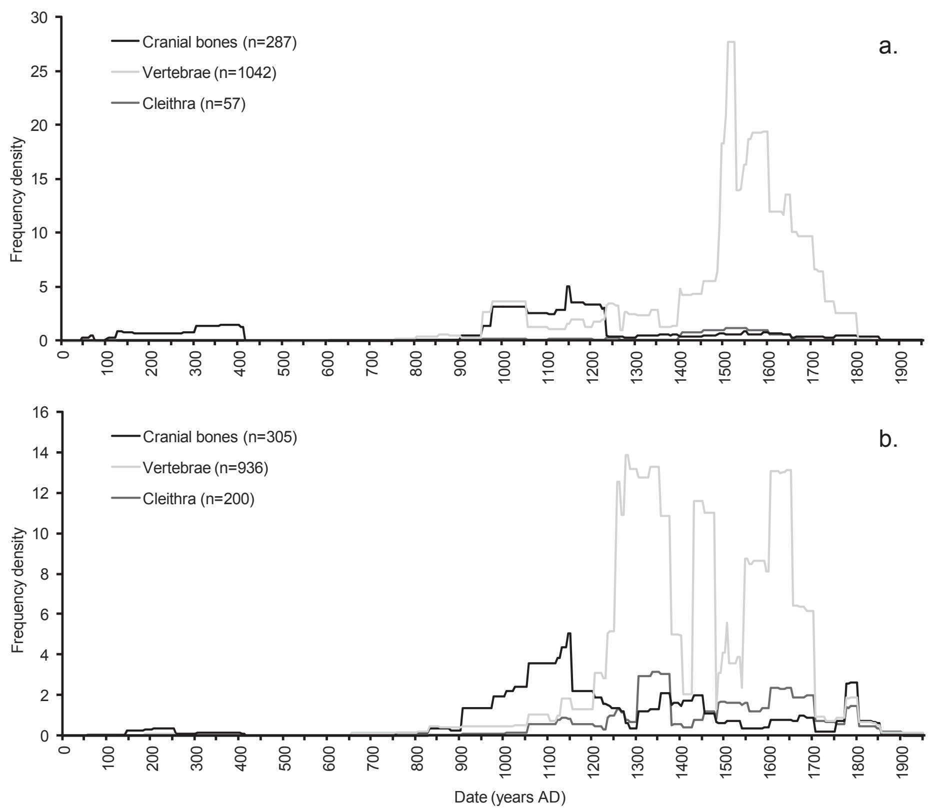

Figure 16.4. Estimated NISP frequency distributions for London cod by anatomical group, separated according to recovery method. a: sieved samples, b: hand-collected specimens.

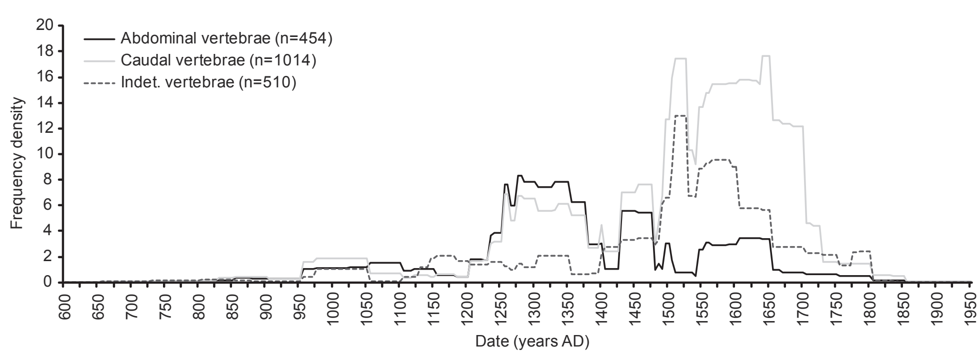

Figure 16.5. Estimated NISP frequency distributions for different classes of cod vertebrae recovered from London.

(Figure 16.5). The initial thirteenth-century increase involves both abdominal and caudal vertebrae in roughly equal numbers, and frequencies of the two groups track each other very closely over the following two-and-a-half centuries, through the *c*. AD 1400 trough and subsequent recovery. However, they part company at the end of the fifteenth century; the *c*. AD 1500 surge in vertebrae is caused entirely by caudal specimens, while abdominal vertebrae actually decline at this point. In fact, an examination of the 'indeterminate' vertebrae data suggests that this trend may have started somewhat earlier, in the early fifteenth century. The reasoning is as follows: cod have between 51 and 55 vertebrae, and those classified as 'indeterminate' in terms of position in the vertebral column (at least in the case of the Locker data) are most likely to be approximately midway, around vertebrae 22–30, and hence technically caudal (Fjelldal *et al*. 2013). It is therefore likely that the 'indeterminate' group includes specimens from this part of the body, plus perhaps damaged vertebrae from farther into the caudal group which could not be definitively identified as such. They might thus be expected to be well represented even where preservation techniques involving the removal of anterior vertebrae were practised (see discussion below), a point that is reinforced by the broad similarity in the observed frequency curves for caudal and 'indeterminate' specimens.

Returning to Figure 16.4, it is this *c*. AD 1500 increase in the frequency of caudal vertebrae that is picked up by the sieved dataset but not the hand-collected one, which makes sense given that caudal vertebrae are smaller than their abdominal counterparts and hence less likely to be recovered without sieving. This can be confirmed by re-plotting the abdominal–caudal comparison with the datasets separated (Figure 16.6). The increase in caudal vertebrae shows up much more clearly in the sieved dataset, although it is also visible in the hand-collected dataset. It is harder to explain the fact that the initial thirteenth-century increase in vertebrae of both types is not apparent in the sieved dataset, but it may be that larger specimens spotted in the field were often collected prior to separation of sediment samples for sieving – an understandable digression from technically correct sampling protocol. It should be borne in mind throughout this comparison that any changes in the typical *size* of fish caught and/or imported will also affect the relationship between hand-collected and sieved datasets, over and above shifts in anatomical representation. It would thus be valuable for future work to consider the size of the bones present, based on osteometry and/or comparison with reference specimens from fish of known total length.

While a systematic date-correlated bias in frequency of sieving is unlikely, it should be noted that the majority of specimens – 501 out of 727 – contributing to the sixteenth-century peak in caudal vertebrae actually derive from only three of the 21 assemblages represented in this period. This peak should thus be treated with a degree of caution since we cannot be sure how representative these three assemblages are of the wider picture. On the other hand, since there is

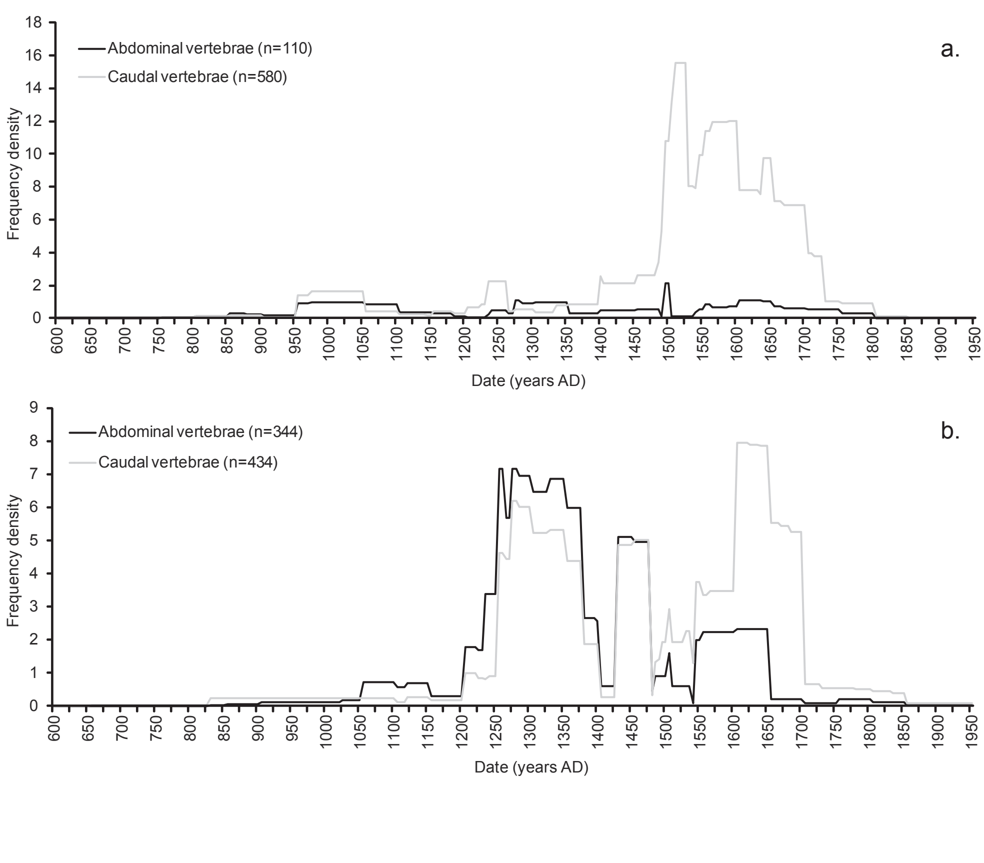

Figure 16.6. Estimated NISP frequency distributions for different classes of cod vertebrae recovered from London, separated according to recovery method. a: sieved samples, b: hand-collected specimens.

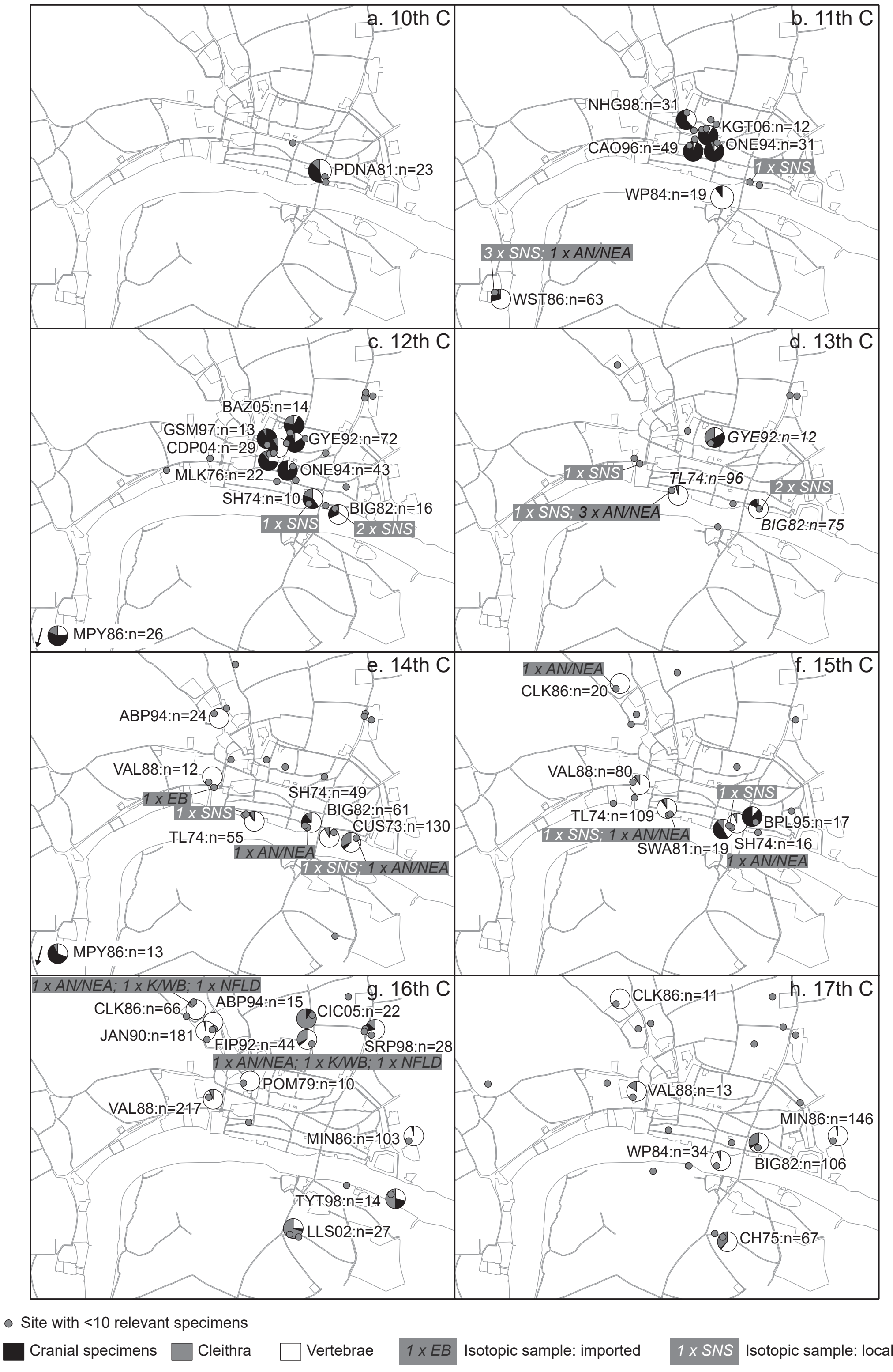

Figure 16.7. Maps showing relative frequencies of cranial specimens, vertebrae and cleithra at individual London sites, by century. Specimens are allocated to centuries based on the mid-points of their dating ranges, so the precise groupings should be treated with caution. Where available, tentative isotopic provenancing results (from Barrett et al. *2011) are also marked. SNS = southern North Sea, AN/NEA = Arctic Norway/northeast Atlantic Ocean, EB = eastern Baltic Sea, K/WB = Kattegat/western Baltic Sea, NFLD = Newfoundland (Drawing: David Orton and James Morris using a base map courtesy of MOLA (Museum of London Archaeology)).*

no shortage of fish bone data from this period, the relative paucity of cod abdominal vertebrae and especially cranial specimens is likely to be meaningful. Taking the vertebra pattern at face value, it would suggest a change in the type of cod products imported, and hence either a shift in source regions, a diachronic change in the preservation techniques used in those regions, or both.

Identification biases must also be assessed, since analysts vary regarding which elements they routinely identify to the taxonomic level of species. Comparison between specimens recorded (a) by Alison Locker and (b) by in-house specialists at MOLA indicate that the latter were much more conservative about identifying cod vertebrae to species. However, there does not appear to have been any date-correlated bias by analyst except in the Roman period versus all other periods. The bulk of Roman assemblages were studied by MOLA specialists, which explains the predominance of cranial bones in this period (see Orton *et al*. 2014, figs 6 and 7).

London is not, of course, a homogeneous settlement, and it is worth assessing from where within the city and its environs the various types of cod bones derive. Figure 16.7 shows the sites from which cod data were taken within each century, based on the mid-point of date ranges for relevant contexts. It should be noted that chronological resolution for specific contexts is often greater than one century, and that therefore the chronological groupings in the maps should be considered indicative rather than firm. The extent of overlap in date ranges for specimens is illustrated by Figure 16.8. Where the sample from a given site and century is ten specimens or more, relative frequencies of cranial bones, vertebrae, and cleithra are plotted on Figure 16.7. Sites have also been annotated with the results of stable isotope research, where available, with the single most likely source listed for each sample (Barrett *et al*. 2011).

The situation in the tenth century is hard to assess due to a profusion of very small samples. The single reasonably large sample, from Pudding Lane (PDN81), has a balance of elements.

Most of the eleventh-century data come from sites in the City itself and are dominated by cranial bones. The exceptions are Westminster Abbey (WST86, included as eleventh century here but actually dated AD 1050–1150) and a group of pits on the site that would later become Winchester Palace (WP84), both of which are, interestingly, already dominated by vertebrae. Four vertebrae from the former site were included in the isotope study, and one of these had a probable Arctic Norway/northeastern Atlantic signature. If some of the remains at WST86 indeed represent early imports, the site's monastic status is likely to be significant. A single vertebra sampled from New Fresh Wharf (St. Magnus, SM75) had a local isotopic signature.

Contexts in the City core dated to the twelfth century show more variation, but are still dominated by cranial bones overall. Postcranial bones make up more than 50% only at Milk Street (MLK76) and at two riverfront sites with relatively small samples: Billingsgate (BIG82; located, appropriately enough, on the site that would become Old Billingsgate fish market) and Seal House (SH74). Three isotope samples from these latter sites all gave local stable isotope signatures. Meanwhile, cranial bones also make up a little over half of the cod assemblage from Merton Priory (MPY86), *c*. 13 km south of the City.

Most of the thirteenth-century data come from three sites in the City, and particularly from Trig Lane (TL74) and Billingsgate on the waterfront. These sites have greater than 50% postcranial bones, but Trig Lane in particular is heavily dominated by vertebrae. Four of these were sampled for isotopes, of which three are probable northern imports. By contrast, two specimens from BIG82 and one from Ludgate Hill Car Parks (PWB88) are probably local.

A larger number of reasonable-sized samples are available for the fourteenth century, but these are biased towards (a) the waterfront and (b) the Fleet Valley and Clerkenwell, outside the City's western walls. This may be a real pattern rather than research bias, since fourteenth-century contexts have certainly also been excavated in the City's core, and smaller numbers of cod bones have been reported from them. All of the waterfront assemblages are dominated by postcranial bones, but those beyond the walls are exclusively composed of vertebrae. It may be significant that Albion Place (ABP94), which is dominated by vertebrae, represents part of the outer precinct of the Priory of St. John of Jerusalem, part of the monastic landscape to the west of the City. It can be contrasted with the cranial-dominated assemblage from Merton Priory (MPY86) in London's southern hinterland, suggesting the consumption of fresh fish at the latter site. Stable isotope results from the fourteenth century all come from sites on or near the waterfront. From a total of five specimens, two are probable northern imports, while a third, from PWB88, has a surprising eastern Baltic Sea signature. This is not inconceivable given the evidence for the production of dried cod around Gdańsk starting in the fourteenth century (cf. Nedkvitne 2014, 130; Orton *et al*. 2011; forthcoming), and the contemporary growth of trade between England and the towns of the Baltic littoral (e.g. Lloyd 1991, 91–2).

The picture in the fifteenth century is broadly similar to that in the fourteenth. The sample from St. Mary's Nunnery, Clerkenwell (CLK86), consists entirely of vertebrae – one of which is thought to be a probable import based on isotope analysis – while Fleet Valley (VAL88) and the waterfront sites of Trig Lane (TL74) and Seal House (SH74) each have more than 80% vertebrae. Three out of four isotope samples from the latter two sites have northern signatures. Swan Lane (SWA81), by contrast, which is also on the waterfront, yielded a cod bone assemblage almost evenly split between cranial and postcranial bones, with a single

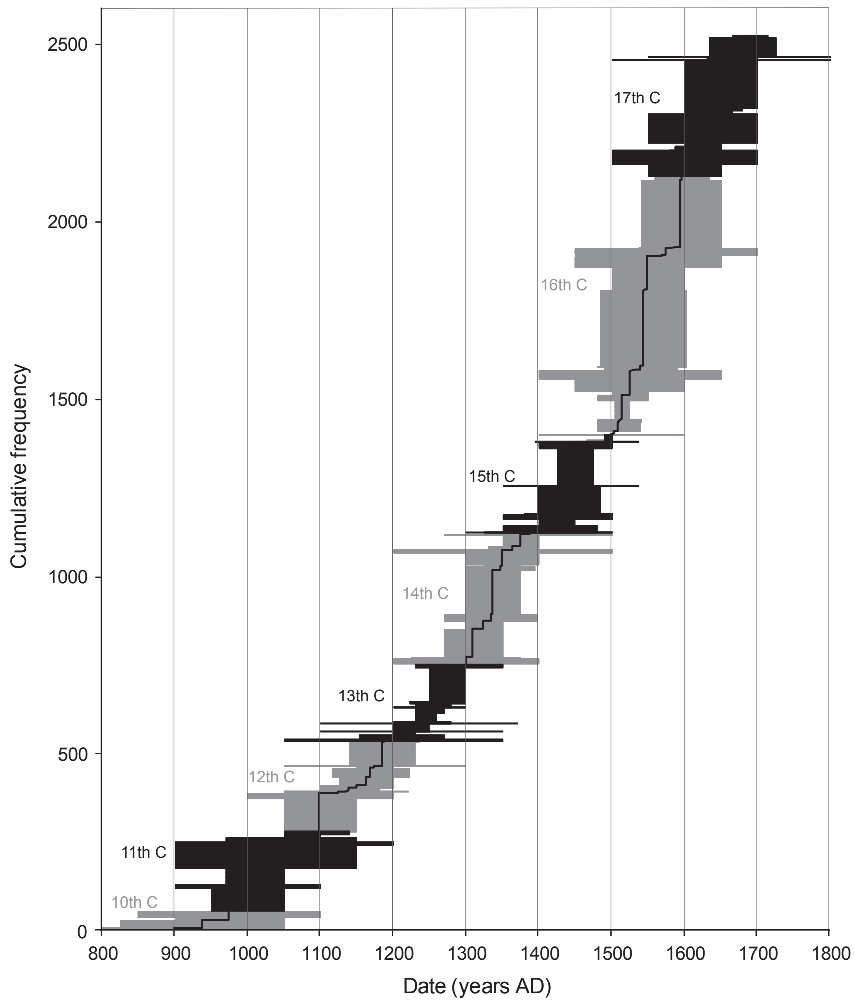

Figure 16.8. Cumulative frequency curve for London cod from the tenth to seventeenth centuries (central line), with associated date ranges for specimens (shaded area). Century groupings as used in Figure 16.7 are shaded in alternating black and grey to show the potential extent of overlap between them.

isotope sample having a southern North Sea signature. The cranial-dominated assemblage from Botolph Place (BPL95) is associated with what was probably a merchant's house.

The distribution of cod remains changes considerably in the sixteenth century. There are still good samples from the Fleet Valley and Clerkenwell, but none from within the City walls. Instead, data are available from sites around the fringes of London, including Islington (FIP92, CIC05) and Spitalfields (SRP98) in the north, Southwark in the south (TYT98, LLS02), and the site of the Royal Mint (MIN86) in the east – the latter a Royal Navy victualling yard at this time. Cranial bones are rare throughout, but cleithra are frequent at several sites north and south of the City. This may suggest changes in how traded cod were processed, and potentially in their source, so it is interesting that the various sites in Clerkenwell (and the west in general) retain the vertebrae-dominated profile seen in previous centuries. On the other hand, the limited available provenancing data do not support any interpretation in terms of differing sources: Clerkenwell (CLK86) and Finsbury Pavement (FIP92) have rather different anatomical signatures but very similar isotopic results, both having single specimens attributed to each of the following three regions: Arctic Norway/the northeastern Atlantic, the Baltic, and Newfoundland (the latter being particularly tentative, however). The variation may thus have to do with either the very general geographical assignments that are possible through isotope analysis or differing fragmentation, recovery, and identification of the large but easily broken cleithra. We should also note that the samples with large percentages of cleithra are generally smaller than those with an overwhelming dominance of vertebrae, and that the map thus over-represents their frequency in London as a whole.

Finally, the seventeenth-century map shows a broadly similar pattern to that from the sixteenth century, but with fewer reasonably sized samples, perhaps due to a drop off in the intensity of environmental sampling on sites dating from the post-medieval period and/or changing refuse disposal practices in the past. No isotope analysis was conducted on seventeenth-century or later material from London.

Discussion and conclusions

While changes over time in the overall frequency of cod bones must be treated with considerable caution due to possible research biases, the patterns of relative anatomical representation can provide more reliable information on shifts in how London was provisioned. The drop in cranial bones and increase in postcranial bones in the thirteenth century is interpreted as evidence of a change in supply away from fresh (whole) locally caught cod from the North Sea to (decapitated) preserved cod from more distant waters, perhaps Norwegian stockfish (Orton *et al*. 2014). This inference is supported by the available stable isotope data (Barrett *et al*. 2011). The subsequent fluctuations in the abundance of postcranial bones in the fourteenth and fifteenth centuries may tentatively be related to the decline and then recovery in stockfish production and trade following the Black Death (see Chapter 5). Until the late fifteenth century, anterior (abdominal) vertebrae and caudal vertebrae are both well represented. This pattern suggests that most imported fish had been headed, but retained their vertebral columns intact. Conversely, from the end of the fifteenth century there was a sharp rise in the representation of caudal vertebrae, whereas abdominal specimens dropped off, remaining low through the sixteenth and seventeenth centuries.

Whereas the initial thirteenth-century change in the relative abundance of cranial and postcranial bones suggests an increasing supply of preserved cod to London, the subsequent sixteenth-century shift in the representation of caudal versus abdominal vertebrae implies the introduction of a different processing technique. The change need not have been absolute, but the body portion representation data nevertheless imply a quantitative trend. If the main source of imports had remained Norwegian stockfish, as was probably being consumed in the thirteenth century based on historical evidence (e.g. Nedkvitne 2014), the shift would be best interpreted as a preference for *råskjær* over *rundfisk* (see above and Chapter 18). However, over the course of the fifteenth and early sixteenth centuries preserved cod from a variety of new sources entered the English market. These included stockfish (perhaps *råskjær*?) brought directly from Iceland by English merchants, as well as cod that was both salted and dried – by English fishermen operating around southwestern England, Ireland, Iceland and (from *c*. AD 1502) Newfoundland. Most of these salt cod were dried by being laid flat on coastal rocks or wooden platforms, methods which entailed removing the anterior vertebrae (e.g. Candow 2009; Kowaleski 2000, 439; 2003). It may be relevant that cleithra were also frequent at several sites of sixteenth-century date. This paired skeletal element was also left in the new salted and dried cures (e.g. Betts *et al*. 2014). In sum, the anatomical shift around AD 1500 is consistent with a switch in London's supply of preserved cod, from stockfish (perhaps a mixture of *råskjær* and *rundfisk*, but with *rundfisk* dominant) to salted and dried products of the expanding long-distance sea fisheries of late-medieval England.

Turning to the spatial distribution of the data, the evidence for dried or salted and dried cod consumption occurs across the City of London and its hinterland. Ecclesiastical institutions were among the consumers, but not exclusively so. Vertebrae and/or cleithra were also over-represented at secular sites, and some monastic institutions produced assemblages with good representation of both cranial and postcranial bones (e.g. Merton Priory). When subdivided by site and century, the sample sizes are small, but such as they are, the data suggest a diverse market for imported cod across the medieval and post-medieval city and its hinterland. In terms of chronological trends, the changes in anatomical representation, and thus probably cod imports, of the thirteenth/fourteenth and sixteenth centuries are also evident at the level of individual sites.

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