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The role of stored fish in England 900-1750AD; the evidence from historical and archaeological data.

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ABSTRACT

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THE ROLE OF STORED FISH IN ENGLAND 900-1750AD; THE EVIDENCE FROM HISTORICAL AND ARCHAEOLOGICAL DATA.

By Alison Mary Locker.

This thesis examines the historical and archaeological data for the consumption of herring and the gadid fishes (primarily cod, haddock, whiting, ling and hake) as stored fish cured by salting, drying and smoking.

The thesis is divided into three parts, in the first part the historical evidence for developing fisheries, storage methods, marketing and consumption is discussed with an evaluation of the nutritional changes to the fish as a result of storage.

In part two factors affecting fish bone preservation and recovery are presented and the authors own recording criteria. A new methodology is introduced using the documented data for portions and rations from monasteries and the forces, showing herring and the gadids by volume of fish eaten compared with the number of bones counted. Distribution of body parts as evidence for stored and fresh fish in the large gadids, hitherto only used to show processing is adapted for application to the data sample which largely represents consumption.

In part three the 20 sites comprising the data sample are described. **Portion** and **body part** methods are applied to the herring and gadid bones from these assemblages. In the majority of sites herring predominate by number of bones, by portion cod becomes the primary fish in many cases. Evidence for stored cod, ling and hake were found by body part distribution in many assemblages.

The results of this study have shown that the archaeological data when expressed as a volume of fish supports the historical evidence for cod as the prime fish among these species, both as fresh and stored. Fish assemblages transcribed into portion from bone numbers present fish as a volume of food and often relegate herring, excessively favoured by bone numbers, into a subsidiary position.

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Preface.

The consumption of heavily salted, hard cured fish has left little impression in the consumption patterns of England, currently reduced to novelty status as a relict of the past. The alternatives offered by innovations in transport, refrigeration and canning of the mid 19th century relegated this former staple food in favour of fresh and lightly cured marine fish.

There seems to have been little desire to retain these strong tasting reminders of our pre-industrial society within the national consciousness. Other western developed nations, notably in Scandinavia and in southern Europe still place value on heavily cured herring and cod as part of their national cuisine. While in the 'third world' in the absence of basic transport and storage facilities salted, dried and smoked fish still hold a significant market sector despite their 'habitually dark, oxidised, rancid, sandy, spoiled and insect infested' condition. Succinctly summarised by Cutting (1962, p. 161), in reference to the low standards of processing and storage commonly encountered.

There is a wealth of documentary data relating to stored fish from the 10th century until the mid 18th century in England, preceding a period of dynamic change in population growth, industrialisation and increasing urbanisation in which demand and innovation changed the food supply. Fish bone assemblages have been recovered from a variety of sites from this earlier period providing a rich source of data amongst which stored fish, judging from the documentary record, must be represented.

In this thesis I have sought to bring these two lines of evidence together. In the archaeological data I refined the analysis to reflect the relative consumption of, and evidence for, the main stored fish: herring, cod and related species. These are historically the most important species and have a documented volume or portion size.

Acknowledgements.

This work has been carried out on a part time basis, over a five year period. During that time many people have been supportive and I would like to thank in particular my supervisor Professor Clive Gamble (University of Southampton) whose encouragement and good advice have been invaluable. Dale Serjeantson (University of Southampton), Ruby Cerron-Carrasco (University of Edinburgh), Sophia Perdikaris (Brooklyn College, New York) provided helpful comments and discussion.

Mr Alwyne Wheeler (formerly of the Natural History Museum, London) first introduced me to fish bones in the early 1980's and has continued to be a friend and source of advice ever since.

Finally a very special thanks to my husband, Gerald, whose unfailing support ensured this reached completion.

Disclaimer.

The data sample was originally analysed as a series of site reports based on counting the number of bones per species. I confirm that the subsequent review of the sample by portion and body part and accompanying historical research all took place during my postgraduate candidature. Unless otherwise stated all the work in this thesis is my own. All work by other authors has been referenced.

Definitions, Abbreviations used.

When referring to a method of fish bone quantification **portion**, **n**, and **body part** are shown in bold.

Types of stored fish such as 'stockfish', 'klipfish' and 'red' herring are shown in inverted commas to distinguish them from species of fish.

The latin names are given for fish the first time a species is referred to, thereafter only the common name is used.

In chapter 10 there are a large number of figures and they could not be inserted within the text and so they have been shown together at the end of the chapter. .

CHAPTER 1. Introduction and aims.

The storage of fish, defined as any method prolonging the 'shelf life' of fish in the fresh state in temperate weather conditions, has a long tradition, from prehistoric times to the present day. In the period I have chosen, from the 10^{th} to mid 18^{th} centuries, the storage of fish is well documented. A variety of historical sources testify to the importance of fish and in particular those stored, including early fisheries data, customs records and household accounts.

The upper limit of the date range confines the study to a period where innovations in transport systems (primarily canals and railways) and methods of storage such as refrigeration and canning were not yet in place. Effectively there were no major changes within the period consequently the cures in use were primarily by drying, heavy salting, pickling and smoking. These hard cured fish could be stored for months and sometimes years.

Although the range of documentary evidence presented here covers all aspects of storage production through marketing to consumption, the complementary range of archaeological fish assemblages I have chosen as my data sample are focussed on consumption. They reflect demand more than supply, though the two are closely linked as discussed by Mennell (1992, p. 279). A primary objective of this study was to determine which of the main stored species: herring, cod, haddock, whiting, ling and hake, were most commonly eaten as represented in my data sample and by the evidence from documentary sources. The variations in date, location and status of the twenty sites in the sample were compared with the representation of the fish to see if these factors might be influential in the types of fish predominantly eaten.

Background to the study.

I have spent 26 years analysing bone assemblages and for the last 18 I have gradually focussed exclusively on fish bones. I am familiar with both the difficulties of linking documentary and bone data as well as the interpretation of bone assemblages as representing food remains.

The documentary data vary in the degree of detail either by the generality of comment or, if limited to a specific establishment, by the date range as exemplified by the accounts used in chapter 7 to establish the methodology. The coincidence of documentary data and bone assemblage at the same household and of the same date is a desirable but unusual occurrence.

With regard to bone assemblages of mammals, birds and fish the use of the bone data record for an interpretive quantification of the food remains is fraught with controversy. Debated for many years, the detail and completeness of the primary bone record remains variable. Subsequent calculations of minimum numbers and other interpretive representations are still to be standardised. A recent electronic mail exchange between archaeozoologists on the validity of interpretive representations of bone assemblages show many aspects still remain unresolved. The most recent synopsis of these methods is to be found in Reitz and Wing (1999) on 'Secondary data'. They point out that most interpretive methods were already in use in the early 1970's, but there is now better understanding of both their strengths and weaknesses.

I have been, and continue to be, a strong proponent of the inclusion of all identifiable bones in the 'primary data' record and have reservations about methods which only include selected elements. The database should be as complete as possible in order to provide a sound basis for subsequent interpretative methods. However, after writing many reports based on the number of occurrences of fish bones it seemed that fish bone analyses from domestic consumption deposits often remain essentially a count of the species identified. This was accompanied by an acknowledgement of the over representation of herring by bone numbers and some discussion of the nearest fisheries in which these fish were caught. Some fish deposits from Northern Scotland and outlying islands (Barrett, 1997, Ceron-Carrasco, 1998, Colley, 1983 and Jones, 1995) are exceptions. Here fish are the dominant class of bone assemblage and represent waste from specialised activities of fish processing

Most fish bones assemblages representing food remains are dominated by herring by bone numbers. They usually also include a variety of gadids[1] and with herring are the most commonly stored species. Documentary data, especially in household accounts, are most detailed for stored fish, while fresh fish may just be referred to as 'fish'. Using this data and evidence for individual portion sizes (Harvey, 1996) the opportunities for progressing the representation of fish species as a volume of food, rather than a number of bones seemed most viable for these species.

From the fish bone assemblages I had analysed myself (for consistency of record) I chose a range of sites representative of the period which also met other criteria such as varying location and status. All of these assemblages included herring and some gadid species and the data for these species have been converted from the 'primary data' or bone count into 'secondary data', which show the fish as portions of fish eaten. These are based on documented allowances per person and present these fish as volumes of food rather than bone numbers. To forestall any criticism of the selective use of interpretative data the representation of **portion** is accompanied by the data as bone numbers, or **n**.

The results of comparing the **portion** data with both the evidence for stored fish consumption of these species from documentary sources and the evidence of the bones assemblages by fish bone numbers have shown an interesting correlation. The **portion** data shows closer agreement for relative consumption from household accounts than for the proportions of species by bone numbers. This is discussed in detail in Part 3. Evidence for stored fish in the large gadids is defined by **body part** representation and shown to be present in many assemblages.

[1] Member of the cod family

Changing demand for stored fish.

Between the 10th and middle of the 18th centuries there is some evidence of change in patterns of consumption for stored fish. The end of the period precedes any major transport innovations but other factors effected change.

The documentary evidence for change can be broadly divided into two levels: major trends resulting from national events, such as the Reformation and evidence collated from individual cases. Evidence for change is fully discussed in the final chapter and so only mentioned in passing here.

Major or national events effecting and reflecting changes in stored fish consumption include, in chronological order, events such as the Black Death in the middle of the 14th century. This created labour shortages, consequently improving wages and spending and favoured increased meat consumption. The effects of the Reformation in the 1540's removed compulsory consumption of fish instead of meat as part of religious fast, though this may have already been in decline. Compulsory 'fish days' re-introduced a century later did not provide the anticipated increase in demand to boost the British fishing industry confirming the general preference for meat. New outlets were sought in Europe by 1700 for Newfoundland cod following the collapse of the English home market, another sign of the decline of stored fish. Stored cod and similar species remained in naval rations comparatively late but, as I will show later, were redundant by 1700.

The preference for and growing availability of meat in England is supported by the increase in the number of domestic animals per acre being at a higher level by the 18th century than any other European nation except the Netherlands, (Fiddes, 1993, p.22). Although not all primarily raised for meat, it was also a secondary product of older animals.

Evidence from individual cases is mainly gathered from the accounts of individual holdings, household accounts etc which may be used to typify certain elements of society at a particular time. Monastic houses have shown change through time where cod and allied species became more favoured than herring. In these establishments adherence to religious fast resulted in a great reliance on stored fish. Evidence from detailed accounts from Westminster Abbey for the late 15th century was studied by Harvey (1996, p.49) who suggested a decline in herring. Other religious houses exchanged a monetary value for the fish formerly served to the poor, as at St Cross, Winchester, (Hopewell, 1995, p.94). Evidence for the meals served to Norfolk harvesters between 1256 and 1424 (Dyer, 1994, p.82) showed a general increase in the proportions of animal protein over bread and dairy produce of which an increasing larger amount was meat, particularly in the 15th century.

There is, therefore, support for a general trend favouring greater consumption of meat over fish. Between types of stored fish there was increasing preference for cod and allied species over herring, while in some cases fish was replaced by a monetary value. This evidence is all from documentary sources and any support from archaeological assemblages must be viewed in the light of difficulties in quantifying and comparing the volume of different flesh groups.

It is not possible at present to compare volumes of different classes of flesh foods in a bone assemblage. Comparisons between different meats, poultry and fish have been based on bone numbers. Even within fish the historical evidence used to recreate **portions** (after the data of Harvey, 1996) covers a limited species range of important food fishes, which by volume are likely to be a major part of the assemblage. Their contribution within the whole fish assemblage can only be shown by comparison of bone numbers which, as will be shown, are unreliable in terms of the volume of fish consumed, being more reflective of individual fish numbers.

The use historical and archaeological data have been limited here to a select number of fish species described below. These comprise those species for which **portion** can be calculated, the major commercially stored fish of the period.

The principal species.

The fish which played a major role in the supply, processing, marketing and consumption of stored fish divide in to two main types: those with a high oil and low water content represented by the herring (*Clupea harengus*) and those with a high water and low oil content. The latter are represented in this study by the cod family, the Gadidae. The main species are: cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangus*), pollack (*Pollachius pollachius*), saithe (*Pollachius virens*), ling (*Molva molva*) and hake[2] (*Merluccius merluccius*). Pollack and saithe were the least abundant of the gadids in the data sample but have been included as they are very similar to cod. They were of regional importance, particularly saithe in Orkney and Shetland, as both subsistence food and for export.

These are the species, led by herring and cod, on which the data analysis in this thesis will concentrate. Other species, such as salmon (*Salmo salar*), were stored in quantity, but salmon has particular problems of bone preservation and has been excluded from the data sample, as have regional specialties such as Cornish pilchards (*Sardina pilchardus*).

The oil content was a determining factor in the method of storage chosen, since it is not lost by dehydration and rapidly deteriorates if not stabilised by salting. Consequently long term storage of herring was based on high concentrations of salt, often in liquid form as a brine or pickle. The gadids, having a high water and low oil content could be successfully stored by drying, often in combination with light salting. Smoking was included as a final stage in storage with salting and drying. These methods produced fish for long term storage, but of a high salt content, or dried to a 'board like' consistency, the latter requiring rehydration before eating. In contrast the milder cures of the mid 19th century, such as 'bloaters' and 'finnan haddock' lasted little longer than fresh fish, but were ready to eat.

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[2] Hake is a cod like fish and processed as such, but no longer classified with the Gadidae.

In order to give some idea of the relative size and features of each species they have been illustrated in Figure 1.1 in descending size order after Stebbings (in Wheeler, 1978). The fish are scaled according to modern data on average catch sizes given in Wheeler (1978), though the size of cod has decreased more recently with overfishing. Illustrating the fish in scale gives some comparison between the contribution by size of individual fish as food and shows the characteristics for each species. The maximum length indicates the possible size variations between species.

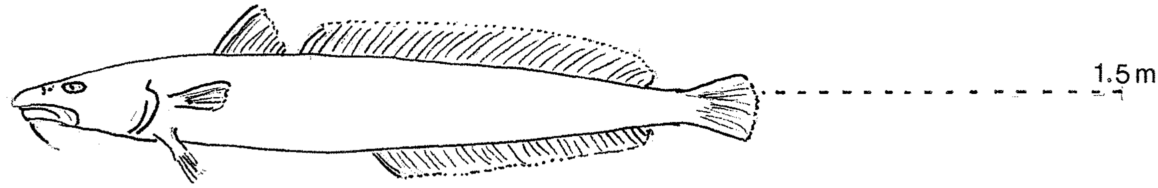
The changing status of fish.

Although now promoted as a healthy food, low in fat (largely unsaturated) and cholesterol, an attitude still pervades in England that fish is a less satisfying food than meat. This perpetuates the gender prejudice that fish is not a 'manly food', an aspect which has also been explored by Bourdieu (1984, p.190) among the French 'working classes'. Among this social group fish was regarded as light fare, suitable for invalids and children, but too fiddly for men's hands and in contradiction with the masculine way of eating. This might now be viewed as an outmoded stereotype, but the ease with which fish is digested results in a less full (or satisfied) feeling than experienced after eating meat. Allied with other prejudices against smells and small bones the market niche in England for fish remains comparatively small.

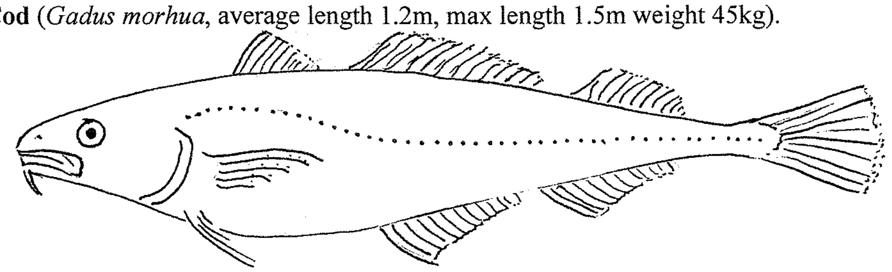
A survey on fish consumption in England was commissioned by Birdseye Frozen Foods in the 1980s, in which Gofton and Marshall (1991) interviewed a number of households in N.E. England. The results revealed that fish was still regarded as an invalid food and for some older interviewees was associated with wartime rationing. Other perceived difficulties included what to serve with fish, which did not go well with the traditional accompaniments to meat of vegetables and gravies. This suggests fish was viewed as a substitute for meat and not a flesh food in its own right accompanied by complementary dishes. Between types of fish there were also prejudices, the darker fleshed fish species, although by colour and texture closer to meat than white fish, were regarded as more 'risky' for

Figure 1.1. The main species used for storage.
After Wheeler, 1978, drawn to scale (1mm = 1cm) at average size (though cod has decreased through over fishing) by total length and ungutted weight.

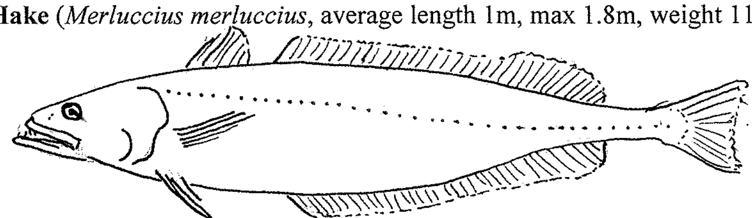
Ling (*Molva molva*, average length inshore 1 – 1.5m. Max length 2m, weight 35kg).



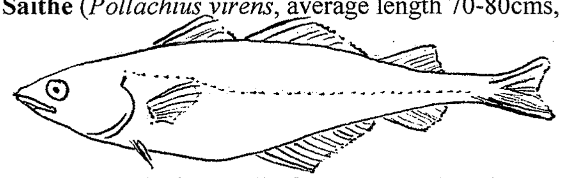
Cod (*Gadus morhua*, average length 1.2m, max length 1.5m weight 45kg).



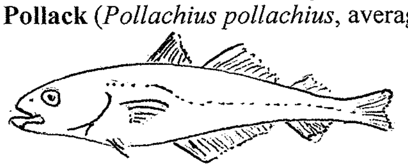
Hake (*Merluccius merluccius*, average length 1m, max 1.8m, weight 11kg).



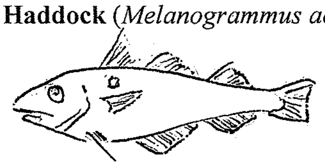
Saithe (*Pollachius virens*, average length 70-80cms, max length 1.3m, weight 14kg).



Pollack (*Pollachius pollachius*, average length 50 cms, max length 1.3m, weight 11kg+).



Haddock (*Melanogrammus aeglefinus*, average length 38-63cms, max length 76cms, weight 4.5kg).



Whiting (*Merlangius merlangus*, average length 30-40cms, max length 70cm, weight 3kg).

Herring (*Clupea harengus*, average length 25cms, max length 45cms, weight 680gms).
'Oceanic herring', west of the British Isles max length 45cms, 'Shelf herring' caught off the East coasts max length 30cms

freshness. Whereas white fleshed fish, particularly cod, were seen as pure, clean and less bony.

Cultural conventions round meal structures and the social order they reflect owe little to nutritional value and a balanced diet. Gofton and Marshall (1992, p.268) concluded that the place of fish in the U.K. was limited to minor meals, supplementary snacks or as informally as fish and chips. Certainly the mild cured fish eaten today are of the first two categories or served as hors- d'oeuvres and appetisers. However, it is surprising that their survey also revealed bias against fish based on fundamental misconceptions of fish biology. Bottom feeding fish were viewed as scavengers and therefore dirty and there was a lack of knowledge about different fish and their feeding habits. If such misinformation still prevails in the late 20th century many preconceptions must have been held about fish in the past.

It is always risky to apply current cultural conventions to the past, particularly when modern consumption trends are facilitated by a variety of choices.
Fish consumption in England in the 20th century is based around a wide range of fresh fish, largely marine, some of which have been transported long distances. Cured fish are largely mild, lightly smoked and salted. Any surviving traditional cures, such as salt pilchards produced at 'The Pilchard Works' in Newlyn, Cornwall, which also operates as a working museum, occupy a specialised niche market.

This is in stark comparison to the Pre Industrial period where both documentary and archaeological data reveals freshwater species, particularly cyprinids, played an important role in fresh fish supplies. These were both a reflection of status and a ready source of fresh fish inland. Fresh marine fish were vulnerable to deterioration during transportation inland, particularly in the summer months and transport added to the purchase costs. Therefore, while a large number of fast days were observed hard cured stored fish were a significant flesh substitute for the meat eating classes. The Cornish salted pilchards were a staple food for the region rather than the gourmet or novelty food they have become.

In contrast to the modern consumer market lack of choice must have played a significant role in any culinary developments. Mennell (1992, p.281) has suggested that in England any changes were initially very slow for all sectors, but after the Middle Ages the pace increased, particularly in the upper secular classes. The growing taste for meat was accelerated both by the removal of fast days and increased numbers of animals available for slaughter.

I have already suggested that various strands of evidence indicate that the consumption of stored fish changed in several respects, including the wider context of general fish consumption in competition with meat. Changes also took place within types of stored fish and this is supported by both documentary and archaeological data and I address these aspects of change.

Aims

Throughout the preceding pages a number of aims of this thesis have been described within the framework of an introduction to types of storage, the main species stored and some historical background. It is appropriate at this point to bring them together and summarise the principal aims as:

1. Determine which of the main stored species (herring, cod, haddock, whiting, ling and hake) were most commonly eaten, as suggested by the documentary data and the archaeological sample.

2. To display the fish bone data from the archaeological sample by a new method showing fish by **portion**, representing a volume of food, compared with bone numbers or **n**.

3. Using **body part** representation as evidence for stored fish among the large gadids in domestic consumption deposits.

4. Explore the relationship between date, location and status of the fish bone assemblages, assessing their effects on the consumption of stored fish and more specifically which types were preferred.

The historical evidence, methodology of fish analysis and the data sample divides into the thesis into three parts:

In the first part I have compiled some of the diverse sources of historical evidence to show the importance of stored fish in the Medieval and Early Post Medieval periods in England. Possible reasons are explored for the subsequent decline of traditional hard cures prior to technological advances in marketing fresh fish and new methods of storage.

The second part is concerned mainly with methodology. I firstly describe existing methods used for recording fish bone. Then, using historical documentary data, discuss a new method I have developed specifically to determine which of the commonly stored species were more important by volume or **portion** of fish eaten. Another method is shown, first used to show evidence of fish processing and implemented here to indicate the presence of stored fish by **body part** representation in consumption deposits.

In part three these methods are applied to the archaeological sample of fish assemblages from 20 sites and the data displayed. Conclusions are drawn as to the status of stored fish from the historical data and the evidence for the presence and comparative volumes of stored fish as represented by the archaeological data.

PART 1: The Historical Data.

CHAPTER 2. The historical development of the main fisheries.

Introduction.

In this chapter I describe the circumstances under which local fisheries might develop into a commercial prospect and sufficiently large for stored fish to be sold outside the area. The biological structure of fish stocks and natural population fluctuations are discussed with regard to their effects on fisheries. The history of the herring and cod fisheries are described and represent the major food fish of the period and the prime species for storage.

Commercial development.

The development of a fishery, which first supported the local community and then expanded into a larger commercial enterprise, is a familiar one. Initially some of the catch was eaten fresh and the surplus stored, feeding the fishermen and their families with limited sales in the locality. The fishery may be based on one species in the season, exploiting a number of other species the rest of the year.

When an opportunity arises to sell the surplus fish to a wider market, increasing the catch requires investment for more boats, fishing tackle and other equipment. From this point what has been largely a subsistence fishery requires ever higher productivity to meet the financing of labour, equipment and marketing. Reliance on a single species could prove disastrous with the natural fluctuations that occur in fish populations and some diversification is important as a safeguard against a poor catch of one species.

A good example is the haddock fishery off the east coast of Scotland which developed much in this manner during the 19th century, (Gray, 1978, p.15). Originally for local consumption, a company was later formed for curing haddock to supply the expanding markets resulting from urban growth in Glasgow and London. The fishermen also caught other fish, including cod and ling, which they dried. Some renowned cures for haddock of varying hardness and desiccation were developed. The surviving 'finnan haddock' was one of the milder cures.

The Cornish pilchard fishery has a long history as a local fishery in the south west of England supplying the region both fresh and salted fish. A salted surplus was exported to Italy from the 16th century (Rule, 1991, p.60), pilchard oil was sold to the Navy and salted pilchards were also exported to the slave plantations of the West Indies. The latter was not a success since herring and cod were preferred. Many of the fishermen were part time, working in the local mines outside of the late summer and early autumn fishing season. The annual glut of fish ensured that, with the availability of salt, many local households had a supply of stored pilchards to last through the winter.

Once a fishery has expanded to meet greater market expectations, with increased boats and gear to support, it is important that demand remains high enough to cover the overhead. If the fishing is seasonal boats may be underused for part of the year. Fishermen routinely moved from their local fishing grounds to take advantage of abundant fisheries elsewhere, including the annual East Anglian herring fishing, (Cushing, 1988, p.80). When the fishing grounds were too distant from the home port curing had to be carried out either in part on board ship, with just enough salting to bring the fish home, or landed and cured at a nearer port. This diversification ensured that men and boats were working all year and not dependant on a single species.

Poor fishing catches occur periodically and can be attributed to a number of causes. In the period I am discussing these were of natural origin, cyclical fluctuations and effects of climate and temperature, unrelated to over fishing which has contributed to plummeting fish stocks in more recent times.

Fish stock structure and some causes of population fluctuations.

The main features for a pre-industrial fishery, where a significant part of the catch might have been wasted without storage, can be summarised as follows:

a) The fish are available in large numbers.
b) They are available seasonally.
c) Those numbers are so great that they could not have all been marketed fresh.

The occurrence of large numbers of fish found together seasonally is often associated with spawning cycles when the fish follow the same annual route towards their spawning grounds. Some, like the herring, form distinct breeding populations.

These mature fish form the 'recruitment fishery'. Recruitment has been defined by Laevastu (1993, p.126) as the 'quantity[1] of fish of a given age becoming fully available to prevailing and traditional fishing gear for the species'. The structure of fish populations, in which a proportion of young individuals survive to maturity to replenish the adult stock, has only relatively recently been affected by overfishing. This is mainly the consequence of the introduction of motorised boats and gear raising the potential catch to a level damaging to the annual regeneration of the stock. One example is the over fishing of cod recruitment stock. The sexually mature adults are fished out and replaced by immature fish, which are faster growing with increased food supplies, but do not mature any earlier. These immature, but comparatively large, fish are then caught before they have the opportunity to spawn depleting future stock still further, (Perdikaris, 1998, p.125).

However, there are also a combination of natural factors, which directly affect both the volume and movement of fish causing changes in fish numbers and migration routes. Regional climatic changes, although subtle, may be sufficient to initiate a response in fish stocks. These have had both positive and deleterious effects on fisheries in the past.

It is not my intention here to offer a synthesis, or even an opinion, on the effects of meteorological changes on the balance of fish populations. This subject is in a

[1] Number and/or biomass.

constant state of change and review by fish biologists. It reveals an increasingly complex interaction of different factors on which I am not qualified to comment. I have presented the range of factors currently thought to affect fish both immediately and with a delayed response. These show the complexity in attributing changes in the location and numbers of fish to specific events, especially when some changes appear to run counter to anticipated responses.

Weather

The most significant weather[2] elements affecting fisheries are surface winds (their speed and direction) fog and ice. Temperature and cloud cover are of less importance, (Laevastu, 1993, p.16). The variability of surface currents affects both fish availability and abundance. Surface currents can be of different types and orders of magnitude: tidal, coastal, near shore and at major current boundaries. Within the boundaries set by these forces fish stocks move seasonally as part of their life cycle, with recruitment to the adult stock. Sexual maturity is age and size related.

Fishermen assess daily weather changes as indicators of fishing conditions. Where fisheries are prosecuted on feeding grounds they also observe the abundance of the food chain, for example the levels of plankton and copepods which indicate where herring are likely to feed, (Cushing, 1982, p.15).

Migration

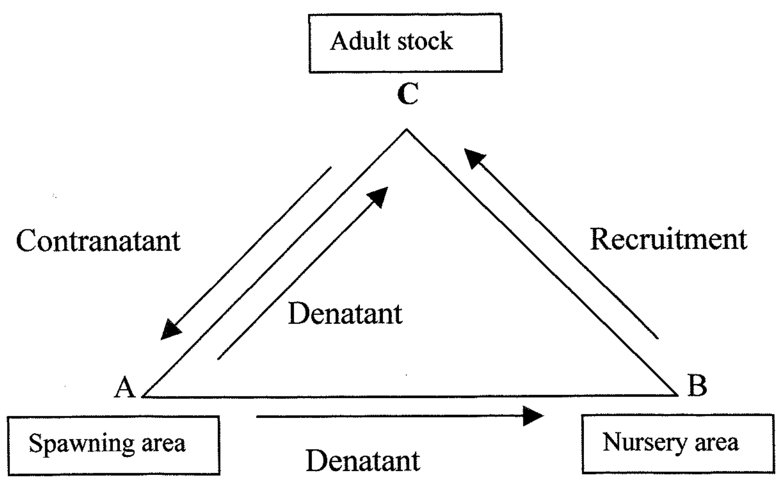
The structure of fish stocks from the larval stages to adulthood is best demonstrated by Harden Jones' 'triangle of migration' shown in Figure 2.1 after Cushing (1982, p.46). Adult fish ready to spawn move to and from the spawning grounds, while the larval forms move from the spawning to the nursery grounds where they feed and grow in preparation for joining the adults as juveniles. Harden Jones (1968) believed fish migrations and movements were related to currents in which fish in their young stages are passive drifters with the current. These are shown as denatant movements in the triangle. The migration of the

[2] As opposed to climatic.

adults to the spawning grounds is contra-natant in direction, (Laevastu, 1993, p.104).

This movement is most clearly observable in temperate waters where the spawning season tends to be shorter and the spawning grounds more clearly defined. It is this regulated movement that has influenced the fisheries under discussion here. Within fish ecosystems many processes are season dependent, including spawning and feeding migrations, migrations from deep to shallow water etc, (Laevastu, 1993, p.74). It is difficult therefore to separate seasonal behaviour from that triggered by environmental change.

Figure 2.1 Triangle of migration.



Fish stocks exploited over many years at a sustainable level may then fail from poor age classes, or a change in the movement of fish initiated by climatic changes. Prior to the regular collection of climatic and biological data the precise combination of factors effecting changes in fish stocks must remain speculative. This has not prevented some interpretations of the effects of climate change within historic times on fish movements.

For example, the fisheries for spring herring off the coast of Norway and for autumn herring off the Bohuslan coast of Sweden (Cushing, 1982, p.78), where the catch data[3] suggest periodicity in the fisheries from 1760-1960. Historical records going back to the early 10th century suggest a similar pattern, with the autumn Scanian fishery starting around the end of the 13th century and continuing until the first half of the 16th century, after which the Bohuslan fishery flourishes, (Cushing, 1982, p.80).

Climate.

Climatic factors affect pelagic, or surface living fish such as herring, more than dermersal species which live close to the sea bed, such as cod. Pelagic larvae of fish which are dermersal as adults may also be affected. Changes are felt more quickly and acutely near the surface of the sea than at depth and stock levels can be affected by sunlight, wind strength and direction, (Cushing, 1982, p.94). The magnitude of the recruitment year class is determined by the amount of food available at an early stage in the life history of the fish and climatic factors help determine the availability of the food. Climatic factors have a strong influence on generating sequences of high and low stock levels, but this is not a simple correlation and less clear when other factors are introduced.

Laevastu (1993, p.3) outlined factors thought to affect the catches and landings data that are often used as an index of stock abundance as affected by climate, also adding other elements he considered should be included:

1) Changes in catches owing to alterations in fishing intensity, such as the size of the fishing fleet.

2) Economic demands of the market and prices, which may cause the fishing intensity to change or shift from one species to another.

3) Changes in the type of fishing vessel may affect the catch causing a shift from one species to another.

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[3] Which have limitations for the interpreting the effects of climate on fish, see Laevastu below.

4) A change in the principal gear, or the introduction of new gear.

5) Switching the principal fishing grounds, or discovering new ones can cause changes in species composition in catches as well as the catch total.

6) Shifts of fish population centres and therefore the availability of fish.

7) Fluctuation of recruitment which occurs in most fish stocks and is caused by diverse factors including predation on juveniles.

Other factors include: growth rate changes, local pollution and more recently fishery management actions.

Factors 5, 6 and 7 are biological and have relevance for fisheries in the historic period. Factors 1 to 4 are technical and economic, they have some application, but largely towards the end of the period when market demand changed. This is demonstrated by the demise of the home market for English produced dried and salted cod from Newfoundland which were subsequently traded in the Mediterranean. Saul (1981-3) in his study of the herring fishery in the 14th century in Great Yarmouth [4] offers some political and economic reasons, which may account for the decline in the East Anglian herring fishery in the latter half of the century. These are all unrelated to fish stock levels.

The interaction of influences affecting fish catches shows that even recent changes, displaying all the features of climatic change, may be more complex. Recently the data have been re-examined concerning the collapse of the Californian sardine industry in 1950 in which temperature changes were thought to be responsible for the sardines being replaced by anchovies, thus terminating a fishery which had flourished since the beginning of the century. It is now known that migration and population shifts also occurred which appear unrelated to temperature change (Laevastu, 1993, p.79), as well as variable spawning rates

[4] Discussed later in the chapter.

and changes in predator populations. This presents a much more complex picture than was hitherto suspected.

Within the period of study four relatively short term climatic changes have been identified by Lamb (Cushing, 1982) and include influences likely to have affected fish stock levels and long term distribution.

1. The Little Optimum 1150-1300 AD. In this period increased temperatures raised the treeline, permitting Viking settlement in W and SW Greenland and bodies to be interred in ground normally frozen. Winters were mild with dry summers in Britain and NW Europe.

2. 1300-1550 AD: when a change to cooler winters and wetter summers, resulted in a lowering of tree, fruit and cereal lines. There were glacial advances in Iceland, Norway and the Alps. The sailing routes to Greenland were abandoned.

3. The Little Ice Age, 1550-1700 AD. During this time temperatures were lower in Europe in all seasons by 1 degree C in winter and 0.5 degrees C in summer. The weather was more variable and many rivers froze in the winter, including the Thames on which Frost Fairs were held.

4. In the 18th century the climate ameliorated and a period of warming started at the beginning of the 20th century. But it is only the beginning of this period that is relevant to this study.

Changes in temperature could have affected the southerly distribution of herring in the English Channel. Herring require the temperature to be below a certain point whereas pilchards[5] require it to be above, (Culley, 1971, p.51). With changing temperatures the herring and pilchard fisheries of the English Channel would have been in a state of interchange. In the higher temperatures of the Little

[5] These two species are closely related.

Optimum the herring fishery of the Channel would have been reduced, while pilchards would show a more northerly distribution than was usual. This situation reversed as the climate deteriorated.

This is a fairly generalised example of how fish distributions are affected by temperature ignoring the subtle effects of winds and currents, but does indicate the temperature dependency of species.

Gray (1992) describes the herring fishery off the north Devon coast and the pilchard fishery of the south during the Elizabethan and Early Stuart period which exemplifies the juxtaposition of these two species. Herring were recorded as first seen off north Devon in 1580, possibly a result of a lowering in sea temperature, while pilchards declined in Devon waters in the middle of the 17th century, (Gray, 1992, p.140).

Temperature.

A recently recorded decrease in North Sea temperatures, effected by events in the north east Atlantic, may have enhanced year classes of cod and other gadids. Other possible causes include a decrease in herring and mackerel numbers from overfishing. Both these species feed on the pelagic gadid larvae and their decline resulted in a rise of gadid[6] stocks, (Laevastu, 1993, p.141).

Any decreases in the temperature of the North Sea and the Atlantic within the period under study, particularly between 1300 and 1700, could have increased the cod and herring stocks available to fishermen. However, as has been shown, fluctuations in fish numbers are affected by so many factors that any such correlation is too complex to attribute purely to temperature change.

Historic Fisheries.

These can be divided into two main types for the species under discussion: drift netting for herring, line fishing for cod and the other large gadids. Whiting were

[6] Dermersal as adults.

both netted and caught on lines. The two primary species under discussion are herring and cod. It is not the intention here to include a detailed account of the types of boats and gear used, this has been described elsewhere by Hutchinson (1998) and Cushing (1988) among others. I have restricted the discussion to aspects of the historic background of the success of those fisheries which had an impact on the production of stored fish.

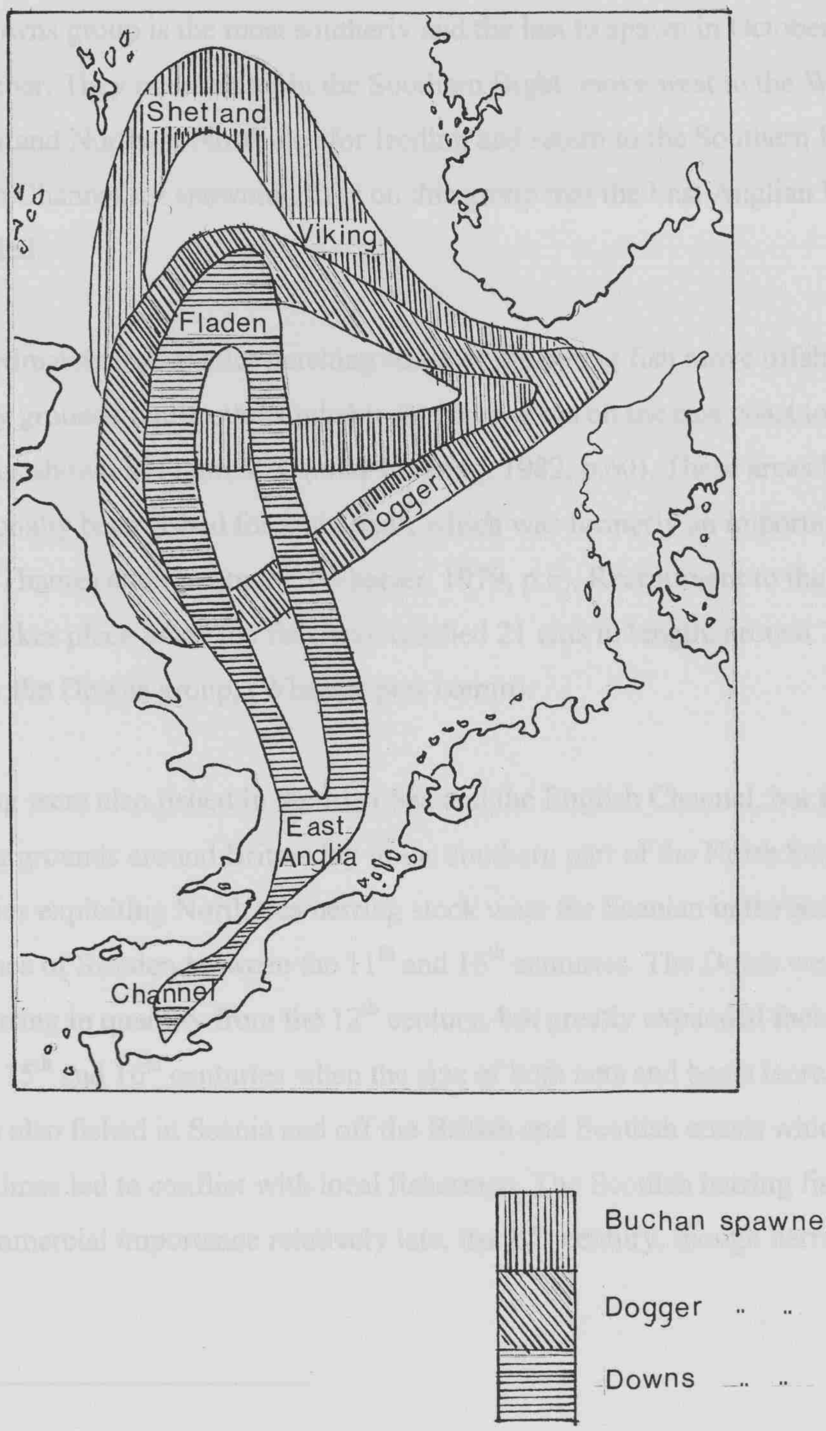
Herring Fisheries

Herring fisheries were active all around the British coast from at least early Medieval times, (Cutting, 1955, p.54). Arguably the most abundant fish around our shores until recently, the herring fisheries have been the subject of many books including 'The Herring; its effect on the history of Britain', (Samuel, 1918) and ' The herring and its fishery', (Hodgson, 1954). The most famous herring fishery was associated with East Anglia and in particular Great Yarmouth, where the annual Medieval herring fair from September to November 11th attracted Gascon, Spanish, French, Florentine and German merchants in addition to English traders, (Saul, 1981-3, p.37).

The main fishing season for herring was autumnal and determined by the annual migration of the adults to their spawning grounds. At this time they are in peak condition, at their fattest and with a high oil content. The fish form three distinct groups in the North Sea which annually repeat a particular route for over wintering, feeding and spawning. There is some spatial overlap in their territories though they remain temporally separate.

The earliest group to migrate are also the most northerly and known as the Buchan, (see Figure 2.2 after Cushing, 1982, p.61). The herring appear in June off the Shetland Isles and go to their spawning grounds off the Scottish and English coasts in August and September. They then move east to over winter off the Norwegian Deep Water. These fish were the objective of the Scottish herring fishery.

Figure 2.2. Migrations of the North Sea herring.
(after Cushing, 1982, p.61).



The Dogger group spawn in September and October before they too move east to over winter in the Norwegian Deep Water. They then return west in the spring to the feeding grounds where they may be joined by recruiting young adults before the next spawning season. This group would be the objective of fisheries operating north of the Wash and up the Northumberland coastline.

The Downs group is the most southerly and the last to spawn in October and November. They over winter in the Southern Bight, move west to the Western Dogger and Northern North Sea for feeding and return to the Southern Bight and Eastern Channel for spawning. It is on this group that the East Anglian Fishery depended.

Approximately a year after hatching some of the young fish move offshore east to nursery grounds while others inhabit sheltered areas on the east coast to feed and grow, as shown in Figure 2.3, (after Cushing, 1982, p.60). These areas have traditionally been fished for whitebait[7], which was formerly an important fishery of the Thames and its estuary, (Wheeler, 1979, p.6). Recruitment to the adult stock takes place when the fish have reached 21 cms in length, around 3-4 years old for the Downs group, (Wheeler pers comm).

Herring were also fished in the Irish Sea and the English Channel, but the richest fishing grounds around Britain lay in the southern part of the North Sea. Other fisheries exploiting North Sea herring stock were the Scanian in the southernmost province of Sweden between the 11th and 16th centuries. The Dutch were fishing for herring in quantity from the 12th century, but greatly expanded their operation in the 15th and 16th centuries when the size of both nets and boats increased. The Dutch also fished in Scania and off the British and Scottish coasts which sometimes led to conflict with local fishermen. The Scottish herring fishery grew to commercial importance relatively late, the 17th century, though herring had

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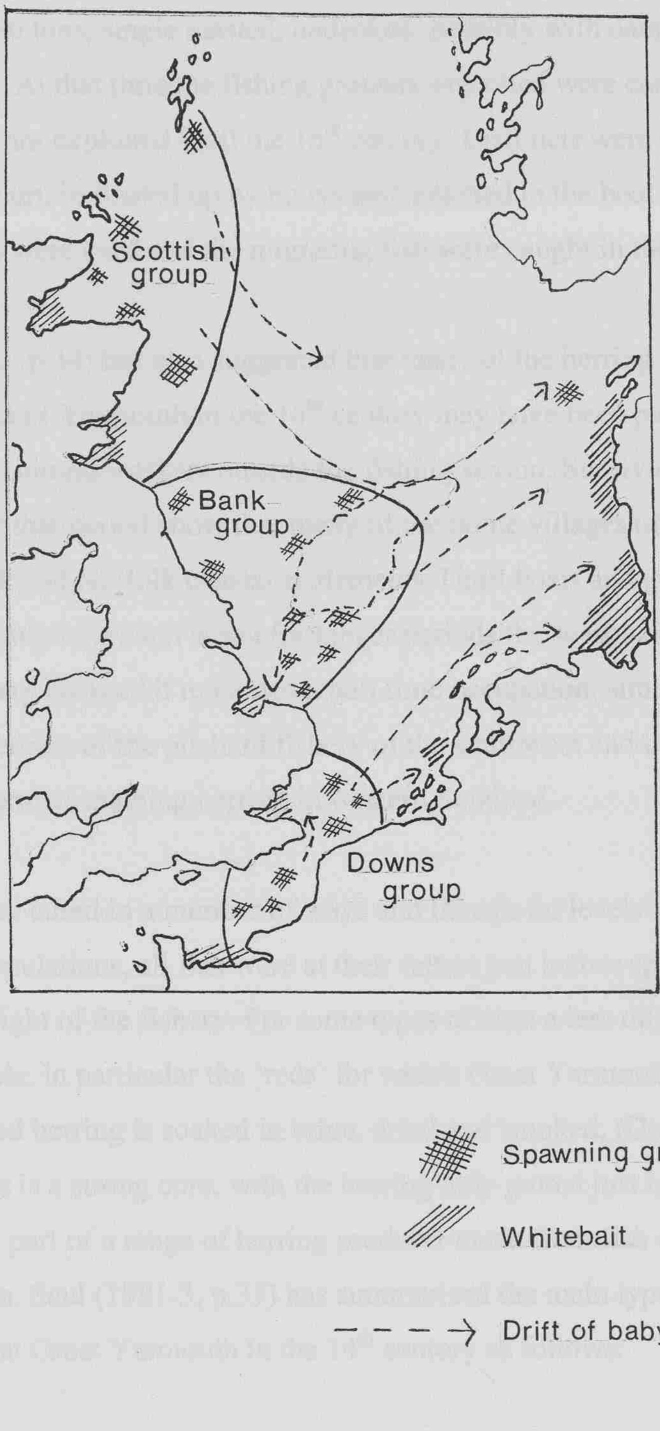
[7] A mixture of young herring and sprats.

Figure 2.3. Larval drifts of three stocks of herring in the North Sea.
(after Cushing, 1982, p.60)



always been caught off Scottish coasts, especially around the Forth and Clyde and the west coast sea lochs, (Cushing, 1988, p.97).

The East Anglian herring fishery, the major British herring fishery, was prosecuted from as early as the 7th century. Little is known about the boats of the early period, but Saul (1981-3, p.34) has suggested that by the 14th century boats were under 30 tons, single masted, undecked, possibly with oars, carrying crews of 4-10 men. At that time the fishing grounds exploited were coastal, distant waters were not exploited until the 15th century. Drift nets were used in which the net forms a curtain floated up by buoys and attached to the boat by a rope. Series of these nets were used and the migrating fish were caught in the mesh.

Saul (1981-3, p.34) has also suggested that many of the herring fishermen operating out of Yarmouth in the 14th century may have been part time, working as local agricultural workers outside the fishing season. Surviving murrage accounts for that period show that many of the home villages of boat masters were Suffolk and Norfolk coastal settlements. Until boats and gear increased in size sufficiently to remain at sea for longer periods the seasonal nature of the herring fishery ensured it remained a part time occupation, similar to the miners/fishermen of the pilchard fishery of the southwest and the crofter/fishermen catching herring in western Scotland.

Herring were cured in a number of ways and though fat levels varied in different breeding populations, all fish were at their fattest just before spawning, the seasonal height of the fishery. For some types of cure a less oily herring was more suitable, in particular the 'reds' for which Great Yarmouth were famous. The ungutted herring is soaked in brine, dried and smoked, (Davidson, 1999, p.380). This is a strong cure, with the herring only gutted just before serving. The 'reds' were part of a range of herring products made from fish caught outside the main season. Saul (1981-3, p.35) has summarised the main types of cured herring referred to at Great Yarmouth in the 14th century as follows:

White: gutted, rubbed with salt and barreled in salt or brine.
Dried: probably salted and sun dried or lightly smoked.
Red: salted (ungutted) and heavily smoked from 7-28 days.

'Red' and 'white' herrings are referred to in many Medieval household accounts.

As well as the climatic effects discussed earlier, economic and political changes were also influential on fisheries. There was a decline in the herring trade at Yarmouth in the second half of the 14th century for which Saul (1981-3, p. 37) has suggested a number of causes. A major outbreak of Plague affecting labour levels is thought to have caused a severe drop in the number of lasts[8] of herrings recorded in customs accounts from 1,537 in 1348, to 9 in 1349. Other events also proved influential, naval demands for boats and men during the siege of Calais in the 1340's and the Hundred Years War (1337-1453) disrupted the herring trade and affected the fishery. The most significant effect, at the end of the 14th century, was competition from the developing curing industry in the Low Countries, whose high quality cures became favoured by London merchants. Great Yarmouth declined as the ports of Hull, Boston and (Kings) Lynn came to be preferred by buyers of fresh herring from the Low Countries.

None of these problems suggest a shortage of fish determined by changes in environmental or climatic conditions. Both labour shortages and poor quality of the stored fish compared to the Dutch herring in the second half of the 14th century were major influences in the decline of Great Yarmouth. Saul has also suggested that the peasant diet may have improved after the Black Death, reducing the demand for herring, (1981-3, p.37). Dyer has made a similar suggestion from evidence for change in the diet of Norfolk harvest workers. By the middle of the 14th century, the recorded amounts of meat and especially fresh meat eaten by the harvesters had become greater than fish. Dyer (1994b, p.97) suggests that these changes in the 14th and 15th centuries show wage earners favoured white bread, fresh meat and strong ale in imitation of the lesser gentry.

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[8] Approximately two tons per last.

The role of herring as a cheap abundant source of protein and a food of poverty and fasting is a theme that is developed later with the archaeological evidence.

Cod and related fisheries.

Line fishing for cod was the other major fishery associated with the production of stored fish. Other large gadid species such as ling, hake, saithe and pollack were also caught on lines, as were haddock, all of which were stored.

Cod has been described as the 'beef of the sea', a lean fish with a low oil content and high in water, it is ideal for drying and/or salting for long term storage. Cod remains the preferred white fish in England today, either fresh or frozen. The history of the cod fishery is described both in 'The Cod Fisheries; the history of an international economy' (Innes, 1954) and most recently in the more populist 'Cod; a biography of the fish that changed the world' (Kurlansky, 1998), demonstrating an enduring interest in this fish.

Cod, ling, haddock and saithe are all in the south of their range around the British coastline, while pollack is also found in shallow waters along the French and Spanish coastline and western part of the Mediterranean. Cod is ubiquitous, while ling and hake are absent from the southern part of the North Sea. Ling, a deep water species, is absent from the Irish Sea and the English Channel. Although these other gadids have a generally wide distribution, higher densities in certain areas concentrated the fisheries, such as for hake in the south west. All the fisheries were based on line fishing, with either single or multiple hooks off each line.

The fishing for cod, ling, haddock and whiting from Hartlepool was based on lines (Sharpe, 1978, p.179) and prosecuted 8-15 miles from the shore in winter and 10-20 miles from the shore in summer. Both cod and haddock move nearer shore in the winter in the south of their range and the Hartlepool fishermen were able to take advantage of this movement.

The demand for cod has always been the greatest of all the large gadids and the search for cod soon extended beyond the home fishing grounds around the British coastline and in the North Sea. In the 15th century fishermen sailed to Iceland bringing back stored cod. Some of these they had caught and stored, while others had been bought while trading a variety of goods. This proved so profitable that it was worth risking using unlicensed boats during the ban on cod fishing and trading with Iceland during this period. False destinations were registered as suggested by the customs port books for Bristol for this period, (Carus Wilson, 1967, p.87).

The discovery of large stocks of cod off Newfoundland at the beginning on the 16th century attracted English fishermen, especially from west country ports such as Bristol, as well as French, Spanish and Portuguese fishermen. The disputes and rivalries between them are well documented, (see Innes, 1954). The distance from the homeports meant the all cod had to be stored, salted and dried. Different nations favoured different methods but all involved some salting, as climatic conditions did not permit successful drying alone.

Processing was initially carried out onshore in Newfoundland where the fish were landed in a large scale fishing operation, but as the boats became larger some cutting and salting took place on board ship. By the end of the 16th century the English market for dried cod had diminished while demand was still high in the rest of Europe, especially in the Catholic countries with whom the cod was increasingly traded. Demand still remained in England for 'green' (wet) salt fish until at least the beginning of the 18th century, (Innes, 1954, p.72).

Cod was the most valuable of the whitefish and landing cod for the fresh fish market, or fresh ready for processing for storage, relied on a swift return to the home port. The earliest documentary evidence of fish kept alive in water at the bottom of boats is in 1339 from Holland, (Hutchinson, 1998, p.142). The first fishing vessels designed to bring 'wet fish' to market in England were introduced in Harwich in 1712, probably from Holland, (Cutting, 1955, p.204). This is towards the end of the period covered in this thesis and still prior to icing, so the landing of fresh fish in good market condition set limits on the distance from port that could be fished. There were three options; the fishery remained local, within the return distance to the homeport for marketing or processing. Alternatively the fish were either part processed on board to a degree where the condition of the fish could withstand the return journey home, or they were taken to a port nearer the fishing ground for sale or processing.

The consumption of ling in the south of England is likely to have been largely from stored fish, as was that of hake outside the south west given the distribution of both these fishes described above. They were significant fisheries and the stored fish traded widely. More difficult to assess is the position of saithe and pollack. The former developed from a subsistence fishery in Orkney in prehistoric times where the young fish living inshore were eaten in quantity, (Locker, 1994a, p.159). The adult fish were a key part of subsistence life in historic times both as food and oil and the fishing was carried out in combination with farming, (Fenton, 1978, p.530). The surplus oil was exported from both Orkney and Shetland for soap making.

Haddock was more popular in the north of England and Scotland, than in the south. The Scots have traditionally consumed more fish than the English and Smout (1963, p.220) states that until the end of the 18th century fish was the main subsistence food for the 'common people' when the harvest failed. Always cheaper than cod, haddock was originally classified as an offal fish, possibly due to the rate at which it deteriorates. Today it is more highly regarded in England and competes with cod, (Davidson, 1999, p.364). In the southern part of its range around the British coast haddock could be caught in inshore shallow waters during the winter months, moving into deeper water during the summer.

Whiting, the smallest of the gadids included here, is an inshore species caught all around British shores, both in nets and on lines. Described by Hooker in the late 16th century as 'always in season' off the Devon coast (Gray, 1992, p.139), whiting formed significant local fisheries in many areas. It was eaten fresh, but was also salted and dried (known as 'buckthorn' in Devon) in the same manner as haddock.

Summary.

Of the species described here, the most commercialised fisheries developed for herring and cod, which supported both local fisheries and more distant water. The treatment of the fish largely depended on the distance from the fishing grounds to the landing port. Major fisheries such as the East Anglian herring fishery attracted both local fishermen and visiting fishermen from other parts of Britain and abroad. Seasonal ancillary workers were also employed for the onshore processing. Gray (1992, p.141) describes the sailings of Devon fishermen, in part a response to their own fluctuating fish stocks, to Ireland for herring and round the east coast to Scarborough and Great Yarmouth for a variety of fish, in the case of the latter all for storage. Devon men were also among the many English fishermen attracted to the distant water fisheries, such as the Scanian for herring and Iceland, Newfoundland and then New England for cod. The distance of these fisheries could only support the demand for stored fish, fresh would have been spoiled during the long transit.

The effects on fisheries by the movements of fish influenced by changes in temperature, surface winds and currents have been shown to be complex and also incorporate changes seemingly unrelated to any environmental factors. The difficulties in ascribing historical fluctuations of fish to specific factors have been shown, underscoring the degree of speculation that is inevitably part of interpreting changes in fish stocks in pre-industrial fisheries.

Chapter 3. Processing methods for fish storage and the effect on nutritional values

Introduction.

The study of the development of different techniques for the processing and storage of fish has involved many disciplines. Historians, archaeologists, fish biologists and food technologists have all found some aspects relevant to their work. Among the published material one particular book attempted to bring all the historical data together. Dr C L Cutting published 'Fish Saving; A history of fish processing from ancient to modern times' in 1955 and this remains unsurpassed as a complete study. Cutting has also published widely on chemical and nutritional changes in fish as a result of storage practices including papers in ' Fish in Nutrition' (Heen and Kreuzer, 1962) and 'Fish as Food', (Borgstrom, 1965). The source of much of the discussion of processing methods, storage and their effect on the nutritional composition of the fish in this chapter is attributable to 'Fish Saving' and related works.

As I stated earlier the main types of fish stored in England from 900 AD – 1750 AD separated into two groups; fish with a high oil content, in this case herring, and fish with a high water content, cod and related species. Any method, whether drying, salting or smoking can be applied to any species, but for maximum storage life oily fish are best salted, pickled and smoked or combinations thereof. Fish with a high water content can be dehydrated by drying alone, or in combination with salting for long storage.

The scale of processing.

The scale of production of fish for storage can vary from a small subsistence operation to commercial scale. As a commercial venture storage was a major activity centred on an important fishery where the outlet for fresh fish was limited[1] compared to that for stored. A good example is the Newfoundland cod fishery of the 16th century where English fishermen, along with other European fishermen, salted and dried all the cod they caught and brought it back for sale.

[1] By the efficiency of contemporary methods of transport.

For herring the numbers landed at Great Yarmouth supported commercial storage producing pickled, salted and dried and smoked fish. This was arguably the major centre of stored fish production in England in the 13th and 14th centuries.

Salmon.

Although salmon are not included in the species under discussion it is appropriate to mention them here as their spawning cycle up river produces an annual glut of fish. In Britain there is only one species of salmon (*Salmo salar*), but the numbers of fish were sufficient for certain areas to produce types of stored salmon which became a regional specialty. 'Newcastle Salmon', somewhat of a misnomer, were salmon caught in the Tweed, brought by horse to Shields where the fish were cured, pickled and sent to London as observed by Defoe in the early 18th century, (Defoe, 1979, p.536). In Scotland salmon was dried and salted to a very hard finish both for home consumption and export and Scottish records a century later show that salmon was a major fish export, second only to herring, (Smout, 1963, p.219). Many of the fish were caught in the Rivers Don and Dee and the stored fish exported mainly to France and Holland, with little going to England. Ireland also produced large quantities of pickled salmon, which in the 16th century were a significant export (second only to herring), particularly to Bristol, (Longfield, 1929, p.47)

The spawning patterns of salmon in both North America and Eurasia have and continue to provide native peoples with abundant annual supplies of fish. In both continents there are different species of salmon with staggered spawning times. The sockeye salmon (*Oncorhynchus nerka*) and king salmon (*Oncorhynchus tshawytscha*) are exploited by the Tutchone people of S Yukon. These fish are eaten fresh in season with large quantities stored by traditional methods to feed both people and dogs the rest of the year. The heads of both species are removed (these are eaten baked, or boiled, or stored in the ground until they ferment), the larger king salmon have the vertebrae removed. The fish are then dried in a wooden smokehouse for up to a week until the flesh is crusted over, after which the salmon are cut again on the diagonal. The king salmon are cut into pieces and then all the fish are dried on poles for 3-6 weeks. Successfully dried fish, stored on poles or stacked, can last for years and do not require reconstitution before eating, though they are sometimes soaked or boiled, (O'Leary, 198?).

Five different species of salmon spawn in the Kamchatka Peninsular between the Bering Sea and the Sea of Okhotsk. The staggered spawning times provide a rich food source for the Itelmen and their dogs. The 'yukola' or dried fish must be ready for storage before the July rains and mists, (Shnirelman, 1994). Different species of salmon are favoured for different products with the late spawning pink salmon (*Oncorhynchos gorbuscha*) preferred for fermented fish, a special guest food.

These two modern ethnographic examples demonstrate that, for some peoples, fish stored by traditional methods remain an important source for stored food. Annual migration patterns, usually allied to spawning, produce a glut of fish that can be a vital food source for peoples living in a pre-industrial society. The commitment to storing these fish bears comparison historically with the annual effort put into storing Scottish salmon and East Anglian herring, as both a local food source and a trade item, together with the intensity of cod fishing and processing in Newfoundland.

Methods of storage and their effect on fish composition and nutritional value.

As I have already stated all fish can be preserved by any method of drying, salting[2], pickling and smoking, alone or in combination. The choice of method is influenced both by the length of storage life and the type of stored fish being produced. The two are not necessarily linked. A light and less lasting cure may have been more popular for its flavour than length of storage, the preference being proven by the increase in lighter cures with improvements in transport in the 19th century.

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[2] The salt may be dry or in a brine.

The oil and water contents of different species have historically influenced the storage methods in mass production. Length of storage also included transport and marketing as well as time spent in the storeroom.

Cutting (1962, p.161), addressing current issues in fish storage in developing countries, described many traditional products as 'habitually dark, oxidised, rancid, sandy, spoiled and insect-infested', factors at least as relevant historically as today. The care taken in the different curings described below, both in the application of the method and the quality of the fish and salt used, determined the quality of the finished product.

Dried fish.

Drying fish naturally outside requires the least investment, but successful drying relies on the quality and size of the fish and particular weather conditions. The attraction of naturally dried fish as a low investment business was balanced by the precise limits imposed by climate.

'Stockfish' was high quality wind dried cod primarily from Norway. Dried cod was also produced in Iceland in the Middle Ages and large quantities were exported. The term 'stockfish' has also been used to describe fish which have been both salted and dried, for example by Hartley (1979, p.253) and Wilson (1973, p.35) and it appears that the term may have been used more loosely. Strictly speaking 'stockfish', so called after the 'stok' poles on which they were dried, should only be dried. The Multilingual Dictionary of Fish and Fish Products (1995, p.225) defines 'stockfish'as 'Gutted, headed, unsplit or split fish, such as cod, coalfish[3], haddock and hake dried hard without salt in open air'. Whereas 'klipfish' are split, salted and dried, (1995, p.556). Perdikaris (1999, p.390) has summarised the elements of the Lofoten 'stockfish' as 'beheaded cod whose body is air dried in the round without the use of salt'. Drying in the round was peculiar to these islands and a reflection of the ideal conditions, it being more difficult to achieve an evenly dried finish for whole fish than for split fish.

[3] Coalfish refers to saithe (*Pollachius virens*).

The cod range from 60 cm in length to a maximum of 110 cms and are caught from spawning stocks in the winter, any larger the fish are difficult to dry evenly. Drying can only take place from January to early April, after which higher temperatures and black fly ruin the fish. The dried fish have a shelf life of over two years without refrigeration.

All the Newfoundland cod were salted and dried since ideal climatic conditions for drying alone[4] did not prevail. However, the cod cured by English fishermen had a lower proportion of salt than the cod cured by the French, Spanish and Portuguese, helping to keep down production costs.

In Britain saithe and other stored fish were a major subsistence food in Orkney and Shetland. Saithe were the least commercially valuable of the fish caught there and formed the main stay of home consumption. Fish were salted, dried and smoked, often by the domestic fire and described by Fenton (1978, p.528), as a 'hunger food' when other sources failed. Dogfish (*Scyliorhinus canicula*) and thornback rays (*Raja clavata*) were also dried in Orkney as food for the poor and in Shetland small saithe were dried on house gables, according to 19th century sources. At that time the price of salt was high because of the tax (Fenton 1978, p.530) and fish stored solely by drying were common. Practices of drying and salting fish have a long tradition in these remote islands as shown by Barrett (1997), Ceron-Carrasco (1998) and Colley (1983).

Dried herring, have a high oil content and will only last until the oil becomes rancid and so tend to be dried in conjunction with salting. Dried and salted herring were produced in some quantity at Great Yarmouth, (Saul, 1981-3, p.5).

Salt and salt cured fish.

The history of salt extraction and trade is a study in itself and it is not the intention to explore it here except for the following observations on salt types and qualities, which affected the success of storage.

[4] Wind (keeping insects away) and clear, cold frosty weather.

Salt supplies were, of course, an essential ingredient in all aspects of storage except drying and smoking. Not only was the price of salt, affected by salt taxes, a consideration, but also the type and purity.

From the Middle Ages, until the 19th century, the best salt for curing fish was 'bay salt' or sea salt. This was made in France and Spain by solar evaporation, (Davidson, 1999, p.688). The large crystals in sea salt dissolve slowly penetrating the fish, whereas fine salt rapidly dissolves and seals the outer layer of the fish, arresting the salting process, known as 'salt burn'. In England salt was extracted from seawater at a number of locations including Norfolk, Essex and Kent and from brine springs from Droitwich, (Wilson, 1991, p.16). Rock salt was discovered near Nantwich in 1670, which was made into strong brine with fresh water and boiled again with saltwater to produce good quality salt, (Wilson, 1973, p.51).

The large grained 'bay salt' is therefore preferred for dry salting, whereas any grain size is suitable for brine solution. In both cases the purer the salt the better and Cutting (1962, p.171) has divided traditional methods of salting into three;

1. Dry salting, includes green salted cod, the 'greenfish' of documentary record.
2. Brining, where the fish are immersed in a concentrated salt solution.
3. Combined dry salting and brine formation, as used in pickled herring.

Salt, whether applied dry or as brine, played a vital role in fish curing, with a few exceptions when the fish were only dried or smoked.

1. Dry salting. The fish are covered in salt and, if stacked, they must be regularly turned and moved for an even cure, or the fish can be laid out individually where space allows. Dry salting was often practiced in combination with drying. Cutting (1962, p.173) has described combined salting and drying as 'probably the commonest and most effective method of preservation in the world'. The salt penetrated the flesh, which was subsequently dehydrated during the drying.

During the salting when the fish are laid in piles, there is a layer of salt between each layer of fish and the liquid drawn from the fish drains away. After about 15 days the salt has penetrated the fish and this 'green cure' is now lying in 'wet stack', (Storey, 1982, p.149). 'Greenfish'[5], were wet salted fish, often cod or another large gadid and sold as such. France had major ports for salt cod from the Newfoundland fishery in the 16th century, largely those in the North of France including Dieppe, Le Havre and Honfleur. At these ports the fish were graded both by size and quality, (Cushing, 1988, p.60).

All the cod caught in Newfoundland by English fishermen were salted and dried, as were some of the cod caught by the French. The latter brought these to southerly home ports including Bordeaux, La Rochelle and Marseille where dried and salted cod were preferred to salt cod, which was more popular in the north particularly in Paris, (Cushing, 1988, p.61). Cushing (1988) and Innes (1954) both give good accounts of the Newfoundland cod fisheries, the rivalries between nations and the political difficulties disrupting both the fishing and marketing of the cod. Suffice to say here, it attracted fishermen from the English ports of the West Country, especially Bristol, who produced a light salted dried cod, minimising the expenditure on salt. This was initially marketed in England, but as home demand decreased, the fish were traded in the Catholic countries of Europe.

Cod and other related species with a high water content would have had a far longer storage life than fattier species like herring prepared in this manner. In the 12th century in Western Europe herring were crudely prepared by salting fish which were piled in heaps, (Cutting, 1955, p.57). These were sufficiently cured for transportation but not long term storage. The stronger cures like pickling, described below, developed out of a need to stabilise the high fat content, which fluctuates throughout the year. The increased fat content reduces the amount of salt that can be absorbed (Storey, 1982, p.99), affecting long term stability in storage.

[5] Commonly referred to in Medieval accounts.

2. Brining. This involves immersion of the fish in a solution of 80-100 percent of salt dissolved in water. However as the salt is taken up into the fish the strength of the brine falls. Brine strength can be maintained by changing it or adding extra salt. Shewan (1961, p.513) gives the usage time of a brine as a fortnight. The use of old brines, or brines with insufficient salt results in a poorly salted fish, reducing storage time before deterioration. A difference in brine strength influences the final salt content of the fish (Storey, 1982, p.98), which is also dependent on many other factors. These include the duration of immersion, strength and temperature of the brine, the shape and fat content of the fish, whether the skin has been left on, the ratio of fish to brine and if the brine has been well stirred. Herring and some of the more oily fishes were either salted by immersion in brine then removed or stored in brine. Sardines (*Sardina pilchardus*), a variety of tunas (Thunnidae) and other fish are canned in brine today, but it is the canning which provides greater longevity of storage.

3. Pickling. For long storage traditional pickling combines salting with brining. Cutting (1962, p.172) summarises the advantages of pickling as maintaining maximum salt content around the fish, optimising preservation while submersion in brine prevents the oxidising of fat. The oil becomes rancid when the saturated fats combine with oxygen, so exclusion of oxygen is vital for long term preservation and also protects from insect infestation.

Traditionally the herring were gutted[6], packed in layers in salt in a barrel until the barrel is full. As the pickle forms the herring shrink and fish from the same catch are added twice more before the barrel is finally stopped up, (Storey, 1982, p.150).

This is an ideal method for storing fish with a high fat content. Barreled fish stored at 10 – 12 degrees C remained edible for up to 10 months (Shewan, 1961, p.527), or longer at lower temperatures. The 'white' herrings of Yarmouth were stored in this manner, while 'reds' were further enhanced by removal from the

[6] Prior to the 14th century they were entire.

pickle and heavy smoking. Since the 'reds' were not permanently stored in pickle a less fatty herring was preferred, less than 15%. These were caught pre and post spawning when the fish were not at optimum fat levels, otherwise stabilising the fat was a problem.

Salmon, although comparatively low in fat compared to herring[7] also fluctuates in fat throughout the year. Preservation was by pickling as 'Newcastle salmon', referred to above, as well as salted ('powdered'), smoked and dried, the latter to a very hard consistency.

For 'whitefish', where the oil content is low, pickling is unnecessary, using excessive amounts of salt to stabilise these fish, the extra salt and any taxes adding to production costs. However, there seems to have been some small demand for 'barreled cod', which suggests it may heavily salted, pickled, or cut in pieces and consequently had to be packed in a container.

Smoked fish

Smoked fish, which had not been dried or salted first, could not be stored for long prior to the use of refrigeration. Smoking has a long history in subsistence storage in combination with other methods. Salted and/or dried fish were hung close to chimneys in houses and huts where they were smoked from the domestic fire. This was common in Scotland until relatively recently, using peat as a fuel, which gave the fish a distinctive flavour. Smoke houses developed as separate buildings built both in wood and stone. The different types of wood used in smoking subtly change the flavour of the fish, in the same way as for bacon and hams. Hardwoods are best, particularly oak as well as beech and birch, softwoods give a resinous bitter taste, (Davidson, 1999, p.729).

Smoke houses were tall narrow buildings, as described by Saul (1981-3, p.35) in the 14th century 'fish houses' of Great Yarmouth, with beams across from which the fish were hung from poles. Gaps in uncemented roof tiles allowed the smoke

[7] 6% in a fresh fillet according to Cutting, 1962, p.164.

to escape. The process took several days and the fish 'rested' in between smokings, (Davidson, 1999, p.728). In Britain historically all fish were 'cold smoked', that is at temperatures below 29 degrees C[8]. 'Cold smoking' has a preservative effect, unlike 'hot smoking', which was more common in Northern Europe with temperatures above boiling point partly cooking the fish.

Used in combination with the other methods cold smoking was a another element in long term storage. Fish already dried and/or salted were further preserved by the desiccating effect of heavy smoking. For example the Yarmouth 'reds'are almost sterile, any surviving bacteria killed by the phenolic constituents of smoke. These seal the surface of the fish preventing oxidation and deterioration of the oil. The later mid 19th century development of light smoking techniques produced a new range of stored fish, including herring 'kippers' and 'finnan haddock'. These less stable products, which with the development of the railways no longer needed to be suitable for long storage, became very popular. This signaled the demise of the mass marketing of the hard smoked fish like the 'red' herrings and salted and dried cod.

The quality and grading of stored fish.

One of the key factors in producing high quality stored fish is that the raw material, the fresh fish, is in prime condition. It would be a mistake to assume that the fish used for storage could be of a lower grade in condition and freshness than those sold as fresh, though certainly some inferior products must have been passed off as prime, only to deteriorate later in storage.

The quality of the finished product is dependent on three main factors as defined by Storey, (1982, p.114);

1. Initial freshness of the fish.
2. The degree of drying, salting and smoking.
3. The conditions of storage.

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[8] 85 degrees F

Once a fish is caught the processing should begin before the end of 'rigor mortis' after which the condition of the fish begins to deteriorate and decay begins. 'Rigor' is known to begin 1-7 hours after death and the available data suggests it could last 1-5 days if delayed by low temperatures. Aitken et al (1982, p.52) showed that cod 'sea fresh' stored at 16 degrees C is fit only for the dustbin on the third day, but at 5 degrees C this is extended to 6 days and at 0 degrees C to 15 days. Therefore, before mechanised transport and refrigeration, the ship to shore to processing time severely curtailed the distance possible for fishing unless some onboard salting took place, or the fish were landed and sold elsewhere[9].

Conditions during processing also require monitoring. Fish stacked outside for salting and drying need to be regularly restacked and checked to ensure even conditions throughout. Bad weather also has a deleterious effect on the fish, which must be covered during rain. The treatment of fish within specialised buildings removed the hazards of changing weather conditions, but the quality of the storage processes can still be variable. High quality salt, replenishment of brines and well packed, undamaged fish all contribute to a product viable for long storage.

Problems occurring in salting include the development of halophile bacteria from solar salt found in the flora of brine, (Shewan, 1961, p.515). Even heavily salted fish may be spoiled by the growth of micrococci, the growth of these micro-organisms is affected by salt impurity and temperatures. 'Sliming' occurs on the surface of some lightly salted fish, while 'pink' can be seen in the stacks of wet fish, especially in the summer and these aerobic cocci give off an unpleasant odour. 'Pink' is said to affect salted cod in 'wet stack' after 2-3 months actually infecting the building they are stored in and is very difficult to eradicate, (Cutting, 1955, p.180). Dry conditions and temperatures below 4 degrees C help prevent formation of 'pink'. Solar salt also has an aerobic mould showing as

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[9] The age of a fish also affects condition, old fish show deterioration in the white muscles and make poor eating fresh or stored, (Cushing, 1982, p.40).

brown and black spots on the fish, 'dun', in the summer. These, even when relatively harmless like the 'dun', detract from the appearance of the fish.

Storage conditions deleterious to stored fish usually involve high temperatures and damp, the latter affects dried and salted fish effecting some rehydration and subsequent mould growth. The proportion of condemned naval provisions in the middle of the 18th century was higher for 'stockfish' than any other stored foodstuff [10]. While this may sometimes have been due to the fish being of poor quality initially, storage on board ship with changing weather conditions was not ideal for fish packed loose, while meat and many other stored foods were in barrels. For storage in hot climates pickling is recommended by Cutting (1962, p.172), as it gives maximum salt penetration and protection from fat oxidation and larval infestation.

One aspect of stored fish that has not been mentioned is the role of fermentation. A degree of decay adds a particular flavour to the fish and was regarded as desirable, if not essential, for certain specialties. Yarmouth 'reds', in which the fish is left ungutted until just prior to serving, owe some of their distinctive flavour to fermentation. An extreme example still enjoyed in Sweden is 'surstromming', fermented herring which have been left in the summer heat with only half the usual amount of salt, (Davidson, 1980, p.368). Opened barrels of this popular local delicacy can be smelt for some distance. Other forms of fermented fish are popular throughout Scandinavia and Cutting (1962, p.162) has referred to the 'benign decay' which give certain fish products their distinctive flavour.

Historically any guarantee of the quality of stored fish was difficult to impose but supposedly assured by specified contracts to ensure the quality and treatment of the fish, as for herring at Great Yarmouth, (Saul, 1981-3, p.35). Unlike the legislation imposed by the Hanseatic League on the quality of the processing

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[10] More fully discussed in the following chapter.

from fishery to finish[11], the Yarmouth herring industry relied more on self regulation, a less reliable approach. Any deviation from the use of high quality fish and salt, or shortcomings in the processing and subsequent storage, would have made the fish susceptible to deterioration. This shortened the anticipated shelf life or storage time, which in the case of 'white' herring was 10 months.

Composition and nutritional changes in fish as a result of curing.

Since stored fish played such a significant role in the consumption of animal protein by all sectors of society during this period, any changes to the calorific values of fish as a result of storage would have impacted on levels of nutrition. All the data discussed here are from recent studies, some of which relate to traditional methods, providing an indication of the changes that would have taken place.

The most immediate change is one of weight brought about by gutting, trimming, removal of bone and, for some fish, by dehydration during drying. Cutting (1955, p.179) has estimated a 45 % reduction for 'whitefish'[12] in heading, cleaning and splitting in which the head is 20 % and the intestines 15 %. Weight lost by dehydration affects mostly 'whitefish', since these are the species most likely to be dried and salted. Cod is particularly affected being up to 80 % water, while herring and other fatty species lose none of their oil content through dehydration and are consequently less stable as described above.

Changes in composition through curing include alterations in the protein and vitamin constituents brought about by concentration through dehydration, or lost through fluid exchange as the fish absorbs salt from the surrounding brine.

The basic differences between the chemical composition of fish with high water content and low oil (cod and related species) and fish with a high oil content (herring and related species) are summarised below. The data are taken from

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[11] In the 18th century at Bergen German merchants recognised 23 different qualities of stored cod (Trebbi, 1996, p.9).

[12] Cod and allied species.

Cutting (1962) on the influence of drying, salting and smoking on the nutritive value of fish. 'Whitefish' are represented by cod, and the fatty fish by salmon, herring and mackerel (*Scomber scombrus*).

Table 3.1. The chemical composition and calorific value of fresh and cured cod, salmon, herring and mackerel (after Cutting 1962 164-7)

	CHEMICAL COMPOSISTION								
	------------g/100g----------			---------mg/100g--------			(wet weight)		
	Water	Protein	Fat	Ash	Ca	P	Fe	I	Cals per 100g
COD									
fresh fillet	80.4	18.1	0.3	1.1	20	200	0.6	0.5	70
dried/salted	39.5	37.8	1.0	22.2	60	300	1.6		160
dried	14.8	78.5	1.4	5.9	160	950	2.5	1.2	325
SALMON									
fresh fillet	71.0	20.5	6.2	1.6	20	200	0.8	0.05	140
smoked	63.1	21.4	8.4	7.0				0.05	160
HERRING[13]									
fresh fillet	69.4	16.9	12.4	1.6	50	250	1.1	0.05	180[14]
fresh fillet	66.1	17.3	14.9	1.7	40	320	0.6	0.05	205[15]
MACKEREL									
fresh fillet	74.3	18.4	5.4	1.5	20	250	1.4	0.05	125[16]
fresh fillet	60.0	18.5	20.2	1.3	20	240	2.4	0.05	255[17]
smoked	61.1	21.5	10.6	5.8					180

Other forms of stored fish were also included, but relate to later techniques not relevant to stored fish before the middle of the 18th century. The figures for smoked fish represent the modern milder cures. The earlier stronger types of smoking would have shown a greater contrast against fresh fish.

Cod shows the greatest contrast with the other species, high in water and low in fat when fresh. Once dehydrated to the level required for 'stockfish' cod has the highest calorific count by weight of all the fish shown. This high calorie value per weight, together with the potentially longest storage time of all the stored fish,

[13] No data available for different types of stored herring.
[14] Winter
[15] Fat
[16] Spring
[17] Autumn

accounts for it's past importance. Once 'stockfish' is reconstituted in water the value drops to 50 calories per 100 g and shows a 29 % calorie loss against a fresh fillet.

For these data the differences given for winter and fat[18] herring are not very great. Fish selected as representative of fat herring are probably East Anglian since Scottish herring are known to reach fat levels of over 20 %. Consequently the fat Scottish herring would have been too fatty to make 'reds' in the Yarmouth style. Mackerel also show a strong seasonal difference in fat content and consequently calorific value. The 20 % fat content of an autumn fish would account for the quick deterioration of fresh mackerel, on account of which sales were permitted on Sundays in the Middle Ages when other fish could not be sold, (Wilson, 1973, p.39).

Salmon shows a lower calorific value than both herring and mackerel, an indication of lower fat content, which varied round the spawning cycle. This is also reflected in the variety of ways, from drying through to pickling, that salmon was stored.

There is some evidence for protein losses during curing with salt. A 1 % loss occurred in dry salted herring compared with fresh. However this rose to 5 % in brine, the increase occurred through exchange from the fish into the surrounding liquid, (Tarr, 1960, p.285)

Sodium and chlorides are all found in high quantities in fish that have been processed using salt. For example sodium increases from 77 mg in a raw cod fillet to 400 mg in a dried and salted cod fillet, while chlorides increase from 110 mg to 670 mg. Chlorides are also high where the fish have been smoked. For example the chloride level increases from 97 mg in raw mackerel to 1139 mg in

[18] Post spawning and pre spawning.

smoked and from 59 mg in raw salmon to 2850 mg in smoked, (McCance and Widdowson, 1992).

Vitamins are also affected by storage procedures. These divide into two main categories; fat soluble and water. The water soluble vitamins found in fish are; B (B1 Thiamine, B2 Riboflavin, B6 and B12 Cobolomin), Carnitrine, Niacin, Pantothenic acid, Folic acid, Choline and C. The fat soluble vitamins comprise; A, D and E, (Higashi, 1961, p.411). A brief summary of their importance is given below.

The flesh of most white fish is a relatively poor source of vitamins and so losses sustained in curing are not very significant. Drying can result in a 50 % loss of thiamine and a 65 % loss of riboflavin, but both vitamins are only present in parts of a milligram so fish are not an important source of these vitamins. Iodine is also present in minute quantities, of which 30-40 % is destroyed by salting and smoking, (Bender, 1978, p.133). Vitamins A, D and E are concentrated in the liver and are removed with gutting. All three vitamins are fat soluble and the fatty fish are a good source of vitamin D.

Water soluble vitamins

Group B vitamins are affected by geographical and climatic factors, with concentrations increased in colder waters. They are found in both the flesh and the liver, with B1 and B2 being more common in dark meat. The amounts are comparable to those found in beef, pork and veal. There does not seem to be any link between losses in these vitamins and drying and salting, but any method that involves submerging fish in a brine/pickle solution has implication for water soluble vitamins which may leach into the surrounding liquid.

Of the B group, thiamine reacts with carbohydrates releasing energy and a severe deficiency can lead to beri beri. Riboflavin is a coenzyme (like thiamine and niacin) and a sign of severe deficiency shows as an inflamed mouth and tongue, (Drummond and Wilbrahim, 1994, p.86). Niacin is associated with the transport of hydrogen atoms round the body and insufficient levels can lead to pellagra[19], common in maize eating areas of the world, but absent in Europe. Pyridoxin has a vital function in the conversion of carbohydrates and proteins to fats. Mackerel is a good source of this vitamin with 888 – 799 ug/100 g fresh weight, herring less so at 515 – 379 ug/100 g fresh weight, while cod fishes are 140 – 400 ug/100 g fresh weight, (Higashi, 1961, p.448). Fish is therefore a rich source of pyridoxin (B6) and found in the flesh, so not lost in gutting.

Cobolamin varies seasonally the richest source is in the internal organs. It is synthesised by micro-organisms and fermented fish products are high in B12, (Higashi, 1961, p.450). The Roman fish sauces *liquamen, garum* and *hallec*, all based on decomposing fish, would have been rich in cobolamin.

Choline occurs in variable amounts, it is higher in fish than in meat and in a low protein diet prevents hunger edema or 'dropsy' which has been recorded in the historic past. Pantothenic acid is part of the enzyme system, found in cod roe and the darker flesh. Folic acid is essential in the production of red corpuscles and the prevention of certain foetal abnormalities. It is highest in the entrails, richer in white than dark flesh and higher in more mobile species.

Vitamin C is present only as a trace element in fish.

Fat soluble vitamins.

These are concentrated in the liver. Vitamin A deficiency can result in an eye disorder 'night blindness' and over a long period a weakening of the immune system. Its' formation is affected by both the season and the temperature, increasing with cold and also with the age of the fish. Cod and pollack are rich in A, as are dogfish, hammerhead shark (*Sphyrna zygaena*) and halibut (*Hippoglossus hippoglossus*), from which the vitamin is extracted commercially.

[19] Dermatitis, diarrhea and dementia.

Vitamin D is extracted from cod liver, it occurs in higher quantities in cod from Norway than Newfoundland and is essential for healthy growth and bones. Levels of vitamin E are depleted in cod during spawning.

Cod liver oil or 'trane oil' was in use first for lighting and curing leather as a byproduct of 'stockfish' production in Norway from the 12th century. The medicinal use of the oil, high in those three essential vitamins, was not recognised until the middle of the 19th century when rickets became prevalent in Britain during rapid industrialisation and accompanying poor food and housing. Although other species have higher concentrations of vitamin D cod remained the prime source as the fish were caught in such quantities.

The main changes occurring through storage altering the nutritional composition on the fish seem to be fairly limited. Exchange of water soluble vitamins from the fish into surrounding brine or pickle would involve losses in all the B vitamin group described above. The fatty soluble vitamins, A, D and E being largely concentrated in the liver are lost through gutting anyway and absent in the fresh or stored fish, unless the particular method demanded whole ungutted fish as part of a specialty cure associated with a degree of fermentation.

Cutting (1962, p.171) concludes that the effects on nutritive value by drying fish are relatively slight compared to other losses taking place during processing and storage. Salting results in some loss of nutrient which is exchanged into the brine and further loss of protein as a result of autolysis [20] which is an essential part of 'benign decay' adding flavour, (Cutting, 1962, p.175). Discarding the brine or pickle loses these vitamins and proteins.

Apart from the leaching into brine, described above, with some inevitable loss of the vitamin B complex, all forms of stored fish have been shown to be a valuable source of calories, proteins and some vitamins. The extreme dehydration and salting practiced did not substantially alter their nutritional value. The more fatty

[20] Breaking down of dead tissue by enzymes.

fish, exemplified by herring in this study are the richest nutritionally, but require different methods for storage than those with high water content for whom dehydration and salting are sufficient for long storage.

CHAPTER 4. The marketing and consumption of stored fish against a background of demographic change.

Introduction.

In this chapter I will examine the evidence for population and demographic changes between the 10th and mid 18th centuries which would have affected and supply of many foodstuffs including stored fish. The population figures prior to the first official census of the early 19th century are open to debate, but the general trends are sufficient for the discussion here.

There is much surviving documentary evidence for the price, transport and destination of stored fish in England, for example Yarmouth herring and North Sea cod. Fish shipped in from abroad were recorded by customs and other tax accounts and evidence will be presented here for the ports of Southampton and Bristol. Much of these data were extensively collated and synthesised by Littler (1979) as part of an unpublished thesis concerning fish in English economy and society up to the Reformation. In this chapter independent research has inevitably utilised some of the same sources to illustrate aspects of the stored fish trade.

Evidence for the purchase and consumption of stored fish can also be found in contemporary household accounts. Some of these have been used as case studies to reflect living standards at different social levels and times, for example by Woolgar (1992 and 1999) and Wood-Legh (1956). The accounts show details of food, including stored fish, purchased throughout the year. Monastic houses kept meticulous records of their expenditure, the kitchener and the cellarer being in charge of purchasing and keeping records of the food for the Abbot's table, guests, monks and distribution of food to the poor. The surviving accounts vary in the details given as to where the fish were bought, quantities, prices and servings at individual meals. Another source of data are the records of the navy and army who were major purchasers of stored fish (particularly the navy) which survived as part of the ration allowance until the beginning of the 18th century. The documented purchase and problems of these stores are a further insight into the declining importance of stored fish through the period.

In the main the documentary evidence reflects the literate, educated and consequently higher social classes. There is some evidence from charitable food donations and boon meals to agricultural workers to suggest consumption patterns among poorer people, but these were in the gift of their social superiors and not reflective of daily consumption patterns. Interest in the poor and their living standards did not become of recorded interest until the 18th century. One of the earliest surveys was by Sir Frederic Eden (1797) who noted conditions in rural districts. Friedrich Engels (1845) and Henry Mayhew (1851) interviewed and recorded the living conditions of the poor, revealing the low levels of nutrition endured by some in the increased urbanisation associated with the Industrial Revolution. Dr Edward Smith carried out an official survey of labourer's diets in 1863 (Rule, 1991, p.49) and showed regional variations in the standard of living for this group. Some hospital diets of an earlier date are known (Drummond and Wilbrahim, 1994, p.465), but by the time workhouse, hospital and prison diets were regularly recorded no fish featured in their dietaries.

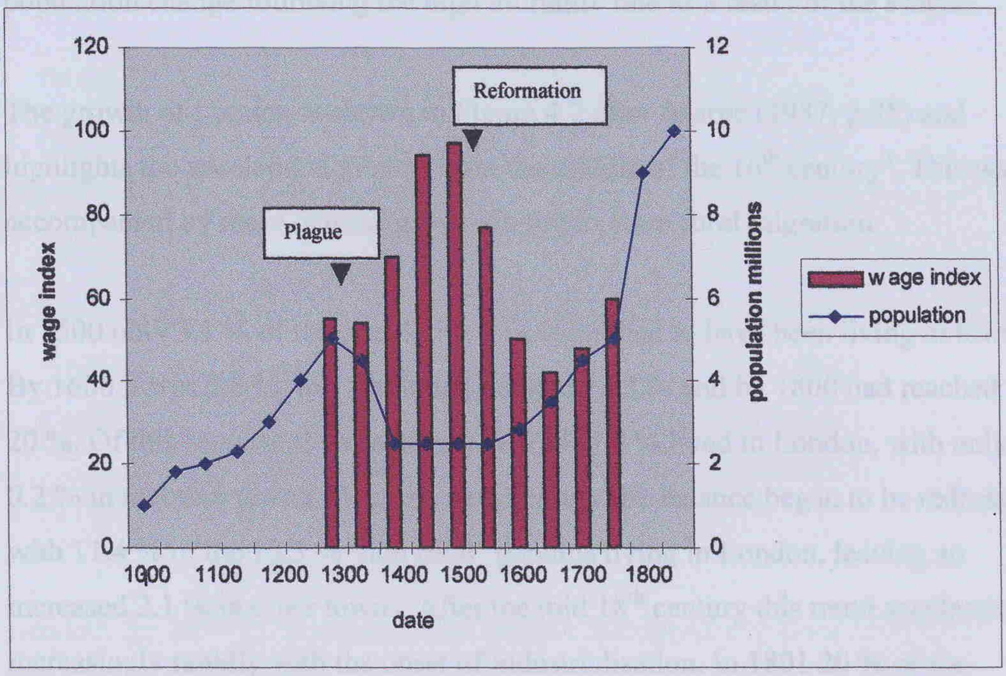
Population and demographic changes.

Many historians have calculated population changes in England from the Conquest to the first official census in 1801. There is a greater degree of uncertainty with the figures before the early 16th century, after which tax returns and muster certificates give more reliable data, (Hatcher, 1977, p.69). A wide range of population growth is given by Hatcher (1977, p.71) for 1100-1350, ranging from 1.5 or 2.5 million in 1100 to 4 or 6 million in 1350.

I do not intend to debate population statistics here, but instead use some of the available data in the context of changes in social structures that might affect stored fish consumption. A compilation of population data from Dyer (1994a, p.4[1]), wage structures (Hatcher, 1977, p.71[2]) and strategic events like major outbreaks of Plague and the Reformation are included in Figure 4.1 which summarises this data.

[1] Data from both Hatcher (1977) and Wrigley and Schofield (1981).
[2] Using Phelps Brown and Hopkins (1956) data for craftsmen's wages.

Figure 4.1. The incidence of population change, wage fluctuation and increase in urban population in England 900-1810.



From the late 11th century the estimated national population levels steadily climb until a major outbreak of the Plague. Thereafter a sharp decline returns the level to that of the late 11th century and remains static until the middle of the 16th century when population starts to increase, coincidentally around the time of the Reformation. Figures for this period also show the beginning of a rise in population in towns and most particularly London. National population growth reached about 5 million in 1700 (Rule, 1991, p.1), climbing to 8.9 million in England and Wales by the time of the first national census in 1801.

This total increased by a million and a half over the next decade and by 1851 had reached 18 million, (Burnett, 1989, p.3). These last three figures show a sharp acceleration in population growth just after the period under discussion. In comparison the growth rate seen in the late 11th to early 14th centuries was a pale forerunner.

The Phelps Brown and Hopkins (1956) wage structure included in Figure 4.1 works in reverse relation to population, a shortage of labour forcing up wages. This peaked in the late 15th century, following two centuries of relatively little population change following the high mortality rate as a result of the Plague.

The growth of London is shown in Figure 4.2 after Sharpe (1987, p.85) and highlights the accelerated growth from the middle of the 16th century[3]. This was accompanied by more general growth in towns from rural migration.

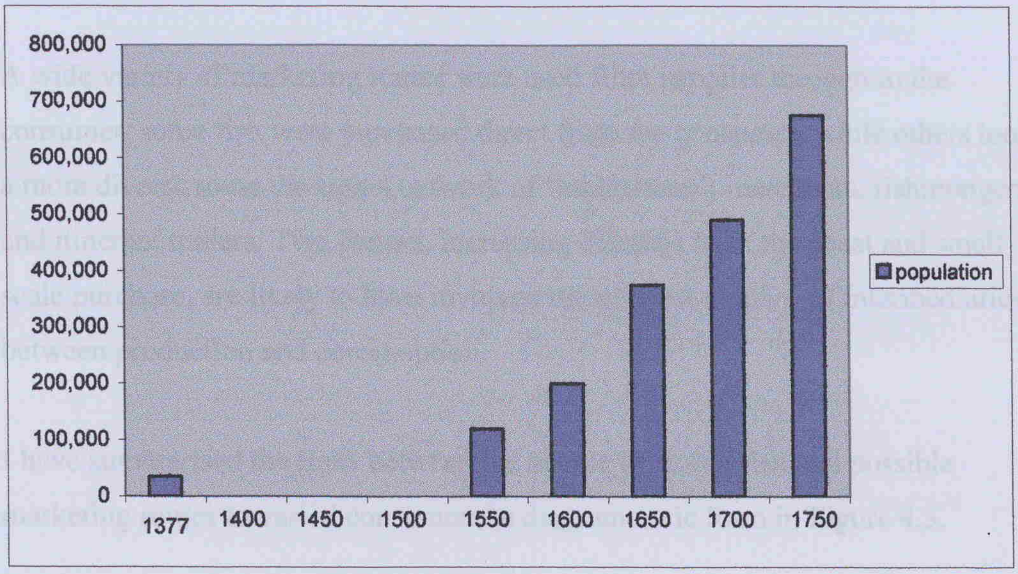
In 1500 only 3.1 % of the population was estimated to have been living in towns. By 1600 it was 5.8 %, in 1700 it had risen to 13.3 % and by 1800 had reached 20 %. Of this 'non rural' population, in 1600 5.6 % lived in London, with only 0.2 % in all other towns. Over the next century the balance began to be redressed with 11.4 % of the 13.3 % 'non rural' populus living in London, leaving an increased 2.1 % in other towns. After the mid 18th century this trend accelerated increasingly rapidly with the onset of industrialisation. In 1801 20 % of the population were town dwellers and by mid century this had risen to 50 % with particular growth in manufacturing towns, (Burnett, 1989, p.3).

Wage differences between town and country affected standards of living. Figures comparing craftsmen and labourers in London from 1590 to 1750 with the rest of Southern England showed wages to be at least 50 % higher in London during the whole of that period, peaking at 67 % greater for craftsmen and 74 % for labourers. The latter have the highest differential by 1750, with London labourers earning 24 d per day against 13.8 d in Southern England, (Chartres, 1986, p.171).

It is clear that both sets of workers in London would have been in a much better position than their counterparts in Southern England to improve their standard of living. Chartres cites this wage differential as part of the lure causing migration to

[3] No figures were available from 1400 – 1500.

Figure 4.2. The growth of London from the 14th to mid 18th centuries. (after Sharpe, 1987, p.85).



London. By 1850 the population had increased dramatically from 650,000 in 1750 to 1,000,000 by 1800 and 2,500,000 by 1850, (Rule, 1991, p.17).

Some prices were higher in London than in rural districts, but this was not always the case as Chartres (1986, p.173) has shown and these increases were always offset by the wage differential. Data for meat consumption in London in the 1690's suggests that beef consumption was 50 % higher and mutton 75 % higher than in the rest of the country, (Chartres, 1977, p.23). As these percentages also include meat destined for export, naval and military supplies the true demand by Londoners is inflated. However, these figures demonstrate increased consumerism with rapid growth in the capital from the mid 16th century. Growth in other towns was at a lesser rate, but with the onset of industrialisation the gulf between urban/town and rural living widened.

The changes in population and demography patterns (though of less consequence than the 19th century escalation) through the Medieval period and up to the mid 18th century would have created more demand for food supplies. In particular in the rise in population preceding the major outbreak of Plague and the later recovery and increase in the early 17th century. The latter, both nationally and in the capital, would have put extra pressure on existing marketing and transport and systems used for stored fish and other goods.

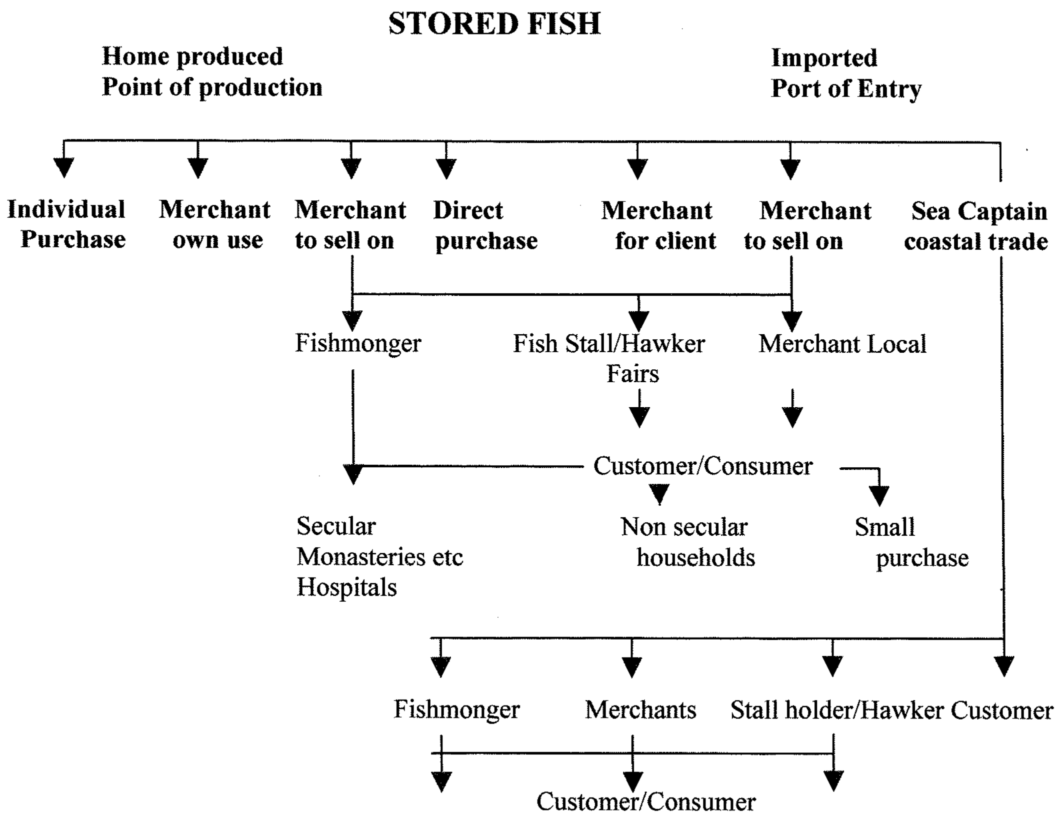
A wide variety of marketing routes were used from supplier through to the consumer, some fish were purchased direct from the consumer, while others took a more diverse route through a network of 'middlemen'; merchants, fishmongers and itinerant traders. Two factors, increasing distance from the coast and small scale purchase, are likely to have involved the greatest number of intermediaries between production and consumption.

I have summarised the links between the source of stored fish and possible marketing routes to varied consumers in diagrammatic form in Figure 4.3.

This is not intended to be an exhaustive list of pathways by which the fish were traded, but gives a generalised picture of some of the likely routes. The customers, merchants and fishmongers dealing in large quantities were often operating direct with the source of production, even when imported from abroad. Subsequent marketing took place through a network of smaller operators buying in and selling on fish in decreasing quantities appropriate to the size of their business.

All those involved had to transport their fish using systems essentially unchanged throughout the period. However as I will show great quantities of stored fish, among many other goods were transported all round the country.

Figure 4.3. The marketing routes of stored fish, from production to consumer.



Transport

The transportation of fish was by four methods: sea, river, carriage and packhorse. Willan (1976) has shown that in the 16th and 17th centuries water carriage was much cheaper than land, particularly for weighty, bulky and low value goods. Stored fish being both weighty and bulky, particularly if barreled, typified such commodities.

An estimate of relative cost by Sir Robert Southwell in 1675 (Willan, 1976, p.1) concluded that the difference in cost between sea and wheel carriage was 1:20 and between inland (river) water carriage and wheel carriage was 1:16. He also made a distinction between packhorse and wheel carriage, claiming that although the former was a third more expensive it was used for 60 % of all overland transport. No reason is cited, but packhorse may have been more useful for smaller loads and on poor trackways.

Whether these price differentials were the same in earlier centuries is difficult to judge but water transport, with the potential for carrying larger loads, was always likely to have been the cheapest. Burnett (1993, p.36) gives the cost of road carriage for goods in the 13th century ranging from 1 d per ton per mile up to 3½ d for a breakable cargo such as wine. Data on the relative costs of water transport up the River Severn against road transport in the West Midlands for wine in the early 14th and mid 15th centuries suggest water transport cost around one sixth of that by road, (Dyer, 1994b, p.262). The rates for transport for the mid 15th century carriage of 22 tuns of wine, using both river and cartage, from Bristol to Maxstoke Castle in Warwickshire added 14 % to the cost of the wine. Dyer (1994b, p.263) also cites fish and spices carried 75 miles overland from London to Wiltshire in January 1407 and fish brought 100 miles from London to Worcestershire in December 1409. He concluded that the documentary evidence suggests the higher costs of overland transport were not considered prohibitive to many wealthy customers for whom large quantities of goods were transported great distances by land cartage. The road systems were evidently adequate for long distance transportation.

Transport systems, the network of tracks, roads, rivers and sea and the watercraft and carriages used on them, remained virtually unchanged throughout the period. The next major innovation to improve the network was the building of canals, which did not begin until the early 18th century, followed by the railways in the 19th century, the latter impacting on the delivery of perishable food.

The extensive coastal shipping of stored fish, particularly barreled herring, reflects the economic movement of a bulky, heavy commodity awkward to move overland. Most journeys, by necessity, would have involved some overland transport but water was used where possible. Records of fish brought to Southampton Harbour survive for 1428 and 1430 and show the variety of stored fish including barreled herring from Suffolk, Devon, Dorset, The Isle of Wight, Newcastle, Dieppe and Etaples, (Studer, 1913). Hake[4] were shipped from Penzance, ling and 'mulwelle'[5] from Cornwall, Devon and the Netherlands and 'stockfish' from Yarmouth. The latter may have been imported to Yarmouth and shipped round the coast. The quantities of fish are in themselves not very significant beyond showing they were an important commodity and which types of stored fish were most numerous. Below I have summarised the data for these two years showing the number of fish where possible:

Table 4.1 Stored fish imported to Southampton in 1428 and 1430. (after Studer 1913)

	1428		1430	
Fish	*Quantity*	*No of fish*	*Quantity*	*No of fish*
Haddock	-	-	1 barrel	?
Hake	82 hundred	9,840	79 hundred	9,480
Herring	1539.5 barrels[6]	923,700	2590.5 barrels	1,554,300
Ling & Mulwelle	64.5 hundred	7,740	99.88 hundred	11,986
Stockfish	-	-	325.5 hundred	39,060
Mackerel	180 hundred	21,600	-	-
Salmon	19.5 barrels	?	12 butts	?
			1 barrel	?

Where there is no information for quantities of fish, such as haddock to a barrel, I have only given the load size. It is evident that herring were a major import in both years (there is no detail as to the type of stored herring) as were 'stockfish' in 1430.

Destinations for these fish included: Salisbury, Warminster, Winchester, Andover and Newbury, as recorded in the brokage books of Southampton, (Bunyard, 1941). The fish were all moved from Southampton docks inland by cart and packhorse.

In Sussex the surviving Cellarer's Rolls from Battle Abbey (Searle and Ross, 1967) show, that from the late 13th to the early 16th centuries, stored fish were

[4] Loose fish were counted in hundreds, very often a 'long hundred', i.e. 120.
[5] A type of salted cod or similar species also spelt 'milwelle' and 'milwelli'.
[6] 600 fish per barrel.

bought both locally and from London. 'Stockfish', 'saltfish', salted eels, herring and salmon were among the purchases and the monks' creditors included fishmongers and stockfishmongers. The fish were brought down the coast to Rye and then up the River Brede or by road to Battle. There are also records of fish bought at 'Feversham'[7] fair as well as locally from Rye, Hastings and Winchelsea. Wages were regularly paid to a man 'sent for fish' and indicate just how important fish (both stored and fresh) were in the monastic diet.

Marketing at ports and coastlines.

At the first point of marketing, the place of production, the quality of the stored fish should be easier to ascertain and the price most competitive having incurred no addition transport costs. This particularly applied to the Yarmouth herring, a centre for landing and processing, as well as other ports along the east coast. Although the East Anglian herring were considered to constitute a major domestic fishery there is evidence that it ranked poorly in size compared with other European herring fisheries. Cushing (1988, p.88) concludes that although profitable in the Middle Ages the quantities landed may not have been very great, possibly 5,000 tonnes in the 14th century. This may have been the maximum amount that could be landed at that time. Later figures show the Yarmouth landings to have been comparatively small and in some poor years herring were imported to Yarmouth to meet demand. Nevertheless Yarmouth symbolised the English herring industry and the port and its surrounds were important areas for processing with fresh fish also carried up river to Norwich to be stored.

Yarmouth attracted large numbers of merchants, who may also have been fishmongers, as well as direct orders from consumers for substantial volumes of fish. Yarmouth typifies the Home Produced/Point of Production shown at the top of Figure 4.3. In the 16th century coastal shipping accounted for a third of shipments made from Yarmouth as shown in the customs accounts. The fish were taken to London, Lynn[8] and Southampton, (Williams, 1988, p.169). The early

[7] Faversham?
[8] Later Kings Lynn, courtesy of Henry VIII.

15th century port books show imports of haddock and salmon from Yarmouth and the east coast ports (Studer, 1913) and in the late 14th century Yarmouth herring were regularly shipped to Exeter, (Kowaleski, 1995, p.310). An increase in local fisheries in the south west and decline of some eastern ports around this time meant that Exeter increasingly marketed fish caught locally. However, these records do illustrate the range of the home market for Yarmouth herring with a significant amount also exported.

Other fish, especially cod, were imported to the East Anglian ports. Records for the mid 16th century indicate that from the end of June ships returned from Bergen laden with salted cod and ling. From the end of July until mid August Icelandic cod arrived, as well as cod from Newfoundland, (Williams, 1988, p.166). Cod and ling were traded from the port at Lynn to London and in 1575/6 some 84,000 fish were sent round the coast and up the Thames. Half of these fish belonged to just three London fishmongers who must have been large investors in the stored fish trade. The importance of fishmongers in London trade and business is reflected in the initially separate gilds for fishmongers[9], stockfishmongers and saltfishmongers described by Stow in 1598 (1603, p.191). The latter two gilds were joined in 1536. Their power and success within London commerce is reflected in the number of fishmongers who became Lord Mayor. Stockfishmongers were found at major ports specifically to deal in 'stockfish' arriving from Norway as part of the trade with the Hanseatic League.

Documentary evidence from the port of London shows the great variety of stored fish being imported. In 1480-1 (Cobb, 1990) cites entries in the port books including: cod fish, cod's heads, dried haddock, ling, 'staplefish'[10] and 'stockfish'. Other stored fish included: barreled salmon, dried plaice (*Pleuronectes platessa*), sturgeon (*Acipenser* sp.), and many types of stored eels (probably *Anguilla anguilla*). These fish were brought from ports such as Hamburg, Ostend, Antwerp and Flushing.

[9] Selling fresh fish, though apparently not always exclusively.
[10] Fish (often cod) not completely cured, therefore not for long storage.

The port books for 1567/8 (Dietz, 1972), show a similar range of fish. From Amsterdam: ling, 'staplefish', coalfish[11] and barrels of cod's heads. Hamburg sent 'titling'[12] and 'croplings'[13] and Danzig was a source of sturgeon. Ling and 'staplefish' were sent from Haarlem and scotch salmon[14], cod's heads and ling from Flushing.

These imports, as well as showing the variety of fish by species, also show the variety of dried and salted cod, or similar large gadid species. 'Stockfish', 'titling' and 'cropling' were defined by their quality and size and are recorded in customs books at other ports including Bristol.

On the west coast of England Bristol was the major port and stored fish arrived there in great quantity. Surviving port books account from the 14th century show herring, hake, salmon, 'scalpin'[15], 'saltfish', 'milwelle' and 'dried fish' arriving in quantity. In the late 15th century a similar range of fish were recorded: 'saltfish', hake, 'scalpin', 'white herring', salmon, 'shorlings', 'gillfish'[16], 'titling', pollack, 'milwelle', sturgeon and pollack, (Carus Wilson, 1967). Most of the boats are entered as coming from Ireland, others Bayonne and Lisbon. However some boats may be falsely declared and illegally trading with Iceland at that time, their cargoes dominated by 'stockfish'.

Two boats entering Bristol in the late 15th century, with quite differing proportions of stored fish, illustrate the types of cargo coming from Ireland and those from Bergen or perhaps illicitly from Iceland. These are summarised below from Carus Wilson (1967).

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[11] Saithe.
[12] Small sized 'stockfish'.
[13] Inferior 'stockfish'.
[14] Whether this is scottish salmon traded twice or a processing method is unclear.
[15] Whiting.
[16] A kind of 'stockfish'.

Entering Bristol in August 1476, the 'Julian of Fowey', was listed as coming from Bergen, with 25 shippers owning the fish cargo. The different types of stored fish were; stockfish' = 55,920 fish, 'titling' = 18,720 fish, 'saltfish' = 1,200 fish. The numbers of fish were calculated from the long hundreds and lasts by which they were counted.

In contrast the 'George of Bristol' entered the port in September 1476 from Ireland, with 23 shippers and the emphasis very much on herring. The numbers of fish totaled: herring = 64,200 fish (107 barrels), 'saltfish' = 1,080, hake = 180, 'scalpin' = 240, salmon = 90 gallons (1 ½ pipes[17]), pollack = 930.

The cargo from Bergen was primarily 'stockfish', produced both in the Lofoten Islands and also Iceland, while the Irish cargo emphasises the importance of herring. Fish, particularly herring and salmon, were a major export from Ireland and considered their most important trading commodity in the 16th century, (Longfield, 1929, p.41). However, much more was exported to continental Europe than to England, though the south and south east Irish ports sent fish to English west country ports. Waterford shipped herrings to Gloucester, which was formerly an important regional port. Salted herrings were sent to Poole and 'whitefish'[18] to Exeter, Ilfracombe and Dartmouth. In the 16th century fish was the greatest import by volume at Chester, much of which was from Ireland. Estimated from customs' duties in 1525-6, 103 tons of herring and ½ ton of salmon were shipped there that year, (Kermode, 1996, p.290).

The position of Exeter to both sea and rivers supported a thriving fresh fish trade, for which the customs' duty at the end of the 14th century surpassed the total of all others, (Kowaleski, 1995, p.308). The city sought to control the fish trade and associated duties including designating where fish were to be sold and banning resale (known as forestalling) to other traders, common restrictions in many towns. Kowaleski suggests that much of the fish traded in and around Exeter was

[17] Number of fish per pipe unknown.
[18] A mixture of salted cod and other gadids.

fresh. Increased local catches resulted from the expansion of the late Medieval Devon and Cornwall fishing trade and the varied list of fish imported to Exeter included: herring, dried fish (probably cod and hake), 'mulwell', and 'stockfish'. Cod, hake, pollack, pilchard, ling and salmon are also listed and may also have been stored. Herring was imported from east coast ports, but increasingly replaced by locally caught fish, (Kolaleski, 1995, p.310).

The rise of the Newfoundland cod fishery, from which English fishermen produced a light salted and dried product, coincided with a decline in the Irish fisheries at the end of the 16th century. Cornish customs' accounts suggest an increase in direct imports of Newfoundland fish. However, the Bristol port records indicate a slower rate of change away from Irish fish. Any loss in trade for Ireland from fish exports was compensated by it's growing importance for intermediary traffic with the colonies, Irish ships bringing Newfoundland cod to English ports, (Longfield, 1929, p.57).

So far the discussion has centred on the distribution of stored fish around coastlines and the ports where it was prepared or imported. However, the real market for these products lay further inland where fresh marine fish was not always an affordable food. Limitations were imposed by the expense of transporting fresh marine fish quickly, reflected in the cost to the consumer.

During the Middle Ages most freshwater fish, particularly the larger fish, were a sign of status. Aristocrats and monasteries kept a ready supply through a complex system of fishpond maintenance and culture. Some of these utilised castle moats and other existing features, while others were purpose built and of considerable size as described for Yorkshire between the mid 11th to 14th centuries, (McDonnell, 1981). Wealthy town dwellers, without their own supplies, bought their fish through the market, sometimes supplied by excess fish sold from these ponds and by the tenants of leased river fisheries, (Dyer, 1994b, p.107). There is also documentary evidence that some freshwater fish, such as roach and dace from the Severn in the late 15th century and eels and lamperns[19] were sometimes as cheap as herring, (Dyer, 1994b, p.108). Together with catches from nettings in local rivers, these provided a source of fresh, if small fish, inland for poorer people. Consequently the availability of fresh marine or freshwater fish inland, to people of low status and income is likely to have been limited to their own local catches of cyprinids[20] and seasonal gluts of eels migrating to the sea.

Inland marketing of stored fish.

The distribution of stored fish was, as previously stated, via merchants, stock/salt and fishmongers who as well as supplying clients directly through their own premises also sold at fairs, markets. Small quantities of fish were sold by hawkers and itinerant traders who regularly visited small villages and the sum of their trade is likely to have been quite significant. The second and third tiers of tradesmen in Figure 4.3 represent these groups.

A substantial amount of trade was recorded through the brokage books, which listed goods and the duty paid as they passed through the town gate. Some survive for Southampton for the 15th and 16th centuries and show repeated journeys by the same carter to inland towns, (Bunyard, 1941, Stevens and Olding, 1985). Many of these were destined for Winchester to fishmongers, religious houses and private individuals. The records for all the stored fish deliveries to Winchester during three years spread in the 14th and early 15th centuries are summarised below to show the range and volume of fish delivered:

[19] Lampreys

[20] Often roach (*Rutilus rutilus*) and dace (*Leuciscus leuciscus*) judging from the archaeological bone evidence.

Table 4.2. Deliveries of stored fish from Southampton to Winchester: November 1439 – August 1440, October 1477 – September 1478 and October 1527 – July 1528

	1439-40		*1477-78*		*1527-2*	
	Quantity	*no of fish*	*Quantity*	*no*	*Quantity*	*no*
Red herring	84 cades	50,400			30 cades	18,000
White herr	45 barrels	27,000				
	1 kilderkin					
Herring			98 barrels	86,400	102 cades	61,200
			+ 4 cades		151 barrels	90,600
					3 lasts & 2 hogsheads	
Stockfish	1 ½ C	180	¼ C	15		
Saltfish	4 ¼ C	510	2 C	240		
	1 pipe		5 burdens			
Milwelle	1 C	120				
Cod					3 C	360
					1 barrel & 3 burdens	
Hake			8 C	960		
Haddock			8 barrels			
Salmon	3 barrels		4 barrels			
			6 butts			
Fysche					39 C	4,690
					65 burdens & 18 loads	

Barrels and cades of herring are estimated at 600 per unit and C is a long hundred, 120. The numbers for the different fish per butt, kilderkin, burden and pipe were not known or are variable

The entries for 1439-40 (Bunyard, 1941) show deliveries were made on 29 days. These were at regular intervals between November and the end of March, after which only two were made in April, then none until one at the end of August. Bunyard has suggested the break in deliveries reflect greater availability of fresh meat in the summer and autumn. It could also be the absence of major periods of fast such as Advent leading up to Christmas and most particularly Lent before Easter, leaving only the usual fast days each week. The stored herring supplies, mostly 'red', may also have run out by Easter and would not be renewed until after the next fishing season in late autumn. Various forms of salted and dried cod made up the remaining fish brought in that year, together with three barrels of salmon.

In 1477-78 (Stevens and Olding, 1985) about the same number of herring were brought to Winchester from Southampton as in the preceding year, but there is no evidence as to the quantities of 'red' or 'white', they are only referred to as herring. A few examples of 'stockfish' and 'saltfish' represent stored cod, with salted hake and, unusually, 8 barrels of haddock, these were probably wet salted. Barrels of salmon were few, with none in the 16^{th} century. Of deliveries on 39 days between October and September only one or two were made a month during the summer, fewer than before Easter. Significantly no herring were delivered after mid March suggesting supplies may have again run out.

A similar picture is seen in the early 16^{th} century data for 1527-28 (Stevens and Olding, 1985), with deliveries made on 58 days between October and July. Plenty of herring was brought before mid March and none afterwards. The entries for this year are not as precise in their description of the fish as in earlier years. Cod is not recorded as any particular type and is assumed to be salted, while there are a number of entries for 'fysche' which could be some salted and possibly dried large gadid species, of which a large quantity were delivered.

These three years of records, though only a tiny window on national fish deliveries from a single port to a town, do show a fairly unchanging supply and demand spanning almost a century. In all three cases there is a pattern with either no deliveries, or fewer with no herring made in the summer months. The steady increase in delivery days may reflect the growth of Winchester creating more demand. Later data, after the Reformation when religious fast days were now longer imposed, would add some valuable evidence regarding any change in demand and therefore consumption of stored fish.

The return journey from Southampton to Winchester is estimated to be 2-3 days for the round trip so did not preclude the delivery of fresh fish. Using recent estimates on the keeping qualities of fresh cod as a guide fish were inedible after 3 days stored at 16 degrees C, but keeping time increased as the temperature dropped, (Aitken et al, 1982). From these data it must be concluded that the marketing of fresh marine fish at this distance from the coast and further[21] during the summer months would tolerate no delays in transport and the fish would have to be consumed as soon as possible after purchase. During the cooler winter months keeping times were extended and the delivery and marketing of fresh fish was less urgent.

Fishmongers[22] operated a network of trade for their supplies and distribution from the coast inland. If evidence from Winchester reflects a more general trend across the country they rose in both prominence and numbers in the later Middle Ages. The importance of the London fishmongers in gilds and as merchants has already been referred to and in Winchester a 12th century survey recorded only one fishmonger, dealing mainly in herrings, compared to five butchers. By the early 14th century fishmongers were far more numerous and had risen in status, with three times as many fishmongers as butchers were recorded as property holders, (Keene, 1985, p.259). The fish were often supplied from Southampton (as suggested by the brokage books described above) and included many stored fish: salmon, 'mulwelle', ling, herring, conger eel (*Conger conger*)[23] and 'stockfish' were most frequently recorded. There was also considerable overland traffic from London, with Winchester acting as a redistribution centre for stored fish to other towns in the region.

In the 15th century the city authorities exerted some pressure on the Winchester fishmongers to restrict their profit to the acceptable level of a penny in the shilling. However, evidence from the court rolls shows this was often exceeded. There were also restrictions on hours of sale and the practice of local fishmongers buying fish from other traders and selling them on. These restrictions were intended to foster competition with traders from outside the city suppressing prices.

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[21] Southampton to Salisbury was a regular journey at 2-5 days for the round trip

[22] Of both stored and fresh fish.

[23] Both fresh and salted.

The efforts of the civil authorities to manage and curb the activities of the fishmongers reflects the latters' growing importance as a merchant class. If Winchester typifies other towns, fishmongers became increasingly prominent as merchants and property holders regionally and in the capital.

Objections to high profit levels were still being made in the 18th century. R. Campbell (1969) described the fishmonger in 'The London Tradesman' in 1747 as a 'Tradesman calculated for the Great and Wealthy: His Profits are without any Bounds, and bear no proportion to his Outlayings. His Knowledge consists of finding out the cheapest Market and selling at the greatest Price'. A further damning comment concluded 'the Properties of the Goods he deals in may be learned in less than seven Years without any notable Genius', (Minchinton, 1995, p.48). Campbell had a more sympathetic view of fishermen whom he described as in a 'laborious useful trade, perfectly well understood. It is only fit for robust Lads'.

The profit margins of fishmongers in regional inland towns would not have been reliant on the patronage of the local aristocracy. Certainly payments to fishmongers by the royal household in Winchester in the early 14th century were larger than to any other merchants, but other evidence suggests that the aristocracy or 'magnate consumers', as coined by Dyer (1994b, p260), ordered their stored fish from London and direct from the ports. Many also owned houses in London and while there could place orders for fish to be delivered to their country estates. The accounts of the Bishop of Salisbury for 1406/7, who lived at Woodford and Potterne, show that with other goods he bought stored fish from London and the ports of Southampton and Bristol, (Dyer, 1994b, p.260). In that year within his overall expenditure only 20 % was spent locally.

Another source of competition were the local fairs, some of which were major events like Stourbridge near Cambridge, St Ives in Cornwall and St Giles in Winchester. Substantial amounts of stored fish must have been for sale at the larger fairs and in 1466/7 Kings College, Cambridge bought most of their fish at

Stourbridge Fair, which was supplied by traders and merchants from Lynn, (Dyer, 1994b, p.260). However, after the 13th century Dyer (1994b, p.279) detected a change from trading at fairs to within towns and the increasingly important role of London in 'magnate' spending, adversely affecting provincial merchants.

At the lowest end of the consumer scale the poorest customers including poor villagers, landless peasants and transients would have bought stored fish in small quantities if at all. A few herrings and 'saltfish could be bought from a variety of sources. There were permanent traders of mixed goods and weekly market stall holders, where the individual transactions were on a much smaller scale than the great fairs. Travelling hawkers, whose wares had also passed through a number of traders and thrived on a quick turnover of goods, were another option. Stored fish would have been more viable in rural areas as the perishable nature of fresh fish made it a risky commodity. A more recent example from the 1870s is cited in 'Lark Rise to Candleford' (Thompson, 1978, p.119) where a trader brings a box of 'bloaters' [24] to the Oxfordshire village. Few could ever afford the 1 d per fish, which was regarded as a treat, a single fish (preferably with roe) was enjoyed by the wife and all the children. He did also sell fresh fish, as John Dory (*Zeus faber)* is mentioned, but for this village even 'bloaters' were a luxury.

Returning to the pre industrial period, Dyer (1994a, p.157) has described sea fish inland as 'items of long distance trade' and as such stored fish would have been favoured over fresh. However many people, prior to improvements in living standards following the Plague, relied mainly on a vegetarian diet and abstention from meat on a fast day was largely irrelevant. On the occasions where meat was eaten poor quality bacon was the flesh of the poor and herring the stored fish equivalent. For the rural poor, living far enough inland to preclude swift delivery of fresh sea fish, herring may have been the only marine fish they ever tasted.

[24] Mild cured herring developed in the 19th century.

Consumers of stored fish at the coast.

Proximity to the coast effectively removed problems of swift transport and attendant costs restricting the marketing of fresh marine fish. Close to the coast seasonal landings of a variety of marine fish provided a year round supply. Kowaleski's (1995) study of markets and regional trade in Medieval Exeter is a good case in point and shows the wide variety of fish available to the town at competitive prices. Much of the fish was fresh[25] and included: cod, conger eel, common eel, 'dried fish,' hake, herring, lamprey, ling, mackerel, whiting, 'mulwell', pike, pilchard, pollack, ray, salmon, 'stockfish' and sturgeon. The clearly stored fish are shown in inverted commas, while others may well have included stored fish. The greatest imports were of herring and hake, cod and conger eel (Kowaleski, 1995, p.310) and fish were clearly an important dietary element locally.

However, the range of fresh fish eaten is sometimes more easily ascertained from bone assemblages than documentary records. In the latter fresh fish are often only described as 'fish', whereas great detail is given as to the type of stored fish. Fish bone assemblages from consumption deposits near the coast often show, apart from the usual number of herring, gadid and flatfish bones, many other marine species occurring regularly in many contexts but in small numbers. Gurnards (Triglidae), sea breams (Sparidae) and mackerel are among those commonly present if not numerous. Some assemblages show the influence of regional distributions such as conger eel, pilchard, hake and sea breams, these are all typify the range of fish found in the seas off the south west.

For the landed 'upper classes', which includes monasteries, freshwater fish were an important part of fish consumption and reflected their status. Many monasteries had managed pond systems and stretches of water for pike and cyprinids, but although large freshwater fish were symbolic of status marine fish usually comprised the bulk of their consumption. There is both documentary

[25] In 1383 78 % the Earl of Devon's expenditure on fish, bought in Exeter and mostly marine, was for fresh fish for his estate at Tiverton, 20 miles from the sea (Kowaleski, 1995, p.314)

(Searle and Ross, 1967) and bone evidence (Locker, 1985) for the fish eaten at Battle Abbey, a Benedictine monastery just 6 miles from the coast, near Hastings. The abbey was 10 miles east of the ports at Rye and Winchelsea, which could be reached by river and road and 12 miles of the port at Pevensey. At 'fleet time' the abbey bought fish from all these ports, (Searle and Ross, 1967, p.22). Fish were eaten both in the main fast periods such as Lent and on four days a week designated for fish or eggs. All the fish bought during the year are recorded in the cellarer's accounts and the greatest detail is for stored fish. Through the 13th, 14th and 15th centuries purchases of stored fish, particularly herring, cod[26], mackerel and salmon[27], show many sources were used, both local and more distant, including London where the cellarer held accounts with merchants, stockfishmongers and fishmongers. However, it is not possible to tell from these accounts whether the amount of fish bought increased during Lent, since the accounts are annual totals. The bone assemblage, though a sample restricted by context type and retrieval methods, does suggest some of the fresh fish eaten and not itemised in the accounts. These include: roker, conger eel, tub gurnard (*Trigla lucerna*), turbot (*Scophthalmus maximus*), plaice and flounder, (Locker, 1985, p.185).

Another Benedictine abbey at Selby, Yorkshire, has surviving kitchener's accounts for 1416-17. The abbey, though not directly coastal, was close to the River Ouse and 12 miles from the Humber estuary where both the Ouse and the Trent flow out to sea. The document shows both 'red' and 'white' herring were bought from a fishmonger in York some 12 miles away. A variety of salted fish including 'lobs', 'ling' and 'keeling' were bought from merchants as far away as Scarborough [28], dried fish were bought from Hull[29] and also from York, (Tillotson, 1988, p.161). Related expenses included vats for soaking dried fish and the transport costs for bringing fish to the abbey by river, (Tillotson, 1988, p.161-8). The records indicate that the abbot, convent and visitors ate stored fish.

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[26] 'referred to as 'mulwelle', 'stockfish', 'lyngis' and 'saltfish'.
[27] Salmon only feature in the early accounts.
[28] 50 miles away.
[29] 30 miles away.

Evidently herring were not considered too lowly for the high table and may have been a sign of this abbot's piety. It is difficult to judge comparative fish prices, but the rolls show some dried fish were 3 d each, salted were more expensive, but varied (perhaps based on size and quality) between 7 – 16 d each. Herrings were purchased in large quantities, around 120 'whites' or 85-120 'reds' could be bought for a shilling. The price must have varied depending on the quantity and transported distance of the fish.

The 15th century expense accounts for a priest's chantry in Bridport, Dorset (Wood-Legh, 1956) show fish in the accounts every week and completely replacing meat in Lent. At only a mile from the sea fresh fish were easily available and mackerel is mentioned, but often the only reference is to 'fish'. Stored fish are mentioned specifically as 'ling', hake, 'mulwelle'[30] and 'scalpin'[31]. The status of the chantry was considered by Wood-Legh to be equivalent to a prosperous burgess so fish prices were not an issue and stored fish were evidently considered an essential element in kitchen stores.

The records for the abbeys at Battle and Selby and the Bridport chantry reflect the consumption patterns of large and small households with sufficient funds to buy fresh fish in season and stored supplies for future use. The abbeys were account holders with distant and local merchants. Their choice of fish utilised a wider market than that offered by the immediate coastline. The relationship between increasing wealth and use of the wider market has been demonstrated by Dyer (1994b, p.259) and is valid whether the consumer lives at the coast or inland.

Consumers of fish in London enjoyed proximity to a supply of locally caught freshwater fish beyond the tidal reaches of the Thames, seasonal fisheries of the Thames estuary and marine fish from the North Sea. The large variety of imported fish has already been described earlier in this chapter and added to the

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[30] Salt cod.
[31] Whiting

great variety of fish available. The main fish market at Billingsgate was not declared a 'free and open market' until 1699 (Drummond and Wilbrahim, 1994, p.191), but fish were sold in the vicinity long before this date. Billingsgate was the main wharf for fish in the 14th century and was included in the sanction of a royal charter as a covered market in 1674, (Hope, 1900, p.15, p.66). In the 18th century there were also 14 other markets in London with a section for fish as well as fixed sites in the city where fish could be sold, (Minchinton, 1995, p.44). Despite the abolition of religious fish days after the Reformation and the subsequent failure of reintroduced fish days[32] the London fish markets thrived at all levels fuelled by the escalating increase in population.

The religious constraints on meat eating in the Pre Reformation period generated a strong demand for fish in London, both from the numerous religious houses and wealthy secular households supplying both their town and country houses. There was a strong representation of stored fish as well as fresh marine fish as shown in the surviving kitchener's accounts for Westminster Abbey, a wealthy Benedictine house. The accounts span the late 15th and early 16th centuries and suggest that fish was served for dinner on approximately 215 days of the year, of which about 50 % were from stored fish, (Harvey, 1996, p.47). Mainly marine fish were eaten, with comparatively few freshwater species. The stored fish were primarily cod and allied species of various types [33] and herring. Fresh fish included cod, eel[34], mackerel, whiting, plaice and freshwater species such as pike and a variety of cyprinids.

The two fish bone assemblages from excavations at the Abbey predate these accounts. The earliest, from a 10th – 11th century ditch, show herring and the gadids to be 44 % of the whole assemblage by bone number, with a variety of other marine species including: rays, garfish (*Belone belone*), gurnard, bass (*Dicentrarchus labrax*), mackerel and flatfishes. Migratory species from the Thames included sturgeon, eel, salmon, smelt (*Osmerus eperlanus*) and mullet

[32] Also known as 'Political lent', to increase fish consumption and boost British fishing.
[33] 'Green fish', 'haburden', 'ling' and 'stockfish'.
[34] Some eel and whiting may have been salted.

(Mugilidae). Freshwater species were pike (*Esox lucius*) and several cyprinid species, (Locker, 1989). The smaller, late 12th – early 13th century, assemblage (Jones, 1976, p.171) from the sub vault of the misericorde included a similar range of species and confirms the monks' consumed a wide range of fish, but dominated by relatively few species by volume. The data from Westminster Abbey are further explored in chapters 7 on methodology and chapter 10 on the data sample.

There are few documentary records attesting to the variety of fish eaten by lower income groups other than as charitable alms or boon payments. If the alms comprised the leftover food from monastic refectory kitchens, then the observance of fast days determined what those alms might be and during observances fish would predominate over meat, (Harvey, 1996, p.12).

Boon meals included those served to harvesters in part payment for their services. The case of the Sedgeford harvest workers in Norfolk, just three miles from the coast near Hunstanton has been described by Dyer, (1994b, p.82). The values of bread, pottage, corn, ale, meat, fish and dairy produce have been compared by percentage and show that from 1256 until 1341, by value, less meat was consumed than fish. By 1353 the positions were reversed, meat surpasses fish culminating in 1424 with meat at 28 % and fish at 6 %, the greatest divergence. The change in the 15th century, which saw a large increase in the overall percentage of meat from 2 % to 23 %, was part of a trend in which the consumption of bread decreased in volume, but increased in quality. Fish and dairy produce decreased while ale and meat increased. Dyer (1994b, p.86) has suggested that stored cod and herrings became unpopular on the evidence of diminishing quantities issued in the late 14th century. Fresh marine fish were first recorded in Sedgeford in the early 15th century. In such close proximity to the coast the earlier absence of fresh fish is surprising, but together with the change towards meat and ale, as well as indicating a change in eating habits, may reflect the greater value of labour after the depopulation of the Plague. However, the harvest workers' meals are likely to represent the best of their diet and as such cannot be said to typify daily consumption within that socioeconomic group. The food was provided for them and not controlled by their own trade and purpose. The changes in diet shown for these harvest workers and borne out by other manorial accounts (Dyer, 1994b, p.93), reflect an improvement in diet enjoyed by the landed classes and skilled tradesmen filtering down to indentured labour. For poorer people living close by the coast fresh marine fish were a bonus to the largely vegetarian diet only alleviated by occasional cheese, bacon and stored herring for inland rural communities. Species classed as 'offal'[35] were cheap to buy and together with fish caught or trapped locally from the shoreline would have supplemented and added variety to the diet.

In London gluts in fish landings, offal species and the fast deterioration of fresh fish made them increasingly affordable at all class levels, a fast turnover being essential. The cheapest fresh fish were bought from hawkers who sold as much fresh fish each day as they could carry. The peak of these fish sales in London was later than the period under discussion. In 1850, with the rise in population and industrialisation of the capital 50 % of the fish at Billingsgate were bought and sold by costermongers[36] specialising in 'wet' fish. They sold 70 % of the 252,000,000,lbs of herring brought there in 1848 (Sterne, 1971, p.63). These were sold cheaply with a large turnover each day. This availability of fresh fish would have helped render the keeping qualities of hard cured fish irrelevant to urban living.

Consumers of stored fish inland.

Inland the consumer had to bear the costs of transporting goods from the coast and stored fish were no exception. Hoffman (1995, p.65) cites documentary evidence for fresh marine fish delivered to Paris in the mid 13th century by a series of relays and coaches. From this evidence he postulates that from this time fresh fish could be transported inland for sale a distance of 150 kms. Such a distance would include all of England as a potential market for fresh marine fish.

[35] What constitutes an 'offal' species varied with at different periods.
[36] Sellers of many wares, including fruit and fish from a barrow. Some did a set round while others remained stationary. Mayhew (1985, p.9) describes them in detail.

However, transport costs and any uncertainty regarding immediate sale and consumption places restrictions on the feasibility of such marketing.

Crossley-Holland (2000, p.85) has described the stringent regulations regarding the transport and condition of fresh fish brought in this manner to Paris in the 14th century. The fish must be sold within one day of being caught between Easter and October and two days after that. On arrival at Les Halles for sale the fish were checked for size, content and condition by inspectors. The attention to the standard of fresh fish delivered suggests that they were a luxury food in Paris at that time.

Demand in a large wealthy market such as Paris was assured and although Hoffman has shown the marketable area as a 150 km girdle round the European coastline the economic reality is more likely to be more specific targets, rather than a general zone inland. These would effectively be major towns, or fish delivered to a specific order and more easily delivered in the cooler winter months. Such a perishable product was risky for speculative marketing in inland rural areas. As late as 1763 Smollett (1981, p.23) remarked that fish, caught in the summer off the coast at Boulogne, were often spoiled by the time they reached Paris 'which is not to be wondered at.......near one hundred and fifty miles'. A similar scheme, set up in 1762, to supply London with fish by land carriage direct from the seaports was financially unsuccessful, (Smollett, 1981, p.365). Five centuries later than Hoffman envisaged for wide scale delivery of fresh fish at a distance of 150 kms the inland delivery of fish, in the heat of the summer at a similar distance, was by no means assured. This highlights the lack of development in transport over this period.

Inland, fresh marine fish would have had more status and value than stored, but apart from certain species such as halibut for whom increasing size compromised taste (Grigson, 1993, p.171), still vied with freshwater fish raised in complex pond systems. These were largely for the aristocracy and moneyed classes and commanded high prices. Only 2 % of the population of Medieval England constituted Dyer's 'magnate class' (1994b, p.102) composed of royalty, higher nobility, knights, bishops and some monasteries with incomes in ranging from five to ten thousand pounds a year. Spending on food, particularly fish and meat, was generous with allowances of 1 –2 lbs per person per day, the quality being scaled according to position within the household. Outside these privileged establishments the aspiring middle classes might mimic some aspects of the aristocratic table. However, with decreasing income was increased familiarity with a monotonous diet, high in carbohydrates.

Accounts from households situated inland show spending on freshwater and marine fresh fish, but always include regular supplies of stored fish. I have already referred to the brokage books from Southampton for 1439-40 (Bunyard, 1941), 1477-78 and 1527-28 (Stevens and Olding, 1985) which show the destinations and customers of stored fish transported over Hampshire, Wiltshire and Berkshire. Some of these were to monastic houses and many to secular customers and Bond (1988, p.76) has suggested the relatively few records of consignments to monastic houses implies they preferred to use local markets.

Inland the poor of both town and particularly country are unlikely to have eaten much marine fish except, under similar manorial boon payments as the Sedgeford harvesters referred to above, or in receipt of charity where they became familiar with herrings. Daily meals were served at the 'Hundred Mens Hall' at St Cross in Winchester where a herring and two pilchards[37] were part of the fare for 100 poor men and 13 poor scholars together with coarse bread, weak beer and pottage recorded in 1373 by Bishop Wykeham, (Hopewell, 1995, p.47). The fish could be replaced by two eggs or cheese and other references to the food provided in charity by St Cross included meat or fish, the latter referred to as 'saltfish', (Hopewell, 1995, p.3). Leftovers may have been taken away to feed the recipients families, so St Cross could have been indirectly feeding a significant proportion of Winchester's poor.

[37] One of the few references to this species outside of the southwest.

In the early 16th century the stewards at St Cross recorded 'white' herrings in the entries for the brethren. However, in the new customary for 1694 some 8 s were paid in Lent to every brother in lieu of meat and 9 d to the poor in lieu of herrings formerly allowed them in Lent, (Hopewell, 1995, p.94). The herrings and other stored fish evident in former Lenten fasts were no longer provided at St Cross and may be representative of changing practices at religious houses and charities of the Late Medieval/Post Medieval period. The menu for Palm Sunday for the brothers did include 'greenfish'[38] to the value of 3 s 4 d for each brother, an expensive fish compared to herring. The steward recorded all food whether for the brothers or the poor, so his entries should be a true reflection of changing trends in fish consumption at St Cross.

Without recourse to household accounts the role of stored fish compared with fresh marine and freshwater fish inland must remain fairly speculative. Dyer's (1994b, p.283) discussion of the many small centres of commerce and trade in operation by the late 13th century is based on evidence from the West Midlands. A hierarchy of markets served both peasants[39] and the aristocracy, these were held on successive days in a district, culminating in a main central one, (Dyer, 1994b, p.289). Fishmongers would have sold at these markets and are also recorded among the food traders of the smallest towns, (Dyer, 1994b, p.289). Such evidence suggests a network of fishmongers selling fish, both stored and fresh, across the country from both fixed and temporary bases.

Despite evidence of the wide availability of stored fish, the documented sources for fish consumption among low status rural groups are limited. Similarly there is little evidence from bone assemblages as at these sites retrieval is generally low, unlike that for mammal and bird bones. This negative evidence suggests comparative little fish was eaten by the poor outside towns. One of the sites in the data sample, the High Street, Huntingdon (Locker, 1996c), is representative of a low status site in a small town, 12th to 14th century in date. Here the fish

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[38] Lightly salted fish, often cod.

[39] Shown by Dyer to have regularly purchased food, clothes and tools in contrast to the former image of their self sufficiency.

assemblage, may come from close to a small market, is very restricted and largely herring and eel. Some small cyprinid species were also identified, but there were few marine species represented by bone number or volume.

The increasing amounts of meat eaten by peasants in the 15th century [40] has already been referred to (Dyer, 1994b,p.87) as part of a change away from carbohydrates towards more meat and ale already experienced by the wealthier classes. As a result the proportions of fish to meat in boon meals changed for the Sedgeford harvesters, favouring meat. This may be evidence of a more general decline in fish consumption, also supported by the replacement of stored fish supplied in the early 16th century for the brethern of St Cross and the poor they fed, by a monetary value in the 17th century.

This change away from stored fish was resisted longest by the armed forces and in particular the navy. The latter constituted the largest single purchasers of stored fish once standard rations were in place. It is on this group that the discussion now focuses.

The armed forces as purchasers and consumers of stored fish.

Once rations became standardised the forces were both the single largest purchasers and consumers of stored fish, and therefore a major customer in the stored fish trade. At first this would have had only a sporadic impact on the food market since forces on land and at sea were not permanently enlisted men, but brought together in response to a specific incident. At this stage victualling was not the ration based food supply it was to become. The monarch could commandeer boats and men as well as taking priority in the market for supplies at preferential prices. Stored fish became an essential part of that supply, particularly herring, 'saltfish' and 'stockfish'[41] which remained in standard rations for the navy until the beginning of the 18th century. Evidence for army

[40] Made possible by labour shortages increasing wages.
[41] 'Stockfish' were preferred by the navy being light in weight with a long storage life.

rations only extends up until the end of the 16th century after which soldiers were often billeted and rations were no longer regular issue[42].

The earliest records for victualling shows supplies bought as total amounts. The accounts for supplies for an expedition by sea by Henry III in 1243 included 112 s 8 ½ d for 1,057 'milwelli'[43], (Hattendorf et al, 1993, p.36).

The standardisation of rations was in place by the early 14th century. On land English troops were famously victualled and defended by barreled herring in 1429. Some 500 wagons of army supplies were arranged in a defensive ring at Rouvray in the 'Battle of the Herrings', (Cushing, 1988, p.81).

English garrisons in Scotland were well stocked, with rations supplying around 5,000 calories a man per day. Bread, pottage and ale featured strongly, with 18 oz of herring or 8 oz of 'stockfish'[44] on fish days and the equivalent in beef or pork on meat days, (Prestwich, 1967, p.537). The Tudor soldier's diet was similarly generous in calories, but equally monotonous and nutritionally unbalanced, with 7-8 herrings and ¼ of a cod or ling on fish days, 2 lbs of beef or mutton on meat days. The value of this ration was about 5 d per day, the same as allotted for the navy, (Burnett, 1993, p.125).

For the army the limited evidence suggests that stored fish were removed from the ration comparatively early. By 1660-80 the British army ration at Tangier was a piece of beef, a piece of pork, 7 lbs of bread, a quart of pease, a pint of oatmeal, butter and cheese per man each week. A man in the field in 1670 had 2lbs of bread, 1 lb of meat or its equal in cheese, one pottle of wine or two of beer daily, (Drummond and Wilbrahim, 1994, p.103). Fish has evidently disappeared from the ration and through the records of the Peninsular wars there is no record of fish, nor in the Crimea in the 1850's where minimal rations of pork and salt biscuit were issued, (Caldwell and Copper, 1994). Fish are also absent as rations

[42] Pers comm Major R Cassidy, Royal Greenjackets Museum, Winchester.
[43] Dry and salted cod.
[44] Dry weight?

in the soldiers' field book for the late 19th century apart from those for the Chinese Coolie Corps, (Wolseley, 1886).

Fish remained in standard naval rations until the early 18th century, after which they were kept as part of alternative rations in hot climates at the captain's discretion. 'Stockfish' being dehydrated, whether the authentic air dried cod or a combination of salting and drying, would have been much lighter to carry at sea than barreled meat and herring. With three fish days a week, well established from a long tradition of religious fast days, it was possible to retain fish in the ration relatively late despite the sailors' fondness for meat. The conservative nature of seamen, particularly regarding any changes to their rations, was commented on by a number of contemporary victuallers in charge of ensuring the purchase and distribution of supplies. The combination of biscuit, beer, fish or meat, butter and cheese remained the same essentially unchanged allowance in 1570 and 1700/1 as shown below for a fish day:

Table 4.3. Naval rations for fish days in 1570 (Hattendorf et al, 1993) and 1700/1 (Merriman, 1961).

Fish day ration 1570	**Fish day ration 1700/1**
16 oz biscuit (496 g) or 20oz wheaten loaf (620 g)	1 lb biscuit (496 g)
1 gallon beer	1 gallon beer
¼ stockfish or 4 herrings	1/8 cod or 1/6 haberdine or 1 lb Poor John[45]
¼ lb butter (124 g) or ½ lb cheese (248 g)	4 oz Suffolk cheese (124 g) or 2/3 Cheshire cheese

In the 1700/1 ration herring have disappeared and the amounts of cod and 'haberdine' seem smaller than those for 'stockfish'. This may be a genuine reduction or the difference in the sizes of different fish.

Remains of 'stockfish' from the Tudor period were found with the wreck of the 'Mary Rose', which sank in 1545. At least 100 fish were present, the heads had been removed as well as part of the vertebral column in the traditional method for preparing these fish for storage, (Hamilton Dyer, 1995). The size of the cod was

[45] 1/8 cod = 24 inch N. Sea cod, 1/6 haberdine = 22 inch dried salted cod, Poor John = salted hake

within the 24 inch range, the same as that for North Sea cod cited in the rations for 1700/1 and a number of other documentary sources. At the equivalent of 60 cms total length they are within the lower end of the size range for Norwegian 'stockfish' given by Perdikaris (1996, p.29).

The quality of the supplies was a long term problem for the navy who, in an effort to standardise quality and supply, appointed their own 'General Surveyor of the Victuals for the Sea' in 1560. They also established their own victualling yards, including Chatham near Portsmouth and Tower Hill[46] in London where meat, beer, bread and biscuit were prepared. Other supplies, including stored fish, were still purchased from outside suppliers and, through inefficiency and fraud, were often discovered to be of poor quality and rotten by the time they came to be used. A typical complaint was voiced by Holland (1896) in 1659 whom claimed many seamen were debilitated by the 'stench of decayed, unwholesome and ill-cured beef, pork and fish' and disputed whether the Dutch or the provisions had been responsible for more deaths of British seamen in recent wars. He claimed 'not one ship in 20 has three quarters of the State's allowance for fish, either in quantity or goodness'. Fish were not properly sized and some were very small. He also asserted that in long voyages most of the fish were wasted and flung overboard. The pursers aboard ship were receiving less than half the fish they expected and made up the shortfall by a monetary allowance to the men, (Holland, 1896, p.180).

In reply the suppliers claimed they had supplied good quality fish, but poor storage conditions aboard ship had caused the fish to deteriorate. In some cases these claims might well have been justified. Damp conditions would partially re-hydrate 'stockfish' causing bacteria to form. However suppliers were known to deceive inspectors by placing the best quality supplies in prominent view, with inferior fish placed hidden at the bottom where they were unlikely to be examined.

[46] Originally a monastery called St Mary Graces and part of the data sample.

It has been suggested that in the 16th century the sailor's standard of living fell in comparison to the 14th and 15th centuries, when pay was relatively high and voyages mainly coastal. Fresh food was taken on board at ports and fishing carried out whenever the opportunity arose. Under those circumstances the victuals were not so crucial as during the 16th century when wages remained the same but prices had risen. Impressment[47] forced men to sign up for long voyages and with fewer stops in port substandard rations had serious implications for seamen's health. There were many outbreaks of disease most famously scurvy, for which the treatments and seamen's resistance to proscribed preventative measures is well documented.

It is under these conditions that the long held place of stored fish in seamen's rations finally dwindled. The instability of certain foods on long voyages was recognised and alternatives were introduced. Oatmeal could be substituted for sized fish[48] at the discretion of the Navy Board. Boats in the tropics could include 4 lbs of Milan rice or 2 'stockfish' instead of sized fish. The changes heralded the end of three fish days a week for sailors and may also have been influenced by the high price of 'stockfish' in the late 17th century referred to in a Contemporary Admiralty note, (Baugh, 1965, p.387) and may also account for the absence of 'stockfish' in the 1700/1 ration in Table 4.3. By 1734 2 lbs of beef was issued on 2 days a week, 1 lb of pork on 2 days a week and for each of the remaining three days: 1 pint of oatmeal, 2 oz of butter and 4 oz of cheese. Beer and biscuit was issued daily, with peas on 4 days a week, (Gradish, 1980, p.141).

The figures for 1749-1757 showing the proportion of each provision that had been condemned would have removed any lingering doubts about removing fish from the ration. Of bread, beef, pork, flour, suet, raisins and 'stockfish' the latter showed the greatest proportion of wastage. 'Stockfish' was already reduced to very small quantities compared to beef and pork as shown below in Table 4.4.

[47] Enforced enlistment.
[48] Salted and dried cod.

Table 4.4. Condemned naval rations 1749-1757.

'Stockfish'	166,943 lbs supplied	7.9 % condemned
Beef	4,498,486 lbs supplied	0.06 % condemned
Pork	6,734,261 lbs supplied	0.03 % condemned

The pickled beef and pork was judged on the basis of a 2 year storage life, (Rodger, 1986, p.83). Despite difficulties with supplying the right kind of cheese to last the proscribed 6 months storage, 'stockfish' was the only provision to have more than 1 % of the total condemned. Figures like these ensured the removal of fish from the ration. Herring seems to have been replaced by 'stockfish' as the fish ration early on, perhaps on account of their greater barreled weight.

Other nations retained 'stockfish' in rations at sea to a much later date. The comparative figures shown below (Morineau, 1970) show the proportions of the main provisions in grams for English mariners in the 16th century and also in the 18th century (the latter from Rodger, 1988, p.83), compared with Dutch, Russian and Swedish in the 18th century[49]. The ration allowances for Spanish soldiers and sailors in the mid 16th century given by Hamilton (1929, p. 434)[50] have also been included and show the highest allowance of bread and fish, while the beef allowance almost matches that of the contemporary English ration for bacon.

Table 4.5. A comparison of mariners' provisions.

	English (1570)	**English (C18th)**	**Dutch (Early C18th)**	**Russian (1725)**	**Swedish (1759)**	**Spanish (1560)**
Biscuit/Bread	420 g	453 g	320 g	529 g	305 g	680 g
Peas	200 g	-	160 g	117 g	300 g	107 g
Bacon	240 g	-	-	-	-	-
Ham	-	-	70 g	-	-	-
Beef	-	906 g	140 g	-	184 g	226 g
Pork	-	453 g	-	117 g	-	-
'Stockfish'	66 g	-	160 g	46 g	121 g	-
Salt cod	-	-	-	-	-	226 g

[49] Meat and fish rations being served on different days
[50] The data from both Rodger and Hamilton have been converted into g for comparison.

The early English ration shows the lowest proportion of fish, apart from the Russian ration (which is lowest in all proteins) but with the second highest amount of bread. Salt cod was an important element in the Spanish ration as was 'stockfish' in both the Dutch and Swedish ration in the 18th century. 'Stockfish' will be under represented by weight compared to salt fish as it was almost totally dehydrated. The Dutch were making long sailing voyages in tropical climates in the 18th century and as a nation with a greater cultural heritage of fish eating than England the quality and quantity of their 'stockfish' may have been higher, thus ensuring it remained part of provisioning. English rations in the 18th century emphasise the important contribution of meat, way in excess of that of other foodstuffs, (Rodger, 1988, p.83). Beef allowances were particularly large being issued twice a week at double those of pork, also issued on two days. Comparatively small amounts of cheese (113 g) were the ration on the remaining four days and perhaps the excessive meat allowance enhanced the lean cheese days. A basic allowance of 8lbs, or 3,629 g, per week underlines the English reputation as meat eaters.

Summary

In this chapter I have sought, through a discussion of population change as a background to changing market demand for stored fish and documentary data of trade and purchase at various levels, the effects of location and status on stored fish consumption. For the landed classes, religious houses, gentry and successful trades people of the Middle Ages stored fish were bought from a variety of sources regardless of whether that lived at the coast, inland, in town or in the country. The evidence suggests that as the later Middle Ages progressed (from the late 14th century) the consumption of meat was rising at the expense of fish. The evidence of food provided for harvest workers and as religious donations show this change also filtering down the social scale. Increased wages resulting from labour shortages after the Plague would also have increased the personal spending power of labouring classes.

For the poorest consumers location did affect fish consumption. Near the coast fresh marine fish were cheaply available, as well as stored fish produced locally or shipped to a local port, reducing additional transport costs. Inland, in rural areas, herring might be the equivalent to occasional bacon to the poor man. Barreled salted herring were sold comparatively cheaply in small towns and villages.

A separate discussion of stored fish consumption has been made for the forces, particularly the navy, whose rations, if not always of the highest quality, fed the men better than most of their peers. In the 16th and 17th centuries the inflation of which the sailors complained also affected the pay and living conditions of other workers (Burnett, 1993, p. 127), when labour shortages following the Plague and resulting higher wages no longer prevailed.

CHAPTER 5. Conclusions to Part 1.

The historical evidence presented in the preceding chapters shows the enterprise involved in the fishing, processing, marketing and consumption of stored fish from the 10th century until the mid 18th century. The stored fish 'industry', if it can be said to justify such a term, was based on home produced stored fish, particularly cod and herring as well as imports from North West European ports, Ireland and Newfoundland. Particular regions of England were well known for certain types of stored fish such as Cornish pilchards and Yarmouth herrings. The seasonal activity associated with the more important fisheries and their storage often outgrew the local labour market attracting fishermen from other English ports and abroad, as well as onshore seasonal workers.

The herring fisheries of Great Yarmouth, described in Chapter 2, are perhaps the best known of the English fisheries having a long history and were active throughout the Medieval period into the early 20th century. The numbers of fish caught and stored were far in excess of any of the other English fishing ports (Cushing, 1988, p.87), even so extra herring had to be imported to meet demand. On the west coast, Liverpool was a late participant in the herring fisheries, supplying fresh, smoked and salted fish. By the late 18th century it was second to Yarmouth in production, although the supply of fish from the Lancashire coastline was restricted by poor communications, (Scola, 1992, p.128). Irish herring were exported to ports in the south west, such as Bristol and were a primary Irish export in the 16th century. The Scottish herring fisheries developed commercially comparatively late, but by the 17th century the east coast fishery was of vital importance to the Scottish economy, both for home consumption and as an export, (Smout, 1963, p.223). However, the Scottish fishery never rivaled Yarmouth, being hampered by lack of development in fishing and storage technology and political restrictions on export markets.

The evidence for stored fish production and distribution has shown a strong coastal trade, moving home produced and imported stored fish along major and minor ports all along the coastline. The major ports for imported stored fish were:

Bristol in the west, (Kings) Lynn in the east and, most importantly, London, a major market with 5 % of the national population in 1600, rising to 11 % by 1700 (Houston, 1992, p.32). The transport systems remained essentially unchanged throughout the period, water (both sea and river) was the cheapest, but inevitably deliveries included some overland travel by cart or packhorse. The building of canals only began in the early 18th century followed by the development of the railways in the early 19th century. Their effects and those of canning and icing on the delivery of fresh and mild cured fish did not impinge on the period under study. However, the evidence has shown the basic road and water transport systems utilised did not restrict the movement of goods in the pre industrial era, and stored fish were no exception.

Temporal changes in demand and consumption of stored fish have proved difficult to assess and should be viewed against the background of changing population numbers and distributions affecting standards of living and purchasing power. Population plummeted after a major outbreak of Plague (see Figure 4.1) and showed little sign of recovery until the middle of the 16th century. Changes in population distribution resulted as the proportion of people living in towns began to increase and the balance between a predominantly rural population began to alter in favour of towns and later, beyond the period of study, urban populations.

Fluctuations in population exert or relieve pressure on available food resources and post Plague depopulation saw an increase in meat consumption, not only for the wealthy classes, but also for manual labourers in a climate of increased wages where labour was in short supply. Increased concentrations in population changed the market for many goods including stored fish. The later increase (after 1500) in the proportion of town dwellers and in particular in London, concentrated consumers so that the marketing of perishable goods became less risky, an increased consumer base ensuring sales.

The general trend for stored fish from the 10th to the 18th centuries seems to be one of decline from as early as the 14th century, but the documented evidence is based on individual cases regarded as symptomatic of a more general trend. In the absence of the modern assiduous collection of data of changing consumption patterns these individual cases are the main source of evidence. They are projected against the social and economic background of the period to suggest change.

Decline in the consumption of stored fish in relation to other foods, primarily meat, consider stored fish as a single commodity, comprising mainly herring, cod and related gadid species. It does not address which species were preferred (a comparative aspect explored in the archaeological data) other than the generalisation that herring were the cheapest of these fish, a determining factor for some consumers.

The overall decline in stored fish consumption is unlikely to be a continuous decrease either temporally or regionally and there are a number of factors, which could affect the market at different levels. On the premise that the market, and therefore profitability, is driven by demand, it was the consumer that determined any decline in the consumption of stored fish. Fishing and transport technology did not deliver any major improvements in the availability of fresh fish before 1750 and I have shown that fresh marine fish could be delivered anywhere in England on demand.

Before the Reformation, where a significant number of fast days precluded the consumption of meat, stored fish clearly ranked as a major consumable for certain sectors of society, i.e. those who but for fast days would have eaten meat. I have shown the importance of these fish in proscribed forces' rations until the early 18th century and from earlier household accounts spanning the 13th to 17th centuries. Through the latter's manorial and charitable duties stored fish were gifted to manual labourers and the poor. As part of household planning for provisions in a seasonal and sometimes costly market for fresh, stored fish was a valuable commodity along with salted meat. However, aspects of the lifestyle of the wealthy has always been copied by those lower down the social scale and here increased meat eating may have been viewed as a sign of upward mobility.

Despite evidence of change and decline stored fish continued to be a valuable, if reduced, commodity throughout the period and although there was increased demand for meat in London in the 17th century, coastal sea trade continued to supply the capital with stored fish. Compared to the rapid growth of London at this time it is difficult to assess its' importance. However, in 1682 a cargo of 56,200 codfish, 81 ½ barrels of codfish[1], 9,796 barrels of herring[2], 1200 ½ ling, 400 Island[3] fish and 740 couple 'stockfish' left Great Yarmouth largely bound for London, but also some other south east ports (Willan, 1938, p.130). Almost a century later, in 1772, only 2,264 barrels of herring left Great Yarmouth for London (Willan 1938, p.131). There is historical evidence for fluctuating levels of East Anglian herring caught in the 18th century cited by Cushing (1988, p.83). These are attributed both to lack of fishermen and boats as well as poor catches of fish as a result of natural dips in population. So it is difficult to assess whether these figures represent a decreasing market for stored herring in London, suggested by the 19th century Billingsgate figures where fresh herring predominate, or a decrease in supply.

Evidence for a decline in consumption and change in the preferred types of stored fish bought for three wealthy houses prior to the Reformation have been described by Woolgar, (1999, p.113). The three accounts are dated 1296-7, 1433-2 and 1503-4 and indicate a decrease from 39 % of household expenditure on stored fish to 12 % by the early 16th century. Dividing the expenditure on stored fish into: herring, 'saltfish' and 'stockfish' showed a temporal decrease in the amount spent on herring and an increase in the amount of 'saltfish'. Spending on 'stockfish' was of less monetary value than either herring or 'saltfish'.

[1] Pickled or cut into small pieces.
[2] Nearly 6 million fish.
[3] Iceland?

Converting the number of fish into **portions**[4] confirmed a relative decrease in herring consumption and an increase in 'saltfish'. These data support a temporal decrease in overall stored fish consumption in 'great households' as well as changes within that consumption away from herring, a trend explored in the data chapter, prior to the Reformation.

With regard to the effects of the Reformation, Woolgar (1999, p.203) has summarised it as a dramatic change in diet from the 1530's, with a rapid decline in fish eating. The documentary evidence suggests that this was already a trend and accelerated by the removal of religious fast. The closure of religious houses also coincided with the removal of fish in the dietaries of schools and hospitals in part influenced by their new secular status. Woolgar (1999, p.203) has pointed to the introduction of the Poor Laws as replacing domestic charity and alms giving, food given as the latter had often included stored fish, particularly herring. By the 18th records for dietaries of workhouses and prison did not include any fish at all (Fussell, 1949, p.83).

However, changes in eating habits are rarely dynamic unless spurred by an event like the Reformation. Daily meals outside of feasting are usually conservative and repetitive as exemplified by daily dietary rolls surviving for St Swithun's Priory in 1515, Winchester (Kitchin, 1892). Repetition increases with decreasing income and a reliance on self sufficiency in food production. I would suggest that the historical evidence supports a gradual change away from stored fish already in progress before the Reformation, with the latter increasing that rate of change. Within the range of stored fish commonly eaten the quantities of herring gradually diminished in favour of salted white fish, the large gadids and in particular cod.

This takes no account of regional and status differences and as such lacks any subtleties of localised changes. The general trends of population changes throughout the period, affecting wages and effects of rural migration to towns

[4] A new methodology described in chapter 7, this data is shown in Table 7.6

changed the relationship between the consumer and the market. Growth of towns supported larger more centralised markets, even though the methods of transporting goods were fundamentally the same. This growth, particularly in London, always a driving force in market and consumer changes, influenced marketing of perishable goods. The concentration of so many consumers made goods with a short shelf life, such as fresh fish, a less risky commodity.

Changes in the availability of foods for rural consumers belatedly follow those in cities and towns, with some areas more resistant to change influenced by their distance from the capital and regional centres. Distance and poor transport connections helped isolate the north east of England and particularly the north west (Lancashire was poorly served by roads) from the developing south prior to the Industrial Revolution.

Other evidence for a decline in stored fish consumption was the marketing of Newfoundland cod, salted and dried by English fishermen, in Europe rather than at home during the late 17th century. The London and Bristol Company was chartered to trade in Newfoundland sending fish directly to south west Europe where the Spanish bought the cod. Poor grade fish were sold to feed slaves in plantations in Virginia and the West Indies (Cushing, 1988, p.67) and the national dish of Jamaica, 'saltfish and ackee', is a reminder of those times. The slave plantations were also briefly supplied with pickled herring and salted pilchards from south west English ports, who sought new markets for these fish. However the slaves preferred cod and the plantation owners were notoriously poor at paying, so this was not a success.

By the mid 19th century, outside the period but included here as continuing evidence for changes in the consumption of stored fish, Mayhew collated the figures for Billingsgate, the main London fish market, in 1848, (Sterne, 1971, p.63). These showed that of the 2,750,000 cod brought in only 15 % were fresh[5],

[5] Described as 'Live'

27 % were barreled[6] and 58 % dried and salted, somewhat at odds with the lack of market for salted and dried Newfoundland cod a century earlier. The source of these stored cod is unknown, but must have retained some market share. In contrast, of 1,422,000,000 herring, 86 % were fresh, 4 % were the hard cured 'reds' and 10 % the milder cured 'bloaters' which lasted little longer than the fresh fish. The contrasting proportions of fresh fish for these two species are reflective of the relative cheapness of fresh herrings and 'bloaters', which could be bought daily from 'costermongers'. These were small scale fish sellers who bought significant numbers of fish as cheaply as possible from Billingsgate and moved around the city selling mainly to the poor. They supplied a new population of urban poor created by the Industrial Revolution. Changes in domestic life, where time consuming activities such as home baking and brewing were replaced by buying direct from the baker[7] and public house, would have included foods requiring comparatively lengthy preparation such as hard cured fish. The desalting time recommended by Hannah Glasse in 1747 for salt fish, was 36 hours through two changes of water and a rest period (Glasse, 1995, p.91), while Mrs Beeton in 1859 advised overnight soaking for salt cod (Beeton, 1982, p.119). Hardly convenient for working people, overcrowded, with poor if any cooking facilities.

In summary the historical data for the 10th to the mid 18th centuries shows changing demand for and between stored herring and the gadids. Their consumption generally declined before, and was accelerated by, the Reformation as the availability of meat increased. The period stops just prior to the sharp rise in population, both nationally and in towns and cities as industrialisation began to develop. Within the types of stored fish available, before the successful marketing of the mild cures and more 'convenient' foods favoured in the mid 19th century, there is strong evidence for stored cod becoming more popular than stored herring. I would suggest that the quantities of stored cod still being

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[6] Mrs Beeton (1982, p.119) describes salt cod cut into thick pieces and barreled for convenience of carriage.
[7] Baking at home continued longer in the north than the south of England where bakers first appeared in villages in the mid 18th century (Burnett, 1989, p.5)

brought to Billingsgate in the 19th century still had a niche market among wealthy households, where lengthy preparation could have been accommodated in the day to day running of the kitchen of large houses. The inclusion of salt cod in Mrs Beeton's recipes indicates it was not an uncommon dish at that time.

The long soaking to desalt the fish would have been an anachronism to the new class of industrial workers and urban poor with working long hours and poor living conditions. Food requiring little or no preparation was preferred in the growing towns and cities (Tannahill, 1988, p.310) and cheap fresh and mild cured fish, such as fresh herring and 'bloaters' described above, could be bought daily from local traders. By the time Mayhew did his London survey in the mid 19th century fried fish, usually plaice, could be bought very cheaply on street corners, ready for eating and a real convenience food, (Mayhew, 1985, p.71). Baked potatoes and ham sandwiches were also sold, both recent introductions to street vending at that time.

Whatever the changes, whether in marketing and the types of fish preferred or variations in class and region in England, fish always seems to be second best to meat historically and through to the present day. Foreign visitors were often surprised at the large quantities of meat eaten in England and there are many documented comments confirming this view. Mennell (1992, p.286), who cited religion, class and nationality as the three most powerful influences on what people eat, considered class and nationality may be stronger than religion in Western Europe. This was echoed by Harvey (1996, p.66) who thought the large quantities of protein eaten by the monks at Westminster Abbey reflected their high social class and region, North European and perhaps distinctly English. The desire for increasing meat supplies meant 'by the 18th century England had more domestic animals per acre per person than any other country in Europe, except the Netherlands' (Fiddes, 1993, p.22).

PART 2: Methodology.

CHAPTER 6. Analysing the data.

Introduction.

In Part 1 I have shown the various sources of historical data which might be considered when interpreting an archaeological fish assemblage in terms of location (both contextually and in the wider geographical sense) and time frame. The fish bone assemblage itself presents a number of limitations imposed by differential preservation, recovery methods and the selection of data to be recorded. In this chapter I discuss these influences in general and the detail of my own data record. This has a direct bearing on the quality of the data sample to which I apply a new method of quantifying fish bones described in the next chapter.

The factors affecting the database of recorded fish bones in an assemblage can be divided into three main groups;

- **Survival**; bone preservation, taphonomy and deliberate disposal.
- **Recovery**; the influence of the methods used to extract the bone.
- **Recording**; aspects of both non metrical and metrical data included in the bone record.

Survival can be classified as a 'first order change' as styled by Reitz and Wing, (1999, p.114). These are changes occurring between deposition and excavation. 'Second order changes' (Reitz and Wing, 1999, p.119) occur during recovery and identification and recording of the material. Both of these factors will be discussed in order to establish the parameters of the data comprising the archaeological assemblages that form the data sample discussed in chapter 9.

The influence of recovery on the quality of the bone assemblage is a primary consideration. Sampling programmes are, by virtue of cost and necessity, tailored to individual sites, a balance of the ideal and what is feasible. Here attention is drawn to the effects of different recovery methods by example of an assemblage from a single, large feature from one of the sites in the data sample. The fish from this feature show the selective recovery of certain species with increasing mesh size.

Finally I describe the non metrical and metrical attributes potentially recordable for each bone depending on completeness and specific identification. There is no set standard for fish bone data, but there is a general uniformity between different specialists. The measurements are based on a number of published sources, such as Wheeler and Jones (1976) for cod premaxillae and dentaries, as well as those that have evolved to meet a particular need for individual aspects of different assemblages.

All the data from the sample of 20 sites are my own records and, given the lack of a standardised recording system among archaeozoologists working on fish bone, it seemed appropriate to describe in detail here the potential of my own data record.

Survival: a record of disposal or survival of the fittest?

The level to which the surviving assemblage is representative of that originally deposited is probably the most elusive of all questions in archaeology. Even the most robust materials suffer post-depositional changes. Before any taphonomic processes exert change on the buried material, the selection of species or skeletal parts discarded in a particular deposit/context are determined by pre-depositional activities. Selection in fish remains will be most evident where a specialised activity, such as heading and removing the vertebrae of cod and related species for salting and drying takes place. Such deposits are usually located on the coast close to the landing site and interpreted as processing waste, for example at Caithness and Orkney, (Barrett, 1997).

Selection of species and body parts may also be suspected in contexts containing a mixture of domestic settlement refuse. This is increasingly likely in deposits associated with habitation in the towns and developing cities of the Medieval and later periods where the scale of supply and choice increased to meet market demands. Additionally certain types of waste, i.e. kitchen waste, table waste or cess may be disposed of in different archaeological features, so selective or restrictive excavation may give biased results not representative of the whole assemblage but typify only that feature.

Belcher (1991) devised 'trade flow' charts from ethnographic data to show the movement of fresh and stored fish and applied them to urban contexts of 3rd millenium date from Harrapa, Pakistan. Although the geographical and archaeological situations are very different to Medieval England they illustrate the selection of pre-depositional processes.

An adapted version of Belcher's dried fish chart, has been included here as Figure 6.1. Head, pectoral and pelvic parts removed from large fish[1] are discarded on landing. These may be scavenged, cooked and eaten and the remains accumulate in domestic deposits near the processing site. The stored fish (retaining vertebrae) are transported to market after the removal of any spoiled fish which may also been scavenged or otherwise utilised. The skeletal remains of the marketed fish are discarded in domestic rubbish deposits where they are remarkable for their distant origin and restricted skeletal parts. Small fish are dried and salted whole[2], any spoiled fish are discarded or scavenged. Some of these small fish are sold locally, others at a distant market where as non local species they can be assumed to be stored, but show no skeletal selection.

The roles of spoilage and scavenging are likely to be of less significance in my data sample[3] than suggested for the Harrapan model and the differences of climate and transport distance less restrictive for the marketing of fresh fish. However Belcher describes a very similar practice for sun drying or salting small

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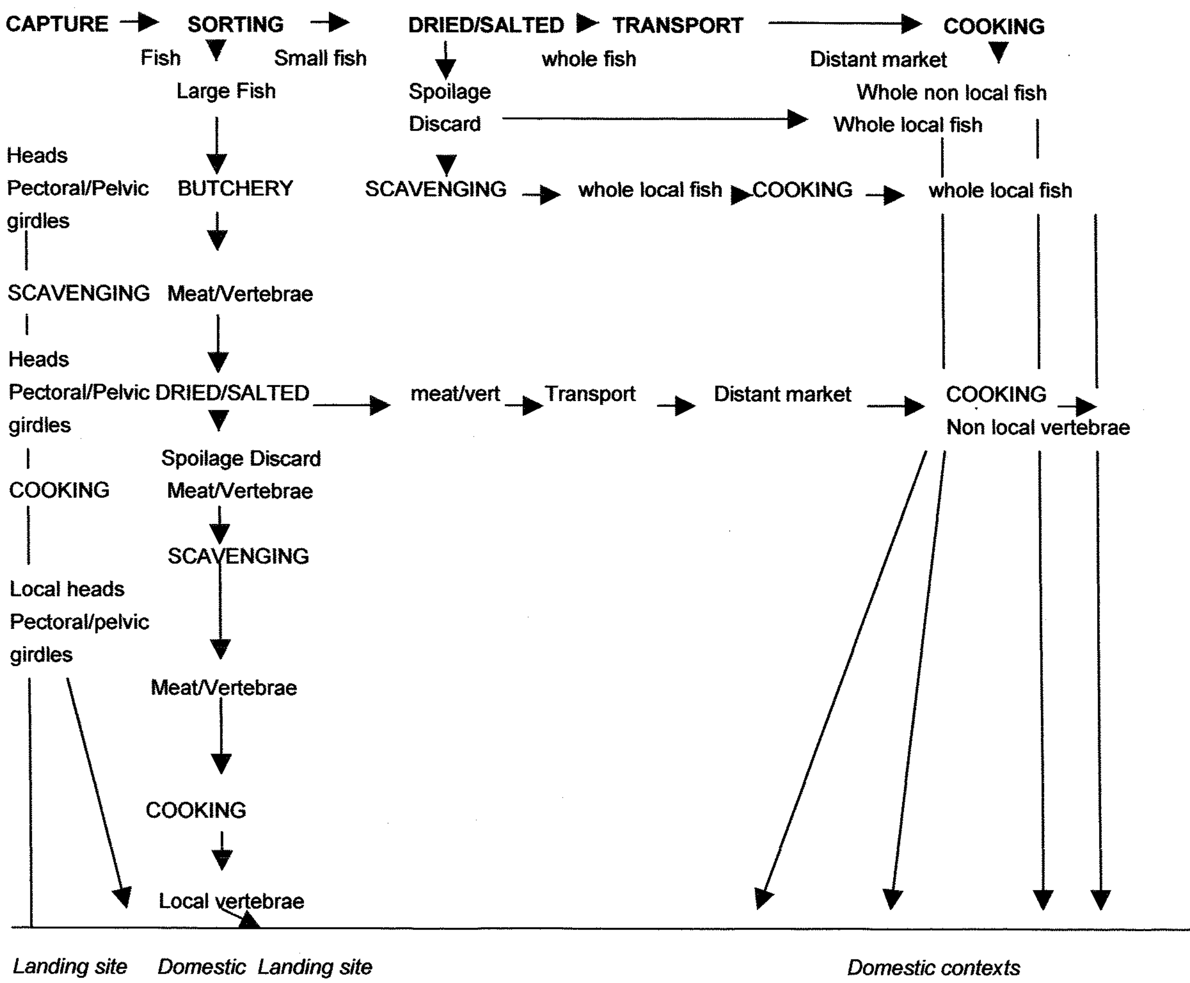
[1] Analogous to cod and other large gadids in my sample.
[2] Analogous to herring.
[3] See Chapter 9.

whole fish, while larger fish have the head removed and often the pectoral and pelvic girdles.

Figure 6.1 The movement of stored fish from capture to disposal, factors affecting bone selection (after Belcher 1991).



Vertebrae are usually retained in large fish and Belcher sees their presence at distant regional markets as evidence of stored fish consumption, (1991, p.111).

However he also acknowledges the likely presence of different bone signatures in domestic contexts. These are the remains of fish of differing size and state, both fresh and stored, obtained from a variety of sources. In this material, which typifies much of my own data sample[4], it may be possible to separate stored fish by direct evidence from the bones or, especially in the case of small fish with no particular bone signature, indirectly from circumstantial evidence of the distance to the nearest fishery.

Post-depositional changes therefore, operate on an assemblage that may already be selective, but to what degree have those changes altered the representative character of the original assemblage?

Certain species survive less well than others regardless of pre-depositional treatment and soil conditions. The elasmobranchs (including sharks, rays and sturgeons) have a cartilaginous skeleton and survive poorly compared to the bony fishes. They are more commonly represented by more robust elements such as dermal denticles, spines and teeth. Few of these can be specifically identified with notable exceptions such as roker 'bucklers', dogfish spines[5], sturgeon scutes and pectoral spines. The poor survival of their skeletal remains leaves the elasmobranchs poorly represented in the archaeological record.

Salmonid skeletal elements also have a poor record of survival. In particular the skull, for which differential preservation was attributed by Wheeler (1978b, p.74) to reduced calcification of skull elements when salmon are about to spawn. Recent experimental work by Butler and Chatters (1994) and Lubinski (1996) supported this, finding variations in bone density between different parts of the skull. Consequently, although salmon was commonly stored, it has not been included in the bone data for reasons of variable preservation and lack of a clear bone signature in storage.

Apart from natural inter-species variation in survival, the influence of prolonged heating, boiling or baking has been shown to affect fish bone preservation. Nicholson (1996) experimented with herring, cod, whiting and plaice, these were

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[4] Plymouth and Hartlepool sites being Landing/Domestic, while the remaining sites are Domestic.
[5] From the dorsal fin.

baked, boiled or raw and buried in five different soil mediums. The results suggested that there was little difference between the survival of baked and fresh herring and plaice. Most diversity was seen in cod, between boiled and fresh specimens and between different parts of the skeleton on the same fish. Nicholson concluded that boiling had a detrimental effect on the overall survival of cod and in particular the cleithrum and the caudal vertebrae. Both of these are part of the 'bone signature' for 'stockfish', so this selectivity could have implications for recognising stored cod in deposits.

These findings, which together with additional stresses including trampling, compression and, for some smaller fish, passage through the digestive system[6], led Nicholson to suggest that with such variability in survival 'relative frequency' may be the best measure of abundance. This method, although appropriate in zoology for counting species occurrence as individuals, severely limits any interpretation of fish bone data. 'Relative frequency' measures which species occurs most often, ignoring any evidence of skeletal representation which could be of anthropogenic origin as opposed to differential preservation. Barrett (1997) accepted the latter as a factor in two assemblages in Caithness and Orkney, but did not regard it as invalidating the bone evidence used to support the commercial export of dried gadids from Norse earldoms in the Middle Ages.

With rich organic assemblages often recovered from many domestic contexts in urban or town deposits, while accepting the selective survival processes, relegating these assemblages to a frequency count seems unduly pessimistic. None of the comparisons on fish consumption using documentary and archaeological data made in the following chapters could be attempted if restricted to species frequency counts.

Recovery.

While the survival of fish bone is an uncontrollable factor, the recovery of the surviving material is directly influenced by sampling. This includes both the

[6] The latter documented by Jones in Wheeler and Jones, 1989.

range of features sampled and in mesh size used in sieving.

The correlation of mesh size and recovery has been discussed extensively with much experimental work carried out regarding the loss of material against mesh size. As supportive data the evidence from a large, late Medieval feature, the Barbican well from Castle Mall, Norwich (Locker, 1997), which was rich in organic remains, is discussed here.

Fish bones were recovered by three different methods from separate samples from the Barbican Well. That is to say that they are not samples which were successively hand sorted, site riddled and finally bulk sieved. They represent bone recovered from different samples of the same feature for which a degree of uniformity has been assumed.

Table 6.1 shows the data for the recovery of skull elements and vertebrae for four common food fish species of differing size. The data shows fewest bones were recovered by hand collection, site riddling was intermediate and bulk sieving retrieved the highest number of bones. A predictable result, with eel and herring recovered in the highest numbers from bulk sieving. The recovery of cod seems unrelated to the method, with the highest numbers from site riddling, which may be a quirk of distribution of species within the samples.

Table 6.1 The comparative recovery of eel, herring, cod and whiting bones from bulk sieving (0.5mm mesh) site 'riddling' (8mm mesh) and hand collection from the Barbican Well at Castle Mall, Norwich.

Species		***Bulk Siev***	***Site ridd.***	***Hand coll***	***Total***
Eel	skull	10	4	3	
	vertebrae	145	51	15	
	Total	155	55	*18*	*228*
Herring	skull	104	113	17	
	vertebrae	881	317	216	
	Total	*985*	*430*	*233*	*1648*
Cod	skull	4	29	15	
	vertebrae	27	152	57	
	Total	*31*	*181*	*72*	*284*
Whiting	skull	3	23	1	
	vertebrae	71	41	25	
	Total	*74*	*64*	*26*	*164*
TOTAL		**1245**	**730**	**349**	**2324**

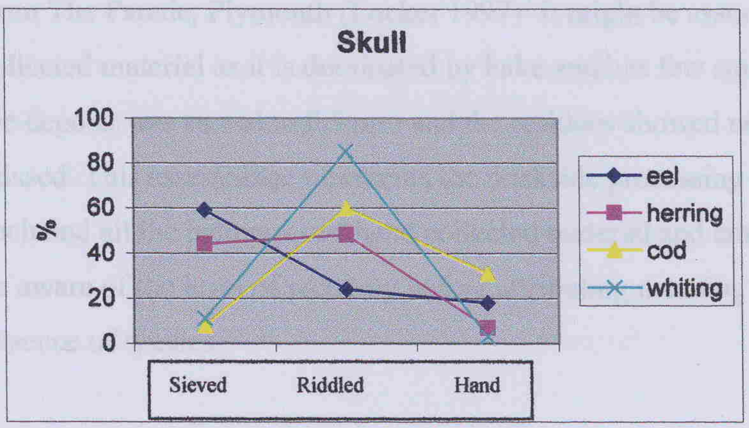
In Figure 6.2 the comparative percentages for skull and vertebral fragments are shown as two separate graphs. Of the two, the graph for vertebrae may be the more reliable. Skull fragments of the smaller fish, particularly herring, are delicate and easily fragmented so their total excludes tiny fragments likely to be that species but not specifically determinable. Vertebrae tend to be less fragmentary and more easily identified. As expected both graphs agree on the low levels of small species recovered by hand collection. The graph for skull bones only shows a clear decline between bulk sieved and site riddled for eel, which was a very small sample. Herring shows a slight increase, whiting and cod a great increase. The latter two may reflect sample variability, their skull bones being of sufficient size to be caught in both mesh sizes.

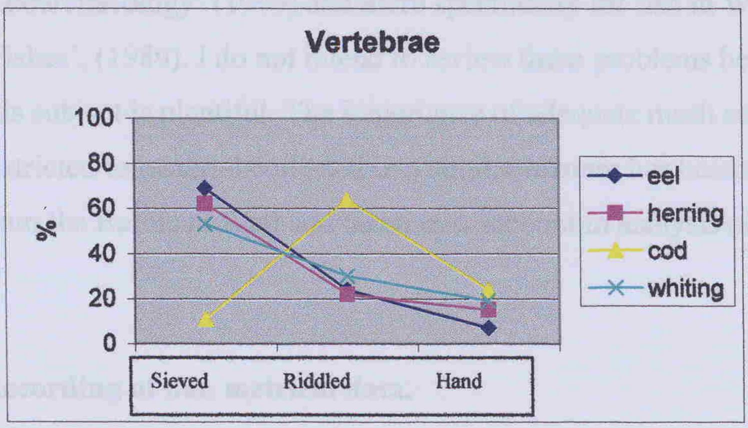
The graph for vertebrae indicates a trend of continuing decline in the numbers of vertebrae recovered for eel, herring and whiting with increasing mesh size. Cod differs in showing the largest recovery by site riddling, but here also the size of the vertebrae may be large enough to reflect true abundance in both methods.

Few cod vertebrae were recovered by hand collection and from these results it would appear that vertebrae of cod and other similarly sized fish are adequately recovered by coarse mesh sizes, in this instance as large as 8.0 mm. For the other species this mesh size was too large to catch all vertebrae. The finest mesh for the sieved material was sufficiently small (0.5mm) to trap the very smallest of fish bones as reflected in the numbers of eel and herring as well as smaller species such as smelt and sprat.

Fig 6.2. Graphs showing the percentage of skull and vertebrae recovered for each species by the different recovery methods from the Barbican Well

		Bulk S	Site R	Hand C	n
Eel	skull %	59	24	18	17
Herring	skull %	44	48	7	234
Cod	skull %	8	60	31	48
Whiting	skull %	11	85	3	27
Eel	vert %	69	24	7	211
Herring	vert %	62	22	15	1414
Cod	vert %	11	64	24	236
Whiting	vert %	53	30	19	134





The rest of the assemblage from Castle Mall was very abundant, 14,530 fish bones were identified to 48 categories of family or species level. Of these, 20 of the 48 were present in hand collected material and 34 of the 48 categories in site riddled samples. In terms of the total number of identified bones, 7 % were found by hand collection and 15 % by riddling through the 8.00mm mesh. The remaining material was sieved through a 0.5mm mesh and is a clear demonstration of the selectivity of recovery imposed by mesh size.

Conversely the presence of only large fish bones is not definitive evidence of hand collection. In the case of the Medieval and Post Medieval fish assemblage from The Parade, Plymouth (Locker 1997)[7] it might be assumed that this is hand collected material as it is dominated by hake and has few small species. In fact the deposit was sieved to 0.5 mm and the residues showed no fish bones had been missed. This assemblage represents the dockside processing of large fish and as such had all the hallmarks of hand collected material and emphasises the need to be aware of the level of recovery before attributing meaning to the presence or absence of species.

The influence of different recovery methods and sampling strategies has been discussed in publication on many occasions, most recently in Reitz and Wing's 'Zooarchaeology' (1999) and more specifically for fish in Wheeler and Jones' 'Fishes', (1989). I do not intend to review these problems here as the literature on this subject is plentiful. The importance of adequate mesh size and comparisons restricted to material collected in a similar manner has been shown with the data from the Barbican Well and taken into account in analysis of the data samples.

Recording of non metrical data.

After the contextual data I then record the greatest number of possible attributes for each bone identifiable to both anatomy, and species. Bones only attributable to family, such as the Sparidae (sea breams), because of the lack of specific

[7] Part of the data sample.

definition for some anatomies, may also be recorded in detail. Bones that will always remain nonspecific or even to family level receive less detailed recording as shown below.

1. ***Recovery method***, including the mesh size.

2. ***Determinate species and anatomy***. Precise species and anatomy are the ideal, but realistically family level may be as precise as confidence allows. Families like the sparids (see above), gurnards and flatfishes can be difficult to separate. In terms of the interpretation, where species share the same habitat and contribute a comparable amount of edible flesh, family level may be sufficient.

a. ***Anatomy*** is usually most precisely identifiable for the skull. The exact position of vertebrae, especially those found midway along the column may be difficult to pinpoint. The first three, close to the head and last few caudal, close to the tail, are more distinctive. Barrett (1997, p.621) divided gadid vertebrae into eight groups along the vertebral column to show processing methods in which certain vertebrae were removed. These are the first vertebrae, three groups of abdominal vertebrae, two groups of caudal, one penultimate and the ultimate vertebra. If these have not been separated with confidence a simple division into precaudal and caudal vertebrae will suffice as shown in my data sample.

b. ***Handedness***, whether the bone is from the left or right side (limited to skull elements) is useful in estimating the number of fish represented (MNI) and also avoids counting the same fish twice when counting possible numbers of individuals based on size.

c. ***Cut marks*** may be evident on both skull and vertebral elements. These may characterise cuts made while processing stored fish, as seen on barreled cod from a merchant ship, (Brinkhuizen, 1994, p.197). Cut marks thought to represent particular processes prior to salting or drying were found by Barrett (1997) on gadid bones that may have been processed for export. Both of these examples are, by their context, clearly associated with storage, firstly with the barreled fish product and secondly at the place where processing took place. In contexts of domestic debris, where the bones have been discarded after consumption of the fish, these marks are more difficult to attribute to initial processing. Preparation in the kitchen may also produce cut marks and the debris from the two processes becomes mixed together and with other material.

d. The degree of ***completeness*** of a bone may be considered in conjunction with butchery. Bones repeatedly seen broken in the same place indicate a point of weakness or processing not distinguished by cut marks.

e. ***Pathology*** is relatively rare, coalesced and compressed vertebrae sometimes occur, usually on gadids. Thickening on other bones is attributed to hyperostosis, the cause of which is not fully understood. One form of hyperostosis occurs in haddock where the thickening of the cleithrum is so frequent as to be the norm, increasing with age and size.

f. ***Condition.*** This refers to the state of the bone resulting from both pre and post-depositional processes, such as cooking, passing through the digestive tract for the former or contact with a soil medium whose pH erodes the surface of the bone.

3. ***Determinate anatomy, potentially determinate to species***. This category includes bones that have determinate features but have not been identifiable to species or family.

4. ***Determinate anatomy, indeterminate to species***. Certain anatomical elements, including fin rays, branchiostegal rays, spines and dermal denticles may remain indeterminate to species or family as they have no special diagnostic features. They may occur in large numbers, particularly fin rays and some do have specific features such as stickleback (*Gasterosteus aculeatus*) fin spines and roker 'bucklers' (dermal denticles), found on the females. When indeterminate to

species these elements should be noted as present, but their inclusion in the statistical data may be problematic, particularly for the elasmobranchs whose cartilaginous bones survive infrequently. However, the distribution of large quantities of fin rays has been used to demonstrate differences between kitchen and table waste in monastic deposits at Canterbury, (Powell, Serjeantson and Smith, 1996). So there is a need for flexibility in the treatment of this sort of material, depending on the context. In this particular case the identification of anatomy alone was enough to be useful in determining differences in the origin of fish waste.

5. ***Indeterminate anatomy and species***. This category includes fish bones for which the only positive attribute is that it is fish. Usually broken and featureless the proportion of this material is a guide to the general condition or level of fragmentation of the bones. It is time consuming and unproductive to count each fragment, but an estimate of the relative proportion of this material in the whole assemblage is a guide to the condition and state of the assemblage in each context or level.

Metrical data.

A standard for fish bone measurements was put forward by Morales and Rosenlund in 1979. Until then the main published work on measurement was Wheeler and Jones' measurement of cod premaxillae and dentaries in relation to total length and weight, published in 1976. Morales and Rosenlund's work included many other bones, mostly from the skull. Their measurements were clearly defined, illustrated and graded in order of accurate measuring and likelihood of application on archaeological specimens. However in many cases optimum measurements relied on the bone being complete to its outermost edges and in my experience overly optimistic regarding the level of completeness surviving in archaeological bone. Since then a number of papers have been published regarding measurements and their relationship to length and weight of fish notably by Desse. He has published personally on many species including perch, *Perca fluviatilis* (Desse et al, 1987) and similar work from other authors within a series edited for the Centre de Recherches Archeologiques du CNRS. For the Pacific region Leach has measured many species including barracouta, *Thyrsites atun*, (Leach et al, 1996). He includes two measurements for each bone, one for the complete specimen and one more likely to be repeatable on an archaeological bone.

There are now, as shown above, a wide range of published measurements, which can be used to reconstruct the size of fish from archaeological bones. Measurements also develop to suit particular assemblages, where the range and survival of bone may not be covered by the published measurements. These adapted measurements may remain unpublished, but are the basis for recreating fish size in a particular assemblage. Even if some of these 'personal' measurements prove to be statistically imprecise in recreating fish length accurately, they may still be sufficient to group the fish in size ranges. In analysing the abundance of Gadidae from two sites in Shetland and Orkney Ceron-Carrasco (1998, p.73) divided the fish into five groups; very small (<15cm), small (15-30cm), medium (30-60cm), large (60-120cm) and very large (120-150cm). These size groupings were sufficient for the interpretation of different fishing methods adapted to the varying habitats of fish as they mature.

Measurements tend therefore to be a mixture of published work, proven to be statistically supportable in relationship to fish shape and length, together with a more 'rule of thumb' approach responding to the need of individual assemblages. The latter may not give such precise results, but together with comparison against sized reference material will certainly give a size range.

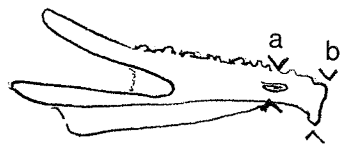
Preferred Measurements.

The following measurements are those routinely used by the author, but not an exhaustive list. They include measurements suitable for those species most commonly stored, particularly the gadids and are applicable when reconstructing the length of fish from individual bones. They are illustrated in Figure 6.3.

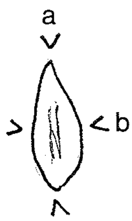
Figure 6.3. Illustration of bone measurements.
(after Morales and Rosenlund, 1979 using cod, not to scale)

1. Premaxilla.

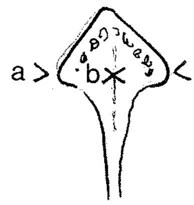
2. Dentary.



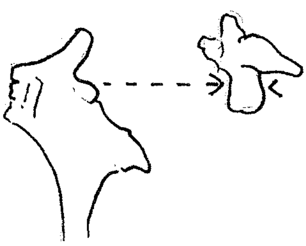
3. Otolith.



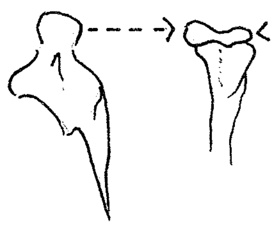
4. Vomer.



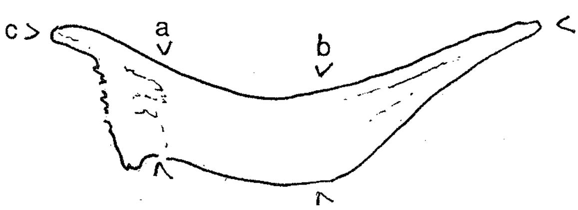
5. Articular.



6. Quadrate.



7. Cleithrum.

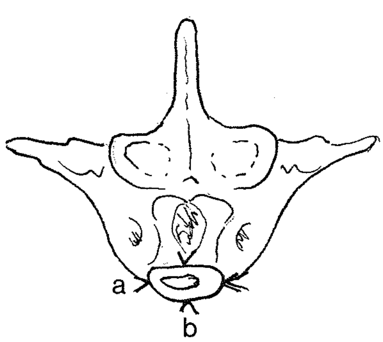


8. Posttemporal

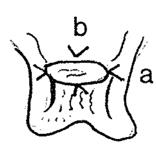
haddock

9. Supracleithrum.

10. Proatlas.



11. Atlas.



Some of the measurements shown below have been in use for over two decades following the publication of Wheeler and Jones' premaxilla and dentary measurements for cod in 1976. Colley's studies (1983) on gadid assemblages from the Orkney Islands in the 1980's also became a focus for discussion on viable measurements and influenced the following list.

1. *Premaxilla* a) Width across the base of the ascending process and the articular process (Wheeler and Jones, 1976, p.240), devised for cod but useful for other gadids.

b) Articular height, also useful for many species.

2. *Dentary* a) Depth across the proximal edge of the foramen from the tooth row base the angle of the bone and not the ventral shelf (Wheeler and Jones, 1976, p.240), for cod and can be used on other gadids.

b) Articular height (Morales and Rosenlund, 1979, p.21.4). For all species including flatfish.

3. *Otolith* a) Maximum length.

b)Maximum width.

4. *Vomer.* a) Greatest medio/lateral length (Morales and Rosenlund, 1979, p.16.2).

b) Measurement axially of the above, as frequently broken.

5. *Articular* a) Articulation width (Morales and Rosenlund, 1979, p.23.3).

6. *Quadrate* a)Articulation width (Morales and Rosenlund, 1979, p.25.3)

7. *Cleithrum* a)Thickness in cod (Brinkhuizen, 1994, p.202), limited use for other species.

b) Haddock; ventral height of the swollen part (Beerenhout, 1994, p.342).

c) Haddock; maximum length (Beerenhout, 1994, p.342).
Haddock cleithra are robust but height (h) is more commonly measurable than length (l).

8. *Posttemporal.* Haddock; maximum length of the swollen part (d), (Beerenhout, 1994, p.342).

9. *Supracleithrum.* Greatest length (Morales and Rosenlund, 1979, p.40.1) only on gadids, looks more like an articulation width.

10. *Proatlas.* a) Greatest medio-lateral length (Morales and Rosenlund, 1979, p.14.3).
b) Greatest dorso-ventral height (Morales and Rosenlund, 1979, p.14.4).

11. *Atlas.* As on the proatlas.

Applications of measurements.

Measurements can be made on the bones of any species and some will show a good correlation with size and weight of individual fish. This correlation can be used to compare against the measurements of archaeological fish bones to reconstruct the size of the fish represented.

However, for the small and fast growing species, although of biological interest, there may be little justification in terms of archaeological interpretation in measuring such species. Herring is a good example, arguably the most common of all species in English Medieval deposits, this fish is fast growing and matures in 2-5 years with a 10-20 year life span. Biologists have distinguished modern breeding populations on the basis on overall size, or by the number of vertebrae per individual being unique to that population. Since the skull bones are delicate the exact points of measurement would be difficult to reproduce resulting in errors in recreating total length and magnified on a small species. The number of vertebrae representing each fish would be impossible to calculate. Consequently herring has not been the subject of extensive measurement in fish bone assemblages. Herring fisheries target large numbers of fish caught during a seasonal migration of spawning adults between 20-30 cms in length. It seems unlikely that any nuances between breeding populations and their location could be detected by any metrical analysis of herring from an archaeological assemblage.

In contrast cod are slower to reach sexual maturity, at 4-9 years depending on size, over a 20-25 year life span and, as with other species of greater longevity, are caught at a variety of sizes, (Cushing, 1982, p.38). Cod size can be used to suggest different fisheries by location and season exploiting the natural habitat of the fish at certain stages of maturity.

The size ranges for a species are usually based on the metrical data from the most commonly occurring repeatable measurement, on the most commonly occurring anatomy, divided by handedness. Where the measurement shows diverse size on both left and right side, i.e. cannot be paired metrically, the minimum number of fish equals the total number of the most commonly measured element.

As previously described for cod, size can be used to suggest the type and seasonality of the fishery which was the source of the fish in the assemblage. Movements of many species into different depths are linked to both seasonality and maturity. Immature fish are often found in shallower water (nursery grounds) than the adults, while some adults make seasonal movements to different depths linked with temperature and water supply. This has been described earlier in Harden Jones' triangle of migration, shown in Figure 2.1.

The contribution of different species as food is more a function of size and weight than numbers of fish caught and consumed as will be shown later. Assessing the relative contribution of different species, when the base line of the data must always be the number of bones, is further complicated by the selective discard when processing the larger species. The average sized cod, ling and hake obviously contributes more edible flesh per individual than a herring. The latter were marketed whole, or with the hyoid and gill arches and the posttemporal removed during gutting, (Enghoff, 1996, p.43). Herring bones occur in large numbers and are the most 'visible' species in most assemblages as numbers of bones or individuals.

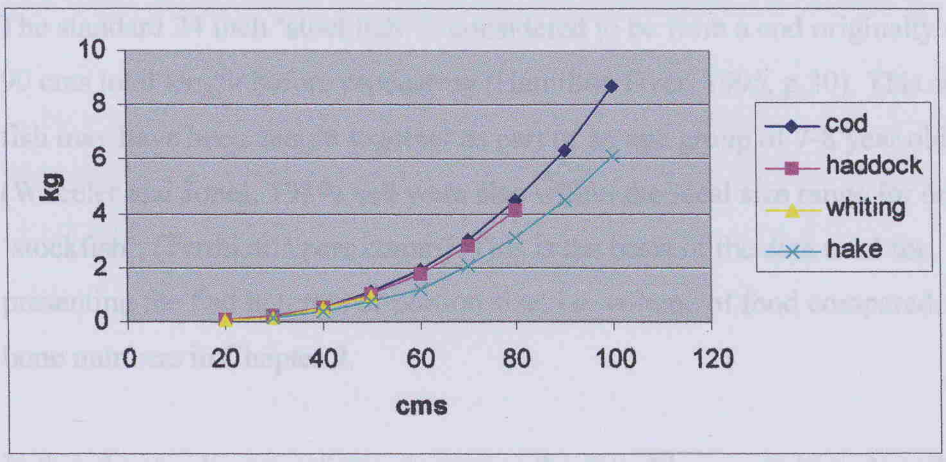
Size has been a key factor in determining how much of the fish is discarded during preparation for storage. Historical evidence for the methods of fish processing, supported by modern evidence of continuing traditional methods, suggests that up to and including the size of an average whiting, around 35 cms in length, fish were likely to be left skeletally whole, whether fresh or stored. This changed with the development of milder cures of the late 18th and 19th centuries, which are outside the period of study.

The strong relationship between fish length and weight also shows a correlation between species. Using data from four marine species: cod, haddock, whiting and hake, gathered by MAFF in 1978-9 (Blacker, 1979, p.38), their gutted weight has been plotted against total length in Figure 6.4. The graph shows that there is a strong weight/length relationship between all four species until 50 cms where hake, a more slender species, begins to diverge showing a slower weight gain with length. Ling, for which there was no available data, is likely to show a similar growth curve to hake being also of a slender conformation, see Figure 1.1.

While recognising the variability in weight associated with feeding and spawning cycles and changes in sea temperature, the relationship between different species with length and weight does seem to be supportive of the historical divisions of stored fish and food portions.

Fig 6.4 Graph to show the relationship between fish length and weight, data from Blacker 1979,38. (gutted weight)

TL (cms)	wt cod	wt haddock	wt whiting	wt hake
20	0.07	0.07	0.07	
30	0.2	0.2	0.18	0.16
40	0.54	0.5	0.48	0.39
50	1.09	1.02	0.93	0.77
60	1.88	1.77		1.14
70	3	2.77		2.04
80	4.45	4.13		3.09
90	6.36			4.45
100	8.67			6.13



In order to create a standard for the numbers of, or parts of, fish per portion I have used the documentary evidence for the quantities of fish. The sources are the navy rations already described in an earlier chapter and summarised below, as well as the accounting of provisions in monastic houses both for the monks and for distribution of alms for the poor.

In the naval rations of 1570 ¼ of a stockfish was considered equal to 4 herrings for a fish day (Hattendorf et al, 1993, p.102). The monks at Westminster Abbey at the end of the 15th century were allowed 4-5 herring, or ¼ of a stored cod, or 2 whiting, or 1/6 ling as a portion (Harvey, 1996, p.225). The two sets of portion sizes are compatible and other evidence from the period also broadly agrees with these divisions. Using the more commonly occurring sizes and gutted weight of cod, whiting and herring the following equivalents are suggested for the three species;

> 1 cod of 70-90 cms total length and weighing 3.0-4.5 kg =
> 6-9 whiting of 40cms total length weighing 0.5 kg =
> 12-18 herring of 25cms total length weighing 0.25 kg

A quarter of a 'stockfish' as equivalent to 4-5 herrings fits well with this ratio. The standard 24 inch 'stockfish' is considered to be from a cod originally of 80-90 cms total length before processing (Hamilton Dyer, 1995, p.30). This size of fish may have been caught together as part of an age group of 7-8 year old fish (Wheeler and Jones, 1989) and were also within the ideal size range for drying as 'stockfish', (Perdikaris pers comm). This is the basis of the data used for presenting the fish in terms of portion size, i.e. volume of food compared with bone numbers in Chapter 9.

In this chapter, by way of introduction to the data, I have sought to describe the pre-depositional processes, excavation and recovery techniques, as well as details of my bone record. All of these influence the data from which the stored fish will be presented as a volume of food by portion, both from documentary and archaeological evidence.

CHAPTER 7. Methods of fish bone analysis to determine relative volumes of fish present and evidence of storage.

Introduction

In this chapter two main approaches to examining the fish bone data regarding the contribution and presence of stored fish within an assemblage are presented. These methodologies can be summarised as:

A. The **portion** method, where herring and the gadids as the main groups of stored fish are compared, by percentage, after transposing the number of bones counted into portions representing volumes of fish. Model assemblages have been created from documentary data describing fixed portion or ration sizes based on monastic portions and naval rations. The percentages by **portion** are also shown in comparison with those based on the number of bones present (**n**) and frequently show diverse results.

B. Comparison of **body part** representation of the gadid species (cod, haddock, ling and hake) between phase and site. This uses 'bone signatures', determined by the proportions of different skeletal parts, to detect evidence of whole fish, processing waste and consumption waste. I also consider the validity of including hand collected bones from the large species: cod, haddock, ling and hake.

Influences of site/context and quantification on the assemblage.

Before describing this methodology in detail, emphasis should made of a major influence determining how the assemblages are analysed and grouped in the data sample. Of primary importance is whether the assemblage is from a context or site considered one of production, marketing or consumption of stored fish. The majority of the assemblages in the data sample are from accumulations of refuse from domestic consumption, either from specific buildings, such as Eynsham Abbey, or more general refuse, as at Castle Mall. The analysis has focussed on evidence of consumption. Notable exceptions are the four sites from Hartlepool and one at Plymouth where some processing activities are suggested by the distribution of large gadid bones. This affects the relevance of calculating **portion**, which considers fish as food and therefore is most appropriate in a domestic context, but irrelevant when looking at processing waste. The **body part** method has potential application for all deposits to determine different types of waste in large gadids.

Quantification – bone number versus volume of fish as food.

Methods of displaying the fish data are all dependent on the initial quantifying of the number of identified bones. This is the basic unit from which all other data are drawn but has, as with all faunal assemblages, an inherent bias. The 'number of bones count' (**n**) in sieved deposits obviously favours small complete fish[1], which will be over represented compared to other larger species. The latter may be skeletally incomplete through processing and further subdivided for consumption. In my data sample these are primarily cod and the other large gadids. Other differential effects of taphonomy, where small bones do not survive well or are poorly recovered, may redress the balance but cannot be quantified. In the data sample, beyond the caution applied to four sites where recovery methods were less rigorous (Nonsuch Palace, Middlegate, Church Close and Church Walk), the assemblages are treated as a full sample of fish bones surviving in the soil.

The weight of bone has also been used to indicate meat yields for cod, (Barrett, 1993). However since none of the assemblages studied here were routinely weighed this method could not be used.

The relative contribution of the main stored fish is considered, but not their place within the overall fish assemblage nor the overall ratio of fish to meat, since these aspects cannot be quantified. Discussion of the comparatively low quantities of all animal protein consumed by the majority of society in pre-industrial times has been extensively debated in the literature. Fiddes (1993, p.22) has succinctly

[1] Typified by herring.

summarised the differences in eating patterns as between different levels of society rather than geographical, meat consumption being the 'conspicuous consumption of a small elite'. Fish was generally not a cheap alternative to meat and could also be included in that statement. However, determining the relative volume of fish eaten from bone assemblages as a sign of status is an impossible task. The choice of certain fishes, either on species or individual size, may be a more viable indicator.

Transposing the raw data based on the number of bones into portions or a volume of fish would facilitate comparison between fish as a numerical occurrence by bone numbers and as a volume of food. The representation by **portion** has been restricted to herring, cod, haddock, whiting as the most commonly occurring species, ling and hake, which were found less frequently and pollack and saithe, both found rarely. These were the main species stored and, as shown below, are also the fish for which portion sizes could be calculated using evidence from monastic accounts, (Harvey, 1996, p.226). Ration sizes for herring, stock and salt fish were also standardised for the army and navy, (Prestwich, 1967, p.537 and Merriman, 1961). The quantities considered sufficient for one person were well established and consistent and have already been described. These fish species invariably form a significant proportion by number of bones within the whole fish assemblage, another measure of their importance. However as yet there is no method to measure their place as a portion or volume against the rest of the fish assemblage.

Assemblages biased by hand recovery and variable sieve mesh size are more limited in their potential since the smaller species, in this instance herring, will be poorly recovered. In these cases comparison may only be made between the larger gadids without reference to smaller fish.

Method A. Model assemblages of stored fish as a portion/volume of food using documentary data. The portion method applied to archaeological fish assemblages.

Among the most detailed chroniclers of household accounts were religious orders. Surviving accounts showing purchases through the year and occasionally detailed records of daily meals are largely attributable to monastic houses.

There are surviving accounts from secular households of foodstuffs purchased (Woolgar, 1999, p.113) and also records of what was eaten at particular feasts, (Hammond, 1993, p.127). The latter, though of interest, tend to chronicle exceptional meals and therefore are not representative of daily living or represent consumption by the elite. Mennell (1992, p.281) suggests that there was broad continuity in what people ate between similar social levels in the late medieval period throughout Western Europe. Differences between varying levels of society were largely in the volume of consumption, as noted by Fiddes above, rather than the quality of the diet. This would suggest there is little clear evidence of status within the fish assemblage, as changes in volume cannot be quantified in a bone assemblage. Some species may be status markers, such as sturgeon, large halibut or any fish of exceptional size. Large fish would have made an impressive centrepiece to the table at an important meal. Other evidence such as price differentials between species, their state (fresh or stored) as well as their size may suggest varying social strata.

As will be shown in chapter 10, using the data from the range of sites I have selected as my sample, the proportion of herring to the gadids and cod in particular may be indicative of preference. The exercising of choice, i.e. buying the more expensive fish, over economics may also imply status.

As a comparative measure against both the documentary and fish assemblage data I have calculated, based on fish portion sizes, the relative numbers or parts of individuals of herring, cod, haddock, whiting and ling needed to provide an equal volume of food. This is transposed into the number of bones per species[2], whether fresh or stored by multiplying by the number of bones in a fresh or stored fish and depicted as comparative bar charts between the two conditions in Figure 7.1.

The basis for these calculations was the documented portion size for different fish issued to the monks from Westminster Abbey, (Harvey, 1996, p.225). At the Abbey one portion is four to five herrings,[3] or a quarter of cod, or two whiting, or a sixth of ling. As there was no documented evidence for haddock an average fish has been included as one per portion on the assumption that one haddock might be considered equal to two whiting. Saithe, pollack and hake have been assumed to be the same portion size as cod. From the data for the equivalent number of fish the number of bones, both in the fresh and stored state, were calculated from the number of fish required to give a similar volume of food for each species. Based on 500 herring the numbers of other fish are shown in the data table accompanying Figure 7.1 and are shown comparatively as relative percentages in the bar chart. Here one set of data shows the percentage of the different species when fresh and therefore skeletally complete compared with the number of bones when all species are stored. The larger fish are suppressed in the stored totals having lost bones during initial processing, favouring herring and whiting, which remain skeletally whole.

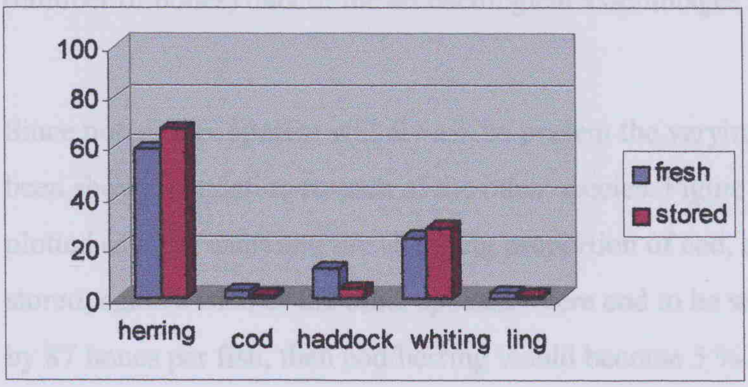
For this model an average size of fish within a species has to be assumed. Herring are likely to be the smaller 'shelf ' herring found off western Scotland, the Irish Sea, the North Sea and the Baltic. These were rarely over 30 cms total length and probably in the 20 cms range, (Nicholls and Miller, 1986, p.27). Cod as 'stockfish', which are air dried, averaged around 80-90 cms, (Perdikaris pers comm). This is the optimum size range for this process and in this range are not large cod, which can reach exceptionally 150 cms in length. Fish that were salted may have been bigger, but generally the archaeological evidence suggests that

[2] For which a certain number of consistently recognisable bones per fish have been described below.
[3] For which 5 has been taken as the standard.

Figure 7.1: The relative percentage of herring and the gadids providing an equal volume of food.

These percentages have been calculated from the number of bones in the whole/fresh state (87) and the stored state (28) based on portion equivalents after Harvey 1996.

		number of bones		percentage of bones	
Species	n of fish	fresh	stored	fresh	stored
herring	500	43,500	43,500	59	67
cod	25	2,175	700	3	1
haddock	100	8,700	2,800	12	4
whiting	200	17,400	17,400	24	28
ling	21	1,827	588	2	1



large cod, around 120 cms and greater, were not commonly caught. Haddock from archaeological assemblages are often within the lower end of the modern commercial size range of 38-63 cms suggested by Wheeler, (1978, p.152). Whiting tend to be generally within 30-40 cms length range, the average size today. There is no documentary evidence for the size of ling, a large but more slender fish than cod averaging 1 to 1.5 m in length in inshore waters, (Wheeler, 1978, p.167). The metrical data from archaeological bones of ling would benefit from a similar approach to that for cod by Wheeler and Jones (1976), where measurements on premaxillae and dentaries can be compared against modern specimens of known length and weight. However, ling must have been generally larger than cod reflected in the reduced portion size, which is discussed below.

Other large fish, namely pollack, saithe and hake, occur infrequently and have regarded as within the same size range as cod.

Figure 7.1 shows that the relative occurrence of herring, as the most frequently occurring species in an assemblage by the number of bones, has to be high (at least 60 % on the evidence of these five species) to be the greatest volume of fish eaten. Very low numbers of cod and ling, particularly in the stored state, are sufficient to represent an equal volume of food as herring. Whiting and haddock are intermediate between herring and cod or ling. Herring and whiting are considered skeletally complete in both states, haddock shares the same stored 'bone signature' as the large gadids. This model is the comparison with the **n** (number of bones) data of the archaeological assemblages in chapter 10.

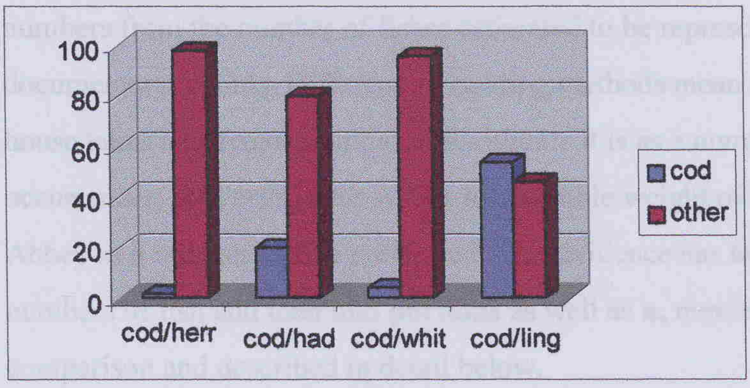
Since not all five species will always be present the varying ratios of cod have been shown in relation to each of the other species. Figure 7.2 shows the data plotted as a bar chart and the changing proportion of cod, as numbers of bones if stored, against each of the other species. Were cod to be whole, i.e. represented by 87 bones per fish, then cod/herring would become 5 % / 95 % and cod/whiting 11 % / 89 %.

Using three sets of data from monastic documentary records, theoretical bone assemblages have been calculated from the number of bones present in stored fish. The monastic houses are St Swithun's Priory, Winchester (Kitchin, 1892), Westminster Abbey, London (Harvey, 1996) and Battle Abbey, Sussex, (Searle and Ross, 1967). These are all Benedictine houses and the diet rolls, cellarers and kitcheners' accounts give details of fish consumed at individual meals or bought during the year.

Figure 7.2 The relationship of cod to each of the other species, expressed as a percentage calculated from the number of bones in each type of stored fish.

e.g The ratio of cod to herring is 1:20, the ratio as numbers of bones is 28:1740 or 2%:98% as shown on the bar chart.

	ratio	% of cod	% of other	
cod/herring	1:20	2	98	n of bones per fish = 87
cod/haddock	1:04	20	80	n of bones per fish = 28
cod/whiting	1:08	4	96	n of bones per fish = 87
cod/ling	1.0.8	54	46	n of bones per fish = 28



The number of bones I consider easily identifiable and therefore counted for each type of fish, whether stored or fresh and were used as the basic data for calculating bone numbers from the documentary evidence can be summarised as follows:

Herring (whole whether fresh or stored)	32[4] skull bone	55 vertebrae	= 87
Cod and large gadids inc haddock (fresh)	32	55	87
Cod and large gadids inc haddock (stored)	6[5]	22[6]	28
Whiting (whole? fresh or stored)	32	55	87

[4] Pairs of premaxilla, maxilla, dentary, articular, quadrate, hyomandibular, ceratohyal, epihyal, opercular, subopercular, interopercular, preopercular, post temporal, cleithrum, supra cleithrum, single vomer and parasphenoid.
[5] Pairs of post temporal, cleithrum, supra cleithrum
[6] Caudal vertebrae

The influences of variability and taphonomy have already been discussed in chapter 6 and are not taken into account in this reconstruction, which assumes all bones were recovered.

There is some variability in the number of vertebrae per fish between the species. Herring have between 52-59 vertebrae and cod 55, (Harden Jones, 1968). In the traditional Scottish processing methods of the 19th century, 22 caudal vertebrae were retained in cod to give some rigidity, (Ross, 1882). This figure has been taken as the maximum number of vertebrae remaining in the stored product.

These numbers of elements have been used as the basis for calculating bone numbers from the number of fishes estimated to be represented in the documentary records. Different accounting methods mean that the data for each house takes a different form; at St Swithun's it is as a number of meal occurrences, at Westminster Abbey as an edible weight of fish and at Battle Abbey as a number of fish purchased. This evidence has been transposed into numbers of fish and then into **portions** as well as **n,** numbers of bones, for comparison and described in detail below.

The documentary data for St Swithun's Priory, Winchester.

The diet rolls for 1515 from St Swithun's Priory, Winchester, (Kitchin, 1892) are the most detailed of all those examined here. They show the individual meals and their value. The period to be examined here is Lent, the 46 days between March 1st and April 15th. During this time of fasting no meat or eggs should have been eaten and the resulting 'assemblage' composed entirely of fish and vegetable remains. The evidence for portions from the documentary data for Westminster Abbey (devised by Harvey, 1996, and discussed later) has been applied here as a measure of the portion for an individual monk.

There were 144 records of fish being served during Lent. At the end of this period, starting with Easter Sunday, meat[7] was eaten on 4 days of that week. Eggs[8] were eaten on six days a week excluding Friday. The daily monetary value of the fish eaten is the same as that for Lent, except for Friday. This was the weekly fast day throughout the year on which only one type of stored fish was eaten in Lent, but outside this period two types could be served. The quantity of meat is not known, only a value is given and, despite the festivities of the Easter week following a long fast, the total spending was only slightly in excess of that of Lent, around 3 pounds 10 shillings. This suggests that overall fish was not cheaper than meat. Both meat and fish seem to have been bought, rather than supplied from the monks' own farms, as a monetary value is always given.

I have summarised the evidence from the Lenten records to show the fish consumed, the number of days they were eaten and the price range. The consistency of price suggests the same quantities were used.

Table 7.1. Fish consumed in Lent at St Swithun's Priory Winchester.

Fish	*No of days eaten in Lent*	*Price range*
'Milwelle'	5	4s 11d
'Haburden'	35	4s 4d - 4s 11d
'Drylynge'	8	4s 6d - 5s 8d
Whiting	5 (+ haddock/lamprey/plaice)	3d - 5d
Plaice	3 (+ whiting/haddock)	3d - 10d
Haddock	2 (+plaice/whiting)	5d - 10d
'Red' herring[9]	17	2s 4d – 2s 8d
'White' herring[10]	17	8d – 1s 4d (once 2s 4d)
Salmon[11]	14	3s 4d
Lamprey	4 (+ thornback/whiting/haddock)	5 - 10d
Thornback	1 (+ lamprey)	5d
Minnow	24	3 ½ d

[7] Mainly beef and mutton.
[8] 274-360 per day.
[9] Smaller amounts for 1s 4d and 2 ½ - 4d were used for suppers. A cask of ?600 fish costing 6s 8d was bought for Easter Saturday.
[10] Served stewed with mushrooms for the ministrants.
[11] Always served on Wednesdays and Saturdays except Easter Saturday.

The price range is that paid throughout Lent for those fish. The fish are listed in descending order of frequency for 'white fish', then herring and the remaining species.

'Haburden'[12] was by far the most commonly eaten type of fish, followed by 'red' herring and minnows[13]. The latter cannot have been important in terms of volume and was served as an entrée.

The pattern to the lenten week for fish consumption was based around the following staples (excluding any pittances and special dishes for the Ministrants).

SUNDAY – 'Drylynge' or 'haburden' with 1s 4d of 'red' herrings at supper.

MONDAY – 'Drylynge' or 'haburden' and 'red' herrings.

TUESDAY – 'Drylynge' or 'haburden' and 'red' herrings.

WEDNESDAY – Salmon and 'haburden' (or 'milwelle').

THURSDAY – 'Haburden'and 'red' herring.

FRIDAY – 'Drylynge' or 'haburden' (or a cask of 'red' herring on Good Friday).

SATURDAY – Salmon and 'haburden' (or 'milwelle').

A model assemblage from the total Lenten accumulation of kitchen debris would consist of a deposit of fish and vegetable remains. Outside of Lent cattle and sheep bones, egg and oyster shells would also be present from the evidence of the dietary rolls. There is no reference to the consumption of poultry or other birds, possibly because they were supplied from the Priory's own stock and therefore not costed.

The cask of 'red' herrings eaten on Easter Saturday can be used as a basic unit of 5 long hundreds (i.e. 120) costing 6 s 8 d. Therefore, the regular consumption of

[12] Together with 'drylynge' and 'milwelle', all forms of salted cod or other large gadid.
[13] Not necessarily this species but any small fish possibly other cyprinids.

2 s 4 d worth of red herring at St Swithun's could represent approximately 200 fish or 40 portions. The 1 s 4 d worth of herring for Sunday supper may be around 100 fish[14], either 20 portions or smaller sized portions at this meal.

Salmon cannot be included in any calculation on the number of bones as it was not included in Harvey's work (1996, p.226), so there is no evidence for the size of the portion per person. Coupled with a lack of evidence for the skeletal completeness of salmon the quantities are incalculable and the bone signature unclear. Descriptions of the preparation of 'Newcastle salmon', (Hartley, 1979, p.342), collared and pickled salmon (Beeton, 1982, p.150 and Glasse, 1995, p.116) suggest that for these cures the fish was completely boned. However salmon was eaten as a main meal twice a week at St Swithun's during Lent and has therefore been included in one series of **portion** data in Figure 7.4.

The summary below shows how the number of fish and the number of bones might be calculated from the detail of the diet rolls from St Swithun's to produce the model assemblage suggested by these data.

For each type of fish the number of occurrences as a meal, multiplied by the number of people = the number of portions.

The number of portions multiplied/divided by the number or parts of a fish in a portion (5 herring = ¼ 'haburden' or 'milwelle' = 1/6 ling) = the number of fish.

The number of fish can multiplied by the number of bones per stored individual = the total number of bones.

The basis for the calculations here is the number of occurrences for each type of fish as shown in the following example:

[14] This assumes a higher price per fish for a smaller quantity.

Herring = 12 (occurrences) x 40 (no. monks) x 5 (portion) = 2400 (fish)

2400 x 87 (bones) = 208,800 bones

'Stockfish'= 5 (occurrences) x 40 (no. monks) divided by 4 (portion) = 50 (fish)

50 x 28 (bones in a stockfish) = 1400 bones

This method makes a number of assumptions regarding the number of people present and the consistency of portion size and bones present within portions. However, with some caution the following numbers of fish and bones were calculated. The data are shown in Table 7.2

Table 7.2. The data for St Swithun's Priory, Winchester.

The number of occasions/main meals on which fish occur x the number of monks (40) = number of portions multiplied/divided to calculate the number of fish x the number of bones per fish = number of bones.

Species	*n meals*	*n portions*	*%*	*n fish*	*n bones*	*%*
Herring	17	680	27	3,400	295,800	96
Drylynge	7	280	11	47	1,316	0.4
Harburden	34	1,360	54	340	9,520	3
Milwelle	5	200	8	50	1,400	0.4
Total	*63*	*2,520*	*100*	*3,837*	*308,036*	*99.8*

Herring was multiplied by 87 bones per fish, all others by 28, the number for stored large gadids.

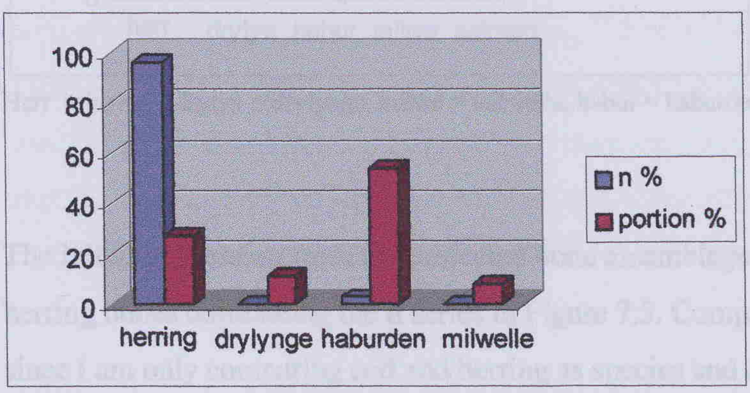
'N meals' includes only those fish eaten at main meals (only 'red' herring) and may differ from the 'n days' category in Table 7.1

Figure 7.3 shows the data for the percentage of fish bones compared with the percentage of portions. Large numbers of whole herrings were present both as numbers of fish, (see Table 7.2) and consequently as a large number of fish bones. In an archaeological assemblage 'drylynge', 'haburden' and 'milwelle' would all be grouped together under cod, or one of the other large gadid species, showing as 96 % herring and 4 % cod by number of bones. Since these are all stored cod comparison with Figure 7.2, the relationship between cod and herring suggests that cod was the predominantly eaten species. This is supported by the evidence from **portion** in Figure 7.3, which shows 'haburden' to have been the most commonly eaten form of stored cod, though herring was still eaten in greater volume than 'drylynge' and 'milwelle'.

Figure 7.3. St Swithuns Priory, Winchester. The estimated proportions of stored fish consumed during lent 1515 using evidence from the diet rolls.

The percentages of number of bones and portions.

	herring	drylynge	haburden	milwelle	n
n %	96	0.4	3	0.4	308,036
portion %	27	11	54	8	2,520



This is further supported when **portion** is compared with the same data with the addition of salmon in Figure 7.4. The inclusion of salmon ameliorates the degree of difference between the other four types of stored fish. However, 'haburden', a type of salt cod, still predominates and with 'drylynge' and 'milwelle' comprises 59 % of the fish eaten. Salmon, which in the absence of any other information but comparative size, has been treated the same as cod[15] and may have been almost equal to herring as a volume of food. This volume of salmon highlights the under representation of this fish in archaeological deposits as a result of the poor preservation of skeletal parts.

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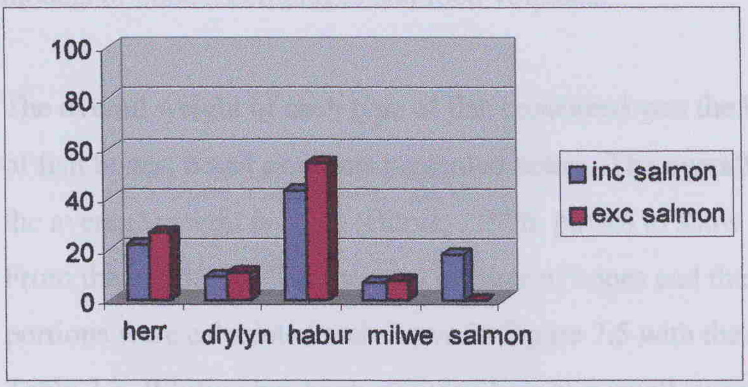
[15] ¼ fish = 1 portion.

Figure 7.4. St Swithun's Priory, Winchester. The percentage of portions of fish including and excluding salmon.

	herring	drylynge	haburden	milwelle	salmon	n
portion % inc salmon	22	9	43	7	18	3,080
portion % exc salmon	27	11	54	8	0	2,520



Herr = herring, drylyn = drylynge, milwe = milwelle, habur = haburden.

The initial impression from the projected bone assemblage is of large numbers of herring bones dominating the **n** series in Figure 7.3. Comparison with Figure 7.2, since I am only comparing cod and herring as species and on the basis of total numbers of stored bones, has shown the St Swithun's projected percentage for herring is too low for herring to be dominant. In Figure 7.2 equal proportions of herring and cod by numbers of bones are 98 % to 2 %, in Figure 7.3 they are 96 % herring and 3.8 % 'drylynge'/ 'haburden'/ 'milwelle'. The dominance of the different types of stored cod is clearly supported by the **portion** data in both Figures 7.3 and 7.4.

Sometimes herring remains predominant whether presented by bone number or portion and this will be evident in the data chapter. This validates the **portion** method as a tool for showing changing fish preferences in food consumption compared with fish bone numbers. The position of herring is not consistently reversed and indicates variation between sites and phases.

The documentary data from Westminster Abbey, London.

The evidence from this important Benedictine house is principally from the surviving kitchener's day books for 1495-1525 which records the main items of cooked food served at dinner and supper, (Harvey, 1996, p.36). Using these data Harvey cited individual portion sizes from which it has been possible to compare models of bone assemblages and food volumes.

The overall weight of each type of fish consumed was the basis for the numbers of fish bones, **n** and **portions** presented below. The overall weight was divided by the average weight per fish (Harvey, 1996, p.226) to show the number of fish. From the number of fish the total number of bones and the total number of portions were calculated and shown in Figure 7.5 with the accompanying data, Table 7.3. Whiting has been included here as a small stored gadid, but whiting may have been eaten largely fresh since it was mainly eaten in winter, possibly as part of a seasonal fishery, (Harvey, 1996, p.48). Since whiting has been treated as skeletally whole whether fresh or stored the bone count is unaffected.

Table 7.3. The data for Westminster Abbey.

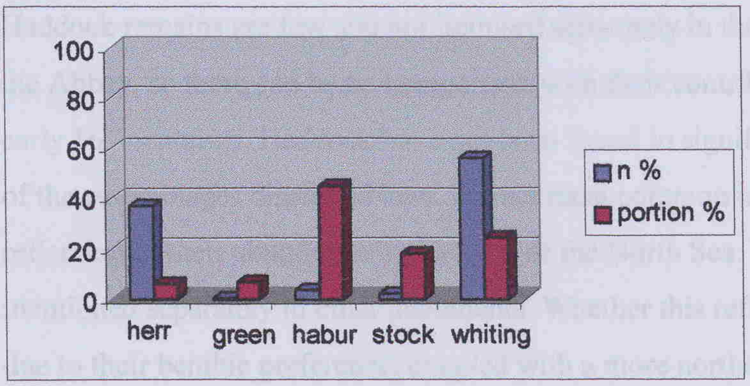
The total weight for each species was divided by the edible weight per fish = the number of fish multiplied/divided to calculate the number of portions OR multiplied to calculate the number of bones.

Species	*tl wt gms*	*wt per fish*	*n fish*	*n portions*	*%*	*n bones*	*%*
Herring	847,618	127	6,674	1,335	6	580,638	37
Greenfish	524,824	1,407	373	1,492	7	10,444	0.6
Haburden	3,351,428	1,407	2,382	9,528	45	66,696	4
Stockfish	1,275,286	1,317	968	3,872	18	27,104	2
Whiting	2,518,792	250	10,075	5,038	24	876,525	56
Total	*8,517,948*		*20,472*	*21,265*	*100*	*1,561,407*	*99.6*

In Figure 7.5 whiting is dominant by number of fish and, consequently, the number of bones, with herring second. For stored forms of cod 'haburden' is the most common, then 'stockfish' and 'greenfish'. The latter were salted and pickled so may be over represented by increased weight because of a higher moisture content. The **portion** bars show a reversal, 'haburden' is clearly in first place (as at St Swithun's), then whiting, 'stockfish', 'greenfish' with herring last.

Figure 7.5. Westminster Abbey, London. The estimated proportions of stored fish consumed annually between 1495-1525.

	herring	greenfish	haburden	stockfish	whiting	n
n %	37	0.6	4	2	56	1,561,407
portion %	6	7	45	18	24	21,265



Using the data for stored herring, cod and whiting from Figure 7.1 the percentage based on the theoretical bone count for these three species to be equal in **portion** should be:

Herring 71 % Cod 1 % Whiting 28 %

On this basis the stored forms of cod are clearly the most important, whiting is second. Harvey has suggested that herring was eaten less regularly at the Abbey in the later Middle Ages (1996, p.49) when it was frequent only in lent and as fresh fish in the autumn. The emphasis may reflect the social status of the monks, equal to 'nobility, gentry or urban elite', (Harvey (1996, p.34). Cod and related species were evidently preferred to other stored fish. This often proves to be the case in later deposits from monastic houses in my data sample.

There are two archaeological assemblages from Westminster Abbey, both of which precede the kitchener's day book. The sample from the 12th to 13th centuries (Jones, 1976) was too small to include. However a larger sample, mainly from a single ditch dated 950-1050 (Locker, 1989), belongs to the early history of the abbey at the time of foundation by St Dunstan, (Harvey, 1996, p.4). From this ditch the data show a clear preference for herring by both **portion** and **n** (see Figure 10.16), followed by whiting and support Harvey's proposal for a temporal change favouring the consumption of more cod based stored fish, at the expense of herring.

Haddock remains are few and not itemised separately in the documentary data for the Abbey, so there can be no comparison with their contribution in the late 15th - early 16th centuries. Haddock have not been found in significant quantities in any of the assemblages discussed later, but are most common in the Hartlepool sites, a reflection of their abundance in that area of the North Sea. Nor are haddock often mentioned separately in other documents. Whether this reflects lower availability, due to their benthic preference, coupled with a more northerly preference for this fish particularly in Scotland, haddock remains are not numerous.

The documentary data from Battle Abbey, Sussex.

The Abbey is another Benedictine house for which the cellarer's accounts (Searle and Ross 1967) survive. These span twenty years of records between 1278 and 1420.

Table 7.4 shows the purchase of stored fish over this period.

The number '1' indicates fish are present but the amount was not specified. This was commonly the case except in the years 1359-60 and 1375-6 where the numbers of fish bought were quantified. These have been used to recreate the number of fish bones (**n**) and fish **portions** from the four types of stored fish purchased.

The data for calculating **portion** and **n** are shown in Table 7.5.

Table 7.4 Summary of stored fish purchased at Battle Abbey 1278-1421.

Year	*Milwelle*	*Stockfish*	*Lyngis*	*Saltfish*	*Salmon*	*Mackerel*	*Herring*
1278-9	200					5,601 gr	8 lasts
1306-7	1	120	1		310	1	1
1319-20	1						
1320-21	100	1					1
1351-52							1
1359-60		100		115	240		9,000
1369-70		100		1	1		1
1371-72		1	1	1	1		red/white
1373-74		1		1	150		1
1375-76		300		190	17		15,000
1378-79		1		1	1		red/white
1382-83		1		1			1
1384-85		1		1	1		red/white
1385-86		1		1	1		red/white
1395-96		1		1	1	1	red/white
1399-1400		1		1	1		red/white
1407-8		1		1	1		red/white
1409-10		650			1		red/white
1412-13		410		1	1		
1420-21				1			red/white

1 = fish present but not quantified.

Table 7.5 The data for Battle Abbey.

The number of fish purchased multiplied/divided by the number/parts of fish per portion = the number of portions
OR the number of fish multiplied by the number of bones per fish =
the number of bones

Year 1359-60

Species	*n fish*	*portion*	*%*	*n bones*	*%*
Herring	9,000	1,800	68	783,000	99
Stockfish	100	400	15	2,800	0.3
Saltfish	115	460	17	3,220	0.4
Total	*9,215*	*2,660*	*100*	*789,020*	*99.7*

Year 1375-76

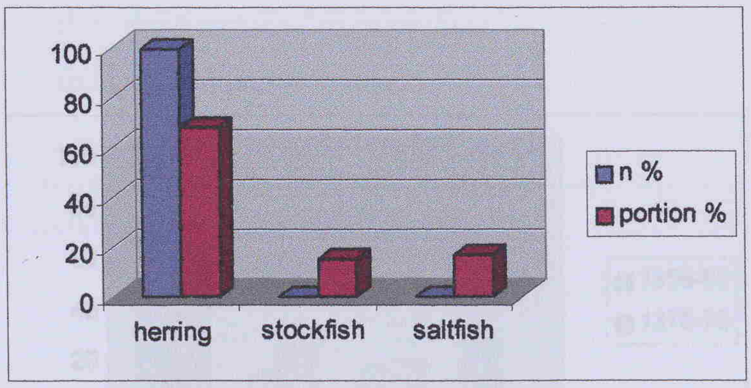
Species	*n fish*	*portion*	*%*	*n bones*	*%*
Herring	15,000	3,000	60	1,305,000	99
Stockfish	300	1,200	24	8,400	0.6
Saltfish	190	760	15	5,320	0.4
Total	*15,490*	*4,960*	*99*	*1,318,720*	*100*

In Figures 7.6 and 7.7 herring are clearly shown to have been the most frequently eaten stored fish in both years by **n** and by **portion**. Salmon is only included in Figure 7.8 where the portions for both years are compared since the bone signature for stored salmon is unclear. As a **portion** salmon was second to herring in the earlier year superceding 'stock' and 'saltfish' combined, while little was eaten in 1375-6, though the overall number of portions had increased. Whether this is a continuing trend is not clear since the data are not precise in most years. Greater quantities of 'stockfish' were bought in 1409-10 and 1412-13, but there is no evidence for the quantities of other fish.

The summary table (7.4) shows that in the period before 1350 'milwelle'[16] were bought in regularly and in one year, 1306-7, 'lyngis', also a type of salt cod or possibly ling. No 'milwelle' are recorded after this date and only one example of 'lyngis'. The greatest recorded quantity of salmon was bought in 1306. 'Red', 'white' and, sometimes, fresh herring were annual purchases.

Figure 7.6. Battle Abbey. Sussex. 1359-1360.

	herring	stockfish	saltfish	n
n %	99	0.3	0.4	789,020
portion %	68	15	17	2,660



[16] Salt cod

Figure 7.7. Battle Abbey. Sussex. 1375-1376.

	herring	stockfish	saltfish	n
n %	99	0.6	0.4	1,318,720
portion %	60	24	15	4,960

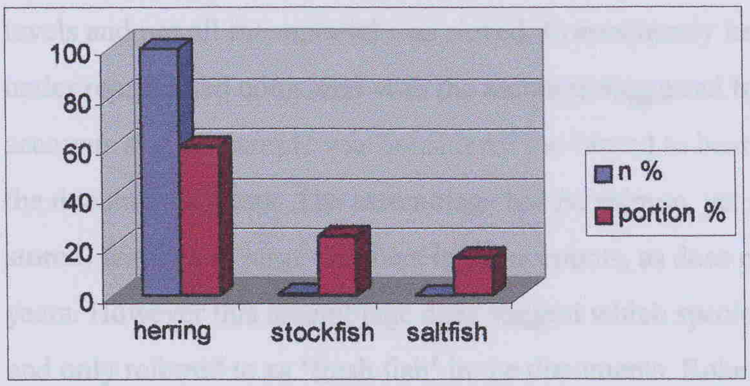
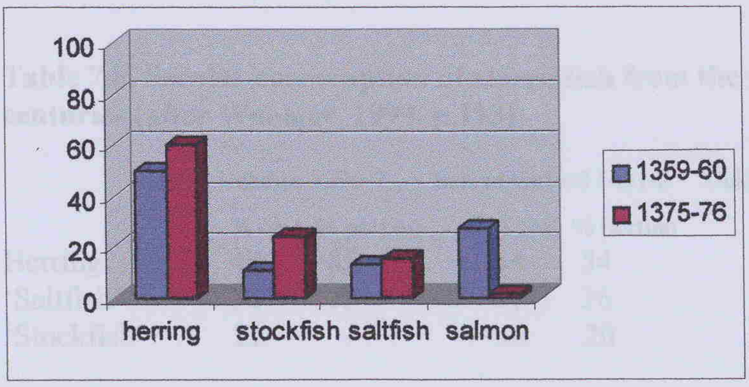


Figure 7.8. Battle Abbey. Sussex. The stored fish portions including salmon for 1359-60 and 1365-6.

	herring	stockfish	saltfish	salmon	n
1359-60 portion %	50	11	13	27	3,620
1375-76 portion %	60	24	15	1	5,028



The documentary data from Battle Abbey predates that from St Swithun's and Westminster Abbey by nearly two centuries and suggests more herring was eaten there in the second half of the 14th century, than in the late 15th to early 16th centuries at the other two sites. The bar charts for Battle Abbey, with herring as the dominant fish eaten, resemble the 10th/11th century ditch deposits from Westminster Abbey more closely than the documentary data for the late 15th – early 16th century from the other two houses. Unfortunately the fish bone assemblage from Battle Abbey was poor (Locker, 1985), comprising a small assemblage from contexts unlikely to produce rich deposits. There are no kitchen levels and not all the material was sieved. Consequently herring may be very under represented compared with the amounts suggested by the cellarer's accounts and the sample was considered too biased to bear any comparison with the documentary data. The assemblage has no salmon, yet salmon (presumably stored) features in large numbers in the accounts, as does mackerel in the early years. However this assemblage does suggest which species were bought fresh and only referred to as 'fresh fish' in the documents. Roker, conger eel, gurnard, flatfishes (including plaice and turbot) were all identified.

Some data for secular consumption of stored fish from three different households in the 13th, 15th and early 16th centuries cited by Woolgar (1999, p.113) provides a comparison to the monastic records. I have shown the expenditure on herring, 'saltfish' and 'stockfish' as percentages and also the same data based on numbers of fish converted into **portions**.

Table 7.6. Secular consumption of stored fish from the late 13th to early 16th centuries (after Woolgar, 1999, p.113).

	Joan de Valance 1296-7		Earl of Oxford 1431-2		Duke of Buckingham 1503-4	
	% cost	% portion	% cost	% portion	% cost	% portion
Herring	49	85	34	54	16	20
'Saltfish'	30	15	50	26	72	55
'Stockfish'	21	- [17]	16	20	13	25

The evidence from these three households suggests a decline in herring consumption and an increase in 'saltfish', while 'stockfish' remain comparatively

[17] Number of fish not known

static. A decline in herring in favour of other types of stored fish is a trend supported by much of the data sample as I will show.

Application of the portion method to bone assemblages.

In applying this method to fish bone assemblages, by which bone numbers are converted to **portion** to show the show the comparative volume of these species, some account needs to be made for the mixed remains of whole[18] and stored fish. For herring and whiting the number of bones are 87 per fish, regardless of their state. For the large gadids (including haddock) the presence of skull bones and precaudal vertebrae in the assemblage indicates the presence of whole fish, while appendicular bones and caudal vertebrae may be from whole fish or stored[19] fish.

Since stored fish formed a major part of fish consumption, as shown by the documentary data described above, it has therefore been assumed that all skull and precaudal vertebral elements indicate whole fish. Appendicular and caudal vertebral elements are treated as from stored fish[20], this assumption has been followed throughout.

Where **only** cranial and precaudal elements are present for a large gadid species these are divided by 87 (as whole fish) and multiplied by the portion amount to give the portion total.

If **only** those elements indicating storage (appendicular elements and caudal vertebrae) are present, these are divided by 28 and multiplied by the portion amount to give the portion total.

When all elements are present some adjustment needs to be made between the two groups of bones. The total number of cranial and precaudal vertebral elements is divided by 59 (the number of non stored elements of the total 87) and

[18] Skeletally complete and considered fresh in the large gadids.
[19] 28 bones.
[20] Though they could also be from whole fish.

multiplied by 87. This number (the whole/fresh fish total) is taken from the total number of bones from the species giving the stored fish total.

The whole/fresh fish total is divided by 87 and multiplied by the portion.
The stored fish total is divided by 28 and multiplied by the portion.
The two portion totals are added together and equal the total portion size for that species.

The data for the bones from the Westminster Abbey ditch are shown as an example where cod has both whole and stored elements. Had cod been treated as stored fish only the **portion** would have been 6.85714, or as whole fish equal to a **portion** of 2.2069, the percentage of cod would have been alternately suppressed and inflated. The different treatment of the two groups of bones takes into account the effect of different bone signatures.

Table 7.7. Data for Westminster Abbey, showing the adjustment for whole and stored cod.

Species	*n*	*stored*		*whole*		*portion*	*%*
Herring	2881[21]					6.62989	42.08
Cod	48	18.5084[22]		20 div 59 x 87 = 29.49153			
		2.64406[23]	+	1.35593[24]	=	4.0	25.39
Haddock	19[25]					0.67856	4.31
Whiting	774[26]					4.44828	28.23
					Total portion	15.75673	

Discussion of the portion method.

[21] Multiply by 87 divide by 5 = portion
[22] 48 – 29.49153 = 18.5084
[23] 18.5084 div 28 x 4 = portion
[24] 29.49153 div 87 x 4 = portion
[25] div by 28 = portion
[26] div by 87 div by 2 = portion

The methods described and applied to documentary data from three monastic houses have shown fish assemblages presented in different ways depending on the questions asked of the data. As a catalogue of fish species that were eaten, the total number of bones for each species indicate the prolificacy of different species and which of those predominate as numbers of fish. However some questions still remain. Are fish remains viewed as numbers of individuals, or bone counts, or fish as food? In other words 'how many fish were there' or 'how much fish did they eat'?

In assemblages of domestic consumption 'how much' may be more appropriate than 'how many' therefore making **portions** the preferred approach over bone numbers. However, any conversion of the data beyond **n** or number of bones (the only real factor of the data however flawed through survival or selectivity) runs the risk of decreasing the integrity of the sample, but the method of dividing the fish into portion sizes is based on historical record. Applied with caution to herring and the gadid species, which formed the major part of fish eaten across the period of study, this method is a progression from the original bone count. **Portion** addresses the question of 'how much' in a relative sense and advances the interpretation of the presence of these species beyond an acceptance that herring is over represented by bone number.

Method B. Body part representation of the large gadids as an indication of the presence of stored fish.

It has been established that the larger fish (over 35 cms in length) required gutting and the discard of certain skeletal elements for storage in order to reduce excess weight. Initial work, looking at the distribution of skeletal parts of stored fish of the larger gadids after processing, was based around those skeletal parts most likely to survive as determined by Barrett (1997) in a study of Norse sites in Orkney and Caithness. These included the singly occurring vomer and parasphenoid and the paired maxillaries, dentaries, articulars and quadrates for the cranial area. Appendicular bones comprised the paired cleithra and posttemporals. Looking at the range of different anatomical elements regularly identified from my own sites I have expanded this list to include the following:

- During processing certain paired cranial bones are discarded as part of the head. These include; 1 vomer, 1 parasphenoid, 2 premaxillae, 2 maxillaries, 2 dentaries, 2 articulars, 2 quadrates, 2 hyomandibulars, 2 ceratohyals, 2 epihyals, 2 operculars, 2 suboperculars, 2 interoperculars and 2 preoperculars

- For the appendicular skeleton, retained in the stored fish, the paired cleithra, posttemporals and supracleithra were included.

- Vertebrae were counted and divided into two groups: precaudal or caudal.

- The 'signature' of a whole fish, the remains of fish processing and stored fish were estimated as;

Whole fish (**W**) Cranial elements = 26 (30%) Appendicular elements = 6 (7%)
Precaudal vertebrae = 33 (38%) Caudal vertebrae = 22 (25%)

Stored (**S**) Cranial = 0 (0%) Appendicular = 6 (21%) Vert. approx 22 (79%)

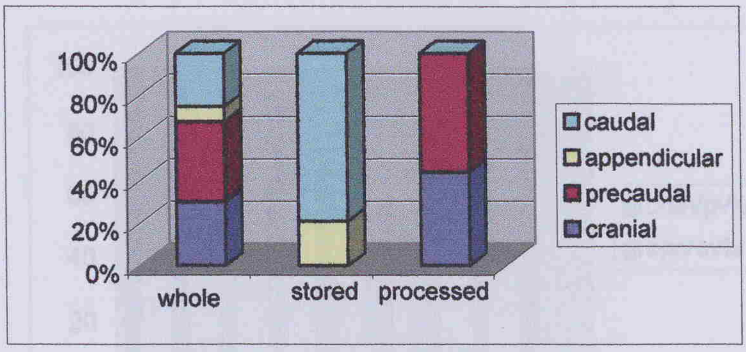
Processing (**P**) Cranial = 26 (44%) Appendicular = 0 (0%)Vert. approx 33 (56%)

These proportions are shown in three comparative columns in Figure 7.9 which gives an idealised representation of the proportions or 'bone signature' for each type of bone waste.

The inclusion of a greater range of elements than at Barrett's (1997) Norse sites in Orkney and also Freswick in Caithness studied by Jones (1995), may have been facilitated by differences in survival and recovery between my data sample and these coastal sites. The former were large deposits of fish bones, mainly large gadid, from coastal fish processing sites, whereas my sample is largely from deposits of domestic consumption and not directly on the coast.

Figure 7.9. The proportion of cranial, appendicular and vertebral elements in the large gadids ideally representative of whole fish, stored fish and processing waste.

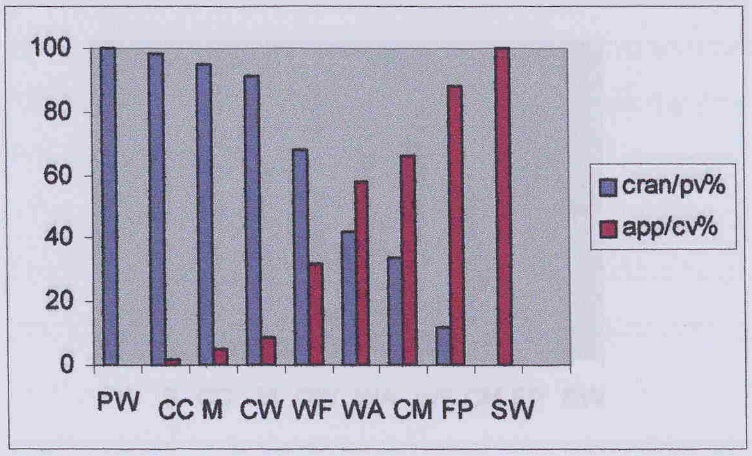
		whole	stored	processed
cranial	%	30	0	44
precaudal vert	%	38	0	56
appendicular	%	7	21	0
caudal vert	%	25	79	0



In the chart in Figure 7.10 the cranial elements and precaudal vertebrae are one bar for each group, appendicular elements and caudal vertebrae the other. The ideal proportions denoting the waste from whole fish, stored fish and those from processing activities are shown in decreasing percentages of cranial elements and precaudal vertebrae starting with processing waste (PW) at 100% on the left. Whole fish (WF) are midway and stored fish (SF) remains at the extreme right. The cod data from selected phases from a few of my sites have also been included, ordered in decreasing percentages of cranial and precaudal elements. It is noticeable that the sites from Hartlepool; Church Close, Church Walk and Middlegate, are closest to processing waste, having a high proportion of cranial elements and precaudal vertebrae. Other assemblages from Castle Mall and Westminster Abbey are closer to whole fish and mixed waste, while the cod from the Fleet Prison are compatible with the remains of stored cod.

Figure 7.10. Cranial elements and precaudal vertebrae versus appendicular elements and caudal vertebrae of cod from selected sites.

	site	cran/pv %	app/cv %
Processing waste	*PW*	*100*	*0*
Church Close	CC	98	2
Middlegate	M	95	5
Church walk	CW	91	9
Whole fish	*WF*	*68*	*32*
Westminster Abbey	WA	42	58
Castle Mall	CM	34	66
Fleet Prison	FP	12	88
Stored waste	*SW*	*0*	*100*

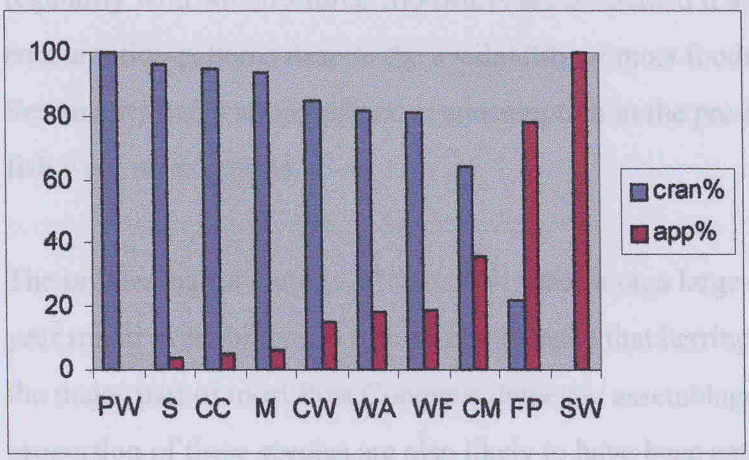


As vertebral centra were not always divided into precaudal and caudal for all data only cranial and appendicular elements were plotted for comparison in Figure 7.11. The proportions between the two were calculated as follows;

Whole (W)	Cranial = 26(81%)	Appendicular = 6 (19%)
Stored (S)	Cranial = 0 (0%)	Appendicular = 4(100%)
Processing (P)	Cranial = 26 (100%)	Appendicular = 0 (0%

Figure 7.11 Cranial versus appendicular elements of cod from selected sites.

	site	cran %	app %
Processing Waste	*PW*	100	0
Southgate	S	96	4
Church Close	CC	95	5
Middlegate	M	94	6
Church Walk	CW	85	15
Westminster Abbey	WA	82	18
Whole Fish	*WF*	81	19
Castle Mall	CM	64	22
Fleet Prison	FP	22	78
Stored Waste	*SW*	0	100



Using the data from the same assemblages and similarly ordered in descending cranial percentage the distributions are similar in both charts, though Church walk and Westminster Abbey are close to whole fish in Figure 7.11. Southgate has only been included in this chart since the vertebral divisions were insufficient for inclusion in Figure 7.10, but it groups closely with two of the Hartlepool sites as processing waste.

Discussion of the body part method.

In the display of the bone signatures for whole, stored and processed waste shown in Figure 7.9 the data shows divisions uncluttered by mixed material. In reality the separation is rarely so clear cut, particularly when the assemblages are of domestic consumption. Here disposal is likely to be of a mixed nature being the accumulation of the debris from a number of activities such as kitchen preparation and table waste of both fresh and stored fish. This is demonstrated by the assemblages plotted in Figures 7.10 and 7.11 closes to whole fish but with stored fish elements. Nevertheless they do show some evidence for zoning, implying that this method has the potential to suggest the state of the large gadids in consumption deposits and as such is explored further in the data sample.

The relationship of stored fish with other species in the assemblage.
Repetition is usually a strong theme of bone assemblages. A reflection of the regularity with which similar foodstuffs are consumed it still pervades today's consumption patterns despite the availability of most foods through all seasons. Seasonality had a strong effect on consumption in the pre-industrial period and fish were no exception.

The processing for storage of some fish species on a large commercial scale gave year round availability. So it is no coincidence that herring and the gadids form the major part of most Post Conquest domestic assemblages, although a proportion of these species are also likely to have been eaten fresh. A method for portraying herring as a volume of fish compared with the large gadids has been shown and supports herring as a key food fish during this period, though not as dominant as suggested by quantifying the assemblage by a bone count. This trend is of particular significance when the fish assemblages in the data sample are tested by both methods. However the repeated dominance of these species indicates they were the basis of fish consumption prior to the improved transportation and ice storage of the late 18th century.

Other species common in fish assemblages may also have been stored. These include eels, salmon, flatfishes, and the elasmobranchs[27]. The poor preservation of salmonids, rays and sharks has already been discussed and they are likely to be

[27] Indicated by documentary records.

seriously under represented. These four groups of fish occur regularly but on a lesser scale to herring and the gadids, the latter often comprise more than 80 % of the assemblage by number. However differences between these other species, often present in low numbers and small fish such as cyprinids, sprats and eels, may reflect site location and seasonal fisheries. These aspects have not been included here as comparison could only be made by bone numbers and not as a volume of food since there are no portion data for these species.

Summary.

In this chapter I have sought to describe two methods of looking at fish bone data. These are intended to give some insight into the relative proportions of storable fish as food within a sample delimited temporally and/or spatially. The **portion** method is a comparative measure by volume against the number of bones counted (**n**). The latter favours small fish on two counts: more of them are needed to provide the same amount of flesh as a large fish and they are more likely to be skeletally complete. By showing the same data by **portion** it is possible to view each species or type of fish as a volume of food and make comparison with the number of fish/bones present.

The **body part** method divides the data from larger fish, subject to skeletal reduction during processing for storage, into anatomy groups that may signify particular waste. The documentary evidence for processing suggests the inclusion and exclusion of cranial and appendicular elements is more consistent than that of vertebrae. However data displayed both with and without vertebrae gave very similar results (Figures 7.10 and 7.11) suggesting the inclusion of the latter, even as a simple division into precaudal and caudal, is worthwhile.

Herring and the gadids represented a narrow range, in terms of the species of fish eaten, but a clearly very significant part by volume of fish consumption in the Medieval and Post Medieval period. It is the relative importance of these species and the evidence of storage in the bone distributions of the large gadids that is to be determined in the data sample.

CHAPTER 8. Conclusions to Part 2.

In chapter 6, the first chapter on methodology, I have discussed the vagaries of survival and recovery, both major influences on the fish bone assemblage and raw data. The former is not quantifiable but the effects of differing soil mediums and the condition of the bones before disposal have been mimicked in controlled experimental work for fish bones, most recently by Nicholson, (1996). The results give some indication of accelerating bone deterioration determined by pre and post depositional conditions. But it is difficult to relate experimental work back to the disconformity of survival within occupational debris, where the mixture of different materials may create discrete pockets of contrasting preservation conditions within the same feature.

Any analysis on excavated archaeological materials relying on the proportions of surviving materials, in this case species or particular elements of fish, has to accept some inevitable unquantifiable losses. These losses can be subjectively assessed from the surviving material. For example, the survival of small friable bones with clear definition around the edges is an indication of good preservation, while flaking, eroded bone suggests poor preservation.

The level of recovery of the surviving bone is determined by the sampling programme and I have shown the effects of varying mesh sizes used in sieving. If the material is sent for analysis, extracted, washed and bagged without a pre sampling discussion of desirable mesh sizes the level of recovery may be biased against small species or certain contexts. It is crucially important to be aware of the mesh sizes used. Otherwise interpretation of the assemblage may view the absence of small fish or over representation of large fish as having meaning rather than a factor of recovery.

The detail of my bone record gives wide scope for a full data base when, if justified by the quality of the material, an informed interpretative case can be made for comparative fish volume as represented by **portion** and evidence of storage for the large gadids by **body part**. These are both described fully in chapter 7 where the evolution of the **portion** method is shown using three sources of documentary data from which model assemblages of stored fish bones were created. This is the reverse of using archaeological fish assemblages to calculate portion back from bone numbers as applied in chapter 10.

The comparison of fish by volume and therefore as food, in Figures 7.1 and 7.2, shows the large numbers of herring bones required to be of equal volume or portion to the larger gadid species. The **portion** method was applied to herring and forms of stored cod and allied species and showed the importance of herring against stored cod at Battle Abbey in the 14th century, (see Figures 7.6 and 7.7). While in the later early 16th century records for St Swithun's Priory (Figure 7.3) and late 15th to early 16th century at Westminster Abbey (Figure 7.5) various forms of stored cod were clearly favoured over herring. The latter is in contrast with the 10th to 11th century archaeological data from the Abbey, where herring were dominant. These data support a move away from herring at some monastic houses in the period just prior to the Reformation. However the **n** data, based on the number of bones, would suggest herring was the most important fish at St Swithun's, second to whiting at Westminster Abbey in the documentary data and 99 % of the fish at Battle Abbey. It is this misrepresentation of herring that I have sought to redress by using **portions**.

In the documentary data it is possible to determine stored herring, referred to as 'red', 'white' or 'salt' from the fresh. When the archaeological herring assemblages are used there is no clear evidence for stored fish from skeletal evidence since herring are stored whole. Enghoff's (1996) evidence for the absence of elements of the throat, removed during a particular method of gutting herring prior to storage, has not been investigated for the herring in my data sample since it could not be applied rigorously throughout.

The significance of the elements retained in stored fish for the larger gadids (cod, haddock, ling, hake, pollack and saithe) lies in their potential to act as markers for stored fish and determined by looking at the distribution of bones or **body parts**.

The presence or absence of certain skull elements and precaudal vertebrae was also used to adjust any over representation resulting from considering all fish bones to be from stored fish, as described in chapter 10. This distribution of different elements in stored and fresh or whole fish has been used before in deposits where the debris of fish processing has accumulated. It has not previously been applied in the context of mixed debris of consumption waste shown in chapter 10.

Certainly by modern day standards the portion sizes recorded for monastic houses and forces ration are very large, 4 herrings or a ¼ of stored cod as a single portion. In terms of calories two herrings were considered ample animal protein per day for a working man in 1948, (Comrie, 1948, p.638). Harvey (1996, p.66) has commented on the high volumes of protein consumed by the monks, particularly outside the fast periods, as reflecting the 'upper-class character of monastic diet'. However there is evidence that these generous portions were part of charitable food alms as leftovers and also for the feeding of servants. The size of naval rations has no explanation for surplus, but the records of poor quality and deterioration are suggestive of a high level of waste.

Whether the quantities are considered large does not affect their validity as equivalent volumes of food or **portions** between species since the amounts are comparative. The application of this method to the archaeological samples in part 3 shows a changed perception to many assemblages dominated by herring by bone numbers.

PART 3: The Data Sample

CHAPTER 9. The archaeological sites comprising the data sample.

Introduction.

The location, chronology and status of the sites as well as the quality of the assemblages has a direct effect on the interpretation of the fish bone data and in this chapter I will present the background to the archaeological sites from which the data are drawn. The fish bone assemblages are largely from sites of domestic consumption. Work on defining evidence of storage from fish bones has previously been concentrated on production, particularly for the large gadids. The evidence has been mainly from sites in Northern Scotland and adjacent islands, where processing waste has been identified, (Barrett, 1997, Ceron-Carrasco, 1998 and Jones, 1995).

Within the range of sites I have chosen, all of them in England, there is the opportunity to look for evidence of stored fish in different types of domestic refuse. The sites show a range of locations, type and chronology, including some examples of fish processing. The majority are domestic deposits and represent the ultimate disposal of fish in which many of the larger species have been reduced skeletally for storage, then transported and eventually prepared for eating. What remains is discarded with other domestic debris.

The assemblages from all 20 sites of the data sample have been analysed by the author. The value of these sites has also been judged on qualitative and quantitative factors and Tables 9.1 and 9.2 summarise the chronology and quality of the assemblages.

Table 9.1. Chronological range of fish assemblages from each site.

Site	C10th	C11th	C12th	C13th	C14th	C15th	C16th	C17th
Hartlepool								
Southgate			+	+				
Middlegate			+	+	+	+	+	
Church Close				+	+	+		
Church Walk	+		+	+	+	+		
Norwich								
Castle Mall		+	+	+	+	+	+	+
St Martin-at-Palace Plain		+	+		+	+	+	
Fishergate	+	+	+	+	+			
London								
St John's Priory, Clerkenwell					+	+	+	
St Mary's Clerkenwell			+	+	+	+	+	+
St Mary Graces					+	+	+	+
St Mary Spital		+	+	+	+	+		
Westminster Abbey	+	+						
Fleet Prison				+	+	+		
Other								
Battle Abbey, Sussex		+		+	+	+	+	
The Parade, Plymouth					+	+	+	
Victoria Street, Bristol			+				+	+
Eynsham Abbey, Oxon	+	+	+	+	+	+	+	
Nonsuch Palace, Surrey							+	+
High Street, Huntingdon			+	+	+			
The Brooks, Winchester	+	+	+	+	+	+	+	

The map, Figure 9.1, shows the location of sites in England. For London, Norwich and Hartlepool, where a number of sites are discussed, the insets in Figure 9.2 show the location of each site within the city or town. These are discussed as discrete parts of a large settlement with access to the same markets.

Coastal sites.

These are either located on the coast or with easy access to it by a main river.

Hartlepool, Cleveland.

The headland on which the Medieval town of Hartlepool developed (see inset on Figure 9.2) formed a small harbour. The town and port was founded by the de Brus family in the late 11th or early 12th century and prospered through the

Middle Ages, primarily from the handling of cargoes and fishing. Imports included cloth, wine, wool, oil and figs, while exporting corn and fish.

The majority of the trade was coastal, though there is also evidence for wool trade with the Low Countries. At the end of the 13th and during the 14th centuries the port supplied the English armies and garrisons in the Scottish Wars.

Table 9.2. The level of recovery, supplementary evidence and number of identified fish bones for all species at each site.

Site	Sieving			Specific	Documentary Evidence		n
	Hand	Coarse	Fine	Activity	Direct	Indirect	
Hartlepool							
Southgate	+		+			+	4,323
Middlegate	+		+			+	4,460
Church Close	+		+				2,101
Church Walk	+						656
Norwich							
Castle Mall	+	+	+				14,443
St Martin-at-Palace-Plain			+				4,416
Fishergate			+				748
London							
St John's Priory, Clerkenwell			+			+	987
St Mary's Clerkenwell			+	+		+	2,867
St Mary Graces			+	+		+	8,606
St Mary Spital			+				1,493
Westminster Abbey			+		+	+	9,610
Fleet Prison			+			+	4,333
Other							
Battle Abbey	+		+		+	+	206
The Parade, Plymouth			+				474
Victoria Street, Bristol			+				5,968
Eynsham Abbey, Oxon	+		+	+		+	6,912
Nonsuch Palace, Surrey		+		+			908
High Street, Huntingdon			+				2,728
The Brooks, Winchester	+		+			+	470
							76,709

Figure 9.1. The location of sites in the data sample.

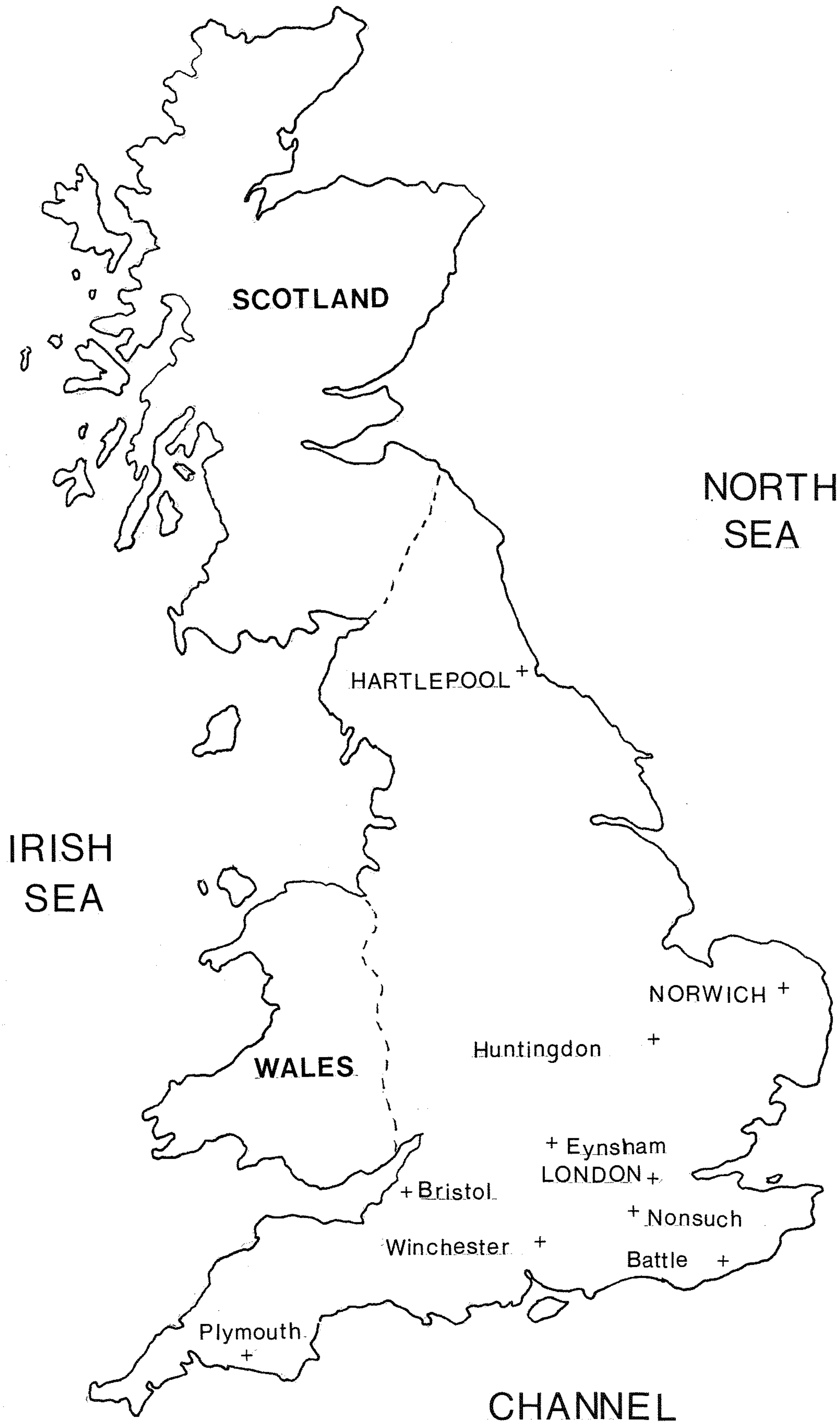
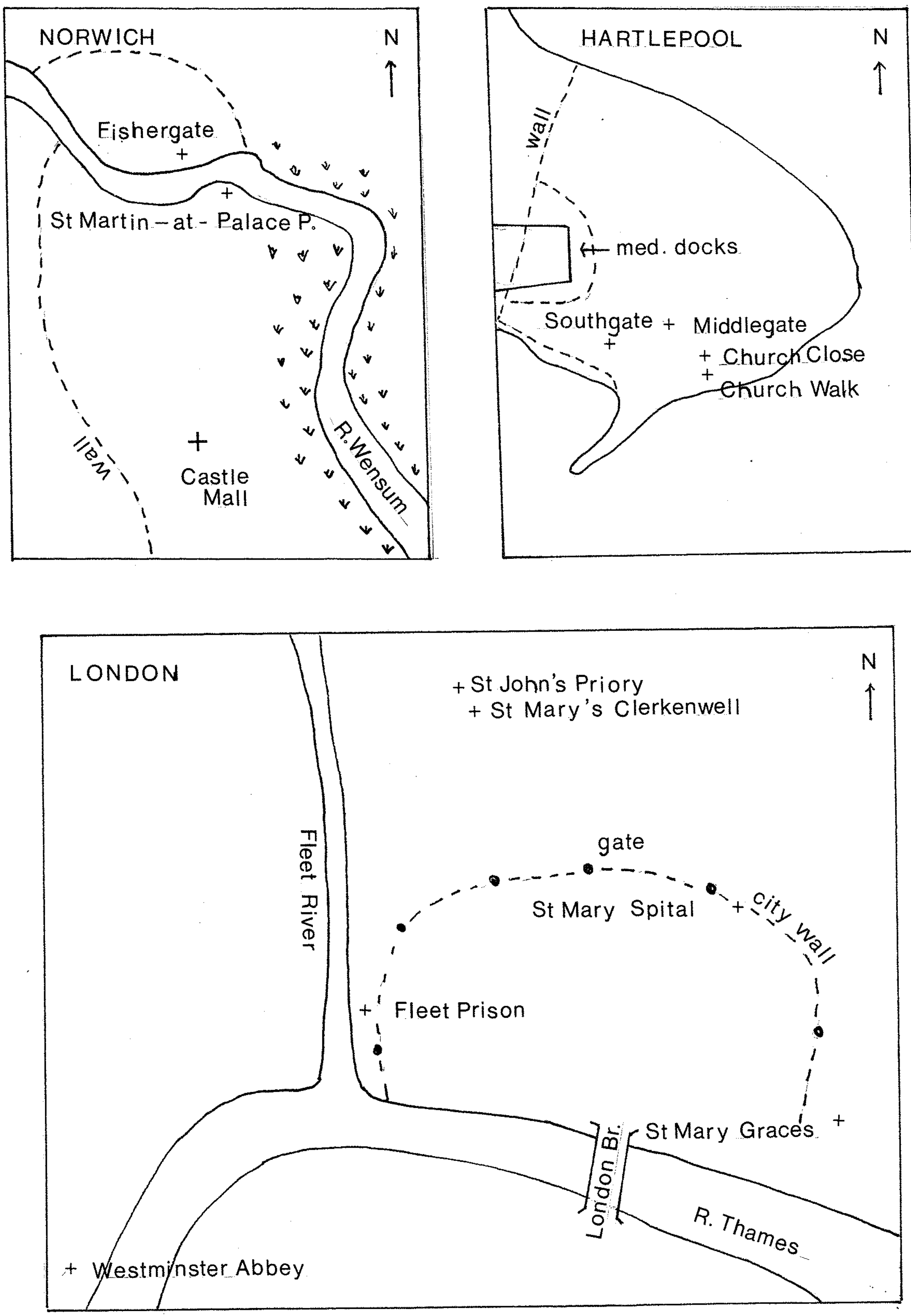


Figure 9.2. The location of sites in Norwich, Hartlepool and London.



The main fisheries at Hartlepool in the early 19th century were based on cod, ling, haddock and whiting on lines, in both winter and summer and a herring fishery from August to March, (Sharpe, 1816). Sharpe also described Hartlepool in the early 19th century as 'better adapted for the establishment of an extensive fishing colony than any other port in the kingdom'. This may be the biased view of a local, but the fish assemblages confirm a long history of fishing for herring, cod and other gadids. The salting and drying of cod was still carried out on the rocky coast between Whitby and Hartlepool as late as 1874, (Cutting, 1955, p.167).

The fish were identified from four excavations on the Medieval headland shown on the inset map in Figure 9.2.

Southgate. Two excavations revealed deposits that had accumulated within and on the floor of the 12th century dock. Preservation was good and the fish assemblage, recovered by bulk sieving, is considered to be contemporary with the dock. Aided by natural silting the dock was reclaimed by the middle of the 13th century. Later deposits had been heavily disturbed and have not been included in the analysis, (Locker and Rackham, 1987 and Locker, 1983).

Middlegate. Excavations close to Southgate revealed waterlaid deposits of the 12th to 13th centuries followed by reclamation, backfill and subsequent use in a succession of buildings on land divided into two properties. The buildings are thought to have been used for industrial and commercial activities and contained a number of ovens and drains. The former may have been used in the provisioning of the English forces. In March 1300 the *Godale* of Hartlepool was one of eight ships supplying victuals to Edinburgh Castle, both herrings and 'stockfish' were an important part of those supplies, (Prestwich, 1967, p.540).

The fish assemblages are both from sieved samples and hand collection. They date from the late 13th century to the beginning of the 16th century (Locker, 1988) at which time the site was abandoned and the whole town was in a state of decline.

Church Close. A small sample of fish was associated with alleyways, buildings and ditches from the 7th century monastery of St Hilda. Early Medieval/ Conquest ditch deposits associated with cultivation contained a small assemblage of fish. The main sample came from the industrial use of Medieval buildings, their associated alleyways and garden soils. These date from the 13th to the 15th centuries and represent the use of stone buildings. Some of these buildings contained ovens, as at Middlegate and are thought to be for industrial or commercial use. They may be connected with the coastal trade of the port or military supplies as described above, (Locker, 1987a and 1990). The presence of both hand collected fish bones as well as those retrieved from sieving has influenced the manner in which this material and that from Middlegate has been used. The hand collected bone has a restricted application as will be seen in the next chapter.

Church Walk. Located just south east of Church Close the fish from these deposits date from the Anglo Saxon period, but are mainly from the 12th to 15th centuries. These deposits are secular and biased by hand collection towards the larger species. There is, however, a substantial sample of large gadids (Locker, 2000a) and these have been included in the body part representation where they concur with the other Hartlepool sites showing some evidence for processing.

Norwich, Norfolk.

The Anglo Saxon settlement at Norwich developed on the banks of the river Wensum some 40 miles in from the coast. Rivers Wensum and Yare were navigable down to the sea, just south of Great Yarmouth. Norwich was a seaport until the middle of the 12th century when excessive silting in the river resulted in goods being transferred from sea to river craft with a shallow draft to be brought up river.

By the 14th century Norwich had grown to become the major settlement of the region, (Ayres, 1994, p.53). It remained an important centre for curing herring with a major fishery off the East Anglian coast, (Williams, 1988, p.168). Other industries, notably cloth, led to it becoming the largest walled town in England by the 14th century. Development continued and the population doubled between the 16th and 17th centuries. Norwich became increasingly important as a regional centre, attracting much trade, with textiles remaining dominant.

There are fish assemblages from three sites;

Castle Mall. Excavations took place in the south bailey of the castle and on an adjacent area of settlement. Occupation deposits were continuous from before the Conquest in the late 9th century. The building of the castle was begun, in earthwork and timber, by the 1060s and by 1100 covered some 14 acres. The castle was a royal foundation, but rarely used by royalty. There is little evidence of status from the finds, including both the mammal bones (Albarella et al, 1997) and fish bones, (Locker, 1997a). The keep was used as a prison from 1300 and the castle declined as the city flourished.

Much of the material, particularly from the 13th century, represents the debris of the growing city. A number of tenements are recorded in the vicinity as well as evidence of crafts and industries. There was a period of decay in the late 14th to mid 16th centuries and evidence of industrial activity and rubbish dumping was found in the castle banks and ditches. The fill of the Barbican Well, thought to have provided a defended water supply in the gatehouse, was of 15th to mid 16th century in date. A rich fish assemblage from this feature reflected the occurrence of species from the rest of the site.

The decline of the castle continued through Post Medieval times as the city grew, culminating in the 18th century when the area was landscaped for use as a cattle market. The development of the site from before the Conquest demonstrates that the finds represent the domestic and commercial debris of local inhabitants and reflect little on the occupation of the castle.

The fish assemblage from the excavation was large with over 14,000 bones identified to species or family level. Bones were collected by three methods: by hand, a coarse 8.00 mm sieve used on site (site riddling) and bulk sieving to 0.5 mm. The fish from the Barbican well have been used as an example of recovery by different methods and already discussed in Chapter 6. The assemblage spans all periods of occupation and shows great homogeneity of species in the different periods.

St Martin-at-Palace Plain. The site was close to the bridging point of the river in the N E part of the walled town. Well placed for a commercial waterfront, dumped material was used to consolidate a landing place for boats. Fish assemblages were dated to the 11th and 12th centuries from Saxo-Norman and Norman deposits on a street frontage, (Locker, 1987b). Commercial activity on the waterfront is thought to have declined after the 12th century and was replaced by small scale industrial activity. Documentary evidence has shown a dye works sited there and there is archaeological evidence for iron smelting, (Tillyard, 1987, p.143). A Medieval fish assemblage is associated with buildings of 14th to 16th century date.

Fishergate. Located close to St Martin-at-Palace Plain, but north of the river, fish bones were recovered from 10th to 14th century waterfront dumped deposits, (Locker, 1994b). Fishergate and St Martin-at-Palace Plain are similar, both representing an area of the town where cargoes were loaded and unloaded. Industries producing odours and organic waste, such as fulling, tanning and skinning and consequently marginalised in their location, were also located here.

London.

The growth of London has already been described including the accelerated population increase from the 16th century. London was always a major port directly accessible to the coast via the Thames estuary. The London fish markets attracted foreign and regional imports as well as the fish from local fleets operating in the North Sea. Ports and Customs books of the late 15th and mid 16th

centuries (Cobb, 1990 and Dietz, 1972) record many different varieties of salted cod, ling and pollack, barrels of cods heads, eels in various forms, white and 'shotten' (spawned) herring, sturgeon and salmon. These were chiefly imported from Amsterdam, Hamburg, Danzig, Harlem and Flushing, usually as part of a mixed cargo belonging to a number of merchants.

The demand for fish was met through commercial markets selling wholesale to merchants on to fishmongers, stock fishmongers and costermongers. The latter operated on a small scale with no fixed premises and represent the lowest end of the commercial chain.

Six sites have been chosen with securely dated fish assemblages. All except the Fleet Prison represent monastic and Post Dissolution secular occupation. The monastic assemblages should all be regarded as high status, which continued after the Dissolution when the buildings were taken by the crown, or subsequently given as gifts by the king. The map inset in Figure 9.2 shows the location of the sites.

St John's Priory, Jerusalem. Located in Clerkenwell, the priory was founded in 1100 by Baron Jordan de Bricet and later became the chief seat of the Templars in England. Most of the fish assemblage belongs to the Post Dissolution use of the buildings, when the church and house was seized by Henry VIII and maintained during his reign as a storehouse 'for the kings toils and tents', (Stow, 1603, p.387). The fish assemblage (Locker, 1996a) is small and includes the middle 14th and middle 15th century deposits of monastic occupation. The small assemblage associated with the Templars' occupation is largely from a possible pond backfill and has no direct association with particular buildings. The majority of the assemblage is the Post Dissolution fill of two rubbish pits and a cesspit.

St Mary's Clerkenwell. The Augustinian nunnery of St Mary de Fonte was a joint foundation with St John's and was founded around 1144. The early buildings were of timber, but rebuilding in stone took place by 1200. There is some evidence that it had been a joint house with 'brethren', relatively common in the 12th century. A period of poverty followed, but by the early 16th century some refurbishment took place. The nunnery held endowments in the form of lands and churches in a number of counties as well as properties in the city. Just prior to the Dissolution, there were only 11 nuns, but it was still the twelfth richest nunnery in the country. After the Dissolution the estate was owned by a number of knights and some buildings survived until the 18th century. The fish assemblage dates from the 12th century through the Post Dissolution occupation of the site, (Locker, 1996b). They include kitchen deposits from all periods before the Dissolution. Most of the fish from Post Dissolution deposits are from a cloistered walk and garden soils.

St Mary Graces, Tower Hill. This Cistercian monastery was established by Edward III in 1360 and became the third wealthiest Cistercian[1] house by the time of the Dissolution. The abbot entertained visiting abbots and royal guests in a separate residence, emphasising its high status. The fish assemblage from this period is from the Reredorter[2] and some isolated features including a rubbish pit. After the Dissolution the site was briefly used as a manor house from 1539-60 and fish were recovered from a cesspit fill dated to this period. In 1560 it was taken over as the Naval Victualling Yard. The fish assemblages from the Victualling Yard cover the three phases of use, 1560-1635, 1635-1726 and 1726-1785. The bones were recovered from drains and pit fills. The largest assemblage came from the middle period of use, (Locker, 1992a). The remains are thought to represent the meals of the staff working there and not naval rations, (West, 1995). The final use of the site was as the Royal Mint from which there were no fish bones recovered.

The Hospital and Priory of St Mary Spital. Located on the east side of Bishopsgate, this important Medieval hospital was attached to an Augustinian

[1] Cistercians were vegetarian and ate no meat or lard only fish (Knowles, 1966, p.641).
[2] Lavatory area behind a monastic dormitory.

Friary founded in 1197. Seven sisters and five lay brothers tended to pilgrims, widows and the sick poor including pregnant women and orphans. The house fell into disrepair and poverty during the 14th and 15th centuries, which was attributed to a drop in property values, winter flooding and the Black Death. Before the Dissolution some of the buildings were already leased out and afterwards they were granted out. One of the recipients was the Mayor of London who allowed the sick to remain in the hospital for the rest of their lives. The fish bones are from a small series of excavations and span the foundation of the Priory to the Post Medieval secular occupation, (Locker, 1992b). The deposits associated with the Priory are mainly pit, latrine and drains fills. The Post Dissolution assemblage is from cesspits and drain fills also used for other debris.

Westminster Abbey. Founded as a Saxon monastery on Thorney Island in the Thames, the monastery lost island status when areas of marshy ground were subsequently reclaimed. Fish were recovered from the 10th to mid 11th century deposits, mainly domestic food debris from a single ditch, (Locker, 1989). At that time the monks still adhered to the restrictions on meat consumption laid down by St Benedict. A later Medieval fish assemblage, analysed by Jones (1976), relates to a period when the interpretation of what constituted meat and where it could be eaten circumvented the rule. The late 15th century and early 16th century kitchener's day books survive and show the food served at each meal over a specific period. Together with the cellarer's and the pittancer's accounts [3], these records have been used as evidence of monastic diet, (Harvey, 1996).

The Fleet Prison. A series of excavations in the Fleet Valley included some deposits associated with the Fleet Prison, first built in 1080. Fish remains were found in construction levels of the middle 13th century perimeter wall and the late 13th to late 15th century occupation, repair and clearance of the moat. Deposits from the 16th century rebuilding and the early 17th century occupation and destruction levels also contained fish bones, (Locker, 1994c). Prisoners bought or provided their own food while incarcerated, so the fish may be the remains of

[3] The pittancer served extra dishes of varying size and quality.

their meals. A single pectoral fin spine of sturgeon from a Tudor pit is suggestive of a high status meal. These fish were highly prized and used to migrate up the Thames, until the water became too polluted.

Battle Abbey, Sussex.

This was a Benedictine house founded by William the Conqueror in thanksgiving for his victory at the Battle of Hastings. Excavations in the Dormitory range, Chapter House and Reredorter were not promising areas for the recovery of fish bones. The deposits were not routinely sieved and only a small assemblage was found. Most of the sample is from the later Post Dissolution occupation, with small numbers of bones from the Norman, 13th century rebuilding and later Medieval occupation, (Locker, 1982 and 1985). A few bones (16 in total) of cod, haddock, whiting and ling represented species that may have been stored found in Pre Dissolution deposits. No herring or other small fish were present in these earlier levels, a reflection of poor recovery. A change in the focus of occupation during the Post Dissolution use of the Abbey, as a country house by the Browne family, led to a greater accumulation of deposits and recovery of small bones including herring. The Chapter House and around the Reredorter provided most of the assemblage, which proved too selective to be of value to the data sample, but has indicated some of the species eaten fresh.

The paucity of the assemblage is compensated by the survival of the cellarer's accounts from 1275-1513, (Searle and Ross, 1967). This is a rare coincidence of the two sources of evidence and has proved an invaluable source of information for the price and market origin of fish bought. Marine fish were bought from London, both shipped round the coast and brought by road. They were also bought locally from Rye, Pevensey and at the gates of the Abbey. Employees of the Abbey were paid expenses to find fish for the cellarer. The accounts are very detailed for stored fish and show both 'red' and 'white' herrings were bought (see Table 7.4) as well as fresh herrings to be cured at the abbey. Herrings were bought in large numbers, though this is not evident from the fish assemblage. The 'fish' referred to in the accounts and eaten fresh may have included conger eel, gurnard and plaice found in Pre Dissolution deposits, as well as roker, eel, and turbot from the 17th century levels. Freshwater fish were absent from the assemblage, apart from two bones classified as 'cyprinid', yet it is documented that the monks caught fish in their own ponds and from a weir at Peppering Eye. Their absence may be a feature of the paucity of the assemblage. They could also have been reserved for the abbot and his guests and eaten in a separate dining area and the remains discarded separately.

The Parade, Plymouth, Devon.

Excavation of the 14th-15th century and 16th century foreshore deposits produced an exclusively marine assemblage, (Locker 1997b). The fish species were dominated by hake, with 13 other species only represented by few bones. The hake were largely identified from skull bones, precaudal vertebrae and scales. The presence of these bones is suggestive of the debris discarded after fish processing, prior to salting and/or drying. In contrast the other species show no particular selection of skeletal parts.

Victoria Street, Bristol, Avon.

The excavations covered the area of four tenement buildings and their associated yards and gardens. Ten phases of occupation spanned the 12th to the 17th centuries, though not all the buildings showed continuous use. Deposits producing fish bones included those inside the buildings as well as some rich garden soils. The tenements were adjacent to the Templar, or Holy Cross Church and one of the objectives of the analysis, which remained unproven, was whether any loss of status was suggested by the fish remains after the loss of the church and increasing urbanisation in the area.

The fish assemblage was large (see Table 9.2) with the largest samples from the 14th century. Over half the identified fish were herring in a predominantly marine assemblage, which also had large number of eel, gadids (especially hake) and flatfishes, (Locker, 1999). There was no evidence of changing status.

Inland Sites.

Eynsham Abbey, Oxfordshire.

Another Benedictine house, the fish assemblage dates from the late Saxon Abbey through to the Dissolution, (Locker, 1997c). Some Post Dissolution material was recovered but none of the finds of this date were included in the post excavation work.

The fish assemblage is most abundant from the Norman and Medieval kitchen deposits. The Abbey owned fishponds and leased stretches of river for fishing. In contrast to the assemblage from Battle Abbey the fish from Eynsham included freshwater species which were evidently important in the Norman (before the fishponds were built) and Early Medieval occupation. They decline from the late 13th century corresponding to an increase in the numbers of herring in kitchen deposits. Other marine species, including whiting also show an increase from this period. There is no surviving documented evidence from the Abbey for purchases or consumption of fish. At Bicester Abbey, nearby, it is recorded that fresh herrings were purchased during the 13th century, (Bond, 1988, p.77). Therefore it is feasible that both fresh and stored herring were eaten at Eynsham.

Nonsuch Palace, Ewell, Surrey.

The last palace to be built by Henry VIII, lavish and of ostentatious design, it was part of the rivalry between the king and Francis I of France. Henry died before completing Nonsuch and it was a favourite retreat of Elizabeth 1. Dent (1988) describes the building of Nonsuch its' use and subsequent decline.

The fish assemblage (Locker, 1993) dates to the Palace occupation of 1538-1682/3 from the Outer, Inner and Kitchen Courts. The largest samples were from the Outer Court and Demolition levels of 1682/4. In the 1600's the Palace was used as government offices when the Plague was epidemic in London. Samuel Pepys, as Surveyor General of the Victualling Yard (located at the former St Mary Graces), was among officials using the Palace. John Evelyn, the diarist, visited in 1666 for a meeting with an officer of the Exchequer. During the middle of the 17th century it is thought (Biddle pers comm) that the rooms of the courts, each with their own chimney and adjacent garderobe chute, were used as self contained appartments. Remains of meals were disposed of down the garderobe chutes, accounting for the rich assemblages recovered.

The Palace was excavated in 1959/60, when sieving through a fine mesh was not common practice. However these deposits were checked through a coarse mesh on site, approximately equivalent to 'site riddling' with an 8mm mesh used at Castle Mall. The lack of small fish species is likely to be a reflection of the recovery rather than a selection of species. Therefore any consideration of species should concentrate on what is present, rather then attaching any significance to absence. Consequently the use of this material has been restricted to **body part** representation for cod and ling.

A wide variety of freshwater and marine species have been identified, including carp (*Cyprinus carpio)* from demolition deposits. These may have been stocked in the fishponds before the palace declined.

112 High Street, Huntingdon, Cambridgeshire.

A series of 12th-14th century deposits were excavated from Medieval tenements in the centre of the town, possibly close to a market. The sieved samples were from a number of pit fills and occupation layers. These produced mainly herring and a number of freshwater fish including eel, dace and roach, (Locker, 1996c).

The Brooks, Winchester, Hampshire.

Medieval deposits spanned the Saxon period to the middle of the 16th century. The majority of fish bones were from a late 13th – 14th century tenement. This building is thought to have been owned first by a London merchant, then by local Winchester merchants. By 1371 it had reverted to the crown and was granted to Bishop Wykeham. He then granted it to Hugh Le Cran, who had to repair the ruined property. The property seems to have deteriorated and been sublet to a series of poor tenants and the evidence suggests that the building was demolished by 1377.

Fish bones were recovered both by hand collection and sieving (Locker, 1997d) and constitute one of the less rigorously collected samples. The fish were recovered from a number of occupation deposits as well as a few bones from the Saxon and Saxo-Norman period. Although there is documentary evidence for changes in ownership and a decline in status, this is unsupported by the fish and other finds.

There was an active fish trade brought from Southampton to Winchester for which a number of brokage books survive, (Bunyard, 1941 and Studer, 1913). These give details of the fish and the merchants who had purchased them. None of the owners of these tenements are mentioned, but the documentary evidence gives detailed information as to the fish that were regularly brought to Winchester.

Chronology and Quality of the archaeological sample.

Table 9.1 shows the chronological span of the data sample. 75 % of the 20 sites spanning the 14th to the 16th centuries and over half include the 12th to the 16th centuries. The earliest and latest periods have fewer well dated deposits.

A qualitative judgement of the sample is more subjective, they have already been chosen as having been analysed by the author with well dated deposits. An indication of other features has been shown in Table 9.2.

- Recovery; all the deposits have been **sieved** and **screened** to some degree, and some include **hand collected** material. An indication of coarse screening or hand collection suggests that in those contexts some small species will have been missed. Some hand collected material will be present throughout, since large fish bones are often collected with the animal bones. The hand collected bone referred to in the table indicates specific collection of fish by hand where it represents the only fish from that deposit and no sieving was carried out.

- Whether any of the deposits are associated with **specific activities**, such as kitchen debris indicating food preparation, or refectory floor levels, the waste from meals.

- **Direct documentary evidence** associated with that particular site, such as household accounts showing which fish were purchased and eaten, sometimes by individual meals.

- **Indirect documentary evidence,** contemporary evidence of fish trade and consumption, which although not directly linked to the site may provide relevant background information. Local port, customs and brokage books document the movement of fish as a commodity from port to market and/or consumer. The surviving books for Southampton were of use when discussing the fish assemblages from the Brooks site, as Winchester was the destination of many of the carts leaving Southampton.

- **N** = the total size of the assemblage identified to family or species level from which certain groups of data have been selected.

Status and Distribution.

Status is difficult to determine, but monastic houses were of equal status to the gentry and nobility, (Harvey, 1996, p.1 and Dyer, 1994a, p.14). All the monastic houses in the data sample should be regarded as of this status, both before and after the Dissolution when the buildings were often given as gifts by the king. Individually they varied in wealth and also had varying periods of prosperity. Nonsuch Palace should also be included as of similar status to the monasteries.

The following table (9.3) shows the sites arranged by status, regardless of their date or location. However some of the sites are difficult to categorise and are better determined by function, which also has some bearing on status

Table 9.3. The sites grouped by status.

High Status. (Clergy, nobility, high ranking officials and merchants)

Westminster Abbey, London	Benedictine	Monastic
Battle Abbey, Sussex	Benedictine	Monastic
Eynsham Abbey, Oxford	Benedictine	Monastic
St John's Priory, London	Knights Templars	Monastic
St Mary's Clerkenwell, London	Sister house to St John's	
St Mary Graces, London	Cistercian	Monastic
St Mary Spital , London	Augustinian	Monastic
Nonsuch Palace, Surrey	Use by government officials	

Mid Status (lesser clergy, merchants etc)

The Brooks, Winchester	Merchant houses
Victoria Street, Bristol	Tenements close to Templars church

Low-Mid Status (working towns people, artisans etc)

Castle Mall, Norwich	Mixed domestic waste
St Martin-at-Palace Plain, Norwich	Waterfront, domestic
Fishergate, Norwich	Waterfront, domestic
Fleet Prison, London	Debris associated with the prison
High Street, Huntingdon	Small town, market site

Fish Processing Waste (may include some domestic waste in last three sites)

The Parade, Plymouth	Waterfront
Southgate, Hartlepool	Dock infill deposits
Middlegate, Hartlepool	Dock infill deposit
Church Close, Hartlepool	Early monastery, later industrial use
Church Walk, Hartlepool	Industrial use as at Church Close

The post Dissolution use of the monastic sites did not alter their status as they were often gifted to the king's favourites, see above. Within those sites evidence of further order by status includes: St John's, being the main Templars house in England and St Mary Graces as the third richest Cistercian house in England. Westminster Abbey's foundation by St Dunstan with King Edgar's support, with later rebuilding by Edward the Confessor and Battle Abbey's foundation by William the Conqueror ensured the prosperity of these houses by royal connections. St Mary Spital, being a hospital site, may be the lesser of the monasteries cited here, housing the sick, poor and homeless. Nonsuch retains high status with post royal usage as a government refuge from the Plague.

Wealth and prosperity increases choice and the cellarer's accounts for Battle Abbey (Searle and Ross, 1967) are rich in information regarding both the variety and source of the fish eaten at the Abbey. Proximity to the coast meant that the demand for fish could have been met locally. However, fish were also sent from London, where the cellarer owed on substantial accounts each year. Coastal shipping brought herrings and cod to Rye in the 16th century (Dell, 1965) and this trade could have supplied the Abbey both then and in earlier times. The documentary evidence for Battle, in contrast with that from a poor archaeological assemblage, demonstrates the monks' wide range of choice. Other documentary sources for monastic and secular households also show the diversity of markets exploited for fish, particularly stored fish, often at great distance.

The religious houses in London were well placed to utilise the great range and numbers of fish coming into the London markets from local and distant sources. Both fresh and stored fish would have been widely available. It is interesting to note that the kitchener's day books for Westminster Abbey (Harvey, 1996, p.47) for 1495-c1525 suggest that approximately half the fish eaten were stored in some way and most fish were marine. Harvey suggests that by the end of the Middle Ages this pattern was typical of great households.

There is no surviving documentary data for the purchase and consumption of fish in the other London religious houses. However, if the Westminster record is typical, as Harvey suggests, there should be a general similarity with substantial consumption of stored fish at all the religious houses, including Battle and Eynsham Abbeys.

The mid and mid-low groups are difficult to categorise, but generally cover occupation in towns, mainly those of substantial size, Norwich, Bristol and

Winchester, as well as one small market town, Huntingdon. At the Brooks there is some documentary evidence for a decline in status, but unsupported by material finds. Documentary evidence from port books has demonstrated the range of fish available. Both The Brooks and the Victoria Street tenements (by their close proximity to the Templars in Bristol) have been considered of higher status that the other town deposits. The Fleet Prison material, a unique assemblage, has been assigned to the low-mid status group.

The remainder, not being representative of consumption debris although Church Close shares some elements, have been classified separately and might be better described as the waste from dockside workers fish processing activities. Waterfront deposits at Hartlepool and Plymouth represent a different source of material to domestic deposits. Evidence for fish processing is clearest at The Parade, Plymouth and at Southgate, Hartlepool. At Middlegate, Church Walk and Church Close, all in Hartlepool reclamation fills and buildings are associated with possible industrial activity. These are known to be places where fish processing took place and, together with evidence of domestic debris, represent the accumulation processing debris and the consumption waste where people worked and lived.

Table 9.3 is divided on subjective grounds, but serves to summarise the status of the data sample.

The geographical distribution of the sites, shown on the map in Figure 9.1, shows a concentration to the south and the east. Single sites in Bristol and Plymouth represent the west of England. These geographical limitations reflect the distribution of the sites that were available to me rather than any archaeological reason. The size of the sample is large, comprising some 76,000 fish bones in total identified to species or family level, from 19 sites (excluding Battle Abbey) with a broad geographical and chronological spread. Of these, assemblages from 13 sites were used to show **portion** against **n**. From a total of 63,561 fish bones 52% were identified as herring or gadid and shown as **portions**, the remaining assemblages were used for showing **body part** distribution. In my view, despite the aforementioned limitations, these are sufficiently diverse to be a representative sample of fish consumption over the period of study.

The weighting towards monastic sites is an asset having supportive documentary data for fish consumption. It is known that monks and secular households of equivalent status ate substantial amounts of fish, particularly when they could not eat meat. Therefore these are the most promising types of deposits when looking for stored fish consumption in a fish bone assemblage. The domestic debris from the poor, who rarely ate meat or fish other than by charity, is unlikely to reveal any evidence of stored fish except perhaps a few bones of herring. These results highlight the limitations of choice at the bottom of the social scale and reveal little bone evidence for the presence of stored fish.

CHAPTER 10. The portion and body part methods applied to the archaeological fish assemblages.

Introduction.

The sites from which the fish assemblages were collected can be grouped according to the attributes chosen. These include: date, location, status (see table 9.3), type of deposit and the quality of the sample. The latter is of great importance and can be interpreted in a number of ways. Quality can refer to the dating of the context, its range and also to the level of recovery determined by the mesh size used in sieving. The date ranges are shown in Figure 9.1 and vary from a few general deposits of Medieval Pre Dissolution occupation, as at St John's Priory, Clerkenwell and St Mary Graces, Tower Hill, to the majority of tightly dated sequences as from St Mary's, Clerkenwell and Eynsham Abbey.

The level of recovery is of utmost importance when applying the **portion** method in order to ensure that the fullest representation of the surviving fish bones was achieved. All but three of the assemblages from sites of consumption were retrieved by fine screening recovering the smallest bones. At the Brooks, Winchester and Battle Abbey in Sussex[1] the sieving was less consistent and at Nonsuch Palace, Surrey extensive, but coarse, screening was carried out. Consequently, only selected contexts from the three tenements at the Brooks were included as portions. Battle Abbey was eliminated altogether as a data sample, only the documentary data was used. Nonsuch Palace was only included for body part representation of cranial and appendicular elements of large gadids as the recovery was certainly biased in favour of larger species.

The **portion** method is intended for application to fish assemblages representative of consumption waste rather than any pre treatment such as fish processing. '**Body part**' representation for the large gadids can be used in assemblages of both consumption and production assemblages.

[1] Ultimately only included in the archaeological data for evidence of fish eaten fresh, as the sample was both small, and selective.

The sites have been divided into four groups depending on their function and the level of documentary evidence linking the assemblage to a specific dwelling or property.

The divisions are as follows:

Group 1. Fish assemblages from domestic consumption attributable to a single establishment. For example, St Mary's Clerkenwell, where the fish are further delimited as kitchen deposits.

Group 2. Fish assemblages from deposits of domestic debris not attributable to a single property. This is usually due to insufficient surviving documentary data regarding individual properties/activities. However the deposits are still attributable to general activity in the area such as at Castle Mall, Norwich.

Group 3. Sites where the fish may represent a mixture of domestic consumption debris with some evidence for fish processing. For example the Hartlepool sites: Middlegate, Church Close and Church Walk.

Group 4. Fish assemblages from dock side deposits showing evidence of processing waste. The only examples being from Southgate in Hartlepool and from hake in 16th century deposits from The Parade, Plymouth.

These divisions do not take any account of date. They encompass a broad range in each group, this is primarily evident in the first two groups. For each site the relationship between location and fish supplies, whether direct from coasts or through intermediate sources such as markets, is a constant factor affecting consumption. In the time frame under consideration supplies of fresh fish did not undergo major changes. Fleeting, icing and canning, which helped suppress the need for fish stored by salting and drying, were later advances. Therefore in the analysis of **portion** versus the **n** of bones all phases for each site are shown in sequence by site.

However, in the subsequent discussion on the differences of stored fish consumption as shown by the **portion** versus bone numbers (**n**) for each site, temporal divisions were made into three sections. These are: monastic deposits, secular Pre Dissolution deposits and Post Dissolution material.

The representations by **portion** and bone numbers are discussed first. These show the comparative proportions of the commonly stored species, i.e. herring and the gadids, without reference to evidence for storage other than data adjustments for elements belonging to whole large gadids. Only groups 1 and 2 have been included for **portion** and **n** comparison, since the fish are directly attributable to consumption debris. The evidence for **body part** representation for the large gadids, primarily cod and ling, follows and suggests where the remains of stored gadids may be present.

The accompanying bar charts and graphs follow the text in this chapter. The data for calculating portions are to be found in the Appendix.

Portions versus bone numbers (n).

Group 1. Fish assemblages from domestic consumption attributable to a specific establishment.

All the monastic sites are included here: St John's Clerkenwell, St Mary's Clerkenwell, St Mary Graces, Tower Hill, St Mary Spital, Westminster Abbey (all in London) and Eynsham Abbey, Oxford. Secular sites comprise Victoria Street, Bristol and the Brooks, Winchester.

Kitchen deposits were found at St Mary's Clerkenwell and Eynsham Abbey, while deposits of a less specific domestic origin represented the other sites.

St John's Priory, Clerkenwell, London.

In Figure 10.1 the Pre Dissolution assemblage of monastic occupation is small and of broad date range in comparison with that of Figure 10.2, the Post Dissolution fish. However the trend by **n** (number of bones percentage) shows herring first, then whiting, haddock and cod in descending order. This changes to whiting in first place, then cod, herring, ling and haddock in the later period. The same data transposed into **portions** shows cod to be the main fish eaten in both periods, increasingly so in the later deposits. Haddock was second to cod in the Pre Dissolution sample but is superceded by all other species in the later period. In the Medieval deposits these storable species[2] together comprise only 34 %[3] of the whole fish assemblage for that period, while in the later deposits this nearly doubles to 61 %.

Here the evidence for the monastic consumption of stored fish is broad in date range but small in sample size. However, it does echo the main trends of relative fish consumption among these species at other monastic fish sites. The evidence suggests a wider range of fish (in addition to herring and the gadids) were eaten during the monastic period than later, when the storable species represent more than half the assemblage. An adjustment was made for cod in the later period.

St Mary's Clerkenwell, London.

The sister house to St Johns provided closely dated groups of fish from kitchen deposits. The data for the figures shows the samples were of good size except for the mid 14th to 15th century.

The data for Figures 10.3 - 10.6 indicates that in the two earliest phases the storable species are a high percentage of the whole fish assemblage by **n**, 80 % and 92 % respectively. This decreases to 60 % and 65 % in the two later phases and suggests that at the sister house these species formed a more significant part of fish consumption by number than at St John's.

[2] Herring and all the gadids shown in the charts.
[3] A percentage of bone numbers, not fish volume.

The figures show that by **n** herring is most numerous in all phases followed by whiting. However the **portion** evidence indicates a different pattern of consumption in most cases favouring other species and cod in particular.

Cod is dominant in the early phase (Figure 10.3) with herring close, followed by whiting and haddock. For the late 13^{th} century there was no cod (Figure 10.4) and the storable sample shows herring to be 94 % by **n** and 84 % by **portion** with some whiting and a small amount of haddock. The distribution in this phase is very similar both by both methods since two of the three species are not altered skeletally in storage.

The mid 14^{th} to mid 15^{th} century deposits (Figure 10.5) are marked by a greater variety of all fish, the stored fish being only 60 % of this very small sample and 65 % in the succeeding phase. Of the storable fish, cod is the primary species by **portion**, followed by herring and whiting.

In the final Pre Dissolution phase (Figure 10.6), with the largest sample of fish bones, cod achieves its' greatest percentage by **portion** at this site. Herring is suppressed from first place by **n**, to approximately equal **portions** as whiting and haddock. The only evidence for cod as whole fish from the site was found in this phase and the data adjusted accordingly.

The detailed stratigraphic divisions from St Mary's show some temporal trends during the monastic occupation. The evidence by **portion** is of decreasing consumption of herring from the mid 14^{th} century onwards. At the same time the overall percentage by **n** of the storable species in the whole fish assemblage decreases. This suggests a wider range of fish were eaten in the later period.

St Mary Graces, Tower Hill, London.

As at St John's the date range is broad for the Pre Dissolution material, but more closely dated for the later periods of use as a naval victualling yard.

In Figure 10.7 the fish assemblage from the monastic occupation shows the same trends for the storable species by both methods. Cod is the dominant species by **n** and more than doubles its percentage by **portion**. Whiting is in second place, followed by herring. In this period the storable species form a very low percentage (by number) of the whole fish assemblage, a trend of all phases but increasing slightly in the later periods.

The monastic phase showed evidence for both whole cod and hake and the data was adjusted accordingly. There was also evidence for whole cod and haddock in two of the later periods and whole ling from the middle phase of the victualling yard.

During the Post Dissolution phase and subsequent periods of use for victualling, herring is greatest by **n** (Figures 10.8, 10.9, 10.10), a recurring theme for herring by this method. However when the data is displayed by **portion** the position changes. Cod is the primary species in all three phases, in particular the Dissolution/Manor house period and the Mid Victualling Yard phase where it is over 80 %. Herring is low by **portion** in all phases, suggesting it was consumed in equally low volume to haddock, whiting, ling and hake.

The victualling yard at Tower Hill only prepared biscuit and salted/pickled meat on site, other supplies were bought already prepared. These fish are thought to represent the consumption of employees, (West, 1995).

St Mary Spital, London.

Two phases are attributable to monastic occupation. These are closely dated and shown in Figures 10.11 and 10.12.

Only three species were identified from these two phases, herring, cod and whiting. In the hospital establishment phase they are only 26 % of the entire fish assemblage, rising to 57 % in the next phase. Both periods show a reversal from herring to cod when comparing **n** to **portion**, herring and whiting are both approximately half the amounts of cod by **portion** in the early phase. In the later monastic sample cod becomes increasingly dominant, with a slight rise in herring, while whiting are few.

In the Post Dissolution material (Figures 10.13,10.14 and 10.15) these species are numerically few and a small proportion of the sample, particularly the 1620-1700 sample which has no cod at all. In the immediately Post Dissolution deposits (Figure 10.13) cod is again the dominant species by **portion**, followed by whiting. Haddock are few in the Post Reformation deposits being best represented in the small 17th century sample.

At St Mary's Spital cod is the only large gadid present, no ling or hake were found. There is no evidence for whole cod or haddock, so no adjustments were made to the data.

Westminster Abbey, London.

The fish assemblage is a single deposit from an early ditch shown in Figure 10.16. Herring and the gadid species are slightly less than half the whole fish assemblage by number. They show a similar pattern of fish consumption by both methods. The high percentage of herring shown by **n** also remains high enough by **portion** for herring to have been the primary species consumed, with whiting and cod of lesser importance. Haddock is poorly represented by both methods.

There was evidence for whole cod and a weighted adjustment made to the data.

This assemblage, showing herring as the prime food fish by both methods, is supportive archaeological evidence for the greater popularity of herring in the early Medieval period, though superceded by cod and allied species later. This is the earliest monastic assemblage in the sample and contrasts with the later documentary evidence from the Abbey for fish consumption in the late 15th early 16th centuries. Harvey (1996) has suggested that the monks would have eaten more herring in earlier centuries, as supported by this data, but by the 15th century other forms of stored fish were preferred.

Eynsham Abbey, Oxford.

Four periods of closely dated monastic occupation relate to the kitchen. The earliest phase, associated with the Early Norman Kitchen (Figure 10.17), is the closest sample in date to the Westminster Abbey material described above. As well as date the two assemblages both share high quantities of herring by either method. This is further supportive evidence for herring, 64 % by **portion**, as the preferred fish among these species in the earlier part of the period under study, as represented by my data sample.

The two assemblages from the kitchens of the 12th to 15th centuries (Figures 10.18 and 10.19) show a reversal back to the more familiar pattern of herring dominant by **n** but cod by **portion**. Ling is equal to herring by **portion** in the Medieval Great Kitchen.

In the latest kitchen deposits preceding the Dissolution, Figure 10.20, herring again becomes the dominant species, with poor representation from all other species. This could be allied to a fall in the fortunes of the Abbey prior to the Dissolution and is the latest deposit to show herring as the main species by **portion**.

Compared with the London monasteries, discussed above, whiting features poorly by both methods and is likely to reflect different markets. Harvey (1996, p.49) describes whiting as more commonly served to the monks in winter and immature whiting would have been abundant in the outer Thames estuary in the autumn and winter months, (Wheeler, 1979, p.178). Fresh whiting could have been supplied to all the London houses from a local fishery.

The final phase, in which where herring becomes dominant once more, is distinguished by a high proportion of storable species of the whole sample. At

86 % it is at its highest level of any phase at Eynsham, in which herring ranges upwards from 46 % and may be further evidence of reduced circumstances in the last years of the Abbey.

Evidence for whole fish was suggested for ling in the Early Norman kitchen, by a single precaudal vertebra. Whole fish were also represented for haddock in the Later Medieval Kitchen and for cod and haddock in the final phase.

Victoria Street, Bristol.

Victoria Street is the only site in my sample with consumption debris from the west of England. The range and relative proportions of the gadids reflect that location. The percentage of fish by **n** favours herring throughout, but the **portion** percentage indicates a different pattern of consumption.

In the earliest 12th century phase (Figure 10.21) herring is overwhelmingly the most common species by both methods, with no gadids present except for a few bones of whiting. This deposit is a small sample in which 79 % by number are the storable species, largely herring.

By the late 12th century (Figure 10.22) herring appears still dominant by **n**, but the **portion** percentage places hake as the more important species. Herring is second, ahead of small quantities of haddock and whiting.

In the late 13th to early 14th century herring is again the most common species by both methods (Figure 10.23), but not to the same degree as in the earliest phase. Hake is second, followed by haddock and ling, plus a small amount of whiting. Here some precaudal vertebrae of hake are suggestive of complete fish and the data were adjusted.

In the 14th century deposits cod appears for the first time, however it is of lesser percentage by both methods than the other large gadids, being identified from only one bone. Figure 10.24 shows herring dominance by **n** transposed into a hake majority by **portion**, with herring second. Ling is the next most important species by **portion** with low numbers of cod, haddock and whiting. Evidence for whole haddock, ling and hake meant the data were adjusted for these species.

The sample for the late 14th century is particularly large, as shown in the data table for Figure 10.25. Here again herring is first by **n** but replaced by hake by **portion**. Herring as a **portion** drops to 19 %, slightly greater than ling. Cod, haddock and whiting are also all low. Evidence for whole fish was found for cod, haddock, ling and hake.

For the 15th century (Figure 10.26) cod is present in just sufficient quantities to suggest it is the main species consumed by **portion**, though herring, ling and hake are close. This period indicates a fairly even consumption of these species. Evidence for whole cod and haddock was found in both the 15th and 15th to 16th century phases and the data adjusted accordingly.

The assemblage from the late 15th/16th centuries (Figure 10.27) shows a limited species range dominated numerically by herring, with no whiting or ling. The bulk of the sample by **portion** is hake, then herring, with few cod or haddock. In this phase herring and the gadids are only 41 % of the whole fish assemblage. The data were adjusted in this final phase for whole cod and haddock.

The final phase shown from Victoria Street is from the late 16th century (Figure 10.28). As in the previous phase it is not a large sample, but one which is dominated by herring by **n**, but the large gadid fish; hake, cod and ling in descending order of magnitude by **portion**.

The assemblages from this site show a gradual trend away from herring through time. Here hake is the most important large gadid, a position normally occupied by cod, which doesn't appear at all until the 14th century and for which the single bone could be from a stored fish. The importance of hake (and ling) reflects the western location of the site, as at The Parade Plymouth.

There is slight evidence for a temporal decrease in percentages by number of bones for herring and the gadids within the whole fish assemblage. This could suggest increasing diversification in the range of fish eaten, though not necessarily by volume.

The Brooks, Winchester.

Three tenements of similar date have been considered. These represent the best recovery for fish assemblages from this site, but are from small samples, as can be seen in the data accompanying the charts.

The representation of species by number shows the usual large number of herring bones at all three tenements. However Figures 10.29, 10.30 and 10.31 show different distributions of species by **portion**.

Tenement A (Figure 10.29) is largely hake, with small amounts of herring, cod, haddock and whiting. While in Tenement B the sample is mainly cod, some hake and small quantities of herring, haddock and whiting (Figure 10.30). Tenement C, unusually, is mostly haddock, with equal amounts of herring, cod and whiting, but no hake (Figure 10.31).

The data were adjusted in Tenement A for whole cod, in Tenement B for whole cod and haddock and in Tenement C for whole haddock.

The occurrence of hake in two of the buildings suggests market links with the fisheries of the south west. The differences between the buildings may be evidence of differential consumption between tenements, though the samples are too small for this to be more than suggestive.

Group 2. Fish assemblages from deposits of domestic debris not attributed to a single property.

Castle Mall, Norwich.

The Castle Mall fish assemblages are consistently large by number and the largest assemblage from any site in my data sample. The numbers of bones per phase are of sufficient size to bear a more detailed examination of context types, but for the purposes of this study have been treated by period. A single, large well with an exceptionally large fish assemblage for a single context has been shown separately in Period 5, (Figure 10.37).

The location of Castle Mall in Norwich, close to the East Anglian coast, places it in an ideal location to benefit from the local herring fisheries and North Sea cod, both of which are evident here. The dominance of species in these deposits is between herring by **n** and cod by **portion.**

In the earliest, late 9th to 11th century deposits (Figure 10.32) herring is particularly abundant by **n**, and only slightly behind cod by **portion**. Few bones of haddock, whiting, pollack and saithe were present. These latter two species are closely related to and resemble cod and some of their bones may have been included as cod.

In the mid 11th to early 12th century deposits there is a complete reversal comparing **n** to **portion** from herring to cod. Haddock and whiting show poorly by both methods as seen in Figure 10.33. A similar pattern is repeated in the 12th century material (Figure 10.34), where herring also prevails by **n** and cod by **portion**. Haddock and whiting are poorly represented by both methods.

The interchange between herring and cod, depending on the method used to display the data, continues through the 12th to 16th centuries (Figures 10.35 and 10.36). Other species barely impinge on consumption. The Barbican Well is of the same period as Figure 10.36 and in both cod is at it's lowest level by **portion**, at 40 % and 56 % respectively, since the 9th century. In the Barbican Well (Figure 10.37) the discrepancy between herring and cod using the two methods is less than that of other periods. Here herring is still very high by **n**, but of equal **portion** to cod. The other gadids: haddock, whiting, pollack and ling are in low quantities as in the other phases.

The final Post Medieval phase, shown in Figure 10.38, is the smallest sample from Castle Mall, but still substantial compared to assemblages from some other sites. It reflects the dominance of cod by **portion**, prevalent in all the other phases, with some herring and little haddock or whiting.

Evidence for whole cod was found in every phase and for haddock in four phases. The data was adjusted according. Situated close to major landing ports and markets for North Sea cod it is to be expected that whole, and by implication fresh, cod would be a significant part of the assemblage.

Cod and herring[4] form together between 63 % – 86 % of the whole fish assemblage in each phase by the number of bones count. This is consistently high, especially when compared with sites such as St Mary Graces and St Mary Spital. However, it is similar to St Mary's Clerkenwell, so it is not a reflection of monastic versus secular consumption. A near coastal location might be expected to encourage greater diversity.

St Martin-at-Palace Plain, Norwich

The comparatively small assemblages from this site and also Fishergate, which follows, provide additional data to Castle Mall for Norwich.

Evidence for early occupation comes from a group of Saxo-Norman pits, shown in Figure 10.39. Here the typical herring abundance by **n** is evident and when shown by **portion** is still only marginally less than cod. This sample, though the smallest of the three, shows the greatest diversity in terms of the **portion**

[4] With the other gadids which are comparatively poorly represented.

percentages of haddock and whiting, the latter two being well represented here. The percentage of these storable species within the whole assemblage is also the lowest from this site at 47 % and bears comparison with another early deposit at Westminster Abbey (Figure 10.16), where herring was dominant by **portion.**

The mid 11th century deposits (Figure 10.40) show the more typical display of herring by **n** and cod by **portion** with little haddock and whiting. These fish, primarily herring and cod, are 91 % of the whole sample by number, in contrast to the Saxo-Norman pits at 47 %.

The same trend, with a further increase in cod by **portion**, is evident in the following century. Figure 10.41 shows 76 % of cod by **portion**, some herring and a small quantity of whiting. These are 87 % of the sample, so the 11th and 12th centuries show little diversity from primarily cod consumption, with some herring.

Cod was the only large gadid identified at St Martin's. Evidence for whole cod was found in all three groups, but it was not possible to divide the vertebrae on the grounds of insufficient detail in the recording. Adjustments were based on cranial data only.

Fishergate, Norwich.

A single 11th century deposit (Figure 10.42) shows the familiar high herring percentage by **n**, changing to a high cod percentage[5] by **portion**, with little haddock and whiting. However these storable species are only 46 % of the whole fish assemblage by number, so the Fishergate sample is generally more diverse than contemporary deposits from Castle Mall and St Martin-at-Palace Plain.

Fleet Prison, London.

The sequence of deposits in association with the Fleet Prison produced the most diverse representations by **portion** of my data sample. Apart from the Late

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[5] As at St Martin's cod was the only large gadid identified.

Medieval group, percentages by **n** show the familiar pattern of herring and more herring. By **portion** however, the picture is more varied.

In the Early Plantagenet phase (Figure 10.43) despite a 90 % numerical dominance of herring, **portion** shows primarily cod, then herring and small percentages of ling, whiting and haddock in descending order. These comprise three quarters of the sample by number.

In the subsequent Late Plantagenet deposits (Figure 10.44) herring and cod are more equal by **portion** with whiting also well represented. These, with a few bones of haddock, are 81 % of the entire assemblage for this phase.

The Late Medieval sample shows an unusual occurrence in the main species suggested by the **n** percentage. Whiting is most common and just the dominant species by **portion** ahead of cod, shown in Figure 10.45. Herring is low by both methods and evidently not a preferred fish as represented in this period. When observing the fall of the storable species to 51 % of the whole fish assemblage, shown in the data table, it is important to remember that these bone numbers are mainly from large fish compared with other assemblages where herring are important by number. The role of these larger fish is suppressed when expressed by the number of occurrences, compared with their smaller counterparts.

Another change is seen in the Tudor assemblage in Figure 10.46. Here herring has recovered partially to 59% by **n** but by **portion** ling is the main species, then cod. Herring, haddock and whiting scarcely register. As with the Late Medieval assemblage the importance of the large gadid fishes is suppressed in a bone count.

The final, Early Stuart, phase (Figure 10.47) sees a return to high numbers of herring by **n**, but cod is first by **portion**. Whiting and ling were present and, as in every phase here, haddock is present but insignificant. Despite increased herring numbers these storable species only comprise 49 % of the assemblage.

Of all the sites discussed the Fleet is perhaps the most unpredictable. There is a preference for whiting, particularly in the Late Medieval deposits. This is a common feature in London sites, but **portion** suggests changing choices in different periods. This may be a direct reflection of the nature of the site, its long history as a prison, transient occupants and the remains of food brought for prisoners and staff.

Evidence for whole cod was found in every phase, for haddock in four phases despite their low numbers and for ling in one phase, the data were adjusted accordingly.

High Street, Huntingdon.

The two samples from this, the final site to be examined by **n** and **portion**, are in contrast with the above.

Herring by both methods is clearly the most common species here. In Figure 10.48 the difference between the **n** and **portion** percentages is only 18 %. There is no cod, little haddock or whiting. Herring comprises most of the 77 % of the sample represented by the storable species.

A century later, 13^{th} to 14^{th} century (Figure 10.49) the picture is virtually unchanged. In a sample nearly five times larger herring is almost the exclusive storable fish, which together are 68 % of the whole assemblage. Cod and haddock feature as only a few bones.

The dominance of herring in this assemblage, in a town, possibly near a market and domestic dwellings, suggests the consumption of cheap stored fish and possibly indicative of low status.

Analysis of the results of n versus portion.

The overall trend of these comparisons is one where herring is dominant by **n** and is likely to be replaced by cod when the data is shown by **portion**. However within that general theme there are some differences.

Summarising the results and dividing the sites and their phases into three broad dating groups; Pre Dissolution monastic, Pre Dissolution secular and Post Dissolution, the results appear as follows:

Table 10.1. Pre Dissolution Monastic Assemblages.

Site	*Phase/date*	*Main sp by 'n'*	*Main sp by portion*
St Johns Priory	Monastic	herring	cod
St Mary Clerkenwell	1200-1280	herring	cod
St Mary Clerkenwell	1280-1350	herring	cod
St Mary Clerkenwell	1350-1450	herring	cod
St Mary Clerkenwell	1450-1540	herring	cod
St Mary Graces	Abbey & Manor	cod	cod
St Mary Spital	1235-1280	herring	cod
St Mary Spital	1330-1400	herring	cod
Westminster Abbey	950-1050	herring	herring
Eynsham Abbey	ENK L11-12th	herring	herring
Eynsham Abbey	MGK C12-13th	herring	cod
Eynsham Abbey	LMK L13-15th	herring	cod
Eynsham Abbey	LrMK 15th-Diss	herring	herring

Although a somewhat crude summary of the data it is evident that in the monastic deposits (Table 10.1), if the fish are portrayed by **portion**, cod is generally the preferred species. The three exceptions include deposits at Westminster Abbey and two from Eynsham Abbey, two of which are the earliest of all monastic assemblages. The dominance of herring both by **n** and **portion** supports the historical data suggesting herring was more popular in the early Medieval period at monastic houses, but was gradually replaced by cod. The high quantity of herring in the final phase at Eynsham may reflect a time of poverty for the Abbey.

The secular Pre Dissolution deposits (Table 10.2) show more variety for the dominant species. In some of the phases where cod becomes dominant by **portion** other species are almost of similar magnitude and these are indicated in the footnotes.

Table 10.2. Pre Dissolution Secular Assemblages.

Site	***Phase/date***	***Main sp by n***	***Main sp by portion***
Victoria Street	12^{th}	herring	herring
Victoria Street	Late 12^{th}	herring	hake
Victoria Street	L 13^{th}-E 14^{th}	herring	herring
Victoria Street	14^{th}	herring	hake
Victoria Street	L 14^{th}	herring	hake
Victoria Street	15^{th}	herring	cod[6]
Victoria Street	$15^{th}/16^{th}$	herring	hake
The Brooks	Ten A L13^{th}-E14^{th}	herring	hake
The Brooks	Ten B L13^{th}-E14^{th}	herring	cod
The Brooks	Ten C L13^{th}-E14^{th}	herring	haddock
Castle Mall	L9^{th}-11^{th}	herring	cod[7]
Castle Mall	1068-E12th	herring	cod
Castle Mall	C12th	herring	cod
Castle Mall	L12^{th}-M14^{th}	herring	cod
Castle Mall	ML14^{th}-L16^{th}	herring	cod
Castle Mall	B Well ML14^{th}-L16^{th}	herring	cod[8]
St Martins-at-Palace Plain	Saxo-Norman	herring	cod[9]
St Martins-at-Palace Plain	M11^{th}	herring	cod
St Martins-at-Palace Plain	12^{th}-M12^{th}	herring	cod
Fishergate	11^{th}	herring	cod
Fleet Prison	1154-1270	herring	cod
Fleet Prison	1270-1399	herring	cod
Fleet Prison	1399-1485	herring	whiting
Fleet Prison	1485-1603	herring	ling
High Street, Huntingdon	12^{th}-13^{th}	herring	herring
High Street, Huntingdon	13^{th}-14^{th}	herring	herring

This reflects a number of factors, including the western location for Victoria Street where hake features as the main species in many phases, this fish being a common catch in fisheries of the south west. On the east coast, at Norwich cod is

[6] Cod, herring, ling and hake are within 7% of each other
[7] Cod is 8% greater than herring.
[8] Cod is 40%, herring is 39%.
[9] Cod is 36%, herring is 33%

preferred, only marginally in some cases, despite the proximity to the East Anglian herring fisheries. At the High Street, Huntingdon herring, dominant by both **n** and **portion** may reflect low status consumption in a limited fish assemblage of mainly one species. The dominance of herring by both methods in early levels at Victoria Street and Castle Mall supports an initial reliance on herring, which changes to the large gadids, this was also seen at Westminster Abbey and Eynsham Abbey. However the link seems to be between the earliest levels at a site, rather than an actual date since these levels span the mid 10th to 12th centuries.

In the Post Dissolution group of deposits (Table 10.3) the popularity of cod by **portion** continues with two exceptions. A small sample from St Mary Spital showed whiting as most numerous by both methods while Victoria Street showed a regional preference for hake. The decline in herring consumption is supported by evidence from these sites in mid 16th century and later deposits. The three previously monastic sites are still high status in this period with mid status represented by Victoria Street and Castle Mall. So the decline of herring here is rather selectively supported, for which some low status sites of later date are needed to broaden the status range.

Table 10.3. Post Dissolution Assemblages.

Site	*Phase/date*	*Main sp by n*	*Main sp by portion*
St Johns Priory	1540-1650	whiting	cod
St Mary Graces	1539-60	herring	cod
St Mary Graces	Vic Yard 1560-1635	herring	cod
St Mary Graces	Vic Yard 1635-1726	herring	cod
St Mary Spital	1540-1620	whiting	cod
St Mary Spital	1620-1700	whiting	whiting
St Mary Spital	post 1700	herring	cod
Victoria Street	L16th	herring	hake
Castle Mall	L16th-18th	herring	cod
Fleet Prison	Early Stuart	herring	cod

The **portion** method has indicated the relative importance of the most common storable species by volume of food. Though data adjustments have been made to compensate for the presence of bones of whole fish for the large gadids, the distribution of body parts for those fish has not yet been addressed.

In the following section selected samples of bones from cod and ling have been examined for evidence of stored fish by differential body part representation. These are displayed individually on a bar chart and also together on two sets of graphs.

Body Part representation.

In this analysis the selected data for cod and ling are from all four groups of sites, including a strong representation for group 3, where both processing debris and some consumption debris is suspected, the Hartlepool sites. The data shown were selected on the basis of sample size, favouring the larger samples.

Cod

Figure 10.50 is an idealised representation of the relative percentages for whole large gadids (cod, haddock, ling and hake). These are defined by the number of bones present of those anatomies likely to be recovered and identified and divided into areas of the body, as described in chapter 7.

The left column shows cranial, appendicular and vertebral elements and utilises the fullest database, while the right column shows only cranial and appendicular elements. The latter is used in cases where the vertebrae cannot be included in the calculations, but is not the ideal because of the restricted range of elements. Comparison of the results of applying the data with and without vertebrae sometimes shows conflicting results as will be seen below.

In the model column for all elements 68 % cranial and precaudal elements and

32 % appendicular and caudal elements represent whole fish. Excluding vertebrae the cranial elements are 81 % to 19 % appendicular. These are the theoretical proportions for whole fish fully recovered.

Group 1; Fish assemblages attributed to a specific establishment.

St Mary's Clerkenwell, London.

The middle 15th to mid 16th century kitchen deposits from St Mary's Clerkenwell had a sufficiently large sample of cod for dividing into body parts on a bar chart shown in Figure 10.51. Although cranial and precaudal vertebral elements were present, they are far outweighed by appendicular and caudal vertebral elements by 10: 90 % and 50:50 %. This suggests that some whole cod were eaten, but the greater part of the bone sample represents stored fish.

St Mary Graces, Tower Hill, London.

The period of monastic occupation produced a cod assemblage, which in part shows the reverse distribution to the preceding site. Here, the all elements category showed percentages of 80:20 % for cranial/precaudal v appendicular/caudal, but 75:25 % for 'cranial & appendicular' shown in Figure 10.52.

All elements suggest above average abundance of the remains of whole cod, with the cranial and appendicular elements slightly under represented. Since this deposit and others in the first two groups comprise the remains of domestic occupation they may include remains from preparation of fish for the table[10], as well as consumption, increasing the numbers of certain elements. The number of cranial/precaudal elements is comparatively high compared to other phases shown here from Groups 1 and 2. This sample seems representative of the consumption of both whole and stored cod, but with a greater proportion of whole fish.

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[10] Kitchen preparation.

Westminster Abbey, London.

Cod from the early ditch (Figure 10.53) show a greater proportion of appendicular and caudal vertebral elements than would be expected if only whole fish were being eaten. Therefore this assemblage also appears to represent a mixture of fresh (whole) and stored fish, the latter increasing the appendicular/cranial percentage. The more limited display of cranial and appendicular elements only shows percentages closest to whole fish and it is the addition of vertebrae that shifts the emphasis to include both whole and stored fish remains.

Group 2. Assemblages not associated with a specific property.

Castle Mall, Norwich.

The numbers of cod bones identified from Castle Mall were sufficient for cod from five phases to be included.

In Figure 10.54, the earliest period, all elements of cod indicate the presence of whole fish, but 42 % of appendicular and caudal vertebral elements indicate some consumption of stored fish as well. The cranial & appendicular elements alone are suggestive of just whole fish. Again it is the presence of vertebrae that indicates the remains of stored fish.

In the following period (Figure 10.55), both columns suggest consumption of whole (fresh) and stored fish. However, two periods later, Figure 10.56, all elements support the consumption of whole and stored fish while cranial & appendicular show the proportions for whole fish only. The evidence for storage is from the presence of caudal vertebrae, since the cranial/appendicular column shows a higher proportion of cranial elements than would ideally be representative of whole fish.

In Figure 10.57, both columns concur in their representation of the consumption of both whole and stored cod. This is also reflected in the proportions of all elements from the Barbican Well from the same phase, shown in Figure 10.58. In the cranial & appendicular column of the latter only cranial elements are present.

In all phases the all elements category for cod suggest consumption of both whole (by implication fresh) and some stored cod at Castle Mall, the latter contributing to an over representation of appendicular and caudal vertebral elements. If only the cranial & appendicular bones are considered there is sometimes conflict between the two sets of data. In some cases the latter suggests whole fish only.

The Fleet Prison, London.

Both cod assemblages included here favour the consumption of stored fish with some whole fish.

In Figure 10.59 the sample is only from appendicular elements, no cranial, but with some precaudal vertebrae as evidence for whole cod. The cod from Tudor deposits (Figure 10.60) showed very few cranial and precaudal vertebral elements and both columns favour stored fish as the predominant remains.

Given the function of the site it is tempting to interpret these distributions as evidence of food brought for prisoners. These need not necessarily have been intended for immediate consumption, ideally fish with a storage life.

Group 3; Assemblages representing some domestic consumption debris with evidence for fish processing.

Middlegate, Hartlepool.

The representation of cod from this and other sites in Hartlepool contrasts with those previously described.

The cod from three consecutive phases have been included. The earliest, the 12th to 13th century assemblage, is shown in Figure 10.61. This typifies all three phases, showing high proportions of the cranial and precaudal vertebral elements whether shown together or without vertebrae. The three groups are discussed together, the other two phases are shown in Figures 10.62 and 10.63. In each sample the low (less than 12 %) numbers of appendicular and caudal vertebral elements in either representation typify processing waste. The presence of small quantities of appendicular and caudal vertebral elements indicates the possible inclusion of some consumption debris.

Church Close, Hartlepool

The cod from a ditch and two Medieval buildings also show high proportions of cranial and precaudal vertebral elements, suggesting processing waste. The strongest representation of appendicular and caudal vertebral elements is seen in Building IV (Figure 10.66). This might signify a greater proportion of consumption debris than in the ditch (Figure 10.64), which has no appendicular bones and those few found in Medieval Building V (Figure 10.65).

Church Walk, Hartlepool.

The proportions of cod here are more closely aligned to Church Close than Middlegate. In the 12/13th century the quantity of cod cranial bones and precaudal vertebrae (Figure 10.67) strongly suggest processing debris with a small proportion of other elements as the remains of consumption. The two later deposits (Figures 10.68 and 10.69) show a decrease in the cranial/precaudal proportions relative to the appendicular/caudal, the latter being close to the proportions for consumption deposits. However, they still remain higher, at 79 % and 70 % of cranial/precaudal elements, than for any of the cod from the sites of consumption, except for the monastic deposits from St Mary Graces, Tower Hill (Figure 10.52). At 80 % the cod from St Mary's are unusually high in cranial remains and atypical of consumption assemblages.

Group 4. Fish assemblages from dockside deposits.

Southgate, Hartlepool.

For the Southgate deposits from the 12th century dock only cranial and appendicular elements were included. The recording of the vertebrae was not sufficiently detailed to incorporate them.

Figure 10.70 shows that there is a high proportion of cranial elements suggesting that the cod remains from this deposit are primarily waste from fish processing.

The cod from all the Hartlepool sites provide clear examples of the distribution of body parts representative of the discard from fish processing, with a limited quantity of elements retained in storage. These contrast with the mixture of bones likely to be found in deposits representative of domestic consumption.

The Cod data plotted together on two graphs.

The data from each of the columns that was shown in Figures 10.50 – 10.70 have been plotted on two graphs, Figure 10.71 for all elements and Figure 10.72 for cranial & appendicular. The cran/pv % and the cran % are shown in ascending order so the graphs read from left to right going down the table.

In Figure 10.71 cranial and precaudal vertebral elements have been plotted against appendicular and caudal vertebral elements. The grouping of the data on the graph indicates that there are diagnostic differences between consumption debris, which may reflect the remains of both stored and fresh fish (the first 9 entries on the data table) and that of fish processing. The consumption debris data shows a wider range of values on the graph, but is still distinct from the processing debris. Cod falling within the area designated as likely to be processing waste[11] (and below the whole fish model on the table) are, with the exception of St Mary Graces, all from Hartlepool.

[11] A cran/pv axis of greater than 68%.

In Figure 10.72 only cranial and appendicular elements were plotted for comparison with all elements. The data for Southgate and Nonsuch Palace have been included only in this graph as the vertebrae from these sites were not recorded in sufficient detail to be shown in the graph for all elements. The general distribution is similar to that for all elements and suggests the Nonsuch cod are largely representative of stored fish while Southgate is similar to the other Hartlepool sites as processing waste. However the exclusion of vertebrae showed the cod from two phases at Church Walk to be closer to consumption waste, while Westminster Abbey, together with three phases from Castle Mall is more reflective of processing waste. This is in contrast with Figure 10.71 and there is no evidence that this was carried out at Westminster Abbey, nor at Castle Mall, although herring were prepared for storage at Norwich.

From other evidence for activities at these sites I must conclude that the data are more reliably represented by including all elements, even with a relatively crude division of vertebrae into precaudal and caudal.

Ling.

Although rarely as prolific as cod, some samples of ling were sufficiently large for the distribution of their body parts to be considered. As a similar stored product to cod, there is a case for amalgamating elements of cod, ling, and by association hake, pollack and saithe, on the grounds of similar size and similar treatment. Haddock being generally smaller would best remain separate.

However in this study I have kept the species separate and considered them as distinct stored species, similar but not as a single product, since any differences between them would be masked.

Most of the data for ling shown here are from group 3, where the samples were larger.

Group 1. Sites attributed to a specific establishment.

Victoria Street, Bristol.

The ling bones from the late 14th century (Figure 10.73) for all elements are almost exactly the ideal of the 68 %:32 % proportions for whole fish, whereas the cranial and appendicular alone support a small quantity of stored ling together with whole fish. The proximity of the port of Bristol to western fishing grounds for ling would have been the source of supply for whole, fresh fish.

Group 2. Sites not attributable to a single property.

The Fleet Prison, London.

The Tudor sample for ling (Figure 10.74) shows only the appendicular and caudal vertebral elements were present, suggesting the remains of stored ling only in this phase.

Group 3.Assemblages representing some domestic debris and fish processing.

Middlegate, Hartlepool.

The three assemblages for ling from Middlegate are shown in Figures 10.75, 10.76 and 10.77. In the earliest phase the proportion of appendicular and caudal vertebral elements is lowest. In the two 13th century deposits it is slightly higher and in Figure 10.77 cranial and appendicular elements alone are sufficient to be part of the remains of whole fish, while the addition of vertebrae in all elements shows excessive amounts of cranial and precaudal vertebral bones.

Overall the evidence is clearly in favour of typical processing waste dominated by cranial and precaudal vertebral elements. There is some inclusion of consumption debris, especially in phases 2 and 3.

Church Close, Hartlepool.

Ling bones from an early ditch (Figure 10.78) and Buildings IV and II (Figures 10.79 and 10.80) also suggest mainly the debris from fish processing. The early ditch, as with cod, has the highest proportions of cranial and precaudal vertebral elements from this site.

Church Walk, Hartlepool.

In the first two phases (Figures 10.81 and 10.82) the remains of ling are almost exclusively processing waste. In the late 14th – 15th century deposit, shown in Figure 10.83, the representation in the column for all elements is more typical of whole fish. However, where vertebrae are not included an excess of appendicular elements suggests stored fish consumption. This assemblage is unique among the Hartlepool data and, with a similar pattern for cod shown in Figure 10.69, could reflect a different type of deposit.

The ling data plotted on two graphs.

In Figures 10.84 and 10.85 the data for ling is shown on two graphs, one includes all elements and the other only cranial & appendicular in the same manner as for cod.

In Figure 10.84 for all elements the largest samples of data are from the Hartlepool sites. Most of the data are plotted within the area representing processing waste, concurring with the interpretation of activities at these sites. Victoria Street is within the limits for whole fish, while in contrast ling from the Fleet Prison suggest only stored elements.

In Figure 10.85 the cranial and appendicular elements of Southgate and Nonsuch Palace have been included and fit as processing waste and stored/whole waste repectively. The clustering in this graph, as for cod, is more variable with two Hartlepool assemblages now plotting on the stored side of whole fish in the absence of vertebral elements. The Fleet Prison still shows storage waste and the Nonsuch ling are also close to this zone. However Victoria Street still favours whole and stored mixed waste. Again the exclusion of vertebrae produces a less defined distribution.

Hake.

One assemblage of hake was of sufficient size to be included in body part representation. This is comprised of three 16th century contexts of dockside deposits from The Parade Plymouth. Together with Southgate, Hartlepool, with early 12th century dock deposits, The Parade is one of two sites representative of Group 4, dockside deposits with evidence of fish processing.

Figure 10.86 shows all elements from the three deposits, which are overwhelmingly represented by cranial and precaudal vertebral elements. These are a clear example of processing waste with the elements found in stored fish virtually absent.

Conclusions regarding body part representation as a method for the data sample.

Although the method is relatively crude, with the division of vertebrae simply into precaudal and caudal and subjective decisions made as to which cranial and appendicular elements were identified and counted, the results have supported the division of the data in this way.

The individual columns for both all elements and cranial and appendicular highlight the characteristics of different body part proportions in assemblages of sufficient size. They also show that the exclusion of vertebrae in the cranial & appendicular column can change the proportions affecting the representation of processing waste, whole and stored fish waste.

The combining of the data for cod and ling on a graph showed similar results for both species. This suggests the large gadids (but excluding haddock on the grounds of size) could be looked at together as a product, rather like the terminology in the documentary data, which refers to 'milwelle', 'saltfish' and other forms of stored fish. The differences seen between the sites were their function, whether the deposits were from consumption debris or represented some other activity, in this case processing.

The inclusion of vertebrae in the all elements column provided the better data base, particularly since some skull bones have been shown to survive more poorly than others, such as the cleithrum (Nicholson, 1996). The graphs for all elements (Figures 10.71 and 10.84) indicate a more compact grouping for processing waste than for consumption debris, which ranges from whole fish through to stored waste depending on the proportions of the skeletal signatures. The consumption assemblages do remain discrete from the processing waste showing that representation by body part is viable in these types of deposit and need not be restricted to the more specialised assemblages of processing waste.

Summary

The comparison of numbers of bone and portions between herring and the gadids within consumption deposits showed a general trend of herring first by **n** and cod first by **portion**. There were exceptions in which herring remained predominant by both methods, these are largely attributable to early deposits and a time when herring is thought to have been more popular in all status groups.

The variation in other gadids can be attributed to regional influences of local fisheries, such as ling and hake in the west and a winter fishery for whiting off the Thames Estuary.

Body part representation could only be applied to the large gadids: cod, ling and hake, skeletally reduced during processing. The evidence shows a mixture of whole (fresh) and stored fish in most consumption deposits while those sites thought to be representative of processing at Hartlepool and Plymouth were biased towards processing waste.

Group 1.

Figure 10.1. St John's Priory, Clerkenwell Medieval

	herring	cod	haddock	whiting	n/portion	% sample
n %	63	4	8	26	27	34
portion %	13	49	24	13	0.29	

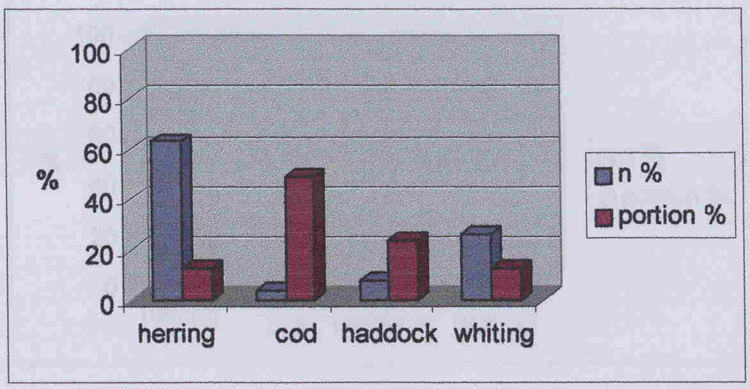


Figure 10.2. St John's Priory, Clerkenwell. Dissolution +, 1540-1650.

	herring	cod	haddock	whiting	ling	n/portion	% sample
n %	21	28	0.4	47	3	658	61
portion %	1	78	0.1	7	14	26.93	

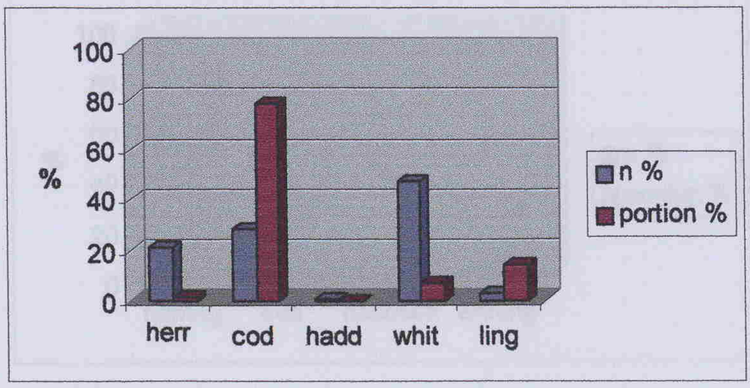


Figure 10.3. St Mary's Clerkenwell. Kitchen deposits. 1200-1280

	herring	cod	haddock	whiting	n/portion	% sample
n %	84	2	2	13	128	80
portion %	36	41	10	13	0.7	

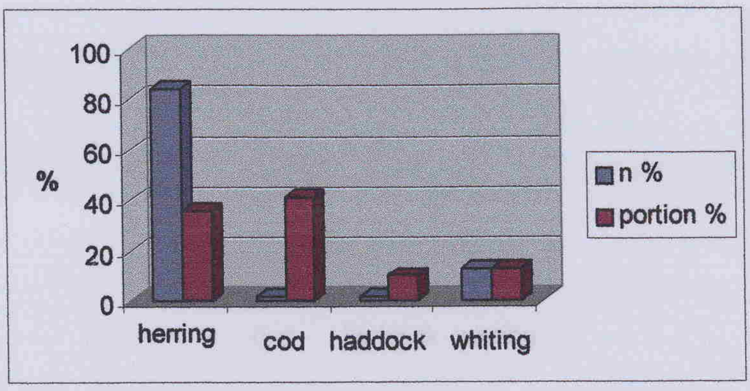


Figure 10.4. St Mary's Clerkenwell. Kitchen deposits. 1280-1350

	herring	cod	haddock	whiting	n/portion	% sample
n %	94	0	0.1	6	646	92
portion %	84	0	2	14	1.65	

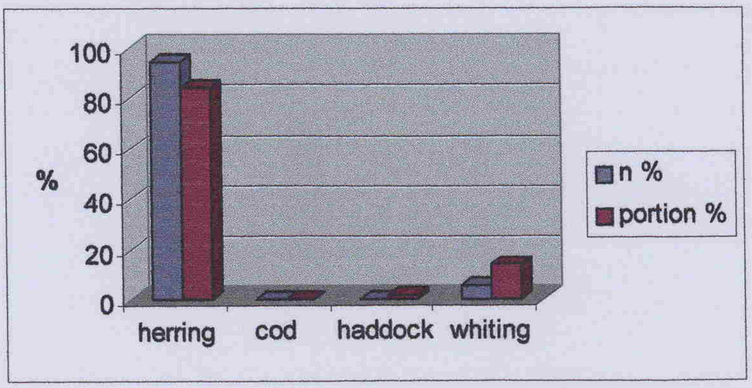


Figure 10.5. St Mary's Clerkenwell. Kitchen deposits. 1350-1450

	herring	cod	haddock	whiting	n/portion	% sample
n %	82	2	0	16	44	60
portion %	31	54	0	15	0.27	

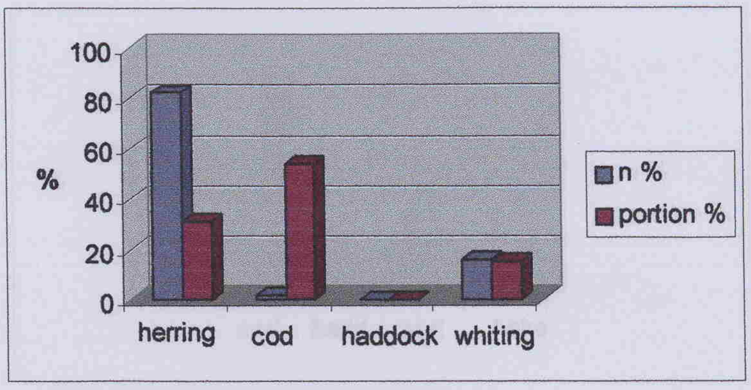


Figure 10.6. St Mary's Clerkenwell. Kitchen deposits. 1450-1540

	herring	cod	haddock	whiting	n/portion	% sample
n %	66	7	4	23	1091	65
portion %	11	70	10	9	15.01	

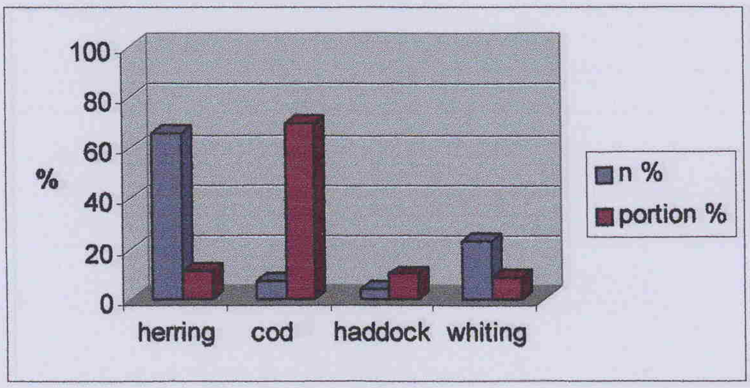


Figure 10.7. St Mary Graces, Tower Hill. Abbey & Monastic occupation.

	herring	cod	haddock	whiting	hake	n/portion	% sample
n %	20	43	1	35	0.5	181	17
portion %	1	90	1	7	1	5.59	

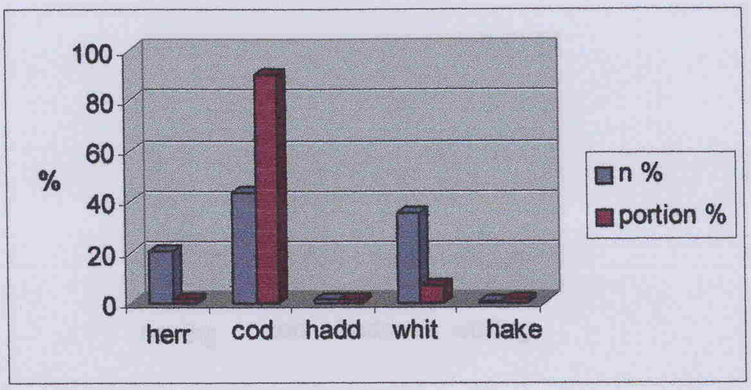


Figure 10.8. St Mary Graces, Tower Hill. Diss. & Manor House. 1539-60

	Herring	cod	haddock	whiting	n/portion	% sample
n %	56	14	6	23	545	28
portion %	5	82	7	6	13.06	

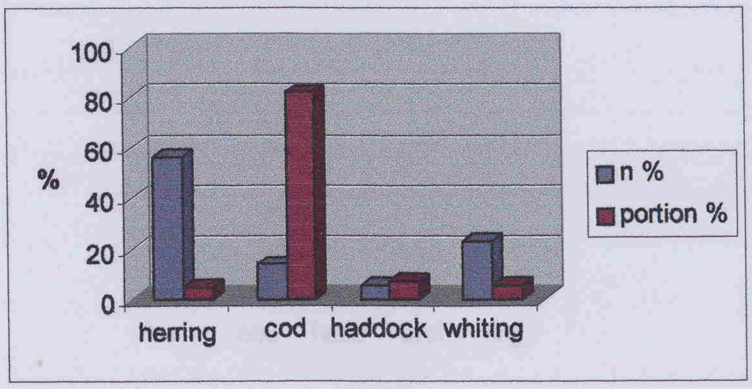


Figure 10.9. St Mary Graces, Tower Hill. Victualling Yard. 1560-1635

	herring	cod	haddock	whiting	n/portion	% sample
n %	69	3	4	24	271	36
portion %	18	49	18	16	2.34	

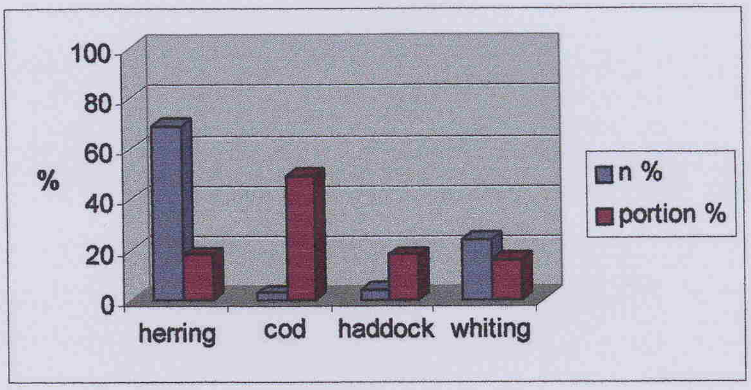


Figure 10.10. St Mary Graces, Tower Hill. Mid Victualling Yard. 1635-1726

	herring	cod	haddock	whiting	ling	n/portion	% sample
n %	62	15	4	17	2	1335	33
portion %	6	80	2	4	9	34.76	

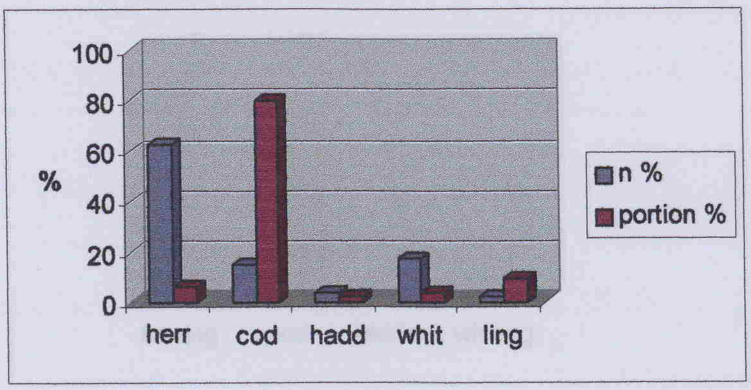


Figure 10.11. St Mary Spital. Hospital Establishment. 1235-80

	herring	cod	haddock	whiting	n/portion	% sample
n %	64	6	0	30	162	26
portion %	22	52	0	26	1.09	

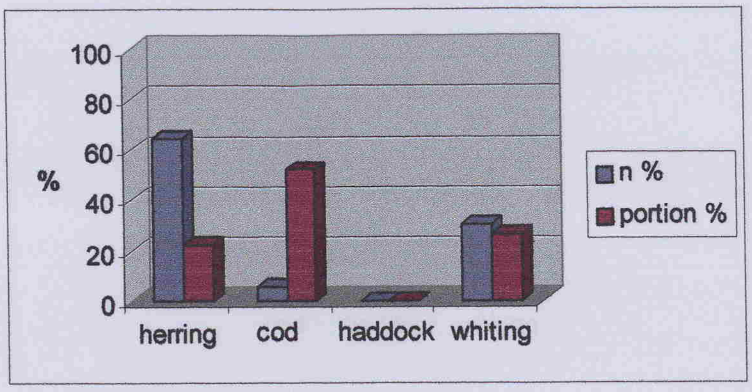


Figure 10.12. St Mary Spital. 1330-1400

	herring	cod	haddock	whiting	n/portion	% sample
n %	88	4	0	8	303	57
portion %	25	69	0	6	2.47	

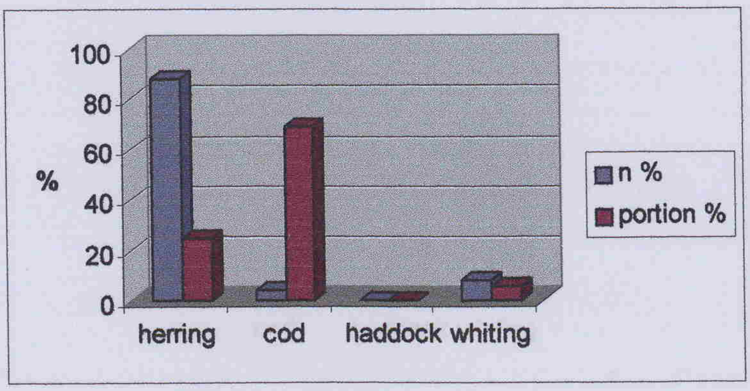


Figure 10.13. St Mary Spital. 1540-1620

	herring	cod	haddock	whiting	n/portion	% sample
n %	40	7	3	50	30	15
portion %	6	66	8	20	0.44	

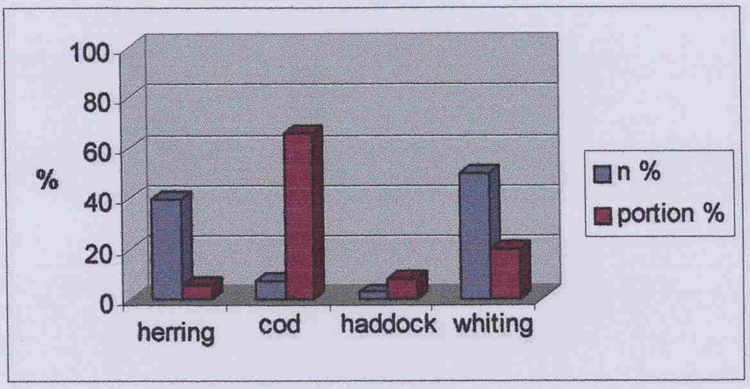


Figure 10.14. St Mary Spital. 1620-1700

	herring	cod	haddock	whiting	n/portion	% sample
n %	25	0	6	69	16	16
portion %	9	0	33	58	0.11	

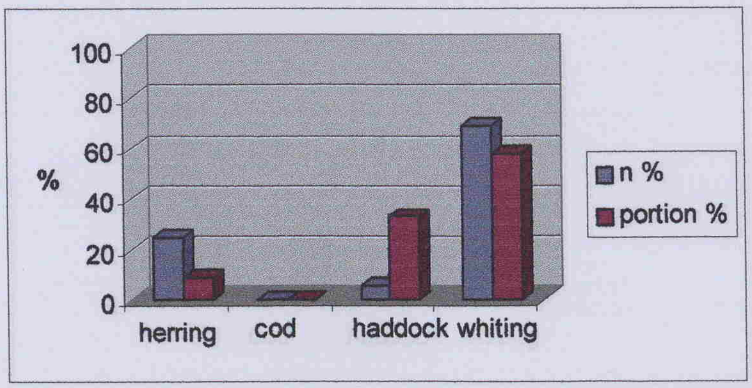


Figure 10.15. St Mary Spital. Post 1700 pits

	herring	cod	haddock	whiting	n/portion	% sample
n %	72	14	0	14	58	29
portion %	8	89	0	4	1.29	

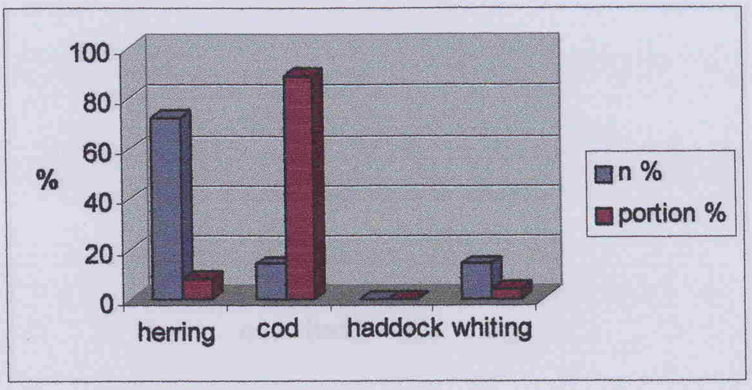


Figure 10.16. Westminster Abbey. Mid C 10th – mid 11th ditch

	herring	cod	haddock	whiting	n/portion	% sample
n %	77	1	0.5	21	3720	44
portion %	42	25	4	28	15.76	

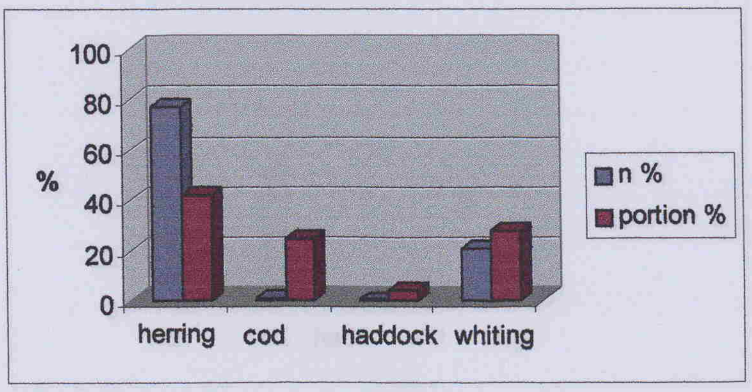


Figure 10.17. Eynsham Abbey, Oxon. E. Norman Kitchen. L C 11th – 12th.

	herring	cod	haddock	whiting	ling	n/portion	% sample
n %	99	1	0	0.3	0.2	970	59
portion %	64	29	0	0.5	6	3.43	

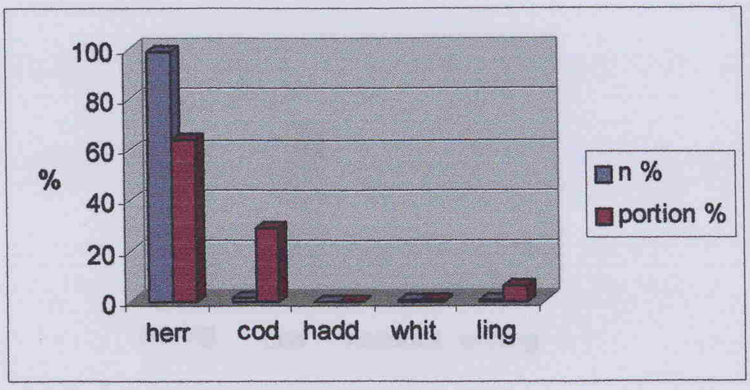


Figure 10.18. Eynsham Abbey, Oxon. Med Great Kitchen C 12th – 13th.

	herring	cod	haddock	whiting	ling	n/portion	% sample
n %	93	3	0	2	1	205	46
portion %	23	53	0	2	23	1.9	

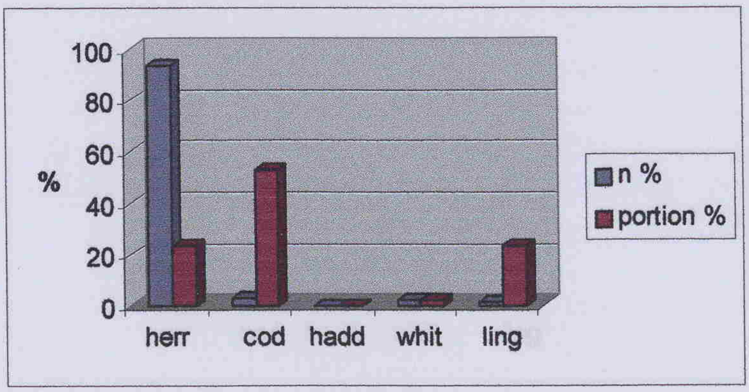


Figure 10.19. Eynsham Abbey, Oxon. Later Med Kitchen C 13th – 15th

	herring	cod	haddock	whiting	n/portion	% sample
n %	86	4	1	9	137	66
portion %	26	68	1	5	1.05	

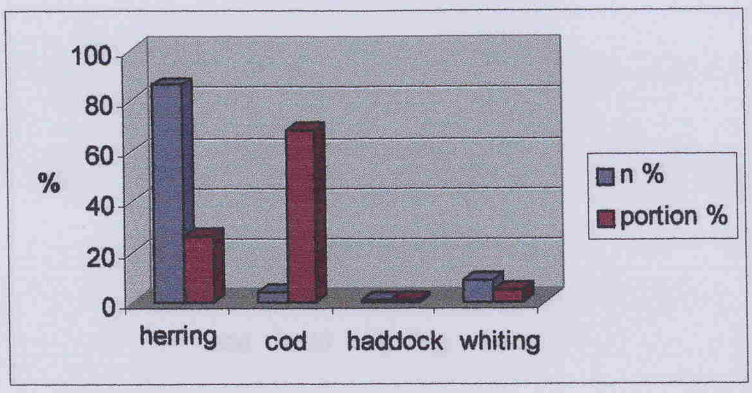


Figure 10.20. Eynsham Abbey, Oxon. Late Med Kitchen C 15th-Diss.

	herring	cod	haddock	whiting	ling	n/portion	% sample
n %	95	0.1	0.07	5	0.1	3831	86
portion %	76	6	0.3	10	8	11.02	

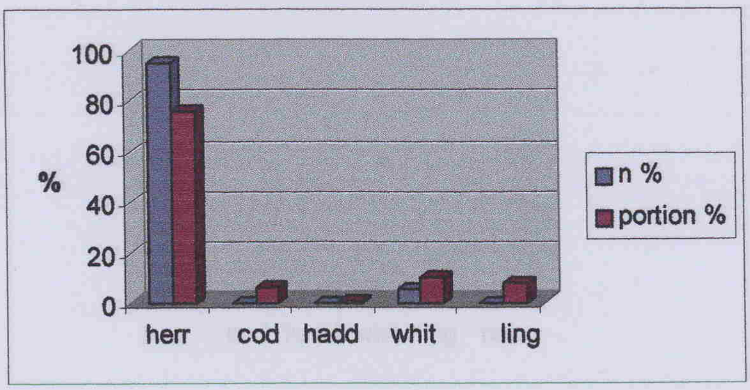


Figure 10.21. Victoria Street, Bristol. Period 1. C 12th.

	herring	cod	haddock	whiting	ling	hake	n/portion	%sample
n %	99	0	0	1	0	0	87	79
portion %	97	0	0	3	0	0	0.2	

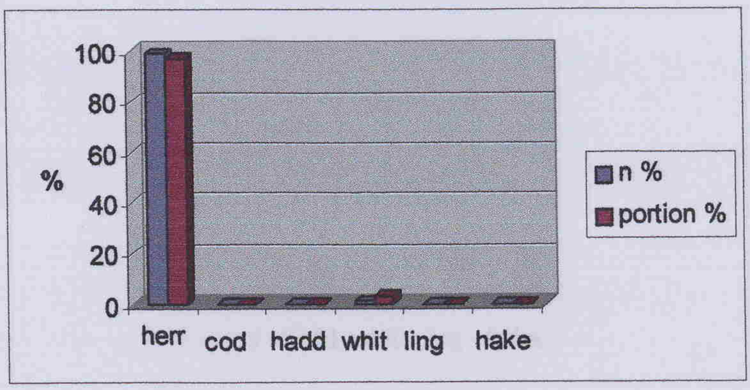


Figure 10.22. Victoria Street, Bristol. Period 2. Late C 12th.

	herring	cod	haddock	whiting	ling	hake	n/portion	% portion
n %	93	0	1	2	0	4	85	68
portion %	28	0	5	2	0	65	0.68	

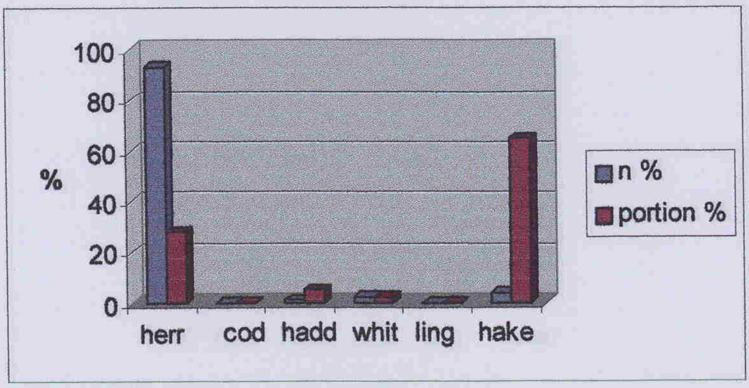


Figure 10.23. Victoria Street, Bristol. Period 4. L C 13th-E 14th.

	herring	cod	haddock	whiting	ling	hake	n/portion	% sample
n %	95	0	2	1	1	1	302	65
portion %	48	0	16	1	16	19	1.38	

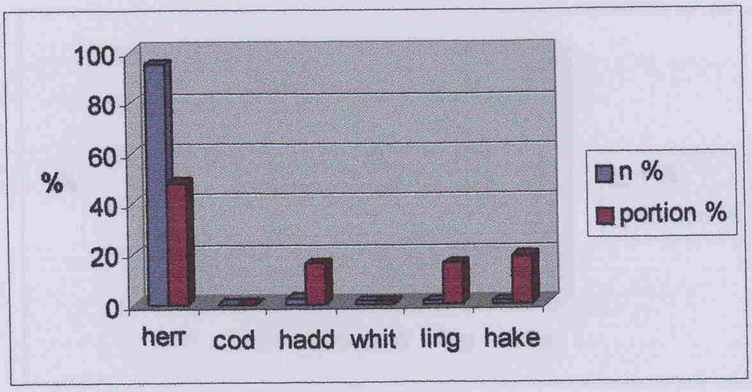


Figure 10.24. Victoria Street, Bristol. Period 5. C 14th.

	herring	cod	haddock	whiting	ling	hake	n/portion	% sample
n %	86	0.4	2	7	1	3	428	64
portion %	26	9	7	5	13	40	3.22	

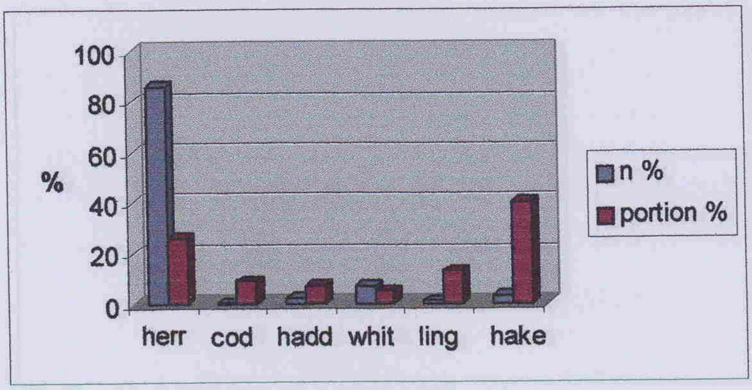


Figure 10.25. Victoria Street, Bristol. Period 6. Late C 14th.

	herring	cod	haddock	whiting	ling	hake	n/portion	% sample
n %	84	0.5	1	8	2	4	1745	57
portion %	19	4	4	5	14	54	17.37	

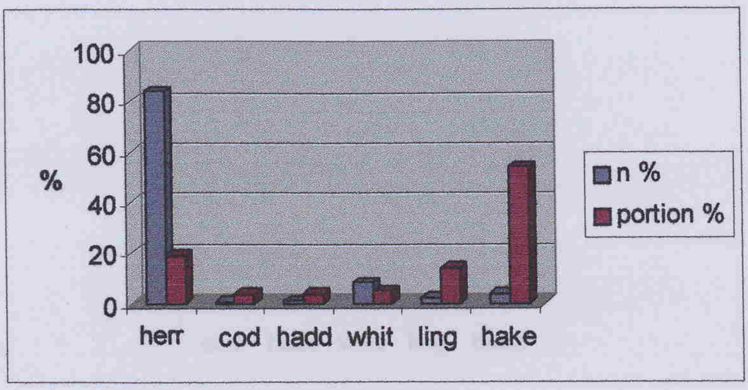


Figure 10.26. Victoria Street, Bristol. Period 7. C 15th.

	herring	cod	haddock	whiting	ling	hake	n/portion	% sample
n %	88	2	0.4	7	1	1	468	57
portion %	24	28	1	5	21	21	4.04	

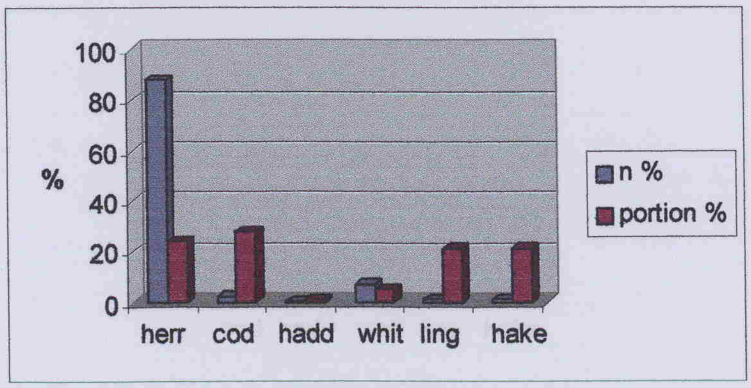


Figure 10.27. Victoria Street, Bristol. Period 8 . C 15th/16th.

	herring	cod	haddock	whiting	ling	hake	n/portion	% sample
n %	92	0.6	3	0	0	4	144	41
portion %	24	5	4	0	0	67	1.28	

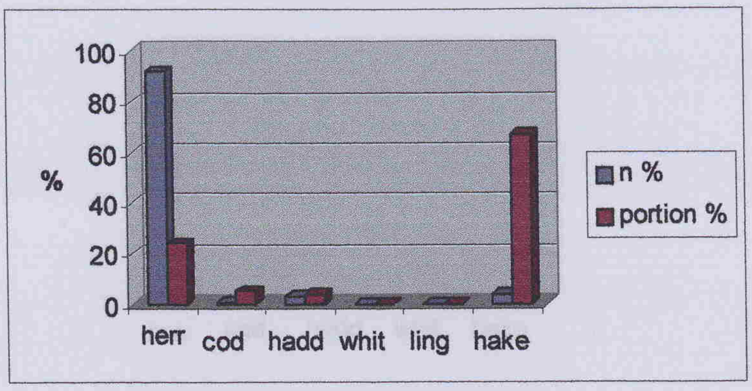


Figure 10.28. Victoria Street. Bristol. Period 9. Late C 16th.

	herring	cod	haddock	whiting	ling	hake	n/portion	% sample
n %	84	3	0.6	5	4	3	148	55
portion %	14	27	2	2	21	34	2.08	

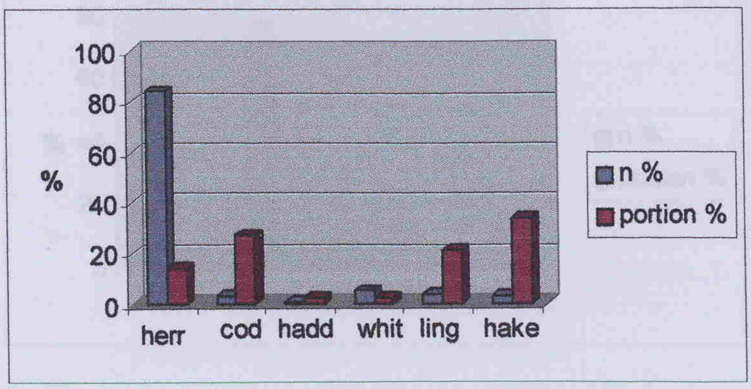


Figure 10.29. The Brooks, Winchester. Tenement A. L C 13th-E 14th.

	herring	cod	haddock	whiting	hake	n/portion	% sample
n %	77	3	3	12	6	35	56
portion %	13	14	8	5	60	0.47	

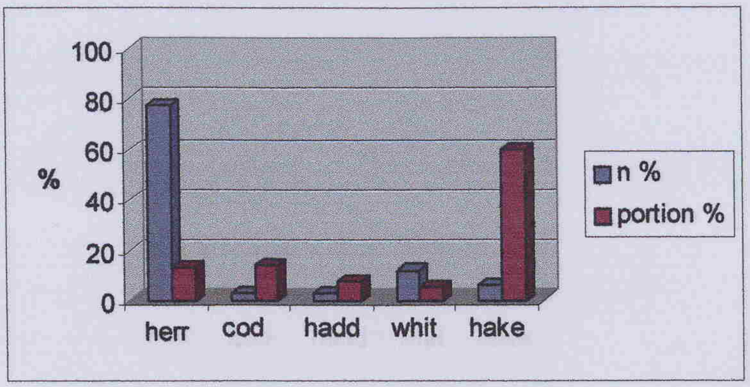


Figure 10.30. The Brooks, Winchester. Tenement B. L C13th-E 14th.

	herring	cod	haddock	whiting	hake	n/portion	% sample
n %	57	21	7	11	4	28	48
portion %	4	75	4	2	15	0.94	

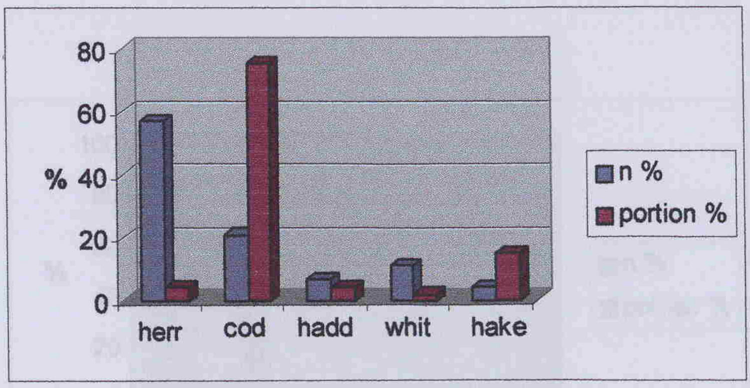
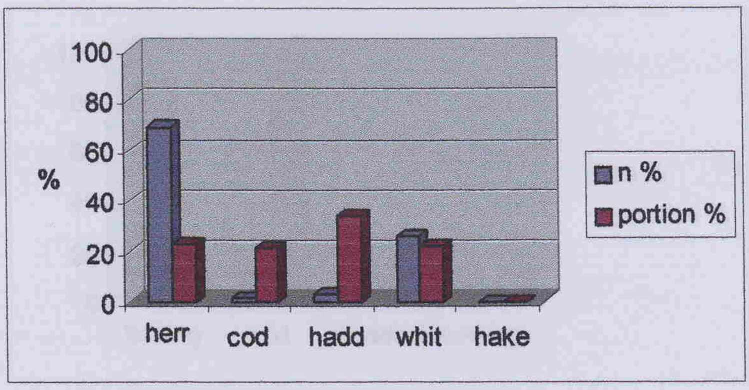


Figure 10.31. The Brooks, Winchester. Tenement C. L 13th -E 14th.

	herring	cod	haddock	whiting	hake	n/portion	% sample
n %	69	1	3	26	0	95	57
portion %	23	21	34	22	0	0.55	



Group 2

Figure 10.32. Castle Mall, Norwich. Period 1. Late C 9th-11th.

	herring	cod	haddock	whiting	pollack	saithe	n/portion	% sample
n %	91	7	0.07	2	0.04	0.03	2732	74
portion %	44	52	0.5	3	0.3	0.2	0.55	

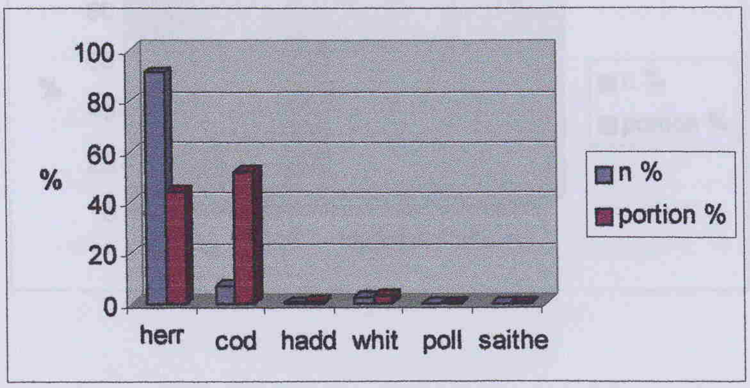


Figure 10.33. Castle Mall, Norwich. Period 2. 1068 – Early C 12th.

	herring	cod	haddock	whiting	n/portion	% sample
n %	85	11	0.4	4	1035	86
portion %	5	94	0.2	0.6	38.1	

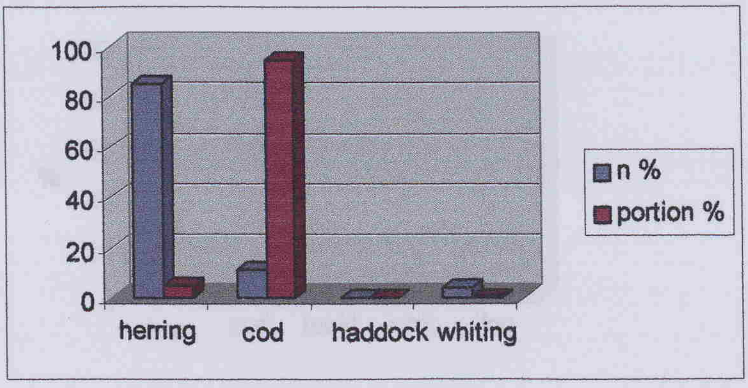


Figure 10.34. Castle Mall, Norwich. Period 3. C 12th.

	herring	cod	haddock	whiting	n/portion	% sample
n %	89	7	1	3	1057	85
portion %	23	71	4	2	9.24	

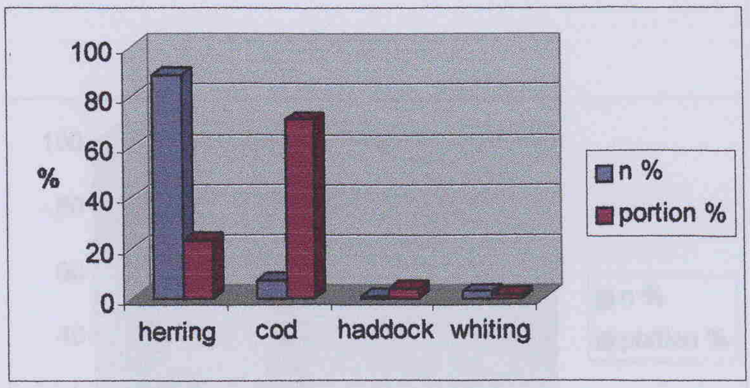


Figure 10.35. Castle Mall, Norwich. Period 4. Late C 12th– Mid 14th.

	herring	cod	haddock	whiting	ling	n/portion	% sample
n %	82	8	0.4	10	0.1	734	83
portion %	21	68	2	6	3	6.64	

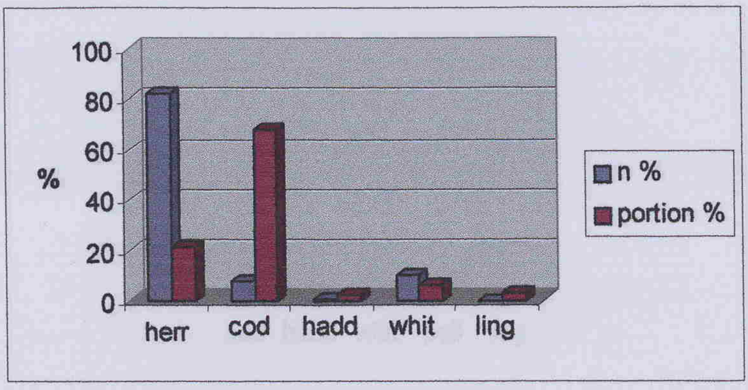


Figure 10.36. Castle Mall, Norwich. Period 5. Mid-Late C 14th –Late 16th.

Exc Barbican well.

	herring	cod	haddock	whiting	n/portion	% sample
n %	81	6	4	10	1134	63
portion %	26	56	10	7	8.14	

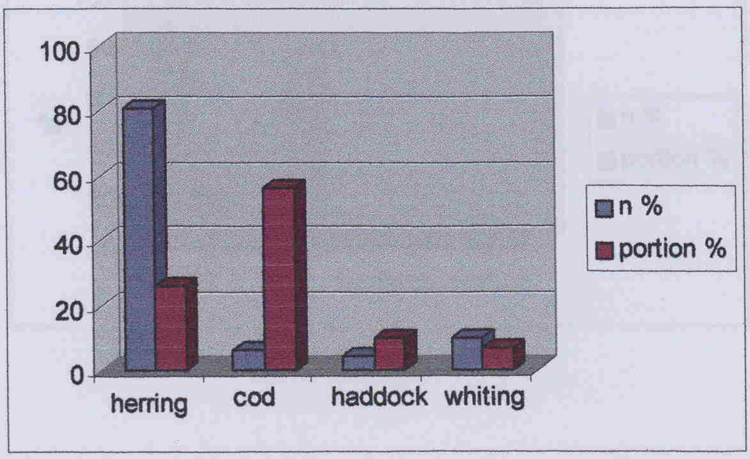


Figure 10.37. Castle Mall, Norwich. Period 5.2. Barbican Well.

	herring	cod	haddock	whiting	pollack	ling	n/portion	% sample
n %	89	3	1	7	0.2	0.05	1682	76
portion %	39	40	6	7	6	2	8.96	

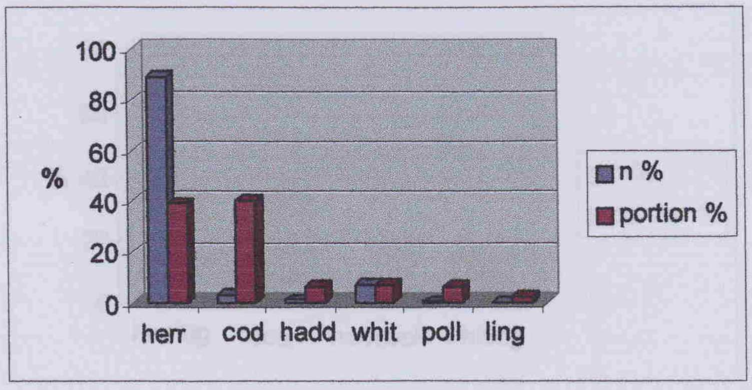


Figure 10.38. Castle Mall, Norwich. Period 6. Late C 16th –18th.

	herring	cod	haddock	whiting	n/portion	% sample
n %	85	10	0.3	5	255	71
portion %	19	77	1	3	2.58	

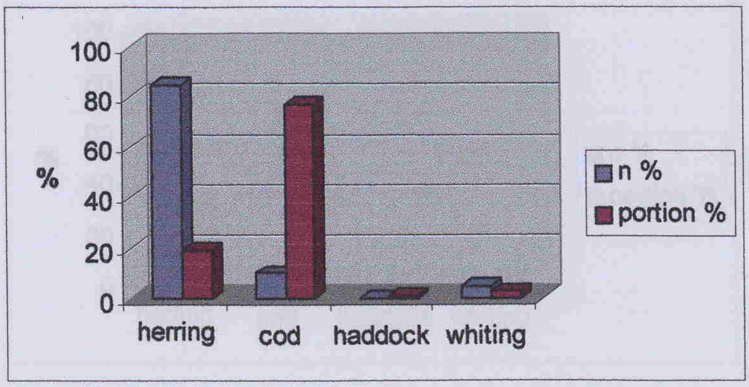
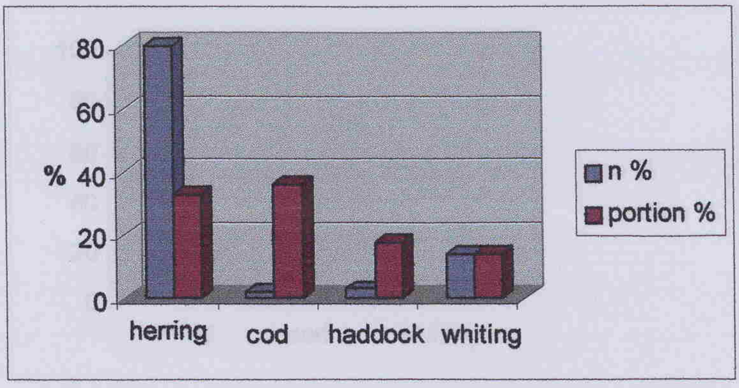


Figure 10.39. St Martin-at-Palace Plain, Norwich. Saxo-Norman Pits.

	herring	cod	haddock	whiting	n/portion	% sample
n %	80	2	3	14	142	47
portion %	33	36	18	14	0.8	



NB no division of vertebrae at this site.

Figure 10.40. St Martin-at-Palace Plain, Norwich. Mid C 11th.

	herring	cod	haddock	whiting	n/portion	% sample
n %	93	5	0.3	2	1914	91
portion %	30	68	1	1	13.92	

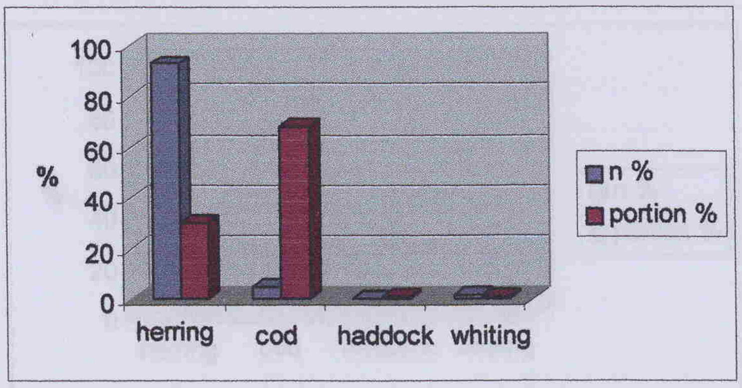


Figure 10.41. St Martin-at-Palace Plain, Norwich. C 12th – Mid 12th.

	herring	cod	whiting	n/portion	% sample
n %	87	7	5	403	87
portion %	21	76	3	3.93	

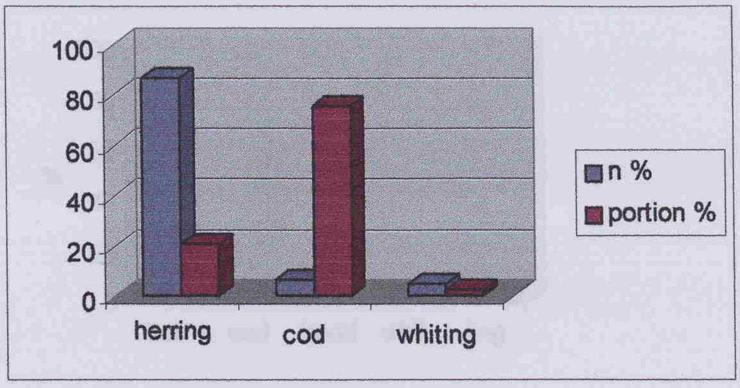


Figure 10.42. Fishergate, Norwich. C 11th. Deposit 78

	herring	cod	haddock	whiting	n/portion	% sample
n %	90	9	0.7	0.7	250	46
portion %	14	84	2	0.3	3.74	

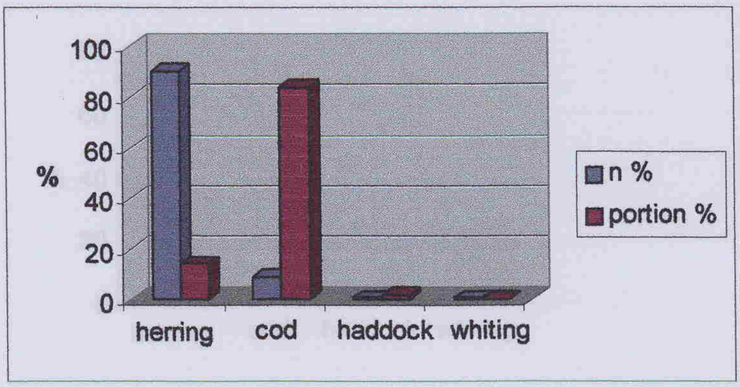


Figure 10.43. Fleet Prison, London. Early Plantagenet. 1154-1270

	herring	cod	haddock	whiting	ling	n/portion	% sample
n %	90	4	0.5	5	0.5	199	75
portion %	26	63	1	3	6	1.58	

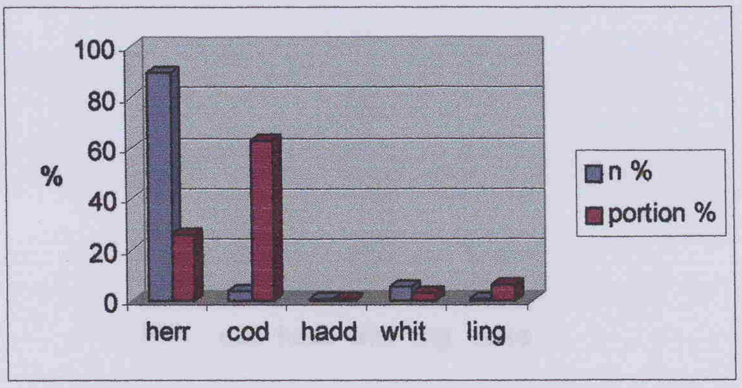


Figure 10.44. Fleet Prison, London. Late Plantagenet. 1270-1399

	herring	cod	haddock	whiting	n/portion	% sample
n %	75	4	1	20	338	81
portion %	34	41	2	23	1.73	

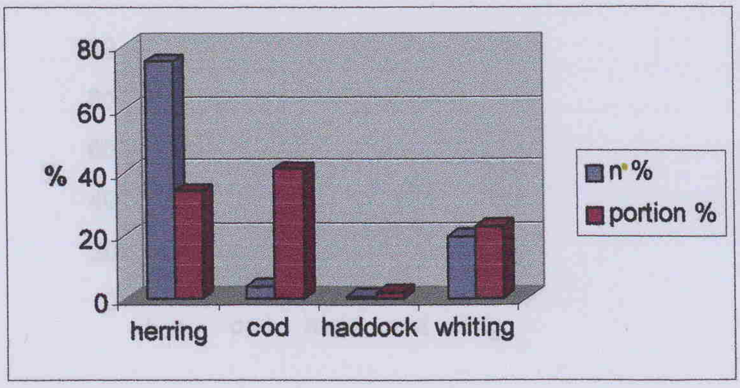


Figure 10.45. Fleet Prison, London. Late Medieval. 1399-1485

	herring	cod	haddock	whiting	ling	hake	n/portion	% sample
n %	11	5	2	83	0.1	0.1	650	51
portion %	2	43	5	45	3	2	6.92	

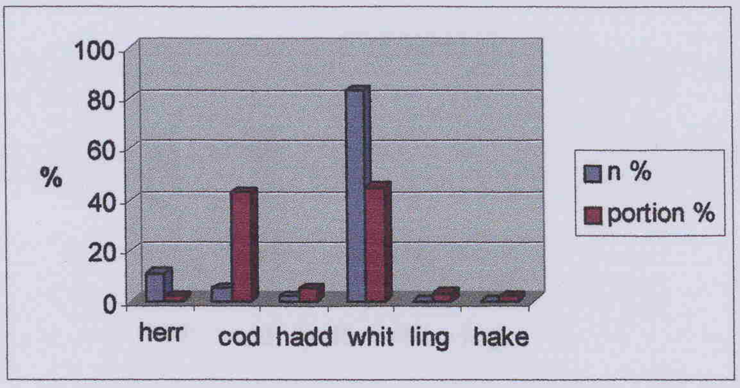


Figure 10.46. Fleet Prison, London. Tudor. 1485-1603

	herring	cod	haddock	whiting	ling	n/portion	% sample
n %	59	10	3	12	15	473	53
portion %	3	27	3	1	66	23.25	

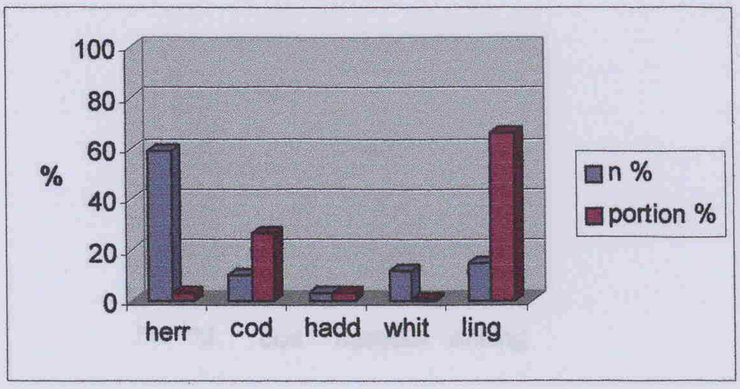


Figure 10.47. Fleet Prison, London. Early Stuart. 1603 +

	herring	cod	haddock	whiting	ling	n/portion	% sample
n %	67	8	1	23	1	155	49
portion %	11	67	2	10	10	2.12	

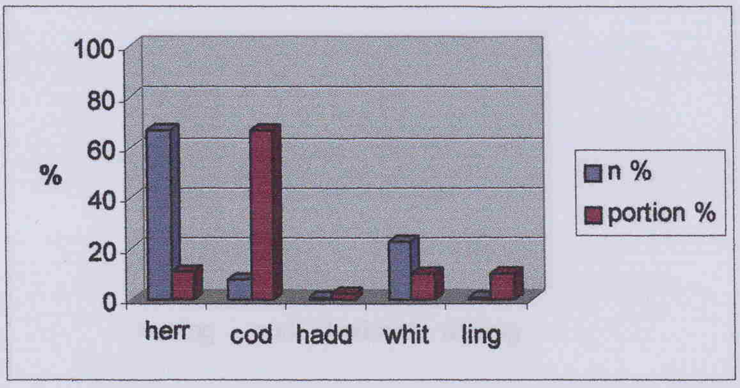


Figure 10.48. High Street, Huntingdon. Phase 2. C 12th – 13th.

	herring	cod	haddock	whiting	n/portion	% sample
n %	97	0	1	1	69	77
portion %	79	0	18	3	0.2	

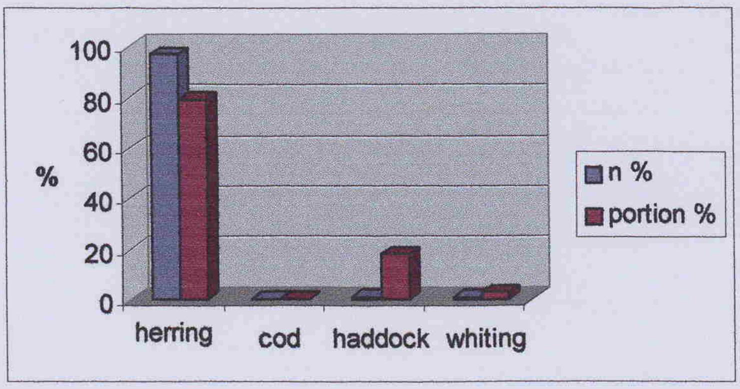


Figure 10.49. High Street, Huntingdon. Phase 3. C 13th –14th.

	herring	cod	haddock	whiting	n/portion	% sample
n %	99	0.1	0.3	0	1720	68
portion %	88	10	2	0	4.46	

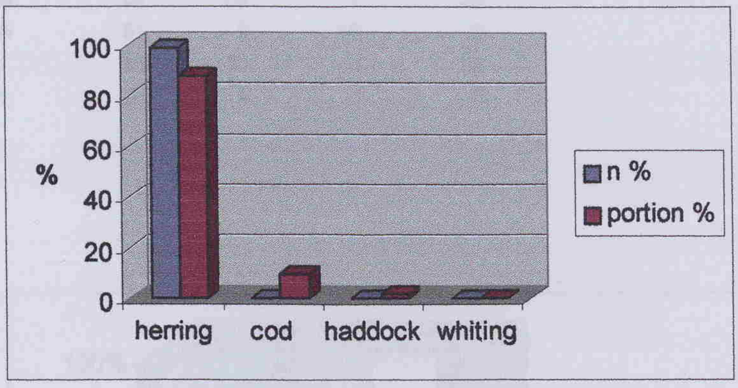
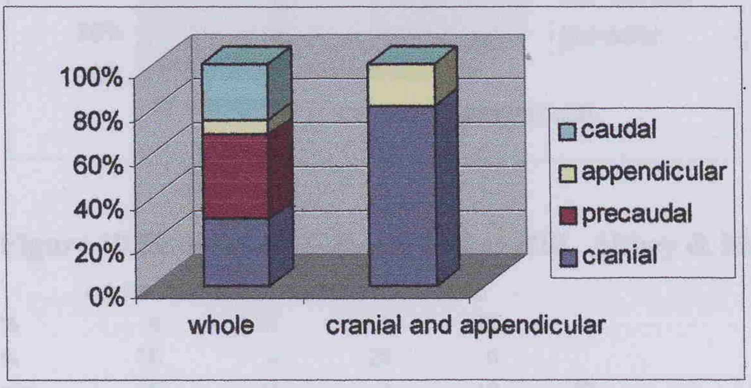


Figure 10.50. Body Part representation. Idealised whole fish showing the proportions of cranial, appendicular and vertebral elements compared with cranial and appendicular elements only.

	cranial	prec vert	appendic.	caudal vert
%	30	38	7	25
%	81	0	19	0
n	26	33	6	22
n	26	0	6	0



Cranial elements; 1 vomer, 1 parasphenoid, 2 premaxillae, 2 maxillaries, 2 dentaries, 2 articulars, 2 quadrates, 2 hyomandibulars, 2 ceratohyals, 2 epihyals, 2 operculars, 2 suboperculars, 2 interoperculars, 2 preoperculars.

Appendicular elements; 2 cleithra, 2 posttemporals, 2 supracleithra.

COD

Group 1

Figure 10.51. St Mary's Clerkenwell. Kitchen deposits 1450-1540

	cranial	precaudal	appendic	caudal	
%	1.9	9	1.9	87	
%	50	0	50	0	
n =	1	5	1	47	= 54
n =	1	0	1	0	= 2

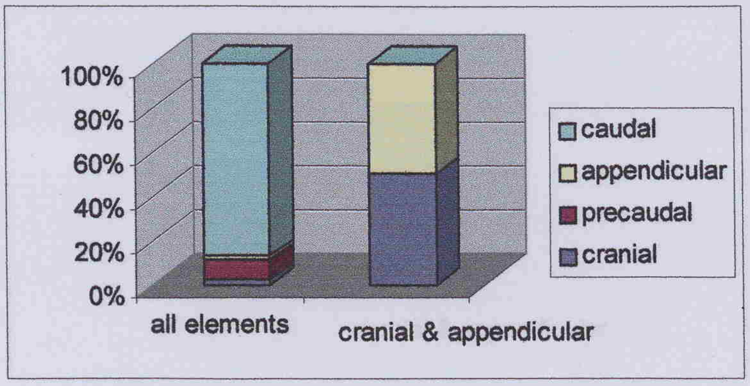


Figure 10.52. St Mary Graces, Tower Hill. Abbey & Monastic Occupation.

	cranial	precaudal	appendic	caudal	
%	5	75	2	18	
%	75	0	25	0	
n =	3	43	1	10	= 57
n =	3	0	1	0	= 4

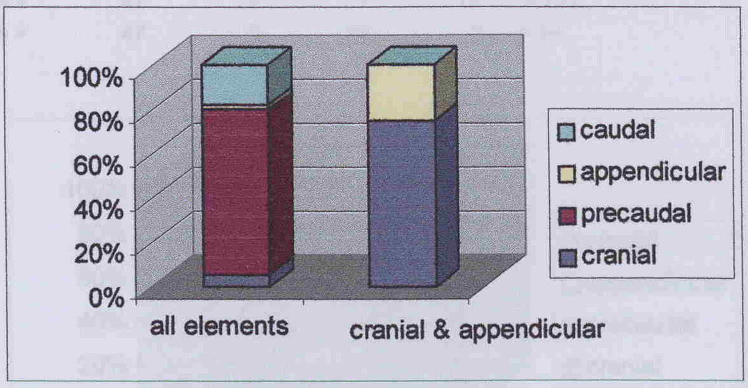


Figure 10.53. Westminster Abbey. Mid C 10th – Mid 11th. Ditch 238

	cranial	precaudal	appendic	caudal	
%	19	23	4	54	
%	82	0	18	0	
n =	9	11	2	26	= 48
n =	9	0	2	0	= 11

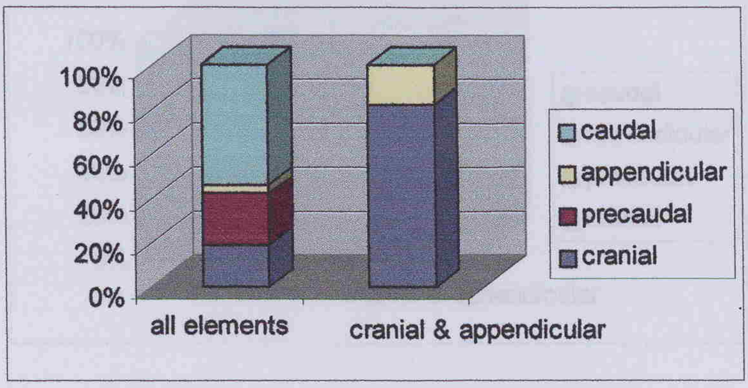


Figure 10.54. Castle Mall, Norwich. Period 1. Late C 9th –11th.

	cranial	precaudal	appendic	caudal	
%	23	35	6	36	
%	80	0	20	0	
n =	47	70	12	72	= 201
n =	47	0	12	0	= 59

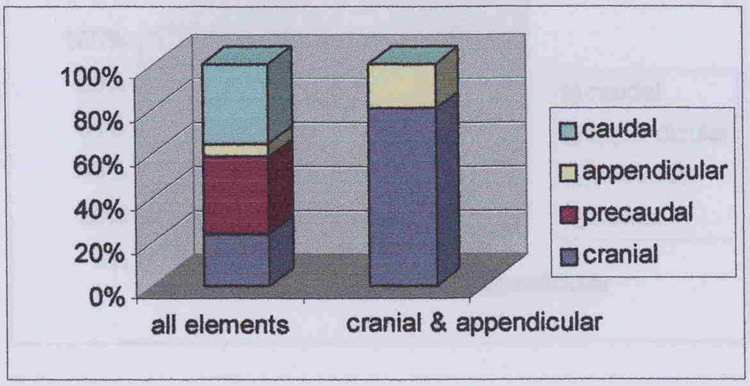


Figure 10.55. Castle Mall, Norwich. Period 2. 1068- Early C 12th.

	cranial	precaudal	appendic	caudal	
%	8	26	4	62	
%	64	0	36	0	
n =	7	23	4	56	= 90
n =	7	0	4	0	= 11

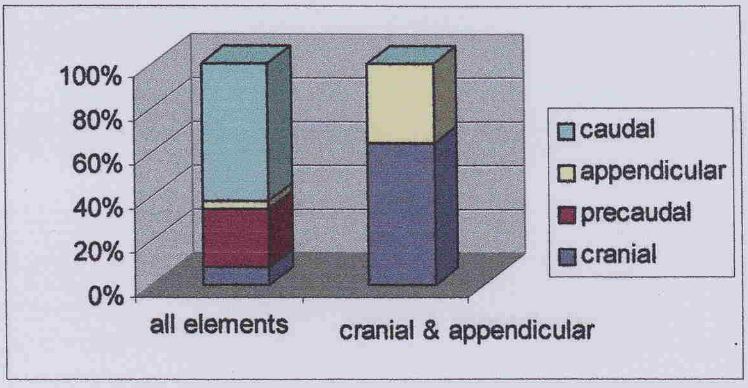


Figure 10.56. Castle Mall, Norwich. Period 4. Late C 12th- Mid 14th.

	cranial	precaudal	appendic	caudal	
%	14	38	2	46	
%	88	0	12	0	
n =	7	19	1	23	= 50
n =	7	0	1	0	= 8

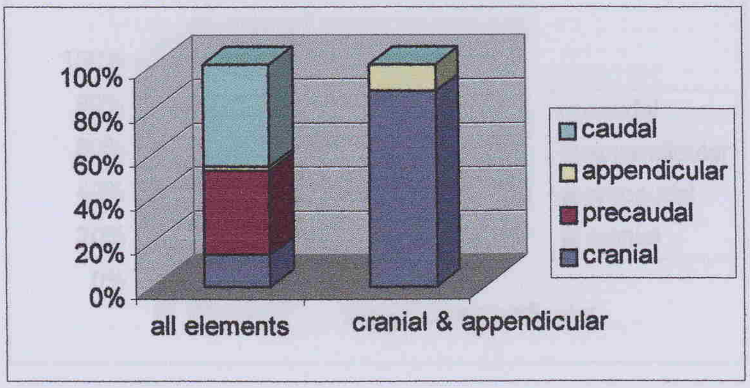


Figure 10.57. Castle Mall, Norwich. Period 5. Mid-Late 14th – Late 16th.
Excluding Barbican Well.

	cranial	precaudal	appendic	caudal	
%	8	43	8	40	
%	50	0	50	0	
n =	5	26	5	24	= 60
n =	5	0	5	0	= 10

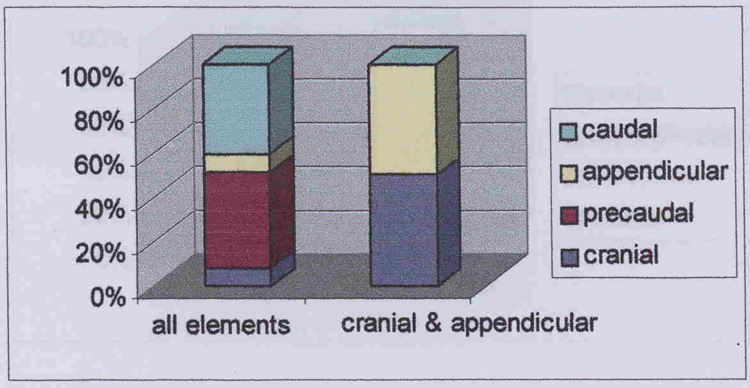


Figure 10.58. Castle Mall, Norwich. Period 5.2. Barbican Well.

	cranial	precaudal	appendic	caudal	
%	20	20	0	60	
%	100	0	0	0	
n =	6	6	0	18	= 30
n =	6	0	0	0	= 6

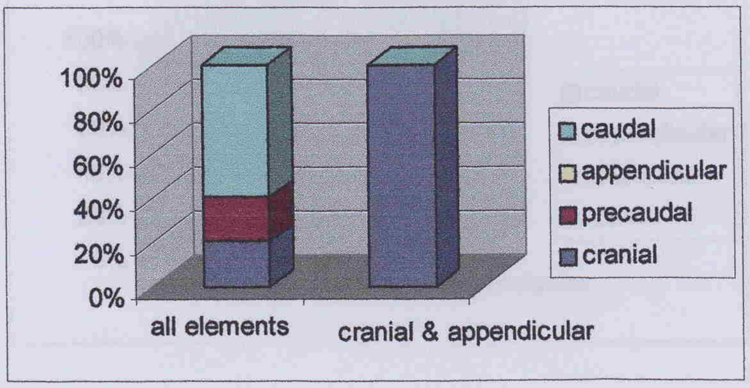


Figure 10.59. Fleet Prison, London. Late Medieval. 1399-1485

	cranial	precaudal	appendic	caudal	
%	0	48	24	28	
%	0	0	100	0	
n =	0	10	5	6	= 21
n =	0	0	5	0	= 5

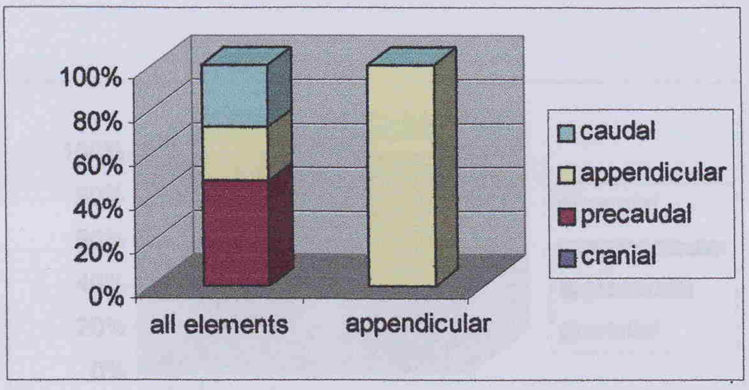
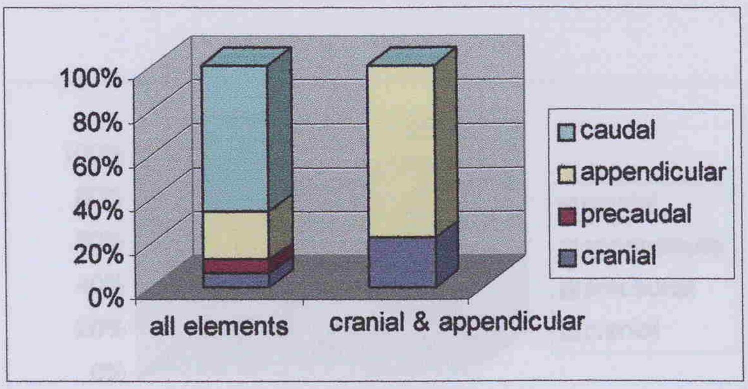


Figure 10.60. Fleet Prison, London. Tudor. 1485-1603

	cranial	precaudal	appendic	caudal	
%	6	6	22	66	
%	22	0	78	0	
n =	2	2	7	21	= 32
n =	2	0	7	0	= 9



Group 3

Figure 10.61. Middlegate, Hartlepool. Phase 1. C 12th/13th.

	cranial	precaudal	appendic	caudal	
%	47	48	3	2	
%	94	0	6	0	
n =	29	30	2	1	= 62
n =	29	0	2	0	= 31

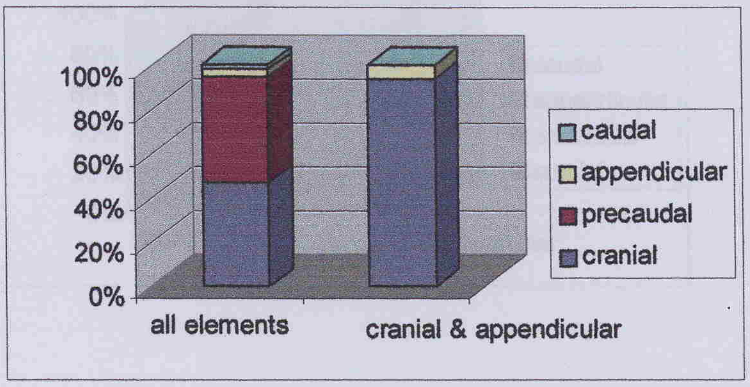


Figure 10.62. Middlegate, Hartlepool. Phase 2. 1200-1250.

	cranial	precaudal	appendic	caudal	
%	51	39	5	5	
%	92	0	8	0	
n =	33	25	3	3	= 64
n =	33	0	3	0	= 36

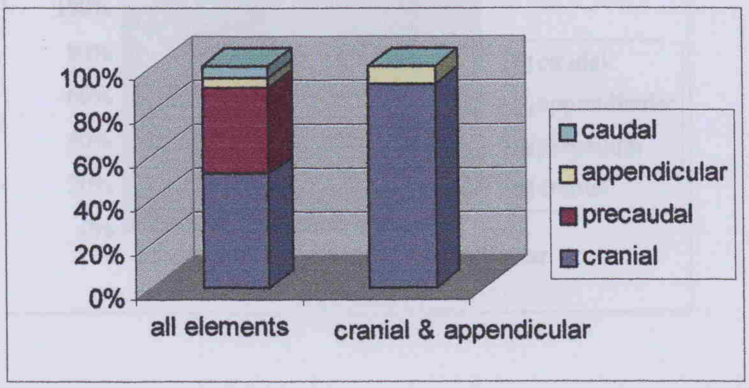


Figure 10.63. Middlegate, Hartlepool. Phase 3. Mid-Late C 13th.

	cranial	precaudal	appendic	caudal	
%	63	32	5	0	
%	92	0	8	0	
n =	12	6	1	0	= 19
n =	12	0	1	0	= 13

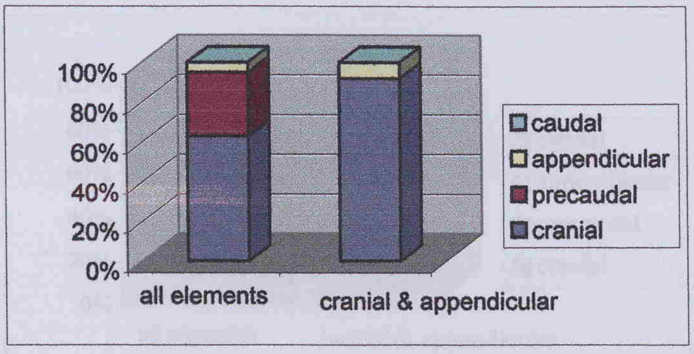


Figure 10.64. Church Close, Hartlepool. Early Med/Post Conquest ditch.

	cranial	precaudal	appendic	caudal	
%	21	67	0	12	
%	100	0	0	0	
n =	10	32	0	6	= 48
n =	10	0	0	0	= 10

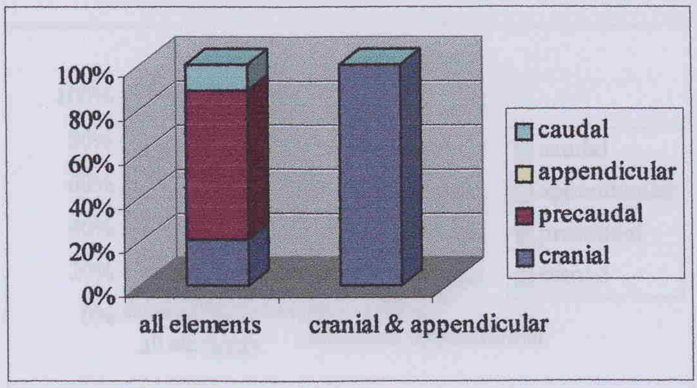


Figure 10.65. Church Close, Hartlepool. Building V. Mid C 13th –14th.

	cranial	precaudal	appendic	caudal	
%	34	64	2	0	
%	95	0	5	0	
n =	20	37	1	0	= 58
n =	20	0	1	0	= 21

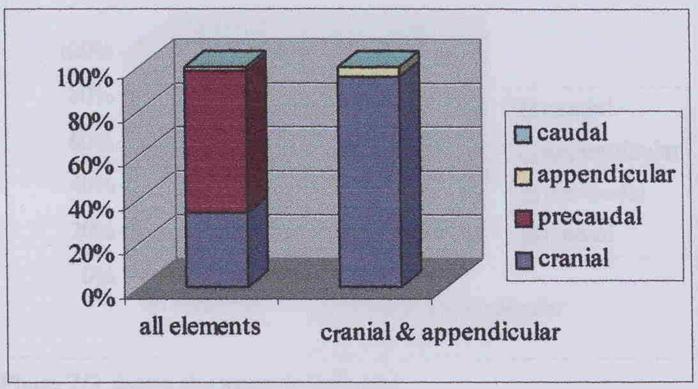


Figure 10.66. Church Close, Hartlepool. Medieval Building IV.

	cranial	precaudal	appendic	caudal	
%	24	56	4	16	
%	86	0	14	0	
n =	18	43	3	12	= 76
n =	18	0	3	0	= 21

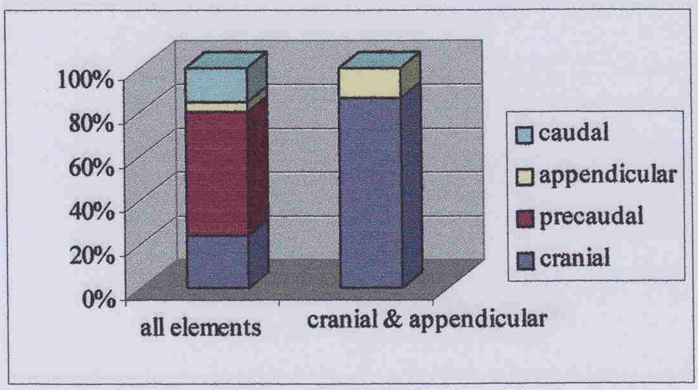
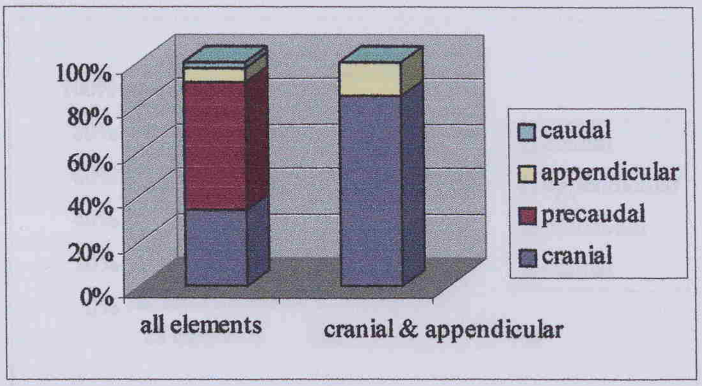


Figure 10.67. Church Walk, Hartlepool. Phase 2. C 12th/13th.

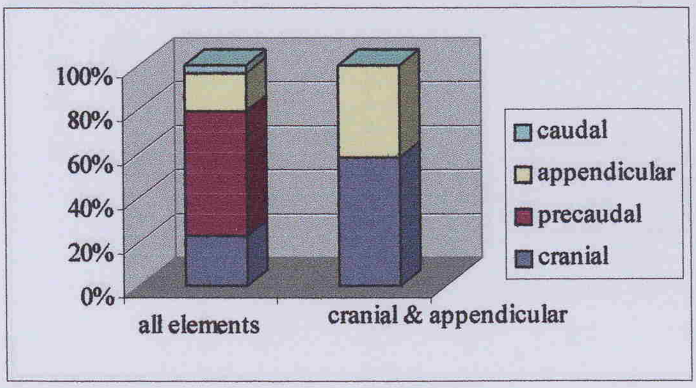
	cranial	precaudal	appendic	caudal	
%	34	57	6	3	
%	85	0	15	0	
n =	22	37	4	2	= 65
n =	22	0	4	0	= 26



Phase 2/3 shows the same distribution.

Figure 10.68. Church Walk, Hartlepool. Phase 3. Late C 13th–14th.

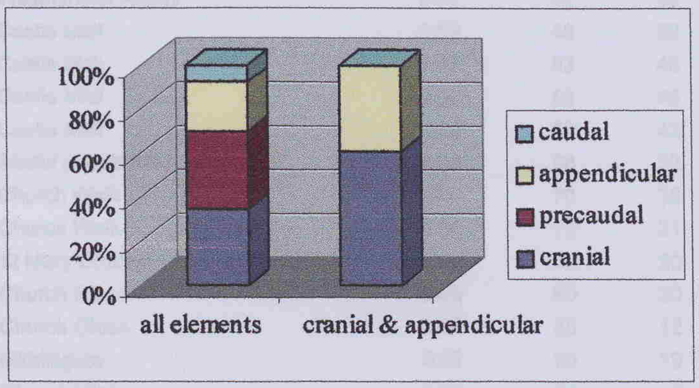
	cranial	precaudal	appendic	caudal	
%	23	56	17	4	
%	58	0	42	0	
n =	11	27	8	2	= 48
n =	11	0	8	0	= 19



Phase 3 / 4 only cranial and precaudal

Figure 10.69. Church Walk, Hartlepool. Phase 4. Late C 14^{th}-15^{th}.

	cranial	precaudal	appendic	caudal	
%	35	35	22	8	
%	61	0	39	0	
n =	8	8	5	2	= 23
n =	8	0	5	0	= 13



Group 4

Figure 10.70. Southgate, Hartlepool. C 12^{th} dock deposits A & B.

	cranial	appendic	
A %	96	4	
B %	87	13	
A n =	110	3	= 114
B n =	20	3	= 23

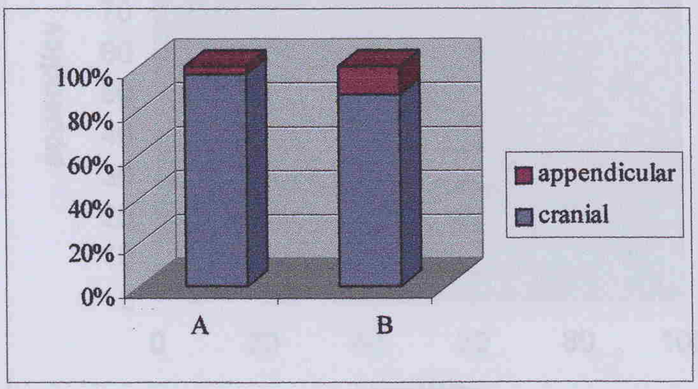


Figure 10.71. Graph showing the distribution of cod data from Figs 10.50 – 10.69. All elements in ascending order of cran/pv%.

Site	Fig no	cran/pv%	app/cv%
St Mary's Clerkenwell	9.51	11	89
Fleet Prison	9.60	12	88
Castle Mall	9.55	34	66
Castle Mall	9.58	40	60
Westminster Abbey	9.53	42	58
Castle Mall	9.59	48	52
Castle Mall	9.57	52	48
Castle Mall	9.56	52	48
Castle Mall	9.54	58	42
Model (whole fish)	9.50	68	32
Church Walk	9.69	70	30
Church Walk	9.68	79	21
St Mary Graces	9.52	80	20
Church Close	9.66	80	20
Church Close	9.64	88	12
Middlegate	9.62	90	10
Church Walk	9.67	91	9
Middlegate	9.63	95	5
Middlegate	9.61	95	5
Church Close	9.65	98	2

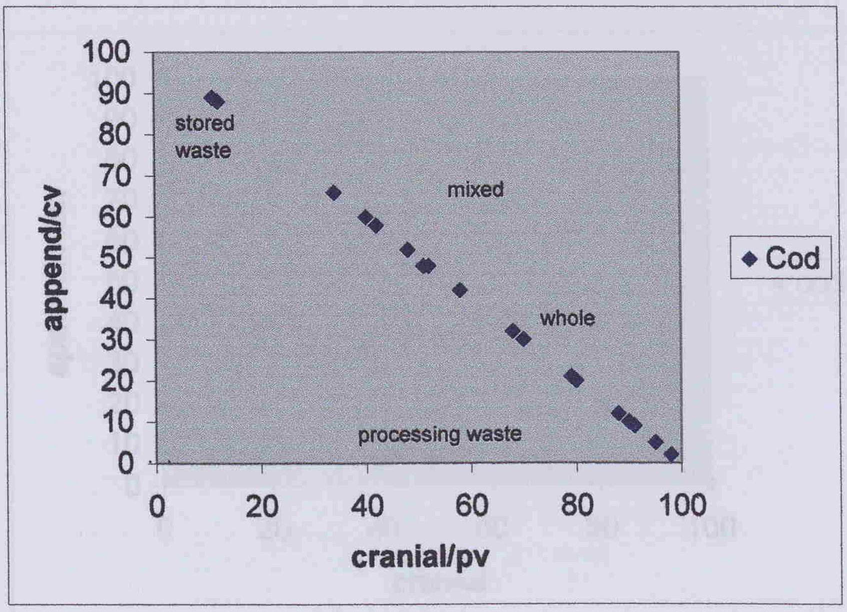
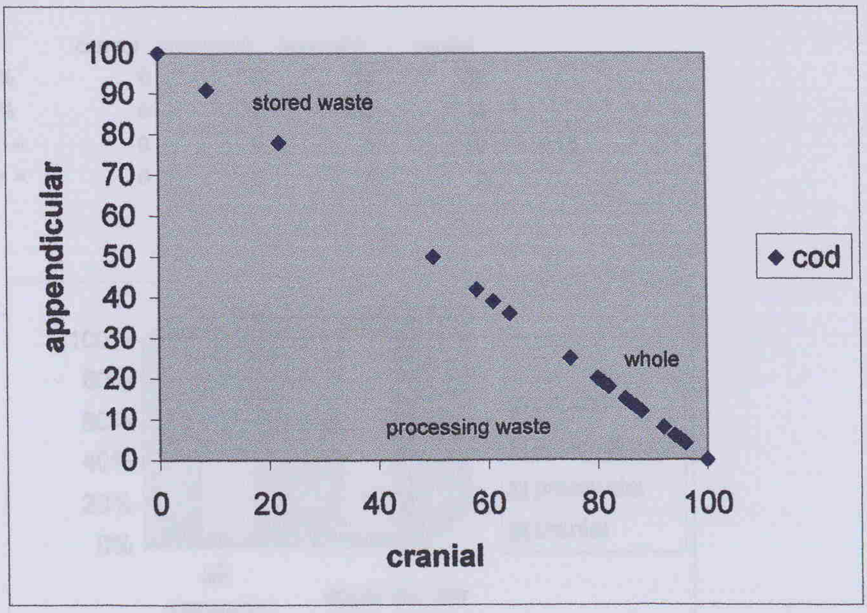


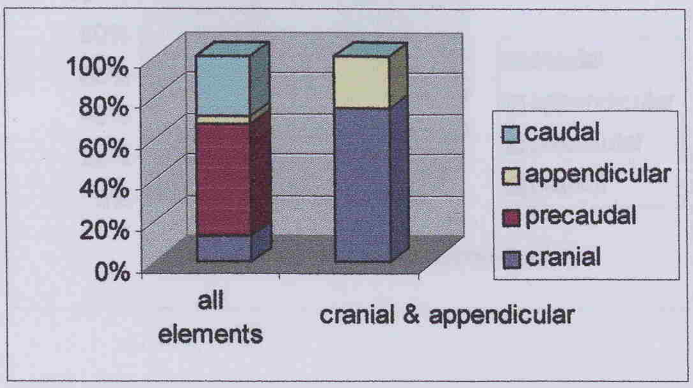
Figure 10.72. Graph to show distribution of cod data from Figures 10.50-10.70. Cranial and appendicular only in ascending cranial %.

Site	Fig no	Cranial %	Append%
Castle Mall	9.59	0	100
Nonsuch		9	91
Fleet Prison	9.80	22	78
St Mary's Clerkenwell	9.51	50	50
Castle Mall	9.57	50	50
Church Walk	9.68	58	42
Church Walk	9.69	61	39
Castle Mall	9.55	64	36
St Mary Graces	9.52	75	25
Castle Mall	9.54	80	20
Model (whole fish)	9.50	81	19
Westminster Abbey	9.53	82	18
Church Walk	9.67	85	15
Church Close	9.66	86	14
Southgate B		87	13
Castle Mall	9.56	88	12
Middlegate	9.62	92	8
Middlegate	9.63	92	8
Middlegate	9.61	94	6
Church Close	9.65	95	5
Southgate A		96	4
Castle Mall	9.58	100	0
Church Close	9.64	100	0



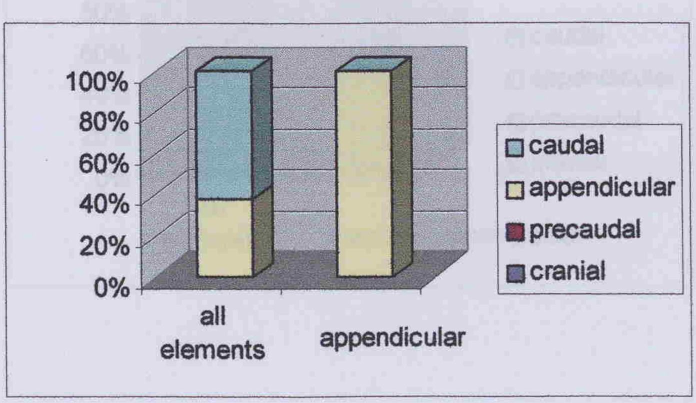
LING
Group 1
Figure 10.73. Victoria Street, Bristol. Period 6. Late C 14th.

	cranial	precaudal	appendic	caudal	
%	13	54	4	29	
%	75	0	25	0	
n =	3	13	1	7	= 24
n =	3	0	1	0	= 4



Group 2
Figure 10.74. Fleet Prison, London. Tudor. 1485-1603

	cranial	precaudal	appendic	caudal	
%	0	0	38	62	
%	0	0	100	0	
n =	0	0	6	10	= 16
n =	0	0	6	0	



Group 3
Figure 10.75. Middlegate, Hartlepool. Phase 1. C $12^{th}/13^{th}$.

	cranial	precaudal	appendic	caudal	
%	74	20	3	3	
%	96	0	4	0	
n =	26	7	1	1	= 35
n =	26	0	1	0	= 27

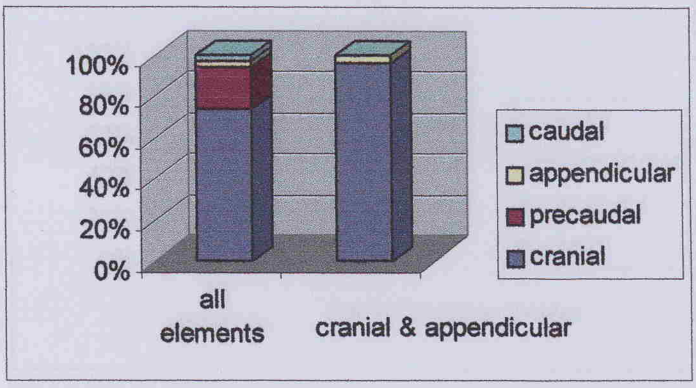


Figure 10.76. Middlegate, Hartlepool. Phase 2. 1200-1250.

	cranial	precaudal	appendic	caudal	
%	40	46	6	8	
%	90	0	10	0	
n =	19	22	3	4	= 48
n =	19	0	3	0	= 21

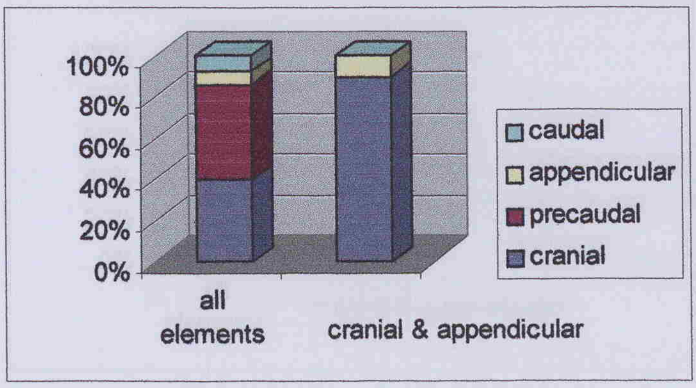


Figure 10.77. Middlegate, Hartlepool. Phase 3. Mid-Late 13th.

	cranial	precaudal	appendic	caudal	
%	31	54	8	8	
%	80	0	20	0	
n =	4	7	1	1	= 13
n =	4	0	1	0	= 5

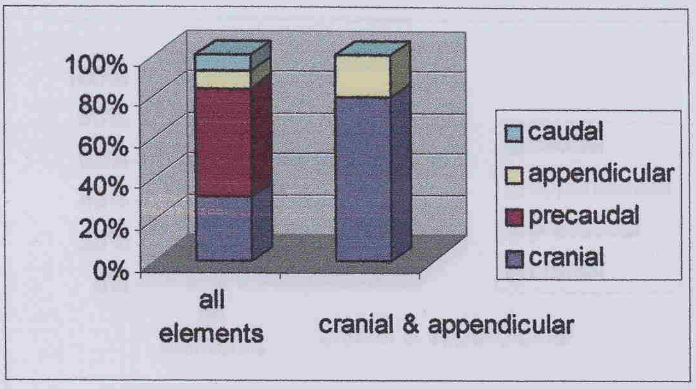


Figure 10.78. Church Close, Hartlepool. Early Medieval/Post Conquest Ditch.

	cranial	precaudal	appendic	caudal	
%	56	41	3	0	
%	95	0	5	0	
n =	38	28	2	0	= 68
n =	38	0	2	0	= 40

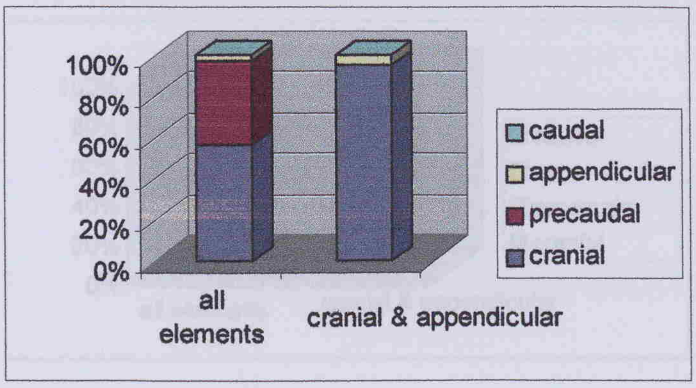


Figure 10.79. Church Close, Hartlepool. Medieval Building IV

	cranial	precaudal	appendic	caudal	
%	38	49	4	8	
%	90	0	10	0	
n =	37	48	4	8	= 97
n =	37	0	4	0	= 41

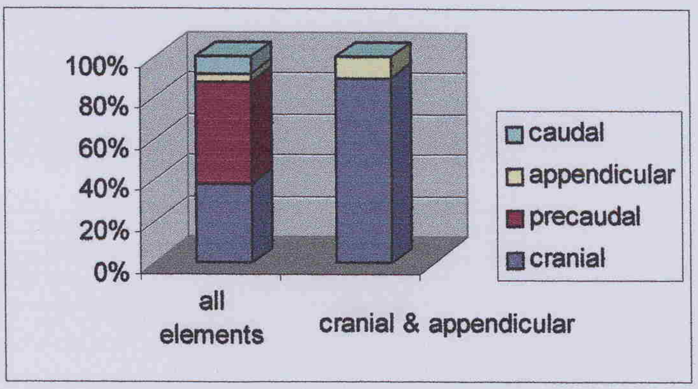


Figure 10.80. Church Close, Hartlepool. Medieval Building II

	cranial	precaudal	appendic	caudal	
%	28	61	6	6	
%	83	0	17	0	
n =	5	11	1	1	= 18
n =	5	0	1	0	= 6

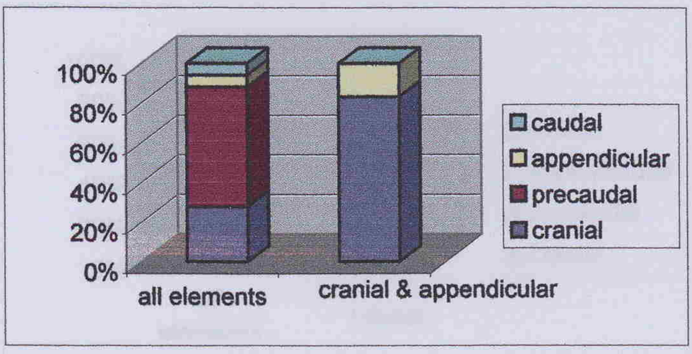


Figure 10.81. Church Walk, Hartlepool. Phase 2. C 12th/13th.

	cranial	precaudal	appendic	caudal	
%	38	62	0	0	
%	100	0	0	0	
n =	6	10	0	0	= 16
n =	6	0	0	0	= 6

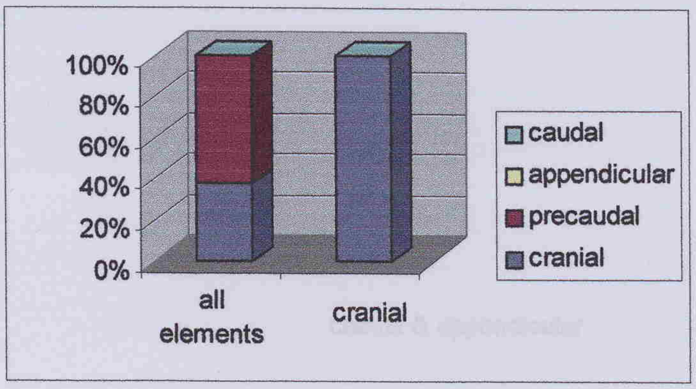


Figure 10.82. Church Walk, Hartlepool. Phase 3. Late C 13th/14th.

	cranial	precaudal	appendic	caudal	
%	32	64	0	4	
%	100	0	0	0	
n =	7	14	0	1	= 22
n =	7	0	0	0	= 7

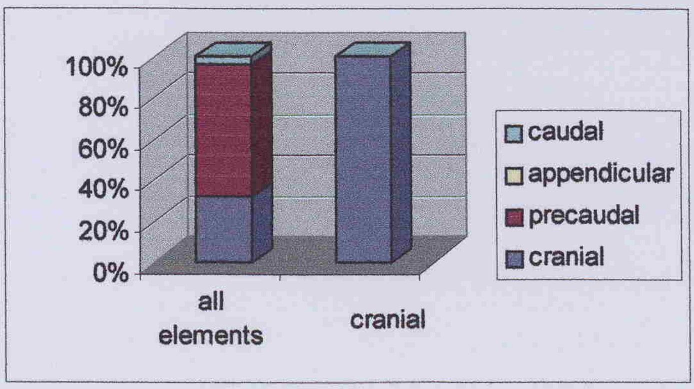


Figure 10.83. Church Walk, Hartlepool. Phase 4. Late C 14th-15th.

	cranial	precaudal	appendic	caudal	
%	21	50	14	14	
%	60	0	40	0	
n =	3	7	2	2	= 14
n =	3	0	2	0	= 5

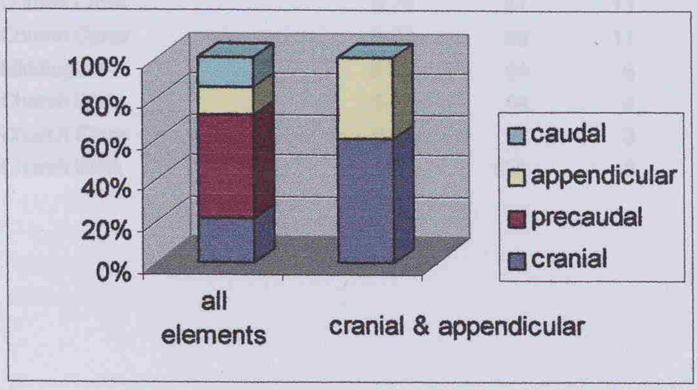


Figure 10.84. Graph to show the distribution of ling data from figures 10.73-10.83 for all elements in ascending cran/pv% .

Site	Fig no	cran/pv%	app/cv%
Fleet Prison	9.74	0	100
Victoria Street	9.73	67	33
Model (whole fish)	9.50	68	32
Church Walk	9.83	71	28
Middlegate	9.76	86	14
Middlegate	9.77	86	14
Church Close	9.79	87	13
Church Close	9.80	89	11
Middlegate	9.75	94	6
Church Walk	9.82	96	4
Church Close	9.78	97	3
Church Walk	9.81	100	0

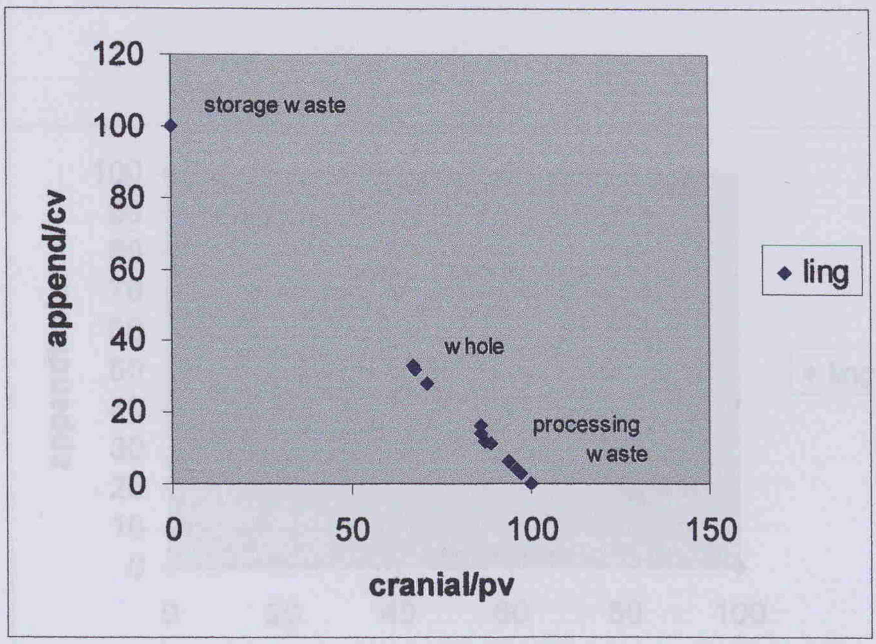
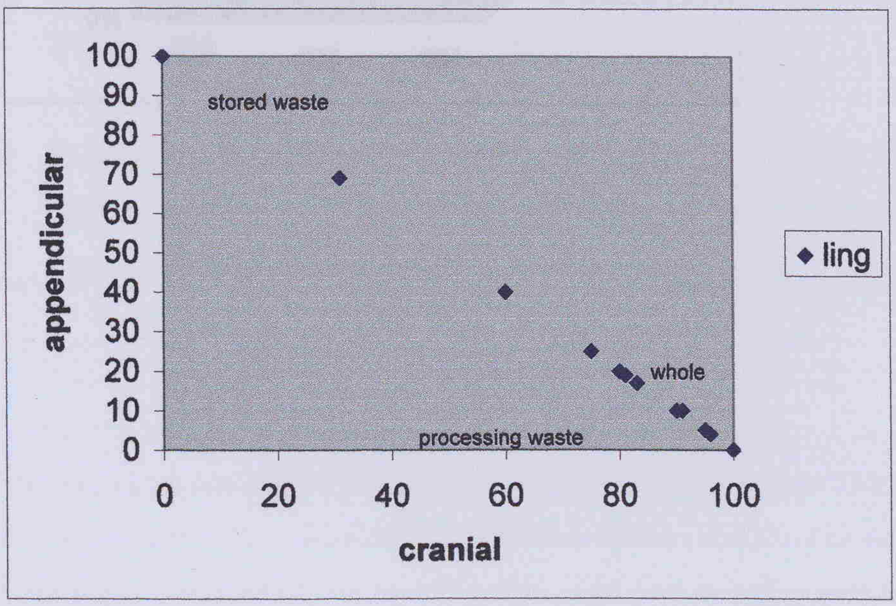


Figure 10.85. Graph to show distribution of ling data from Figures 10.73-10.83 cranial and appendicular elements only in ascending cran %.

Site	Fig no	Cranial %	Append%
Fleet Prison	9.74	0	100
Nonsuch		31	69
Church Walk	9.83	60	40
Victoria Street	9.73	75	25
Middlegate	9.77	80	20
Model (whole fish)	9.50	81	19
Church Close	9.80	83	17
Church Close	9.79	90	10
Middlegate	9.76	90	10
Church Close	9.78	95	5
Middlegate	9.75	96	4
Church Walk	9.81	100	0
Church Walk	9.82	100	0
Southgate A		100	0
Southgate B		100	0

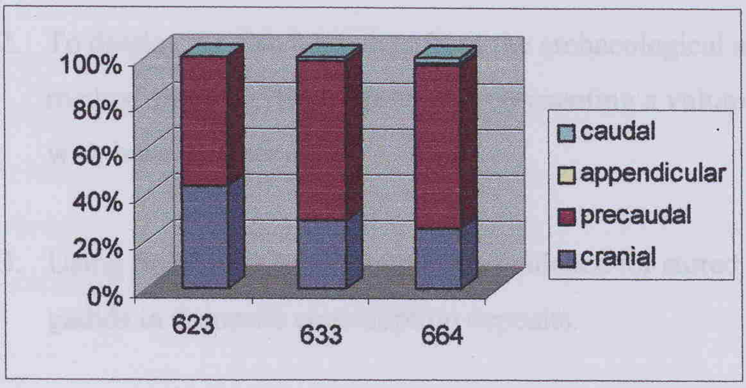


HAKE

Group 4

Figure 10.86. The Parade, Plymouth. C 16th.

Context	cranial	precaudal	appendic	caudal		
623 %	44	56	0	0		
633 %	29	69	0	2		
664 %	26	71	0.5	3		
623 n	7	9	0	0	=	16
633 n	49	118	0	3	=	170
664 n	39	106	1	4	=	150



Chapter 11. Conclusions.

Introduction.

In this final chapter I discuss the main results of this thesis as shown by the use of documentary and archaeological data and how they relate to the main aims listed below from chapter 1.

1. Determine which of the main stored species (herring, cod, haddock, whiting and ling) were most commonly eaten, as suggested by the documentary data and the archaeological sample.

2. To display the fish bone data from the archaeological sample by a new method showing fish by **portion**, representing a volume of food, compared with bone number or **n**.

3. Using **body part** representation as evidence for stored fish among the large gadids in domestic consumption deposits.

4. Explore the relationship between date, location and status of the fish bone assemblages, assessing their influence on the consumption of stored fish and more specifically which types were preferred.

In the first part of the thesis I looked at the documentary evidence for the importance of stored fish from the 10th to the mid 18th centuries. This was a static period in terms of new developments in transportation and icing to extend the shelf life of fresh fish. A variety of sources were used including port records of imported and home cured fish, evidence of fish transportation and marketing, to individual household records of purchase and consumption.

Evidence from documentary data.

Some measure of the commercial quantities and types of stored fish in use throughout the period can be found in surviving records from port books and customs accounts. I have shown evidence for substantial quantities of stored fish moved round the coast, both home produced and imported. Some port records reflect regional influences in the species of fish caught and subsequently stored, such as hake at Bristol and other south west ports. The growth of London as a market in the 15th and 16th centuries is reflected in the varieties of stored fish arriving at the port, both of domestic origin and from north European ports.

The main types of stored fish were herring and the gadids, particularly cod. This is evident both from port records and also from other documentary data regarding the historic fisheries. Herring fishing was concentrated off the East Anglian coast with lesser fisheries along the East coast, in the Channel and the Irish Sea. Farther afield the Northern European herring fisheries, known as the Bohuslan and Scanian, also attracted English fishermen.

However, herring fishing was localised compared to that for cod. Cod could be caught around the English coastline and was a significant fishery of the North Sea. These catches were supplemented by importing Norwegian stored cod (through the Hanseatic League), as well as fish from Iceland and, later, Newfoundland to meet demand. The importance of cod as a prime food fish is emphasised by the scale of acrimony associated with fishing rights. 'Cod wars' are not just a recent phenomenon and antagonism was rife between European fishermen in Newfoundland in the 16th and 17th centuries.

The more northerly distribution of ling off the east coast of England meant catches were often brought down to main ports at London in a stored state, whereas in the southwest ling were a local catch with hake. Haddock are not well represented in port or other records, unless disguised in more general listings of salt fish. Records of whiting, both fresh and stored, confirm its ubiquitous occurrence inshore round the coastline.

Documented movements of many commodities during the period testify to the active market in foodstuffs utilising water transport and overland, by cart and packhorse, to all areas of the country. Inevitably records reflect the commerce of a sector of society who, through inheritance or business acumen, could afford a wide range of fish.

The port lists and customs accounts show a bewildering variety of terms to the modern reader, all used to describe stored fish. These often refer to the type of cure; 'milwelle', 'haburden', 'saltfish' are all likely to be stored salted cod, while 'Lyngis' causes confusion, being sometimes referred to as salt cod and also as ling. The terminology denotes a precise range of types and qualities known to contemporary merchants by which the price was set.

The complexities of marketing involved a network of merchants and traders. These ranged from wealthy successful business men dealing solely in fish (many of whom became of civic importance as part of a gild or as individuals), down to local markets and small scale traders of fish and other goods supplying remote villages. Evidence of consumption is found in the accounts of monasteries, rich households and occasionally clergy of lesser status, as at Bridport, (Wood-Legh, 1956). The precise recording of the different types of stored fish bought has revealed a detailed picture of the different types of stored fish bought, an accuracy not deemed necessary for fresh fish which are often described as 'fish'.

The documentary evidence[1] supports a stronger market for herring ('red', 'white' and 'salt') in the earlier centuries, for instance the Battle Abbey accounts for the 14th century (see Figures 7.6, 7.7). While salt cod ('mulwelle, 'haburden', 'lyngis') is preferred by the late 15th century at Westminster Abbey and early 16th century at St Swithun's Priory, (Figures 7.5, 7.4). A similar change was seen at three secular households (Figure 7.6). Evidence from charitable alms at St Cross

[1] Transcribed into **portions**.

show herring were replaced by a monetary value in the early 17th century, (Hopewell, 1995).

Although household accounts represent elite spending, servants and retainers were also fed while in service, consequently changes in eating habits did filter down through society. Choicer cuts or species of meat and fish may have been preserved for the top table, but signs of status were largely determined by increased volumes of flesh foods, rather than by improved quality. The proportion of carbohydrates increased down the social scale, particularly in the earlier part of the period as shown by Hilton (1966, p.111) for the 13th century.

The documentary evidence does therefore support a change between the relative popularity of species and types of stored fish, favouring cod and allied species over herring. This thesis has addressed this particular aspect of fish consumption, using evidence from both documentary and bone data. At a more general level a change has been detected towards increased meat eating, initiated after the 14th century and not just in high status households. Following depopulation after an outbreak of Plague, severe labour shortages increased wages for manual workers who were able to purchase more meat than hitherto. Later, by the mid 16th century, population had begun to catch up with labour demands, but the Reformation removed a major barrier to meat consumption; religious fast days. Stored fish and fish generally, already in decline as a food resource, lost further ground to meat. The changes favouring stored cod over herring are an element within a larger dietary trend towards increased meat consumption.

Before the Reformation stored fish were a major part of fish supplies, particularly in the religious houses and this was unaffected by ready access to fresh fish. I have cited evidence from Battle Abbey, only a short distance from the sea and several fishing ports, for the purchase of quantities of stored fish each year, some of which came directly from London, a sign of the Abbey's purchasing power. Westminster Abbey was close to all the London markets for fresh fish and used them, but Harvey (1996, p.47) has estimated that half the fish bought in one year in the late 15th century were stored. As at Battle Abbey this reflects their high status, both houses could afford to invest in large supplies of stored fish for the coming months, as well as purchasing fresh fish daily.

Long storage and light weight were also leading factors in the retention of 'stockfish' in naval rations. These were included until the beginning of the 18th century when, after a steady decline and restriction to certain climates, they were totally replaced in English rations.

Evidence from the archaeological data, where herring and the gadids are compared using **portion**, also support a change away from herring to cod. A majority of my samples show cod as the preferred species and in most consumption deposits there is evidence for both whole (fresh) and stored cod. Where herring remains the most important species by both **n** and **portion**, this usually occurs in the earliest phases of occupation. Where herring remains dominant, in later deposits at Eynsham Abbey, this may be attributable to times of reduced circumstance for the Abbey prior to the Reformation.

The use of fish volume (portion) rather than bone number (n).

The fish bone assemblages from deposits representing consumption waste are direct evidence of how much fish was eaten[2], though the number of meals they represent and the exact time scale are unknown. Within an assemblage the different fish species will vary greatly in size and the quantity of food they represent per individual. However good the preservation and recovery some important food fishes, including elasmobranchs[3] and salmon, do not survive well and are continually under represented. While much has been written on possible fishing grounds as the likely source of different fish species using size[4], little has previously been said about the contribution of fish as food. The precise listings of types of stored fish in documentary sources and the fish allowances given by Harvey (1996) for the monks at Westminster Abbey, together with naval ration

[2] Problems of taphonomy and recovery not withstanding
[3] Rays and sharks
[4] Relating to maturity and habitat.

allowances, have provided the basis for comparing herring and the gadids as **portions** of food calculated from bone numbers.

Having first tested this method creating model fish assemblages from documentary evidence of individual meals, fish weight and fish numbers from three monastic sites, the bone data, **n**, was compared by **portion** on assemblages from 19 sites. The results indicated a dramatic change away from herring as the main species by **n** when viewed by **portion**. A degree of change was anticipated, herring was a popular food fish, but being small and whole likely to out number other larger food fishes. However, the differences (summarised in tables 10.1, 10.2 and 10.3) show that of 49 samples representing phased assemblages, 45 showed herring most numerous by **n**, but when changed to **portion** 40 were dominated by another species, of which 31 were cod. This is the first quantatitive measure of the over representation of herring compared with other species in archaeological fish assemblages.

Whether the individual **portions** seem excessively large by modern standards is irrelevant, it is the equivalent amount by **portion** between these species that is important. Other sources have cited different quantities, 7-8 herrings (Prestwich, 1967) for soldiers, 3 herrings for nuns at Wherwell Priory, while at Barking Abbey 4 herrings were given to each nun (Coldicott, 1989, p.77). However, this data is restricted to herring with no equivalent portion given for other fish.

As regards nutrition, the allowance is double the average protein requirement supplied by 2 herrings a day, (Comrie, 1948, p.638). Both the fattier herring and the 'white fish' provided different elements of essential proteins, particularly during the early part of the period when evidence suggests a heavy dependence on carbohydrates in the form of bread. The large quantities of fish served at meals also fed secondarily, servants and the poor, so wastage was an important element of charity.

Use of body part representation in the large gadids

The principal of calculating **portions** from bone numbers required some adjustment for the presence of both whole (and potentially skeletally complete) fish and stored fish with reduced skeletal elements[5], described as **body part** representation. On the evidence of the skeletal distribution in large gadids an adjustment had to be made to take account of the presence of both forms. This applied to cod in 29 phases from the following sites: St John's Priory, St Mary's Clerkenwell, St Mary Graces, Westminster Abbey, Eynsham Abbey, Victoria Street, The Brooks, Castle Mall, St Martin-at-Palace Plain, Fishergate, The Fleet Prison and The High Street, Huntingdon. The scale demonstrates a broad geographical and date range for the concurrent consumption of fresh and stored cod. Ling were whole and stored in 5 phase groups from: St Mary Graces, Eynsham Abbey, Victoria Street and the Fleet Prison. All except for Victoria Street are distant from the ports where ling are landed and the latter was the only site representing consumption where whole and stored hake were found in quantity over 3 phases.

Metrical data on the size of cod[6] showed a wide range of sizes from 60 – 130 cms and a substantial number of these fish were between 60 and 100 cms in length. Ling measurements were fewer and more restricted by site, but larger fish than cod, all well over 100 cms and mainly from the Hartlepool sites. The few hake measurements suggest a similar range to average cod lengths. These sizes justify the **portion** divisions of ¼ cod or hake = 1/6th of a ling.

Skeletal reduction for storage is only detectable for gadids over 35 cms, which excludes whiting which has been treated as whole in the same way as herring. Haddock is not a major species at any of these sites, but there is evidence for whole and stored fish.

[5] See Appendix 1

[6] See Appendix 2, the measurements quoted are all from the premaxilla and dentary (jaws) and representative of whole fish, not imported 'stockfish' which are headless.

The effects of date, location and status on the assemblages.

The date range of the data sample shows a good cover over the period of study. I have shown that transportation remained essentially the same throughout the period so the logistics of delivery were unchanged. However, there is some evidence for change between the relative quantities of these fish which can be broadly categorised by date. The late 14th century has been associated with a decline in the Yarmouth fisheries (Bond, 1988, p.78) and although not the only source of English herring, was certainly the prime location among many fishing ports on the east coast. Prior to this date there are many records of purchases of herring by monastic houses, some acquiring land and premises for processing fresh herring for their own supplies, (Bond, 1988, p.76).

Many of the instances where herring remains the main species eaten, whether shown by **n** or **portion**, fit into a 10th to late 14th century period where herring was thought to have been more popular. The archaeological data at Westminster Abbey for the mid 10th – mid 11th century shows herring first by both methods (Figure 10.16), while in the later documentary data for the late 15th – early 16th century herring fares poorly compared to three types of stored cod, (Figure 7.5). Harvey (1996, p.48) has described cod as 'king in the monastic refectory' at this time, it was almost half of all fish served in a single year, mostly in stored form. At another monastic house in London, St Mary's Clerkenwell, in the 13th century (Figure 10.3) cod are first by portion, though herring are almost equal, while in the following phase herring are first with no cod at all, but after 1350 cod is increasingly dominant. The documentary data from Battle Abbey for the late 14th century transcribed into **portions** (Figures 7.7, 7.8) showed herring as the preferred fish in both years

In other secular cases where herring dominate, the assemblages are all pre 14th century: Victoria Street (Figures 10.21, 10.23) and the High Street, Huntingdon (Figures 10.48, 10.49). At Castle Mall herring is at its highest levels and closest to cod in the earliest Late 9th – 11th century phase (Figure 10.32). Thereafter cod is the clearly the prime fish, except for the Barbican Well, which in contrast to other deposits of the 14th –16th century showed equal **portions** for herring and cod. This feature may reflect a different disposal pattern to that of contemporary deposits.

Some exceptions occur; at St Mary Spital (a hospital) cod are always first, from the establishment in the second half of the 13th century, except for a small Post Dissolution sample of whiting. After strong representation by herring by both methods in the early Norman phase at Eynsham Abbey (Figure 10.17), it is superceded by cod in the next two phases. The former (12th to 13th century) is early in the context of a post 14th century change towards cod, (Figures 10.18, 10.19). The Post Dissolution assemblages show no return to herring, the gadids, most particularly cod, are clearly favoured.

Location played an important role in the accessibility of fish. The quantities of fish arriving at ports, both fresh and stored, are evident from the surviving accounts of customs duties. At the coast fresh and stored fish were important at all levels, as shown for Exeter by both documentary evidence for the Medieval period (Kowaleski, 1995) and fish assemblages analysed by Wilkinson, (1979). At Southampton the coincidence of documentary and bone assemblages was compared by Coy (1996), with evidence from bone data adding to the list of species eaten.

Inland, delivery of stored fish was regular, directly supplying large quantities to individuals, and also available through a range of commercial outlets. Fresh fish were also delivered, but with some urgency, especially in the summer months, incurring extra costs. The poor in a remote hamlet without access to a market or visiting traders would not see much, if any, fresh marine fish and little stored fish compared to those in inland towns. However isolation may have been less of a factor than status.

Status appears to be the overriding factor in determining what foods were consumed and all forms of fish could be delivered to any part of England throughout the period at a price. Long distance travel overland with stored and fresh fish is attested to in surviving documents detailing the supply of wealthy households as well as evidence from fish bone assemblages as at Eynsham Abbey, (Locker 1997c). In terms of spending power, as reflecting status, this influence was greatest farthest from the coast and marine fish consumption, whether stored or fresh, would have been more affected than meat or plant foods. With decreasing status, changes in inland fish consumption would have been visible in a reduction of the range of fish afforded, leading to the exclusion of fresh fish and increasing reliance on stored herring as the cheapest fish. The change away from herring as exemplified by the sites in my data sample has to be seen largely within the context of high or middle status, where choice was an option. Regardless of any decline in the Yarmouth herring fisheries demand could have been met from elsewhere if required and I suggest the change represented by my sites reflects choice rather than circumstance.

Decreases in herring consumption from fish bone assemblages are only quantifiable when comparing with the gadids as a volume of food and it is here that the **portion** method has supported the historical data. Shortcomings in the range of the data sample lie in the few assemblages from low status sites by date or location.

Inclusion of other species.

In this work I have concentrated on herring and the gadids as quantified **portion** sizes were available for these species, in itself a reflection of their importance. However, the table for each of the figures in Chapter 10 shows the percentage (by bone number) these fish represent of the whole fish assemblage. The range is wide and any correlation between these percentages and original sample size, date, location or status is unclear, but the high percentage of herring and gadids in many phases at or near coastal locations suggests a conservative attitude to other food fishes in term of volume. For example at Norwich, the data for Castle Mall show over 80% for herring and gadids in the first three phases, thereafter dropping slightly to between 63 % - 76 %, but remaining a high percentage of the assemblage.

The other species identified in the data sample are largely marine. Species caught in fresh water include; pike, salmonids, some cyprinids (often small fish) and regularly, in large numbers of bones, eel. The latter have approximately double the number of vertebrae of other fish, are often small[7] and, with their slender shape, are disproportionately represented by number as food.

The marine element includes flatfishes, often small plaice and flounder caught on the shoreline and other fish such as: conger eel, mackerel, gurnards, mullets, sea-breams, which are often present but in small numbers. The rays and sharks, identified from teeth and denticles, are clearly under represented due to poor preservation. Some species add a regional bias, for instance sea-breams, conger eel and hake suggest a south west origin based on their natural distribution, as shown at Exeter (Wilkinson, 1979), The Parade Plymouth (Locker 1997b) and Victoria Street, Bristol, (Locker, 2000b).

Quantification of these species[8] is poorly served by presenting bone numbers alone if a measure of their contribution as food is sought. I suspect that if some comparative **portion** measure were possible flatfishes would be shown to be a major contributor in the volume of fish eaten. The only reference I have found to quantities for flatfish is cited by Bond (1988, p.70) for an allowance at Canterbury Cathedral Priory in 1300: 2 soles or 1 plaice or 4 herrings or 8 mackerel as a dish for each monk. The large number of mackerel cast some doubt on this as a useful measure and the single plaice must have been large. Plaice and flounder[9] vary in size greatly in bone assemblages from small immature fish to large individuals and some account would have to be made for this.

[7] Around 20 cms though they can reach 50 cms in length
[8] Poor preservation of the elasmobranchs and salmonids apart.
[9] The most common species

Any refinement of the **portion** method further to include some of the other commonly occurring species would put a new perspective on the relative amounts of fish eaten which might show other markers for status and date.

Application of portion to other data.

At the outset I decided to restrict the data sample to assemblages I had identified and recorded myself, not because I considered them in any way superior, but because I had the original data and knew the parameters of my record. Together with work by other specialists there is a large and growing database for fish assemblages. As with my own data sample others have also had to accept variations in the quality of the recovery, sample size and preservation imposing some limitations on interpretation, but trends for regions and developing towns and cities are visible.

Andrew Jones' work on a number of sites in York has resulted in a large body of fish data spanning the development of the city. Here, the general trend in Anglo-Scandinavian assemblages shows the importance of herring and eels, with a change away from riverine exploitation to sea fishing for cod and other gadids during the Medieval period[10]. Jones has published the data quantified as total numbers of bones for Medieval deposits at 46-54 Fishergate (O'Connor, 1991, p.264) and 24-30 Tanner Row, (O'Connor, 1988, p.114). While the Anglo-Scandinavian deposits from 16-22 Coppergate were also quantified by the relative frequency of species in the samples, a method designed to redress the distorted representation of some species by bone number through differential preservation and over emphasis from distinctive elements peculiar to some species[11], (O'Connor, 1989, p.196). The **portion** method could be applied to these and other data for herring and the gadids, but only by using the original data records to show quantified change in relative consumption of these species.

[10] A trend echoed in Saxon and Medieval assemblages from London (Locker, n.d.)
[11] Such as cyprinid pharyngeal bones identified to species while other skeletal elements may only be attributable to family.

Jones' work has been cited here as an example of a growing body of fish data from a single town/city. Although only the broad trends are described here in the context of applying **portion**, the data also showed spatial and contextual variation by species, (Bond and O'Connor, 1998, p.398). This is not to ignore past and ongoing work by Bourdillon, Coy, Nicholson, Wheeler and Wilkinson among others, but it is not the intention to review those here.

The **portion** and **body part** methods on fish bone data have been successfully applied to a restricted window of fish consumption in pre-industrialised England. I have tested the archaeological evidence for stored and fresh fish in the large gadids and quantified relative consumption between herring and the gadids. My data sample supports increasing consumption of cod, both stored and fresh at the expense of herring, as suggested by historical record and confirms cod as the premier food fish in England since at least the 14th century.

The size of the most common food fishes, ranging between a number of fish per portion to a sixth of a ling, provided defined units with a set number of possible bones for relative comparison between species. A further development could be to extend the range of fish species[12] using supportive data for portion sizes. Inclusion of birds and mammal species[13] might be investigated, but the bone signature representing a portion of meat from large carcases of cattle, sheep and pig presents a new set of problems. These include adjustments as to the division, use and perceived quality of different parts of the carcase as affecting portion size. However, if faunal analyses are to address 'flesh as food' and comparatively 'how much' of each type between different periods and sites, then a further development of the **portion** method described here could be a valuable adjunct to quantified analysis by bone numbers.

[12] Limited to the bony fish with a set number of elements.

[13] Whole carcase weights have been used for comparison (e.g Ryder, 1971 and Maltby, 1979) and **portions** might be developed from these.

Appendix 1. The data for 'portion' for figures 10.1 - 10.49

Site	Species	Total no	Stored	Whole	Adjusted port	Portion	%
St Johns Priory	herring	17				0.03908	13.31
Fig 10.1	cod	1	1			0.14286	48.65
	haddock	2	2			0.07143	24.32
	whiting	7				0.04023	13.7
St John's Priory	herring	140				0.32184	1.24
Fig 10.2	cod	188	69.30508	118.6949	s 16.95642	20.14286	77.7
					w 3.18644		
	haddock	3	1.92915	0.05085	s 0.00181	0.03572	0.13
					w 0.03390		
	whiting	310				1.7816	6.87
	ling	17	17			3.64286	14.05
St Marys Clerkenwell	herring	108				0.24828	35.61
Fig 10.3	cod	2	2			0.28571	40.97
	haddock	2	2			0.07143	10.24
	whiting	16				0.09195	13.19
St Marys Clerkenwell	herring	606				1.3931	84.28
Fig 10.4	cod	0				0	0
	haddock	1	1			0.03571	2.16
	whiting	39				0.22413	13.56
St Marys Clerkenwell	herring	36				0.08276	31.13
Fig 10.5	cod	1	1			0.14286	53.74
	haddock	0				0	0
	whiting	7				0.04022	15.13
St Marys Clerkenwell	herring	720				1.65517	11.02
Fig 10.6	cod	79	70.15254	8.84746	s 10.02179		
					w 0.4068	10.42859	69.46
	haddock	43	41.52542	0.47458	s 1.48305	1.49999	9.99
					w 0.016949		
	whiting	249				1.43103	9.53
St Mary Graces	herring	36				0.08276	1.48
Fig 10.7	cod	78	14.59322	63.40678	s 2.08475	5	89.45
					w 2.91525		
	haddock	2				0.07143	1.28
	whiting	64				0.36782	6.58
	hake	1		1		0.0678	1.21
St Mary Graces	herring	307				0.70575	5.4
Fig 10.8	cod	79	73.10169	5.89831	s 10.44310	10.71429	82.03
					w 0.27119		
	haddock	35	21.72881	13.27119	s 0.77603	0.92857	7.1
					w 0.115254		
	whiting	124				0.71264	5.46

Site	Species	Total no	Stored	Whole	Adjusted port	Portion	%
St Mary Graces	herring	186				0.42759	18.25
Fig 10.9	cod	8				1.14286	48.78
	haddock	11				0.39286	16.77
	whiting	66				0.37931	16.19
St Mary Graces							
Fig 10.10	herring	829				1.90575	5.49
	cod	206	188.30508	17.69492	s 26.90073 w 0.8136	27.71433	79.79
	haddock	47	21.9322	25.0678	s 0.7833 w 0.01006	0.79336	2.28
	whiting	230				1.32184	3.81
	ling	23	20.05085	2.94915	s 2.86441 w 0.13559	3	8.64
St Mary Spital	herring	104				0.23908	21.89
Fig 10.11	cod	9	1.62712	7.37288	s 0.23245 w 0.33898	0.57143	52.37
	haddock	0				0	0
	whiting	49				0.28161	25.79
St Mary Spital	herring	266				0.61149	24.76
Fig 10.12	cod	12	12			1.71429	69.42
	haddock	0				0	0
	whiting	25				0.14368	5.82
St Mary Spital	herring	12				0.02759	6.34
Fig 10.13	cod	2	2			0.28571	65.65
	haddock	1	1			0.03551	8.21
	whiting	15				0.08621	19.81
St Mary Spital	herring	4				0.0092	8.51
Fig 10.14	cod	0				0	0
	haddock	1	1			0.03571	33.03
	whiting	11				0.06322	58.47
St Mary Spital	herring	42				0.09655	7.51
Fig 10.15	cod	8	8			1.14286	88.91
	haddock	0				0	0
	whiting	8				0.04598	3.66
Westminster Abbey	herring	2881				6.62989	42.08
Fig 10.16	cod	48	18.50847	29.49153	s 2.64406 w 1.35593	4	25.39
	haddock	19	19			0.67856	4.31
	whiting	774				4.44828	28.23

Site	Species	Total no	Stored	Whole	Adjusted port	Portion	%
Eynsham. Abbey	herring	958				2.2023	64.76
Fig 10.17	cod	7	7			1	29.12
	haddock	0				0	0
	whiting	3				0.01724	0.5
	ling	2	0.52542	1.47458	s 0.11259	0.21429	6.24
					w 0.10176		
Eynsham. Abbey	herring	191				0.43908	23.15
Fig 10.18	cod	7				1	52.73
	haddock	0				0	0
	whiting	5				0.02874	1.52
	ling	2				0.42857	22.6
Eynsham. Abbey	herring	118				0.27126	25.86
Fig 10.19	cod	5	5			0.71429	68.11
	haddock	1		1		0.01149	1.09
	whiting	9				0.05172	4.93
Eynsham. Abbey	herring	3633				8.35172	75.77
Fig 10.20	cod	6	4.52542	1.47458	s 0.64649	0.71429	6.48
					w 0.06780		
	haddock	3	0.00509	2.94915	s 0.00182	0.03571	0.32
					w 0.03389		
	whiting	185				1.06321	9.65
	ling	4	4			0.85714	7.78
Victoria Street	herring	86				0.1977	97.17
Fig 10.21	cod	0				0	0
	haddock	0				0	0
	whiting	1				0.00575	2.45
Victoria Street	herring	79				0.18161	27.63
Fig 10.22	cod	0				0	0
	haddock	1	1			0.03571	5.43
	whiting	2				0.01149	1.75
	hake	3	3			0.42857	65.19
Victoria Street	herring	288				0.66207	48.06
Fig 10.23	cod	0				0	0
	haddock	6	6			0.21428	15.54
	whiting	3				0.01724	1.25
	ling	1	1			0.21429	15.54
	hake	4		5.89831	w 0.27119	0.27119	19.66
Victoria Street	herring	368				0.84598	26.29
Fig 10.24	cod	2				0.28571	8.88
	haddock	10	4.10169	5.89831	s 0.014649	0.21428	6.66
					w 0.06779		
	whiting	30				0.17241	5.36
	ling	6		7.37288		0.41379	12.86
	hake	12	7.57627	4.42373	s 1.08232	1.28571	39.96
					w 0.020339		

Site	Species	Total no	Stored	Whole	Adjusted port	Portion	%
Victoria Street	herring	1472				3.38391	19.48
Fig 10.25	cod	10	2.62712	7.37288	s 0.3753	0.71428	4.11
					w 0.33898		
	haddock	26	15.67797	10.32203	s 0.55927	0.67791	3.9
					w 0.11864		
	whiting	141				0.81034	4.66
	ling	27	3.40678	23.59322	s 0.73002	2.35714	13.57
					w 1.62712		
	hake	69	64.57627	4.42373	s 0.20339	9.42857	54.11
					w 9.22518		
Victoria Street	herring	412				0.94713	23.44
Fig 10.26	cod	9	7.52542	1.47458	s 1.07506	1.14286	28.28
					w 0.0678		
	haddock	2	0.52542	1.47458		0.03517	0.87
	whiting	35				0.20115	4.97
	ling	4	4			0.85714	21.19
	hake	6	6			0.85714	21.19
Victoria Street	herring	133				0.03575	23.86
Fig 10.27	cod	1		1.47458		0.0678	5.29
	haddock	4		4.42373		0.05085	3.97
	whiting	0				0	0
	hake	6	6			0.85714	67.66
Victoria Street	herring	124				0.28506	13.74
Fig 10.28	cod	1	3.52542	1.47458	s 0.50363	0.57143	27.53
					w 0.0678		
	haddock	1	1			0.03571	1.72
	whiting	7				0.04023	1.94
	ling	6	0.10169	5.89831	s 0.02179	0.42857	20.65
					w 0.40678		
	hake	5	5			0.71429	34.42
The Brooks	herring	27				0.06207	13.09
Fig 10.29	cod	1		1.47458		0.0678	14.29
	haddock	1	1			0.03571	7.53
	whiting	4	4			0.02299	4.85
	hake	2	2			0.28571	60.24
The Brooks	herring	16				0.03678	3.88
Fig 10.30	cod	6	4.52542	1.47458	s 0.64649	0.71429	75.4
					w 0.0678		
	haddock	2	0.52542	1.47458	s 018765	0.03517	3.72
					w 0.01695		
	whiting	3				0.01724	1.82
	hake	1	1			0.14285	15.09
The Brooks	herring	66				0.15172	22.91
Fig 10.31	cod	1	1			0.14286	21.57
	haddock	3	1.52542	1.47458	s 0.05448	0.22398	33.82
					w 0.1695		
	whiting	25				0.14368	21.69

Site	Species	Total no	Stored	Whole	Adjusted port	Portion	%
Castle Mall	herring	2490				5.72414	44.13
Fig 10.32	cod	183	9	174	s 1.28571	6.711	51.74
					w 5.42529		
	haddock	2	2			0.071428	0.55
	whiting	56				0.32184	2.48
	saithe	1	1			0.14286	1.1
Castle Mall	herring	880				2.023	5.3
Fig 10.33	cod	111	13.67797	97.32203	s 1.95399	35.82206	93.82
					w 33.86807		
	haddock	4	2.52542	1.47458	s 0.0902	0.01715	0.28
					w 0.01695		
	whiting	40				0.22989	0.6
Castle Mall	herring	937				2.15402	
Fig 10.34	cod	76	31.76271	44.23729	s 4.53753	6.57143	71.15
					w 2.0339		
	haddock	11	8.05085	2.94915	s 0.28753	0.32143	3.48
					w 0.0339		
	whiting	33				0.18966	2.05
Castle Mall	herring	599				1.37701	20.74
Fig 10.35	cod	58	19.16102	38.83898	s 2.73729	4.52299	68.11
					w 1.7857		
	haddock	3	3			0.10714	1.62
	whiting	73				0.41954	6.32
	ling	1	1			0.21429	3.23
Castle Mall	herring	918				2.11034	25.94
Fig 10.36	cod	63	17.28814	45.71186	s 2.46973	4.57142	56.19
					w 2.10169		
	haddock	43	13.50848	29.49152	s 0.48245	0.82143	10.1
					w 0.33898		
	whiting	110				0.63218	7.77
Castle Mall	herring	1505				3.45977	38.59
Fig 10.37	cod	43	16.45763	26.54237	s 2.35109	3.57143	39.83
					w 1.22034		
	haddock	16	13.05085	2.94915	s 0.46610	0.5	5.58
					w 0.03390		
	whiting	113				0.64943	7.24
	pollack	4	4			0.57143	6.37
	ling	1	1			0.21429	2.39
Castle Mall	herring	216				0.49655	19.25
Fig 10.38	cod	25	8.50001	16.49999	s 1.21429	1.97291	76.47
					w 0.75862		
	haddock	1	1			0.03571	1.38
	whiting	13				0.07421	2.89

Site	Species	Total no	Stored	Whole	Adjusted port	Portion	%
St Martin-at-Palace Plain	herring	116				0.26666	33.14
Fig 10.39	cod	3	1.52532	1.47458	s 0.21792	0.28572	35.52
					w 0.0678		
	haddock	4	4			0.14286	17.76
	whiting	19				0.1092	13.57
St Martin-at-Palace Plain	herring	1787				4.10805	29.5
Fig 10.40	cod	91	54.13559	36.86441	s 7.73366	9.42858	67.77
					w 1.69492		
	haddock	6	6			0.21429	1.54
	whiting	30				0.17241	1.24
St Martin-at-Palace Plain	herring	351				0.8069	20.54
Fig 10.41	cod	31	16.25424	14.74576	s 2.32203	3	76.38
					w 0.67797		
	whiting	21				0.12067	3.07
Fishergate	herring	242				0.51494	13.77
Fig 10.42	cod	25	20.57627	4.42373	s 2.93947	3.14286	84.02
					w 0.20339		
	haddock	2	2			0.07143	1.91
	whiting	2	2			0.01149	0.3
Fleet Prison	herring	180				0.41379	26.12
Fig 10.43	cod	8	6.52542	1.47458	s 0.93220	1	63.13
					w 0.0678		
	haddock	1	1	1.47458	w 0.01694	0.01694	1.07
	whiting	9				0.05172	3.26
	ling	1		1.47458	w 0.1017	0.1017	6.42
Fleet Prison	herring	254				0.58391	33.74
Fig 10.44	cod	13	1.20339	11.79661	s 0.17191	0.71428	41.28
					w 0.54237		
	haddock	2	0.52542	1.47458	s 0.01876	0.0357	2.06
					w 0.01694		
	whiting	69				0.39655	22.92
Fleet Prison	herring	69				0.15862	2.29
Fig 10.45	cod	31	16.25424	14.74576	s 2.32203	2.9999	43.33
					w 0.67796		
	haddock	11	8.05085	2.94915	s 0.28753	0.32143	4.64
					w 0.0339		
	whiting	537				3.08621	44.58
	ling	1	1			0.21429	3.1
	hake	1	1			0.14286	2.06
Fleet Prison	herring	281				0.64598	2.77
Fig 10.46	cod	48	42.10169	5.89831	s 6.01453	6.28572	27.03
					w 0.27119		
	haddock	16	16			0.57143	2.46
	whiting	56				0.32184	1.38
	ling	72	72			15.42857	66.35

Site	Species	Total no	Stored	Whole	Adjusted port	Portion	%
Fleet Prison	herring	104				0.23908	11.26
Fig 10.47	cod	12	9.05085	2.94915	s 1.29298	1.42857	67.3
					w 0.13559		
	haddock	2		2.94915	w 0.0339	0.0339	1.6
	whiting	36				0.2069	9.75
	ling	1	1			0.21429	10.1
High Street, Huntingdon	herring	67				0.15402	78.79
Fig 10.48	cod	0				0	0
	haddock	1	1			0.03571	18.27
	whiting	1				0.00575	2.94
High Street, Huntingdon	herring	1710				3.93103	88.01
Fig 10.49	cod	4	2.52542	1.47458	s 0.36077	0.42857	9.57
					w 0.0678		
	haddock	6	1.57627	4.42373	s 0.0563	0.10715	2.4

Appendix 2. Measurement summary for cod, ling and hake

(using premaxilla and dentary measurements after Wheeler & Jones 1976 and by comparison with modern specimens.

Cod

Site	*Date*	*Length range (cms)*	*n*
Southgate	C 12th	60 – 140	4
Middlegate	C 12th –13th	65 – 123	16
	C 13th	68 – 125	19
	C 13th – 15th	65 – 150	14
	1700 – C E20th	60 – 117	12
Church Close	Medieval	65 – 125	36
Church Walk	C 12th – 13th	85 – 115	4
	C 12th – 14th	85 – 130	12
	C 13th – 14th	70 – 125	7
	C 14th – 15th	70 – 130	5
Castle Mall	C L9th – 11th	45 –125	34
	C L11th – E12th	50 – 120	12
	C 12th	75 – 105	3
	C L12th – M14th	60 – 120	15
	C ML14th – M16th	50 – 85	9
	C L16th – 18th	65 – 125	8
Victoria Street	L 14th	115 & 120	2

Ling

Site	*Date*	*Length range (cms)*	*n*
Southgate	C 12th	82 – 155	6
Middlegate	C 12th – 13th	100 – 123	6
	C 13th	110 +	12
	C 13th – 15th	80 –125	4
	1700 – E 20th	116	1
Church Close	Medieval	150 –180	32
Church Walk	C 12th – 15th	150 – 180	9
Victoria Street	L 14th	70 & 120	2

Hake

Site	*Date*	*Length range*	*n*
Victoria Street	L 14th	74 – 104	4
The Parade	L 16th	75 – 113	13

Glossary.

Appendicular; referring to a series of bones at the 'shoulders' of the fish, here specifically the posttemporal, supracleithrum and cleithrum.

Bay (or Baie) salt; salt extracted by evaporating sea water, the best salt for dry salting fish because of the large grain size. So named after the french Atlantic coast where it was produced

Benthic; bottom living

'Bone signature'; the suite of bones typifying the waste of fish processing or those bone remaining in stored fish.

Dermal denticle; enamel structures embedded in the skin, typically in the elasmobranchs. Typically the 'bucklers' found in the roker or thornback ray.

Demersal; close to the sea bed

Elasmobranch; The name given to fish with a cartilaginous skeleton, including the sharks, lampreys, sturgeons and rays.

Gadid; A member of the Gadidae or cod family

Greenfish; wet salted cod fish,or allied species.

Klipfish; salted and dried cod, split open.

Lyngis; a type of salted cod fish or allied species.

Milwelle, mulwelle, milwelli; dry salted cod or allied species.

Pelagic; living at the surface of the sea.

Saltfish; salted fish, usually a gadid species.

Scutes; bony plates lying under the surface of the skin.

Stockfish; wind dried cod, typically from the Lofoten islands, headed and split, though occasionally dried in the round.

Stored; cured for storage

Taphonomic; changes taking place on organic materials after burial in the soil.

Whitefish; a general term, typified by the gadids, with white flesh, high in water and low in oil.

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