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Frontier Foods for Late Medieval Consumers: Culture, Economy, Ecology¹

RICHARD C. HOFFMANN

*Department of History
York University
Toronto, Ontario, Canada*

ABSTRACT

A continual western history of humans feeding beyond the bounds of natural local ecosystems goes back to Europe's high and later Middle Ages. This essay considers medieval long distance trades in grain, cattle, and preserved fish as antecedents to today's globalised movements of foodstuffs. Pulled by demand from consumers in populous and wealthy western Europe, significant amounts of plants, animals, their biomass, and their calories moved across major ecological boundaries, notably from thinly populated areas on Europe's peripheries. As today, the large cultural, economic, and ecological consequences are unevenly acknowledged. Distant zones of perceived abundance let consumers avoid changing their own cultural preferences and social practices by externalising, even forgetting, the social and environmental costs of satisfying them.

KEY WORDS

Medieval Europe, grain trade, cattle trade, fish trade, ecology of consumption

The cultural and physical gulf between present-day consumers in developed countries and the natural production of their foods is a popular commonplace. Milk comes from hermetically sealed cardboard cartons and glistening chicken legs from a glass case or shrink-wrapped plastic packet. Boatloads of bananas, coffee, and chocolate flow from west Africa to Rotterdam and Central America to New Orleans; prawns fly from Thailand and salmon from Norway to diners in Japan, Europe, and America. Geographer Ian Simmons describes today's globalisation as the culmination of processes which turned humans from many distinctive 'ecosystem peoples [each] living largely within one ecosystem and adapting their economy to that ecosystem, into a [single] biosphere people who

make demands on the ecology of the whole.² Economic exchange has supplanted ecological ones, erasing boundaries of natural systems. Rolf Peter Sieferle holds mass prosperity and the automobile especially responsible for ending household autarky in Europe since the 1950s and in America since the 1920s, thus contrasting the most recent generations with traditional dependence on local resources and ecosystems.³ Recent commentators thus identify the uncoupling of human economy and consumption from natural organisms and processes as generic to those modern environmental relations which they think have resulted from dominant world-wide trends of the past century or two.⁴

Concrete historical processes behind this difference are surprisingly little treated, or viewed without particular ecological awareness. One exception is a brilliant environmental history of the city in which American and European contemporaries recognised the epitome of nineteenth century American achievement, Chicago. For analytical insight and broad comparative potential William Cronon's *Nature's Metropolis: Chicago and the Great West* (New York: Norton, 1991) should be essential reading for all environmental historians. Among other issues Cronon relates how cattle from the Great Plains were hauled by rail to Chicago, where they were slaughtered and processed, and then the meat moved by rail to eastern markets.⁵ This central feature of historic Chicago, says Cronon, marked the *revolutionary* separation in space and time between an animal's life, its death, and its consumption by humans.

In particular, what happened in Chicago triggered two transformations which Cronon, like others, takes as characteristic of the modern situation: (1) Human consumers became radically alienated from the death, life, and biological reality of the organisms they ate. As human diets were so de-natured, human links to productive nature were obscured and attenuated. And at the same time (2) members of one ecosystem exploited, impacted, and consequently transformed another ecosystem not their own. Cronon's findings from the nineteenth century call up further applications for such present-day conceptual tools as urban 'engines of consumption' whose broad 'ecological footprints' mark a wider environment⁶ through their export of demand to ghost acreage⁷ elsewhere. Two central ecological variables, biomass and energy, are transferred from one ecosystem to another. Although Cronon reflects little on how such behaviour derives from human wants and needs, he makes readers fully aware how 'the growing incursions of a market economy into ever more distant landscapes and communities ... profoundly altered existing ecosystems...'⁸ and, incidentally, were doing so a century earlier than other writers seem aware.

In the sometimes limited framework of American history Cronon is largely correct to see Chicago's role as unprecedented. In the wider historical context of a western economy in which America started as an outlying part, however, the economic and ecological relations embodied in Cronon's Chicago were by no means unique. And even Cronon's insight foreshortened these relationships,

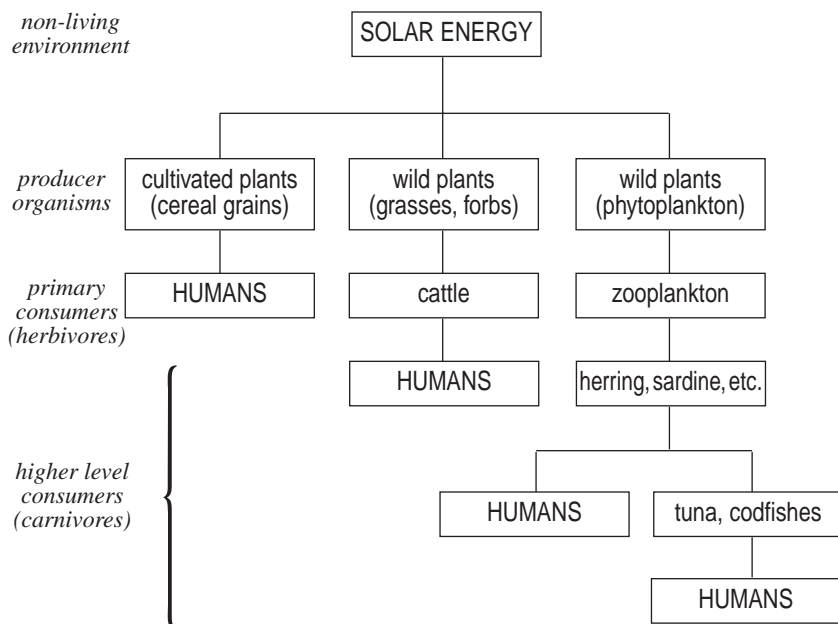
which were by his 1800s and 1900s neither unprecedented nor without direct formative antecedents in western (and hence global) history.⁹

A continual western history of feeding beyond the bounds of natural local ecosystems goes back to Europe's high and later Middle Ages. This essay examines from this perspective long distance trades in grain, cattle, and preserved fish. These medieval antecedents to Cronon's rail cars of cattle and beef and today's cargo containers of oranges or cacao moved significant amounts of plants, animals, their biomass, and their calories across major ecological boundaries in western and central Europe. As today, the large social, economic, and ecological consequences are most unevenly acknowledged. Alert exploration of the early encounters can promise better understanding both of present global issues and of complex interactions between humans and natural systems in the medieval western past.

Before continuing, let me identify plainly the two intellectual tools with which I would build an interpretive hypothesis, namely 'frontier' and 'ecosystem'. Ecology stresses interrelationships among living organisms and their non-living surroundings. An 'ecosystem' is an assemblage of organisms and their environment that acts as a unit, in other words, a zone of relatively dense mutual interactions. A flow of energy leads to exchange of materials between living and non-living components of every ecosystem.¹⁰ What we might call a landscape or region is an assemblage of ecosystems which also interact, though less directly than do the components of each constituent ecosystem.

Among the charms and frustrations of using 'frontier' to analyse history are the very ambiguities of that concept. Especially in North American usage, two related aspects, periphery and encounter, here come into play. A frontier is the periphery on an occupied range, where we see a reduced density of population (members) and of interactions in a (in this case, human) community. In economic terms, labour is relatively scarce and land (natural resources) relatively abundant. At the same time a frontier is a boundary zone or edge between two communities, ecosystems, or landscapes and hence, given our other definitions, a zone of reduced (less dense) interaction. In this sense medieval east central Europe and waters offshore from western Europe – thinly populated, thinly used extremities of Latin Christendom – much resembled the nineteenth-century American plains.

This paper considers three large substantive cases of humans eating from frontiers beyond natural local ecosystems in later medieval Europe. Their parameters range from near-cliches to the previously little known, so for each a brief description precedes a relatively unprecedented ecological analysis. In the latter special attention is paid to biomass (the total and share of living matter in a system) and energy flows (the movement of what begins as solar radiation through the food webs supporting all life on earth, see Figure 1). How did each interaction between human needs and natural relations play out? Proceeding



At each stage most energy maintains life of the organism and is dissipated as heat

FIGURE 1. Trophic levels of human foods

from a pan-European perspective, the familiar grain and cattle trades can set some bench marks for the more obscure frontier fisheries. The result is meant to provide a quick overview from what may be an unfamiliar perspective on medieval western Christendom and its natural as well as human frontiers.

GRAIN TRADES

As the long-distance trades in cereals and notably those of northern Europe during the thirteenth through sixteenth centuries are widely treated in the literature only some features need special attention here.¹¹

Cereal foods closely tied to energy needs of the human organism dominated caloric intake for medieval Europeans. The poor added little else. Mean annual consumption demand averaged 300 litres (225 kg) or more per capita. Most of the grain Europeans ate came from local or regional sources, but densely urbanised Tuscany and the western Low Countries were by 1200 in a regular deficit condition. Large towns elsewhere had also to look beyond their immediate neighbourhoods (Figure 2).

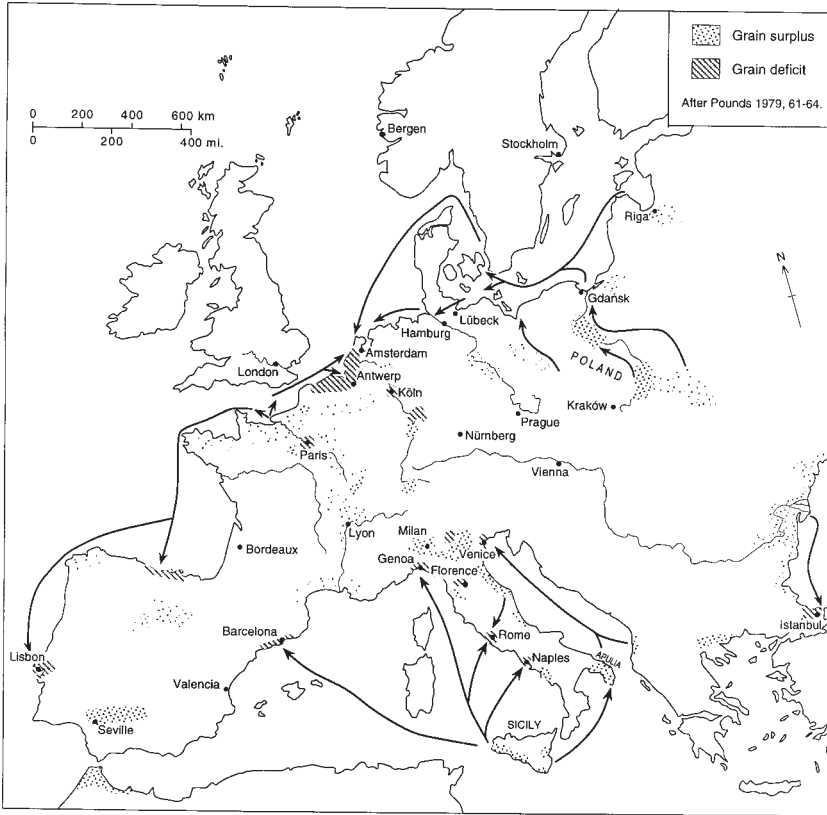


FIGURE 2. Long-distance grain trades at the end of the Middle Ages

These systemic local shortfalls of grain were notably met from afar during two time periods, first in what might be thought a prelude of roughly 1250 to the 1340s, and then in the famously massive reenactment of large-scale imports between the 1460s and the seventeenth century. Tuscans and townspeople elsewhere in Italy covered perhaps half their needs from local sources, but drew the rest of their grain from Apulia and Sicily, regions with relatively similar Mediterranean climates, physiography, and agrarian systems which underwent economic devolution into latifundia. Predominant spatial and institutional structures in the Mediterranean grain trades changed little between the thirteenth century and the eighteenth. High medieval Flanders relied on regional supplies from Artois, Picardy, and Hainault. Already before the late thirteenth century

German merchants had organised a flow of grain from the north – notably down the Elbe to Hamburg and then south along the coast – but its relative importance to western consumers remains obscure. During the fourteenth century's demographic contraction western consumers generally reduced their dietary reliance on cereals and many western agricultural regions reduced grain monoculture, so promoting interregional market exchange of more diverse agricultural products from regional specialists.¹²

When continued urbanisation and renewed population growth again by the mid-1400s turned European demand for cereals upward, higher market prices called for more supply. Grain in transit from interior Poland (the Wisła basin) toward Holland, Zealand, and Brabant is visible by the 1460s in customs records from the port of Gdańsk. Soon Dutch merchants, who had supplanted the Hanseatics in control of Baltic trade, made it their principal westbound commodity. In the sixteenth century these supplies were probably an essential condition for continued urban expansion in the European west while retaining dietary and agrarian systems of greater variety and complexity than had there been the case in the high Middle Ages.¹³

Long distance western market demand for grain in the fifteenth and sixteenth centuries was always small relative to both total subsistence needs and regional market demand on the part of eastern consumers. Still, this marginal opportunity for profit refracted through institutional contexts in lands of the Polish crown, where magnates and gentry could control the sale of the exportable surplus – 90 per cent of which was grain by the 1550s – and the peasant labour needed to produce and carry it to points of sale. Probably well before the quantifiable evidence of the 1560s, cereal prices over most of Poland were set by the market in Gdańsk and that was set by western demand.¹⁴ The economic and social importance of the medieval and early modern Baltic grain trade is proverbial. What of its ecological parameters?

Grain Trade: Environmental Impacts

In central parts of the north European plain medieval humans' greatest modification of the environment – their clearance of woodland to make permanent fields – was plainly driven by local subsistence needs, not export demand. Likewise the presence in medieval east central Europe of a local market exchange sector with interregional and long-distance links is not itself to be attributed to western demand for grain. Westerners' need – as reflected in cereal prices – to bring in basic foods from a thinly populated frontier of their economy can, however, properly be recognised as driving the central importance of a foreign trade staple economy in east central Europe by the end of the Middle Ages. That demand was, therefore, an essential precondition for the contingent formation of command-based agrarian relations there. Simple economic reasoning then suggests that, to some perhaps marginal degree, western demand

diverted eastern agricultural resources more toward cereal production than would otherwise have been the case.

Europe's climatic gradient from the damp maritime west to a drier continental east is reflected in differences among native plants which adapt especially to different growing seasons and precipitation regimes. Hence while eastern agriculturalists used the same short-fallow dry grass-based agroecosystem as did their western counterparts, environmental conditions of eastern production commonly favoured rye over wheat. Consequently the northern grain trade, unlike that of the less differentiated Mediterranean, provided western consumers, whose preference for wheat bread is proverbial, with a distinctive and less-appreciated, though not unfamiliar or alien, food.

The grain trade moves only a mature part of a plant, a concentrated chemical store of solar energy and vegetable protein rather than a significant share of biomass.¹⁵ Coming from a low trophic level cereals provide to human herbivores a maximum share of the solar energy which the plants had captured (see Figure 1). Low human population density in eastern cereal production zones made it easier to generate a surplus cheaply. But overall, the medieval and early modern grain trades brought to the west a familiar product from a reasonably comparable agroecosystem, something resembling an extension of the west's own farmlands. This was the very prototype for Eric Jones's metaphoric 'ghost acreage'.¹⁶

CATTLE TRADES

During the fifteenth and sixteenth centuries large numbers of live cattle moved overland each year from pastoral regions on Europe's periphery to distant, largely urban, consumers (Figure 3).¹⁷

Meat was never absent from medieval European diets, though it nowhere served as the principal source of calories and was eaten as much for reasons of taste and social prestige as on nutritional grounds. Large consumption of meat by the wealthy of the early and high Middle Ages spread down the social scale with increased per capita wealth after the 1350s. Considerable and widespread evidence indicates per capita levels of meat consumption in the fifteenth and early sixteenth centuries not again reached in Europe before the late nineteenth and twentieth. Annual rates came to fifty kilograms in Hamburg, forty-seven in south German towns, and even twenty-six at Carpentras, for Mediterranean consumption was typically less than in the north. Köln with no more than thirty thousand human inhabitants slaughtered six to eight thousand head of cattle each year in the 1490s.

Already by 1400 long-distance droving supplemented local supplies. The trade grew strongly through the fifteenth and early sixteenth centuries as historic regional beef production reached limits and then fell back, unable to compete for pasture land against renewed demand for arable. The few thousand beasts being



FIGURE 3. Long-distance cattle trades at the end of the Middle Ages

shipped any distance at all in the early fifteenth century became 85,000 a year at its end and that number had doubled by 1570, when long distance cattle traders were handled three times the value of Baltic grain exports. In Ian Blanchard's words, 'the international system became the mainstay of the west-central European network of metropolitan meat provisioning'.¹⁸

Three regions emerged before 1500 to form a cattle production belt on Europe's northern and eastern frontiers. In seesaw fashion they vied for market regions and market share.

Oldest were the Hungarian exports, known since the late thirteenth century,¹⁹ and they often comprised the largest, too, numbering by 1500 over 10,000 head yearly to Venice and more than 50,000 to Austria and across south Germany even to Strasbourg. As an anonymous Nürnberger said in 1518, from Hungary 'the whole of Germany was provided with meat'.²⁰

But in fact Germany north of the Main had through most of the fifteenth century been principally supplied by Polish producers in Masovia and parts of Great Poland, who shipped through Poznań. And in the late sixteenth century more and cheaper cattle would again walk westward from the steppes of Moldavia and Ukraine through wholesale markets in Upper Saxony or Buttstädt near Weimar.

From the open woodlands and pastures of southern Scandinavia, Europe's third major zone for beef production, animals moved through Schleswig to fatten in marsh pastures of northwestern Germany, then walked on to consumers in the Low Countries, the Rhineland, and in some decades all of northern Germany. Numbering but a handful before 1450, within thirty years Danish exports surpassed 10,000 head and then multiplied another three or four times by the mid-1500s. Central and western European urban populations thus depended on eastern suppliers of beef.

Northern beef, like traditional western production, was mainly steers culled from peasant draft and dairy stock, but on the Hungarian *puszta* and beyond the Carpathians semi-wild herds of distinctively large grey steppe cattle grazed an open range. Natural grasslands supported animals capable of travelling long distances without much loss from their normal 300–400 kilogram starting weight. About 1500 the Hungarian kingdom's three million animals provided subsistence to four million humans, who ate on average some 66 kilograms of beef a year.²¹ Exports were thus a mere five to seven percent of the herd but, like grain on the northern plains, cattle moving out of Hungary and southeastern Poland generated a strong positive trade balance which local gentry elites controlled. Customs records then show cattle making up 55–60 percent of Hungarian exports.²²

Cattle Trade: Environmental Impacts

Europe's northern and eastern pastoral belt was another foreign trade staple sector driven by western demand for food and shaping commercial infrastructures in producing regions. Cattle walked up a price gradient from zones of origin to those of consumption. Hungarian cattle in Vienna, though thirty percent more valuable than at their origin, were still only two-thirds the price they would get in southern Germany. Northern animals gained less value per head because of greater weight loss. Price increases over time drove growth of the trade: the price at the Elbe of animals for fattening doubled between the 1470s and 1540s; that of slaughter cattle in Hamburg rose by 27 percent. Cattle merchants were able steadily to increase supply by offering producers those higher prices while lowering transactions costs enough that urban demand remained strong. Per capita meat consumption in western cities, chief recipients of the imported beef, continued to rise after 1500 while it collapsed in surrounding rural areas which relied mainly on local herds.²³

Eastern animals came from a distinctive ecosystem, both as natural semi-arid continental grasslands and as open-range agro-pastoralism quite unlike the natural pastures and stock-rearing practices of central and northwestern Europe. Danish cattle also shifted at this time from traditional forest forage to open pasture and meadows which occupied more land than did the country's arable and were not fertilised. Thorkild Kjærgaard blames overgrazing and the long-term transfer of nutrients away from pasture land (removal of animals, manure, hay, and turf) for the loss of fertility, sand drift, and bog formation which marked the deep ecological crisis of early modern Denmark.²⁴ Dutch, German, Austrian, and Italian beef eaters were gaining or sustaining their more diversified, culturally-satisfying diet by tapping into natural processes not only distant from but different than those with which they might be familiar near home.

Insofar as eastern cattle also looked different to western breeds this trade even acquired an alien aspect. Recent archaeozoological findings argue for emergence of the distinctive Hungarian Grey cattle – long-horned, rangy, pale in colour – only as a result of large scale grazing to meet rising late medieval export demand.²⁵ But by all accounts superficial changes to the animals left unchanged the 'food' humans made from them.²⁶

Already by the end of the Middle Ages the cattle trades had certainly put hundreds, even thousands, of kilometres between the lives of some millions of animals and the sites of their deaths and consumption. In ecological terms we recognise a self-propelled transfer of biomass and energy from one ecosystem to another. Plant-eating cattle occupy a trophic level above cereal grains (Figure 1), so a larger share of annual biological productivity lay behind each calorie or kilogram of food consumed. Movement of whole organisms diverted a larger biomass from the producing to the consuming ecosystem. The 'ecological footprint' of western urban carnivores was deeper than that of their poorer compatriots who could afford only imported grain.²⁷

COMMERCE IN PRESERVED FISH

From at least the twelfth century and even beyond the sixteenth, merchants carried preserved marine fishes from Europe's maritime frontiers on the Atlantic and the North, Baltic, and Mediterranean Seas to consumers in inland and eventually deep interior Europe. Long distance fish trades were, however, more complex than those in grain and cattle, for they responded more to general cultural and social pressures than to peculiar regional economic circumstances and they relied chiefly on wild resources. Fishes of economic importance included different animals with particular habits, habitats, natural ranges, population dynamics, and susceptibilities to capture and preservation for large-scale consumption and transport. No study has heretofore covered all branches

of even one major commercial species, much less the several varieties and regions which supplied large medieval demand for fish.²⁸

Fish consumption in medieval western Christendom was as much driven and shaped by cultural considerations as it was by biological needs.²⁹ Put simply, a religious taboo on eating the flesh of terrestrial animals covered about 135 days, 37% of the year, including Fridays, vigils of major feasts, and most stringently the forty days of Lent. Since the seventh century the Latin church did permit eating fish in place of meat, which established steady weekly and heavy seasonal consumption of fish by those who could afford it (Figure 4³⁰). Social prestige reinforced religious practice: as a German proverb put it, 'Wildpret und Fisch gehren auf dem Herren Tisch' (Game and fish belong on the table of lords).³¹ Elites liked eating freshly-killed specimens of certain big local fishes, notably pike, salmon, and sturgeon. But preindustrial transport limited overland movement of fresh fish to about 150 kilometres, the distance fast horse relays could barely carry them in an edible state from coastal Normandy to Paris. Consumers farther inland (Figure 5) were limited to freshwater fishes and/or preserved ones. Medical authorities discouraged the latter and they were often shunned by other than ostentatiously penitent elites. Brined, salted and dried fishes were commonly designated as food for the poor, including servants.

What is now known of the fishes actually eaten by medieval Europeans comes from two kinds of sources. On the one hand, written recipe collections, menu lists, and kitchen accounts record expectations. On the other hand, archaeological fish remains are evident consequences of eating fish. Though

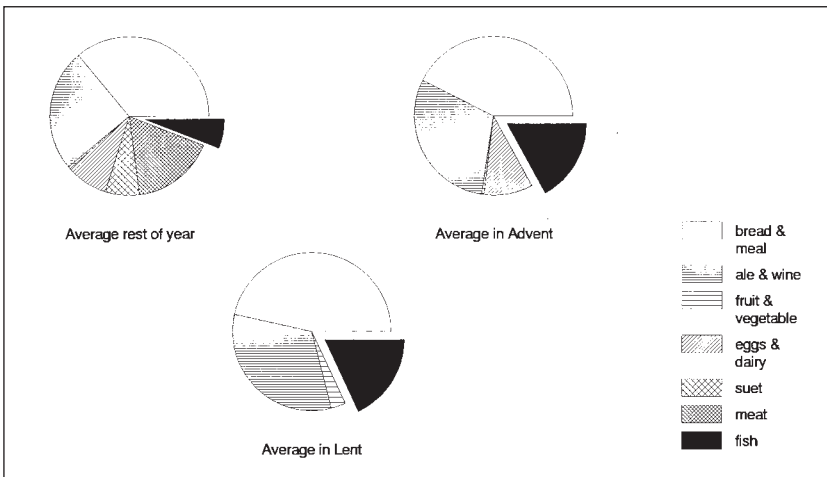


FIGURE 4. Contribution of different foods to the energy value of the diet of monks at Westminster, ca. 1495–ca. 1525.



FIGURE 5. Preindustrial access to fresh marine fish. Shaded area is within 150 km of salt water. Medieval and early modern transport could not normally move fresh marine fish farther inland before they spoiled.

neither type of source is perfect, their coincident general pattern has ecological and economic significance.

Only a few written lists of fishes meant to be eaten predate the thirteenth century, but extensive records from the last two medieval centuries occur in many parts of European regions. I have tabulated varieties named in almost sixty major published and manuscript cookbooks (recipes and menus listing fishes to eat) prepared in western Christendom between 1000 and about 1520. Properly located and dated, these texts identify the native and exotic aquatic fauna which contemporaries contemplated eating. So, for instance, all the six fishes named as available to monks at Cluny about 1080 lived in nearby waters,³² but of the 48 species for which the late fourteenth-century *Menagier de Paris* (a manual of household management) gives cooking instructions, only 21 could have lived or migrated through the waters of the Ile-de-France and 27 came from the sea.³³

Precisely dated and located household or kitcheners' accounts offer quantifiable records of seasonal consumption. One example comes from the toll station and border stronghold of the Duke of Gelders at Lobith, where the Rhine split into its delta, 160 kilometers by river and estuary from the open sea but only half as far overland from the Zuider Zee. In just 6 of 48 weeks accounted during 1428–29 did ducal officials, servants, and visiting dignitaries not consume fish, which comprised 20 per cent of 'kitchen' expenditures. Generic local 'fresh fish' were served in moderation year-round except in April, while regional marine speci-

alities (lamprey, fresh or wet salted whiting and haddock, fresh and smoked herring (*bücking*) were typical autumn dishes. Barrelled herring and stockfish had a separate budget line; they were bought in bulk and eaten exclusively between November and springtime, especially during Lent.³⁴ In comparison, a middling Austrian noble family, the Puchaim, lived at Horn castle on the River Kamp, a Danube tributary. Their household accounts from 1444–46³⁵ also show consumption of fresh local fish nearly all year round and likewise dozens and hundreds of brined herring between late November and the end of Lent. But apart from those herrings, no marine creatures came to their tables. During late winter and Lent, when stockfish were being served at Lobith, the Puchaim bought live carp, individually and in bulk, from nearby artificial fish farms, which offered a means other than imports for replacing wild supplies.

Results of medieval fish dinners now survive as the fish bones found in archaeological food remains from medieval sites and, even in a few instances, as chewed fish vertebrae in latrine deposits.³⁶ When meticulously recovered and painstakingly identified, these samples of medieval leftovers yield results like those shown in Figure 6, which highlights both consistencies and changes in fishes consumed by well-off late medieval Parisian households. The rising importance in those finds of marine and cultured varieties differs greatly from the exclusively local freshwater fishes reported at eleventh-century Nürnberg.³⁷ No more than the dozens of medieval cookbooks or household accounts can the mounting catalog of excavation reports here be examined in detail, but what follows draws on findings from all genres of sources.

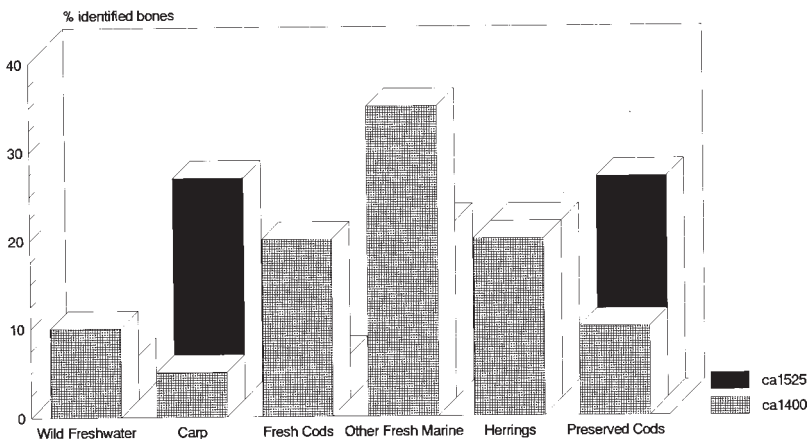


FIGURE 6. Fishes eaten at late medieval Paris. Remains from the Rue Fromenteau.

All the evidence coincides. Local fisheries were active all over early and high medieval Europe and local consumption overwhelmingly dominated. On a region by region basis this pattern lasted until rising human numbers and even faster-rising market demand increased pressure on local fish populations just as destruction of their inland and riparian habitats – a result of deforestation, agricultural development, and urbanisation – began to curb or shrink those same indigenous stocks.³⁸ Then in stepwise fashion all over high and later medieval Europe the evidence of fish eating slides from exclusive use of local varieties to a rising share of imports, animals from elsewhere which had to arrive in a preserved and packaged state. The most characteristic products originated on Europe's maritime frontiers and came but slowly into the hands of distant consumers.

Herring from the North Sea and Baltic, for example, took time to enter human diets in interior Europe. Up to the late eleventh and twelfth century distribution was chiefly coastal or riverine, so closely associated with easy access to areas of production. Herring made up 42 per cent of all fish remains from tenth-twelfth century Roskilde, Denmark, and 40 per cent from Kołobrzeg in western Pomerania, but only a few day's sail from the fishery contemporary Gdańsk. consumed much less herring (five per cent of remains) and 250 kilometres inland from the Baltic the evidence fades out entirely.³⁹ Further to the west herring first gain mention well inland up the Loire (at Fleury), the Rhine (at Hirsau and Worms), and the Elbe (at Prague) only in the last dozen years of the eleventh century.⁴⁰ A hundred years thereafter toll schedules anticipated traders with these goods at Radom in interior Poland (1198) and far down the Danube at Vienna (early 1200s), but Silesian abbeys still thought it best to send their own boats down the Odra 'to Pomerania for herring' (*in Pomerania pro allecibus*).⁴¹ Likewise while verbal references were by then common in interior France and upper Germany, the oldest herring remains actually recovered at twenty Swiss sites of the eleventh–seventeenth centuries are from fourteenth-century layers at Basel.⁴² Kitchen accounts kept at Klosterneuburg in the 1320s record many purchases, but not so those of princes in Tirol.⁴³ A generation thereafter, however, herring were a regular feature on markets and tables of kings, nobles, monks, and workers in Kraków, Nürnberg, and the Vinschgau.⁴⁴ By the later fifteenth century they ranked second only to salt among goods imported by Gdańsk and some of that quantity in turn became 15 per cent of imports into northern Hungary.⁴⁵

Tracing the herring south from its natural range finds it often on the table of canons at Arles in 1352⁴⁶ and in several recipes from a 1420s cookbook by Chiquart, chef to the Count of Savoy. Meanwhile about 1340 the poet Juan Ruiz, known as Archpriest of Hita (on the Castilian plateau), considered herring a well-known northern import.⁴⁷ It had taken a reputed miracle to turn Italian sardines into herring for Thomas Aquinas (1225–1274), dying in his native Campania,

who craved this dish from his years in Paris.⁴⁸ Other Italian consumers lacked the saint's power, but by 1396 Saminato del Ricci's merchant's manual was explaining how Tuscan demand made it profitable to ship herring there from Flanders.⁴⁹

A different fish differently preserved, the large headless dried cods called *stockfish* were feeding coast dwellers in northern Norway by the Bronze Age and by the ninth century AD also their descendants around a wider Norse Atlantic.⁵⁰ Stockfish entered the English and Swedish archaeological and written record in the twelfth century and became commonplace in the thirteenth.⁵¹ Still this food remained little known on the continent. Though present in archaeological finds from thirteenth-century Göttingen and Duisburg, they were unfamiliar to Albertus Magnus⁵² and to the extensive French culinary literature of about 1300. Rich remains of fresh marine fishes at late medieval Flemish sites obscure the bone assemblage typical of dried cods,⁵³ but since the 1390s French cookbooks treat them regularly. Meanwhile in the oldest known German work of that genre, the *Buoch von guter Spîse* made at Würzburg in 1350, 'stockfisch' was the one food of marine origin. By 1400 the Polish royal court in Kraków and commanderies of the Teutonic Order in Prussia and Bohemia were often buying and serving these dried fish.⁵⁴ No surprise, then, to find stockfish named in four more southern German recipe collections dating to the 1430s–50s and likewise to have Austria's oldest known cod bones turn up in early fifteenth-century layers at Salzburg.⁵⁵ South of the Alps and Pyrenees, however, contemporary mentions then still reflected only recollections from northern travels. Actual remains of cod appear in kitchen waste dated to the late fifteenth – early sixteenth century from the Carthusian house at Seville, and the dried product was available on Andalusian city markets by 1503.⁵⁶ The dietary tradition of *bacalao* around the western Mediterranean has at earliest fifteenth century origins.

Medieval European consumer demand for fish must have seemed insatiable. It drove commercialisation and growth of what had been local subsistence fisheries on frontiers open to expansion (Figure 7). What follows will briefly trace this process for herring, for northern codfishes (family *Gadidae*, gadids), and for a few other varieties, each with its own significant biological, technical, and economic characteristics.

Herring (*Clupea harengus*) eat plankton drifting in open water of the cool North Atlantic and connecting salt waters (Figure 8). Regional groupings of migratory shoals form local spawning populations during summer in the off-shore North Sea and Atlantic, in early autumn along Baltic and East Anglian coasts, and by November on Flemish and Picard shores. Vast quantities of 16 to 32 cm fish could be caught within sight of land, but saving them to eat even a day or two later required their oily flesh to be kept from the air, smoked, or treated with salt. Indeed while the Germanic word *harinc* is said to derive from their army-like masses, the Latin term *hallee* simply means *salted fish*.⁵⁷

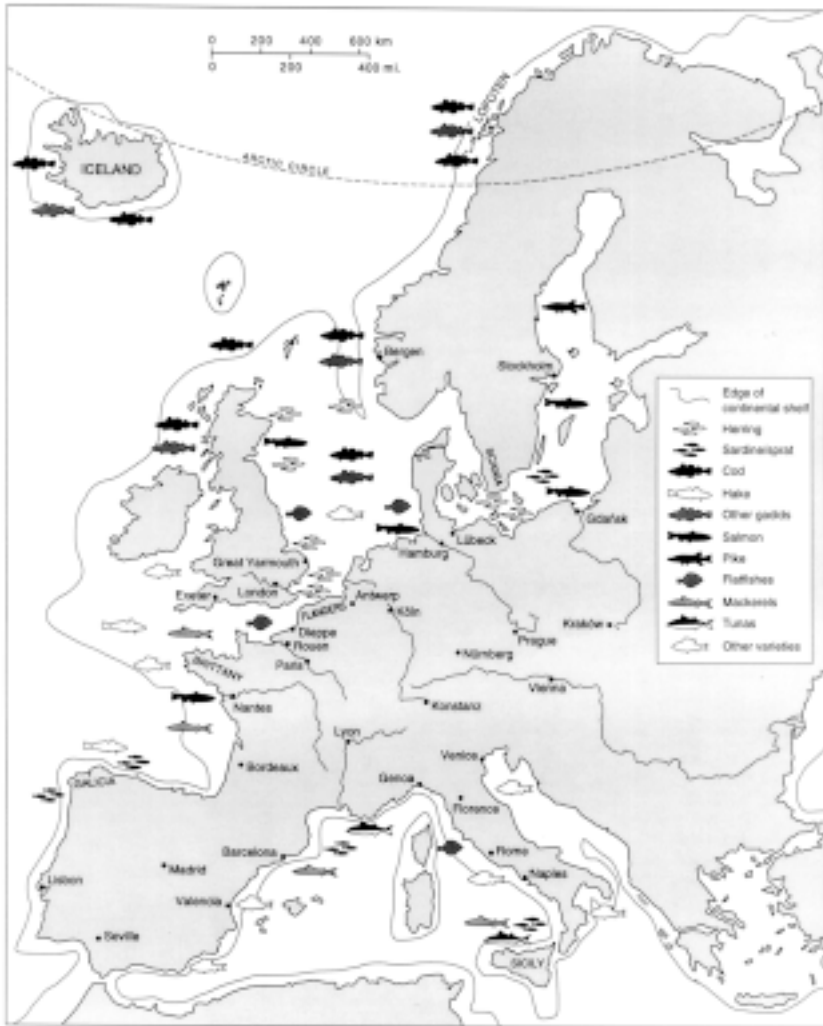


FIGURE 7. Major fisheries on medieval maritime frontiers.

Early medieval coast-dwellers from Picardy to Pomerania ate herring they caught from local shoreline and estuarine stocks. Surely by about 1000 they were supplying the fish to nearby inland consumers, too. Bede (d. 731) reported mythic beginnings of a coastal Suffolk fishery which could have provided the herring which contributed most of the 554 fish bones in an eleventh-century rubbish dump at Norwich.⁵⁸ Catches on the other side of the Channel may also

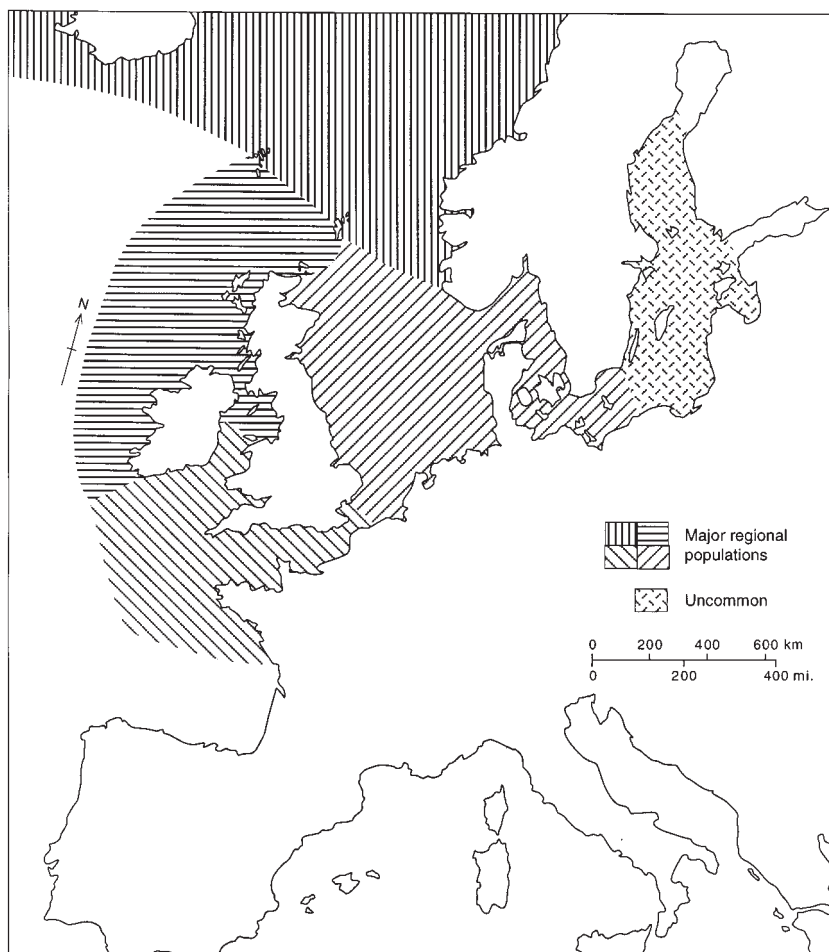


FIGURE 8. The range of herring (*Clupea harengus*) in the eastern Atlantic.

go back to the eighth century. Although market regulations from Arras in 1024 treat herring as if fresh, by 1088 the herring fair at Fécamp was handling a preserved product.⁵⁹ At Haithabu (Hedeby), where Viking Age traders and artisans lived on the Schleswig isthmus from before 808 until 1066, herring contributed 38 per cent of the 13,842 identified fish bones.⁶⁰ Chronicler Gallus Anonymus reported eleventh-century Polish warriors seeing fresh herring on the Pomeranian shore but only salted ones inland.⁶¹

With the twelfth century herring production everywhere grew in parallel with nearby human communities. Picard and Flemish coastal municipalities then chartered as fishing ports paid such rich dues to territorial princes that Count Eustace of Boulogne could endow Cluny with 20,000 herrings a year.⁶² By 1170 the fishery had such importance that Pope Alexander III permitted even Sunday work in coastal areas when the run was on. In 1187 the Count of Flanders received 150,000 herrings as an annual charge on the trade.⁶³ At the same time visitors to the south Baltic were reporting rich stocks and business everywhere from Rügen to easternmost Pomerania.⁶⁴

Tasty but quick spoiling fresh or lightly-smoked herring were enjoyed right away by local consumers. Most of the catch was gutted and salted in piles right on the foreshore, making loose dry *sapoudre* herring with a few months' storage life. Bundled by the thousand, they were sold to merchants and eventually in ones and twos reached consumers up to some hundred kilometers away. The fish were small and cheap so, as Alan of Lille put it in the 1160s and Burgundian councillor Philippe de Mézières echoed in 1389, poor people could afford a little fish (or receive it in rations or alms).⁶⁵

Thirteenth-century herring fisheries intensified commercial exploitation of large near-shore spawning concentrations in the southern North Sea and at the entrance to the Baltic. More than five hundred English, Flemish, and French vessels gathered off Great Yarmouth to supply unnumbered English and Flemish needs, while Paris had more than thirty million salt herring annually barged up the Seine and another twelve million plus were shipped to Gascony.⁶⁶ At the same time along the southwestern coast of Danish Scania each year for a century and more, five to seven thousand small boats caught more than a hundred million fish and the merchants from northern Germany who ran the industry shipped 10,000 to 25,000 tonnes of product.⁶⁷ By the early 1300s some of them were probably packing the fish in barrels with salt brine and perhaps experimenting with a special gutting technique – eventually called *kaken* – which left an intestinal enzyme with preservative effects. Both innovations famously made a more durable product which could bear longer shipment and storage.⁶⁸

Later myth associates mastery of the innovations with fourteenth-century Dutch newcomers to the industry. Together with larger vessels equipped for initial processing at sea these methods won the Dutch access to larger, hitherto untouched, offshore North Sea stocks and to more consumers deeper inland. As economic historian Richard Unger put it, 'The greatest impetus to the use of all the superior methods was the presence of a market for the preserved herring and a market that had potential for growth'.⁶⁹ Soon the Dutch dominated the business. Their production mastered the Flemish market by 1400 and then entered the Baltic, replacing the Hanseatics as chief suppliers of herring to all interior northern Europe. By the late fifteenth century the Baltic and Dutch pack provided most of the herring imported by the English.⁷⁰

In each successive stage of expansion of the herring industry over several medieval centuries Picard, Pomeranian, Anglo-Flemish, Hanseatic, and finally Dutch merchant entrepreneurs had supplied eager consumers on ever more distant markets with larger production from stocks further offshore.

Fisheries for **sardine** (*Sardina pilchardus*), another schooling, pelagic, plankton eater, were in both ecology and technology a precise warm water counterpart to northern herring. Local Galician and Portuguese production was commercialised during the thirteenth century, first to feed western Iberia, then in the fourteenth century the rest of the peninsula and western Mediterranean. Sardines from the Atlantic reached southern Italy by the 1420s. A generation or two later annual Galician shipments into Seville, Valencia, and Barcelona each ran in the range of five to ten million sardines.⁷¹

Cod (*Gadus morhua*) and its close relatives (other gadids) differ greatly from herring in both ecology and fisheries technology. Codfishes are cold-water predators habitually oriented to the sea bottom (demersal) rather than open surface waters. Small individuals and stocks occur near shore along much of the cool Atlantic coast, but the largest cods live offshore and in the far north (Figure 9). Especially large spawners gather in late winter and spring around Lofoten and Iceland. The oil-free flesh of fish caught on simple baited lines, beheaded, split, and gutted, dries without salt in the open, chill Arctic air to make stockfish. As

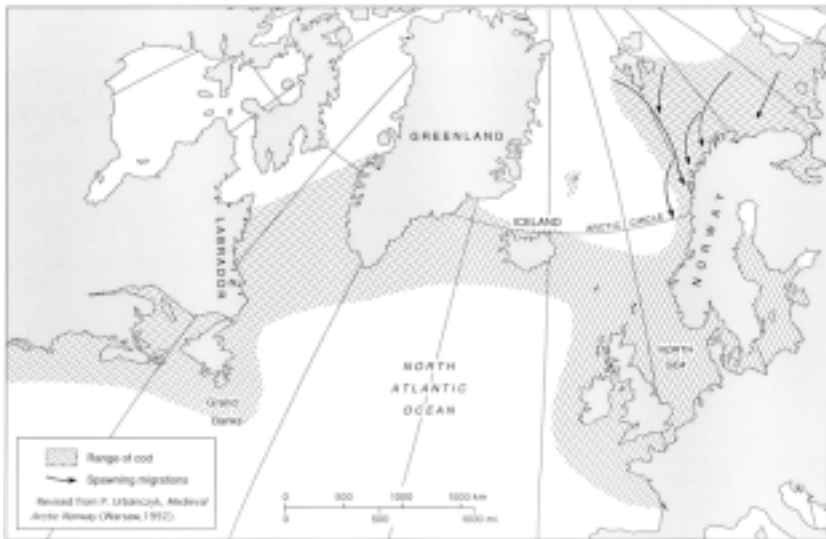


FIGURE 9. Range of cod (*Gadus morhua*) in the north Atlantic.

a result of the production process, archaeologists recognise processing sites by the discarded head bones and dig up the tail vertebrae where the fish were finally eaten.⁷²

Medieval growth in frontier exploitation of cod for stockfish depended more on mercantile access than it did on technology, which changed little.⁷³ Norwegian and English merchants were bringing some of this old northern Norwegian subsistence product south to lower Norway and northeastern England by about 1100. It entered the Rhine and Lübeck by about 1250, when traders from northern Germany gained firm grip on exports from the Norwegian entrepot Bergen. Norwegian scholars estimate annual exports at 2000–4000 tonnes, half to England and half to the continent; in 1368 that made up 90 per cent of Bergen's export trade. In 1370 the stockfish moving through Lübeck were worth one quarter of that port's herring.

Stockfish from Iceland were similarly commercialised for export after 1310 and first shipped via Bergen. English merchants and fishers largely captured this resource for their own market after 1400, but by the century's end, with the English driven from Iceland, it came entirely into the control of Hamburg.⁷⁴ The rejected English, incidentally, looked further west and found North America with its own potentially lucrative cod stocks.

Fisheries for **hake** (*Merluccius merluccius*), cod relatives with a warmer temperature preference, also provide a southern analogue. The dry heat of a Galician summer worked as well as dry northern cold to make a durable product for thirteenth-century Iberian consumption and, by the fifteenth century Italian as well.⁷⁵ The same species taken some days' sail offshore from more humid southern England and Brittany, a fishery initiated in the 1300s, had to be salt-dried to keep for marketing to the same Mediterranean consumers.⁷⁶ By the second half of the fifteenth century just the shipments from Galicia to Valencia ran between 35,000 and 60,000 hake per year;⁷⁷ larger sectors of this trade remain unquantifiable.

Barely brackish frontier waters of the north and east Baltic were the source of another dried fish product, *strekfuss*, made especially from pike (*Esox lucius*) and other low-fat freshwater species. After the thirteenth century pike remains massively replaced those of Norwegian stockfish in finds from Uppsala.⁷⁸ Already before 1400 written records for the Teutonic Order in Prussia and the Polish royal court plainly distinguished *strekfuss* from stockfish.⁷⁹ The zones of production in northern Bothnia became as famous for their profits as for the 'stench of fish hung out to dry [so that] far out to sea approaching sailors are aware of it flying out to meet them'.⁸⁰ The product, which made up ninety per cent of the value which Bothnia exported through Stockholm, reached into Czech lands and across the Carpathians into northern Hungary.⁸¹ In inland central Europe, not all 'dried fish' was stockfish, but much still came from far away.

A distinctive medieval fishery targeted **tuna** (*Thunnus thynnus*), a pelagic predator with flesh so rich in oil that it kept poorly and was thought barely edible fresh. Though tuna are incidentally available on several European shores, notably the feeding and spawning migrations of western Mediterranean populations seasonally bring large schools along the northern coast of Sicily, where a carefully sited and heavily capitalised traditional barrier trap (*tonnara*) could capture a thousand and more fish (each weighing up to 100 kg) per year.⁸² When butchered and brined in airtight barrels by an expert team, that catch became forty to eighty tonnes of *tonnina*, prepared tuna meat more valuable than the fresh. As these enterprises multiplied from the mid-thirteenth century to number thirty and more by the fifteenth, total Sicilian output approached the lower bound of Norwegian stockfish exports. At least one barrel in four was exported, especially to Naples, Rome, and northern Italian towns, where already in the 1320s the merchant Francesco Pegolotti knew it as a commercial commodity. *Tonnina* arguably ranked second only to agricultural exports (grain and others) as a late medieval Sicilian earner of foreign exchange.⁸³

Fish Trades: Environmental Impacts

By the expansion of frontier commerce Hanseatic, Dutch, and other traders engineered the spatial extension of European demand into what had been local subsistence fisheries – Flemish, English, and Danish inshore herring, for example – and into unexploited marine ecosystems – the North Sea offshore, Icelandic continental shelf, and eventually the Grand Banks – on Europe’s periphery. Thus the merchants triggered market commodity production on the part of foreign trade staple economies in the North Atlantic – Norway, the Atlantic archipelagos, Iceland – and in northern Sweden, Galicia, and northwestern Sicily. Effects are visible in both producing and consuming regions.

The long-distance trades in preserved fish took biomass from distinct aquatic ecosystems – pelagic and demersal – which remained little or wholly unknown to those people who would consume the product. On a trophic scale (Figure 1) the fish stand higher than terrestrial herbivores like cattle. Large-scale medieval commerce extracted them from two different ecological niches: (1) Small plankton-eating herring and sardine comprise a very large biomass near the consuming base of aquatic food webs. Such organisms react quickly and massively to changes in oceanic environment (temperature and nutrients), and all the animals which eat them are affected in turn; that includes humans. Catches of herring can fluctuate wildly from one year to the next. (2) Top-level predator populations such as codfishes, pike, or tuna are less sensitive, but an intensively targeted fishery which selectively removed large annual production from aquatic communities affected those species and their relations to prey. Either effect on particular past ecosystems remains imponderable, but was surely large

and real. Ocean ecologists are suddenly now aware of the need to learn ‘what the removal of vast numbers of fish from the oceans might mean to the structure, function, and conservation state of ocean systems’.⁸⁴ Our historical disciplines may help contribute some answers with regard to both species mix and sustainability.

Some evidence points toward overfishing of certain heavily-pressured stocks. Medieval writers long thought the frontier a zone of mythic abundance. Early twelfth century chronicler Cosmas of Prague looked back to a time when Czechs settled in a pristine Bohemia teeming with tasty fishes.⁸⁵ From the mid twelfth to the late fourteenth century the Baltic herring shoals repeatedly moved local and visiting observers to hyperbolic metaphors for unbelievable numbers and density.⁸⁶ Even at the end of the Middle Ages Zuan Caboto and his English shipmates would describe the cod of Newfoundland⁸⁷ with like wonder. In the Gulf of Bothnia Olaus Magnus reported ‘such an abundance of fish ... that you are dumfounded at the sight and your appetite can be wholly satisfied’.⁸⁸ Indeed no cultural constraints inhibited anyone’s taking as much as he would of this masterless wealth.⁸⁹

The fish varieties important to large scale medieval commerce were not only well suited to available means of preservation, they were present in great seasonal abundance⁹⁰ and accessible in large numbers to simple capture techniques. Even the most complex tuna traps comprised only stakes, mesh, and floats. Herring and sardine were taken in simpler estuarine traps or with floating gill nets in open water, cod and hake on mere baited hand lines. Many like-sized fish were thus easily captured and available for processing all at once, which made for a relatively uniform product. Such consistency is a prerequisite for investment in capital equipment and marketing infrastructure for any large-scale commercial fishery, and especially one unable to offer its customers a regular fresh catch.⁹¹ Hence the frontier fisheries targetted fishing effort and impact on specific stocks and most did so at the very time their quarry were segregated by the reproductive behaviour which defined and sustained those stocks.⁹²

There are now grounds to suspect that certain spawning populations of herring were under pressure (as evidenced by historically peak catches) just before their commercial collapse, which may then have been triggered by extreme natural fluctuations. The late thirteenth century commercial disappearance of the south Baltic (Pomeranian) fishery coincided with large-scale clearances, soil erosion, and flooding in the Odra and Wisła basins,⁹³ which drain directly into this part of the sea. These events should have affected water chemistry and nutrient levels in estuarine and near-shore areas. Large shoreline changes – formation and consolidation of offshore barrier islands and peninsulas – certainly ensued.⁹⁴ The heavily-fished herring stocks in the southern North Sea broke down after 1360 and those off Scania in the 1420s⁹⁵ while contemporaries were observing ferociously unstable weather which historical climatologists

now attribute to Europe's transition from the 'Medieval Warm Period' to the 'Little Ice Age'.⁹⁶

Weakness in some commercial cod stocks may also be hinted in certain sources. In 1415 English fishers blamed a recent decline in North Sea catches for their illegal voyages to Iceland.⁹⁷ Some commentators think a failure of southern coastal cod stocks in 1517 explains the sudden subsequent enthusiasm of the entire western European littoral for voyages to Newfoundland, fully 20 years after its discovery.⁹⁸

At the consuming end of the process people received foreign, even wholly alien, animals. The imports competed with and substituted for domestic sources of supply. Economies of scale and of price propelled Dutch herring into the fifteenth-century Baltic, where they replaced shrunken domestic herring production, especially for inland consumers. To what extent had the earlier entry of Baltic and North Sea herring into inland diets supplanted small and cheap native fishes, the bony little cyprinids like roach or dace which inland French monks or Nürnbergers, for instance, once ate in considerable quantity?⁹⁹ Or had the salty fish more filled a protein gap opened by widened adherence to religious precepts? Imported stockfish plainly fit into older dietary habits as a cheaper and more durable but culturally acceptable substitute for dwindling stocks of high quality native fishes, so in some inland areas they contested that role with live domestic carp.¹⁰⁰ In inland Iberia and Mediterranean Europe, where earlier evidence shows consumption of mainly inland and a few coastal fishes, like functions were served first by Atlantic sardines and hake, then by northern stockfish. As already remarked (p. 145 above), it is now clear that what southerners called *bacalao* or *bacalá* – note that even the traditional Spanish and Italian names for the exotic dried cod are derived from northern *kabeljaw*¹⁰¹ – was unimportant, perhaps unknown, in those regions before the fifteenth century, but had entered their diets by its end. On many tables in most parts of Europe a few widely available imported fishes took the place of more diverse local varieties.

These animals arrived separated from their natural conditions and identities. Far in advance of other food producers, the late medieval fisheries disconnected the lives of certain animals from the sites and even the physical form of their consumption by humans. What European landsman or -woman could then imagine 'the frontiers of the sea' (*es marces de la mer*) whence, said an elderly Parisian, originated the cod now become *stofix*?¹⁰² Processing and packaging made already unfamiliar animals wholly alien and artificial: stockfish and *strekfuss* are boardlike objects, named not as animals but for the poles and racks on which they were dried; slippery *kaakharing* and *tonnina* swam in barrels of brine. No-one in Poland, Valencia, Nürnberg or Naples had ever laid eyes on animals such as these.

Not only distance, system, and form but also time, elapsed and seasonal alike, separated the lives and deaths of these animals from their human consumption. Herring caught in late summer and autumn were chiefly eaten the next winter and spring. Lofoten cod taken during February and March and dried in the frozen Arctic spring were carried a thousand kilometres south to Bergen during May and June. The stockfish would not reach consumers in England or the continent before late summer or fall and would appear on Lenten tables a year and more after their lives had ceased.

GENERAL CONCLUSIONS

Driven by demand, medieval Europeans did move large amounts of certain foodstuffs across distant ecological boundaries. This activity affected human economies and natural ecosystems in several ways. A first distinction is drawn between consequences of subsistence demand – for grain, maybe herring – powered by consumer numbers and those of ‘luxury’ demand – for beef, tuna, perhaps stockfish – powered by wealth. Cultural preferences shaped both of these, but while the former called for simple calories, the latter wanted a more complex mix of nutrients and social display taken from further up the trophic ladder. As today, both the many medieval poor and the fewer rich had economic and environmental significance, and the impact of neither was necessarily confined to their own surroundings.

The producing ecosystems lay on distant frontiers where abundant natural or cultivated resources and low human densities sustained a price gradient relative to dense, commonly urban, consumption zones, whose ecological ‘footprint’ thus extended far beyond their own physical proximity. Supplying those distant consumers commercialised existing subsistence activities and called up larger capital investment in institutional and technological infrastructures. Ensuing transfers of energy and biomass gave the consumers access to ‘ghost acreage’ in arable, pasture, and fertile waters, so relieving their pressure against comparable resources closer to home.

Resource endowments relative to the loci of demand established different regional roles in different sectors. Grain and cattle moved from terrestrial frontiers in the east to western consumers. Preserved fish moved from maritime frontiers in the west to eastern and southern consumers who themselves included both importers and exporters of grain and cattle. In other words, medieval Europeans were forming complex bonds between natural systems that had at this scale of analysis hitherto been effectively independent.

The new relationships had predictable consequences for producing ecosystems. Particular note was taken of fairly strong evidence for potential overgrazing in Denmark and for accelerated evolution of a distinctive race (breed) of cattle

in the east. Plausible overfishing left certain, especially inshore, stocks vulnerable to natural environmental disturbances. Continual extraction of nutrients with no return flow put local systems at risk.

The consuming end witnessed a denaturing of organisms turned into food from afar. This experience ranged from strange-tasting grain or odd-looking cattle to board-like stockfish and oily *tonnina* or herring scooped from a barrel in a wholly different human landscape and at a season set by human cultural rules, not biological cycles. What were once plants and animals had no more recognisable place in a familiar local world for which people might take some responsibility. Ecological relationships faded from the view of especially urban consumers, replaced in their consciousness by economic links.

In sum, ecological principles plainly held in the Middle Ages: human activities were both shaped by and themselves shaped natural relationships. Medieval Europeans anticipated many of the environmental relations now wrongly thought peculiar to a capitalist and post-industrial age. Medieval frontiers provided distant zones of surplus and 'abundance', which let consumers avoid changing their own cultural preferences and social practices by externalising, even forgetting, the social and environmental costs of satisfying them.

NOTES

¹ I presented earlier and partial treatments of this material at an international conference entitled "Constructing and Deconstructing Frontiers: A Cross-Disciplinary Workshop" under the aegis of the Department of Medieval Studies, Central European University, Budapest (19–22 February 1999), the symposium 'Beyond natural local ecosystems' presented by Zwaartepunt Ecologische Geschiedenis of the Leerstoelgebied Economische en Sociale Geschiedenis, Vrije Universiteit Amsterdam (8 April 1999), the New York meeting of the Fish Remains Working Group of the International Congress of Archaeozoology (September 1999) and as seminars for the Institut für Wirtschafts- und Sozialgeschichte at Universität Wien and the Historical Research Group at York University. Thanks to organisers Gerhard Jaritz, Petra van Dam, Sophia Perdikaris, and Markus Cerman and to other participants and colleagues for their attention, comments, and criticisms. Maps were drawn by the author, with assistance of the Cartographic Drafting Office, Department of Geography, York University.

² I. G. Simmons, *Changing the Face of the Earth: Culture, Environment, History*, 2d ed. rev. (Oxford: Blackwell, 1996), 422–423.

³ Rolf P. Sieferle, *Rückblick auf die Natur. Eine Geschichte des Menschen und seiner Umwelt* (München: Luchterhand, 1997), 85–92 and 186–196, with sources there cited.

⁴ Compare I. G. Simmons, *The Ecology of Natural Resources*, 2d ed. rev. (London: Edward Arnold, 1981), 26–33; Fred Spier, *The Structure of Big History: From the Big Bang until Today*. (Amsterdam: Amsterdam University Press, 1996), notably 73 and 82; Evan Eisenberg, *The Ecology of Eden* (New York: Knopf, 1998), 380.

⁵ William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: Norton, 1991), notably 254–256.

⁶ William E. Rees and Mathis Wackernagel, 'Ecological Footprints and Appropriated Carrying Capacity: Measuring the Natural Capital Requirements of the Human Economy', in AnnMarie Jansson *et al.*, eds., *Investing in Natural Capital: The ecological economics approach to sustainability* (Washington, DC: Island Press, 1994), 362–390; Mathis Wackernagel and William E. Rees, 'Perceptual and Structural Barriers to Investing in Natural Capital: Economics from an ecological footprint perspective', *Ecological Economics*, 20:1 (1997), 3–24.

⁷ Eric L. Jones, *The European Miracle. Environments, economies, and geopolitics in the history of Europe and Asia*, 2d ed. rev. (Cambridge: Cambridge University Press, 1987), 70–95.

⁸ Cronon, *Nature's Metropolis*, 378–379.

⁹ I here confess and regret my ignorance of non-western economic systems, insofar as these may provide other early analogues, though not, in this regard, origins for the present situation.

¹⁰ Emily W. B. Russell, *People and the Land through Time: Linking Ecology and History* (New Haven: Yale University Press, 1997); Simmons, *Changing the Face*, 12–27.

¹¹ Norman J. G. Pounds, *An Historical Geography of Europe 450 B.C.–A.D.1330* (Cambridge: Cambridge University Press, 1973), 425–428; Norman J. G. Pounds, *An Historical Geography of Europe 1500–1840* (Cambridge: Cambridge University Press, 1979), 55–62 and 277–280; Bartolomé Yun, 'Economic Cycles and Structural Changes', in Thomas A. Brady, Jr., Heiko A. Oberman, and James D. Tracy, eds., *Handbook of European History 1400–1600 Late Middle Ages, Renaissance and Reformation*, Volume I: *Structures and Assertions* (Leiden: Brill, 1994), 113–147; Maurice Aymard, *Venise, Raguse et le commerce du blé pendant la seconde moitié du 16e siècle* (Paris: SEVPEN, 1966); Robert-Henri Bautier, 'Les mutations agricoles des XIVe et XVe siècles et les progrès de l'élevage', *Bulletin philologique et historique (jusqu'à 1610) du Comité des travaux historiques et scientifiques ...* 1967; Henri Bresc, *Un monde méditerranéen. Économie et société en Sicilie 1300–1450*, 2 vols. (Rome: École Française, 1986); S. R. Epstein, *An Island for Itself: Economic Development and Social Change in Late Medieval Sicily* (Cambridge: Cambridge University Press, 1992); Antonio Petino, *Aspetti e momenti di politica granaria a Catania ed in Sicilia nel Quattrocento* (Catania: Università di Catania, 1952).

¹² Richard Unger, 'Feeding Low Countries Towns: The Grain Trade in the Fifteenth Century', *Revue belge de Philologie et d'Histoire*, 77 (1998), 63–92; Gerhard Theuerkauf, 'Brandenburg, Böhmen und die Elberegion. Zur Handelsgeschichte des späten Mittelalters', in Norbert Angermann, ed., *Die Hanse und der deutsche Osten* (Lüneburg: Nordostdeutsches Kulturwerk, 1990), 67–78.

¹³ John D. Fudge, 'The Supply and Distribution of Foodstuffs in Northern Europe, 1450–1500', in Walter Minchinton, ed., *The Northern Seas: Politics, Economics and Culture* (Pontefract, 1989), 29–39.

¹⁴ Stanisław Mielczarski, *Rynek zbożowy na ziemiach polskich w drugiej połowie 16 i pierwszej połowie 17 wieku: próba rejonizacji* (Gdańsk, 1962); Yun, 'Economic Cycles and Structural Changes.'

¹⁵ This is not to deny Fox's recognition that 'heavy transfers [sc. of nutrients] away from the arable fields ... characterize all market-oriented systems of cereal production' (H. S.

A. Fox, 'Some Ecological Dimensions of Medieval Field Systems', in Kathleen Biddick, ed., *Archaeological Approaches to Medieval Europe*, Studies in Medieval Culture, 18. (Kalamazoo: The Medieval Institute, 1984), 144), but would estimate those of cereals less than what occurred in the cattle and fish trades to be discussed below. Most of the grain plant remained in the producing ecosystem and its embodied energy went directly to human use. Compare the analysis of material and energy flows in sedentary preindustrial agricultural enterprise by Simmons, *Changing the Face*, fig. 5.2 and p. 143.

¹⁶ Jones, *European Miracle*, 70–95.

¹⁷ Except as otherwise noted, information on the trade in cattle is from Ian Blanchard, 'The Continental European Cattle Trades, 1400–1600', *Economic History Review*, 2d series 39 (1986), 427–460.

¹⁸ Blanchard, 'Cattle Trades', 446.

¹⁹ Zsigmond Pál Pach, *The Role of East-Central Europe in International Trade, 16th and 17th centuries*, Studia historica Academiae Scientiarum Hungaricae, 70 (Budapest: Akadémiai Kiadó, 1970), 223–246.

²⁰ As quoted from Friedrich Lütge, *Strukturwandlungen in ostdeutschen und osteuropäischen Fernhandel des 14. bis 16. Jahrhunderts* (München: 1964), 6, by Blanchard, 'Cattle Trades', 435 note 37.

²¹ See also István N. Kiss, 'Agricultural and livestock production: wine and oxen. The case of Hungary', and Jerzy Topolski, 'A model of East-Central European continental commerce in the sixteenth and the first half of the seventeenth century', both in Antoni Maćzak, Henryk Samsonowicz, and Peter Burke, eds., *East-Central Europe in Transition from the Fourteenth to the Seventeenth Century* (Cambridge: Cambridge University Press, 1985), 88–91 and 135–136.

²² Eric Fügedi, 'Die Aussenhandel Ungarns', in Ingomar Bog, ed., *Der Aussenhandel Ostmitteleuropas 1450–1650: Die ostmitteleuropäischen Volkswirtschaften in ihren Beziehungen zu Mitteleuropa* (Köln: Bohlau, 1971), 56–86. By 1540 they counted 90% of Hungary's westbound exports exclusive of copper (Pach, *Role*, 220).

²³ Blanchard, 'Cattle Trades', 455–456.

²⁴ Thorkild Kjærgaard, *The Danish Revolution, 1500–1800. An Ecohistorical Interpretation*, tr. David Hohnen (Cambridge: Cambridge University Press, 1994), 18–32.

²⁵ László Bartosiewicz, 'Animal Husbandry and Medieval Settlement in Hungary: A Review', *Beiträge zur Mittelalterarchäologie in Österreich*, 15 (1999), 148, and 'The Hungarian Grey cattle: a traditional European breed', *Animal Genetic Resources Information*, 21 (1997), 49–60. Contrary to long-standing myths of an ancient steppe origin for these animals, recovered horn cores and bone from Hungarian cattle of the tenth-twelfth century 'conquest' period lack the distinctive features which became visible by the sixteenth. Were these visible traits mere byproducts of selection for growth and weight retention or had they value as 'trademarks' on foreign markets?

²⁶ Or was it? Present-day consumers claim to taste differences among wheat-, corn-(maize), and grass-fed beef.

²⁷ This is true even if the eastern animals lived off natural climax vegetation in semi-arid or seasonally-flooded areas unsuited for arable agriculture (Laszlo Mákkai, 'Economic landscapes: historical Hungary from the fourteenth to the seventeenth century', in Maćzak *et al.*, eds., *East-Central Europe*, 24–35). But because large-scale grazing does modify botanical assemblages, more plainly needs to be learned (from written,

archaeobotanical or pedological evidence) about stability or change of vegetation types in the Pannonian plain from Roman times to the Ottoman occupation.

²⁸ Helpful recent surveys of local studies include Jean-Claude Hocquet, 'Les pêcheries médiévales', in Michel Mollat, ed., *Histoire des pêches maritimes en France* (Toulouse: Privat, 1987) and Angelika Lampen, *Fischerei und Fischhandel im Mittelalter: Wirtschafts- und sozialgeschichtliche Untersuchungen nach urkundlichen und archäologischen Quellen des 6. bis 14. Jahrhunderts im Gebiet des Deutschen Reichs*, Historische Studien, Bd. 461 (Husum: Matthiesen Verlag, 2000).

²⁹ For elaborated discussion of medieval demand for fish see Richard C. Hoffmann, 'Medieval Fishing', in Paolo Squatriti, ed., *Working with Water in Medieval Europe* (Leiden: Brill, 2000), 336–338 and an entire chapter in my forthcoming book entitled 'The Catch. Medieval European Fisheries and the Antecedents of Today's World Fisheries Crisis: An Essay in Environmental History.'

³⁰ Barbara Harvey, *Living and Dying in England 1100–1540: The Monastic Experience* (Oxford: Clarendon Press, 1993), 38–57.

³¹ Klaus Schreiner, 'Zisterziensisches Mönchtum und soziale Umwelt: Wirtschaftlicher und sozialer Strukturwandel in hoch- und spätmittelalterlichen Zisterzienserkonventen', in K. Elm, ed., *Die Zisterzienser. Ordensleben zwischen Ideal und Wirklichkeit, Ergänzungsband* (Köln: Rheinische Museum, 1982), 106–109. The sentiment is echoed in fifteenth-century poet Heinrich Wittenwiler's comic epic *Ring*: 'Visch ... ist ein Herrenspeis' (lines 2905–6). Edmund Wiessner, *Kommentar zu Heinrich Wittenwilers Ring*, Deutsche Literatur: Reihe IV, Realistik des Spätmittelalters, Ergänzungsband (Leipzig, 1936), 119, lists more literary parallels, and Christopher C. Dyer, 'The Consumption of Fresh-water Fish in Medieval England', in Michael Aston, ed., *Medieval Fish, Fisheries and Fishponds in England* (Oxford: BAR, 1988), 28–31, confirms similar English practice.

³² See the list of fishes in Ulrich of Cluny's customal, lib II: c.4 (Walter Jarecki, ed., *Signa loquendi: Die cluniacensischen Signa-Listen eingeleitet und herausgegeben*, Saecula spiritalia, ed. Dieter Wuttkke, vol. 4 (Baden-Baden, 1981), 122–124, which also includes (preserved) cuttlefish, a mollusc.

³³ *Le Ménagier de Paris*, ed. Georgine E. Brereton and Janet M. Ferrier (Oxford: Clarendon, 1981), 231–243.

³⁴ G. R. Bosscha Erdbrink, ed., *Het 'Keuckenboeck' van de Tollenaar van Lobith 1428/29*, Fontes minores medii aevi uitgegeven vanwege het Instituut voor Geschiedenis, Rijksuniversiteit te Utrecht, vol. 18 (Groningen: Wolters-Noordhoff, 1979) can support a close ichthyological reading of one accounting year which the more general 3-year dietary study of Johanna Maria Van Winter, 'Nahrung auf dem Lobither Zollhaus auf Grund der Zollrechnungen aus den Jahren 1426–27, 1427–28 und 1428–29', in T. J. Hoekstra, H. L. Janssen, and I. W. L. Moerman, eds., *Liber Castellorum. 40 variaties op het thema kasteel* (Zutphen: de Walburg Pers, 1981), 338–348, indicates was in no way abnormal.

³⁵ Archiv Horn-Rosenburg, Hs. Horn 44 (transcription courtesy H. Knittler).

³⁶ Benoît Clavel, 'Étude sur l'alimentation carnée d'après les restes osseux retrouvés dans la fosse dépotoir 3162 du site des Hallettes à Compiègne (Oise)', *Revue archéologique de Picardie*, no. spécial 13 (1997), 271–286, reports many chewed herring vertebrae from a sixteenth-century latrine. Similar are in Andrew K.G. Jones, 'The Survival of Fish Remains at Monastic Sites', in Roberta Gilchrist and Harold Mytum, eds., *The Archae-*

ology of Rural Monasteries (Oxford: BAR, 1989), 178. Like most archaeological finds, fish bone itself bears no dates, but the deposits where it occurs (latrines, kitchens, garbage heaps, etc.) are placed in time through associated and datable items (coins, wood, charcoal, etc.), written records, stratigraphy, and other means common to historical archaeology.

³⁷ Jean Desse and Nathalie Desse-Berset, 'Pêches locales, côtières ou lointaines: Le poisson au menu des parisiens du Grand Louvre, du 14^{ème} au 18^{ème} siècle', *Anthropozoologica*, 16 (1992), 119–126; Johannes Lepiksaar, 'Fischreste der Burggrabung in Nürnberg', *Jahrbuch für fränkische Landesforschung*, 28 (1968), 70–73.

³⁸ Richard C. Hoffmann, 'Economic Development and Aquatic Ecosystems in Medieval Europe', *American Historical Review*, 101 (1996), 631–669.

³⁹ Inge Bødker Enghoff, 'A Medieval Herring Industry in Denmark: The Importance of Herring in Eastern Denmark.' *Archaeofauna*, 5 (1996), 43–47; Inge Bødker Enghoff, 'Fishing in the Baltic Region from the 5th century BC to the 16th century AD: Evidence from Fish Bones', *Archaeofauna*, 8 (1999), 44–55; Marzena Makowiecka, and Daniel Rębkowski, ed., *Archeologia średniowiecznego Kołobrzegu*, Tom I: *Badania przy ul. Ratuszowej 9–13* (Kołobrzeg: Instytut Archeologii et Etnologii PAN, 1996), 417–419; Zbigniew Dąbczewski, 'Szczątki rybie z grodu gdańskiego z XIII w.', *Studia Wczesnośredniowieczne*, 1 (1952), 93–95; Marian Kubasiewicz, *Badania Archeozoologiczne na terenie Gdańska IX–XIV wieku*, Gdańskie Towarzystwo Naukowe wydział i nauk społecznych i humanistycznych, Prace komisji Archeologicznej Nr. 9 (Gdańsk: Gdańskie Towarzystwo Naukowe, 1977), 243; Marian Rulewicz, *Rybołówstwo Gdańska na tle Ośrodków Miejskich Pomorza od IX do XIII Wieku*, Gdańsk Wczesnośredniowieczny, vol. 10, Gdańskie Towarzystwo Naukowe, Wydział i Nauk Społecznych i Humanistycznych: Prace Komisji Archeologicznej, nr. 11 (Wrocław: Ossolineum, 1994), 68–88; Stefan Górzyński, *Zarys historii rybołówstwa w dawnej Polsce* (Warszawa: PWRiL, 1964), 24–26; and see map in Norbert Benecke, 'Zur frühmittelalterlichen Heringsfischerei im südlichen Ostseeraum – ein archäologischer Beitrag', *Zeitschrift für Archäologie*, 16 (1982), 283–290.

⁴⁰ Jarecki, ed., *Signa loquendi*, 252 and 165–168; Heinricus Laureshamensis, *Summarium Heinrici*, ed. Reiner Hildebrandt, 2 vols. (Berlin, 1974–1982), vol. 1, pp. 156–160 [compare Norbert Wagner, 'Zur Datierung des 'Summarium Heinrici'', *Zeitschrift für deutsches Altertum und deutsche Literatur*, 104 (1975), 118–126]; Cosmas of Prague, *Chronica Bohemorum*, lib. 2, c. 42, ed. Berthold Bretholz, MGH Scriptorum rerum Germanicarum, new series, vol. 2 (Berlin: Weidmann, 1923). On the other hand, herring were distinctly not a normal dietary expectation at Cluny in the 1080s (Jarecki, ed. *Signa loquendi*, 122–124) nor familiar to Ekkehard IV (d. 1060) at St. Gallen, see his 'Benedictiones ad mensas' ed. Johannes Egli as *Der Liber Benedictionum Ekkeharts IV. nebst den kleinern Dichtungen aus dem Codex Sangallensis 393*, Mitteilungen zur vaterländischen Geschichte hggb. vom Historischen Verein in St. Gallen, no. 31 (St. Gallen: the Verein, 1909), 285–289. For the many coastal sites with early remains of herring see: Inge Bødker Enghoff, 'Fishing in the Southern North Sea Region from the 1st to the 16th Century AD: Evidence from Fish Bones', *Archaeofauna*, 9 (2000), 59–132.

⁴¹ Georg Wacha, 'Die Tierwelt im mittelalterlichen Österreich in Sage und Legende, Quelle und Bildwerk', in Gerhard Fischer, ed., *Die Stadt und die Wildnes. Wien 1000–1500* (Wien: Daedalus, 1992), 75–76; J. A. Tomaschek, ed., *Die Rechte und Freiheiten*

der Stadt Wien, Geschichtsquellen der Stadt Wien, I. Abt. (Wien, 1877–1879), nrs. 4 and 28–30; Lech Leciejewicz, ‘Z denara otrzymasz wóz świeżych śledzi’, in Stefan K. Kuczyński *et al.*, eds., *Nummus et historia. Pieniądz Europy średniowiecznej* (Warsaw, 1985), 103–109, and ‘Zum frühmittelalterlichen Heringshandel im südlichen Ostseegebiet’, *Zeitschrift für Archäologie*, 25 (1991), 209–214; *Schlesisches Urkundenbuch*, ed. Heinrich Appelt and Winfried Irgang (Wien-Köln-Graz: Bohlau, 1963–1988), nrs. 123 and 140.

⁴² Heidemarie Huster-Plogmann and Andre Rehazek, ‘Historical record versus archaeological data. Fish remains from Roman and medieval sites in Switzerland’, a paper delivered at the 10th meeting of the Fish Remains Working Group, ICAZ, New York, September 24–October 2, 1999.

⁴³ Karl Holubar, ‘Das Spital des Stiftes Klosterneuburg’, *Jahrbuch des Stiftes Klosterneuburg*, 15 (1994), 42–43; *Urkundenbuch des Stiftes Klosterneuburg bis zum Ende des vierzehnten Jahrhunderts*, ed. Hartmann Zeibig, 2 vols. *Fontes rerum Austriacarum*, II: *Diplomataria et Acta*, vols. 27–28 (Wien, 1867–1868), 2:254 and 265–266. Contrast the absence of all northern fishes from purchases for early fourteenth-century princes of Tirol in Otto Stolz, *Der geschichtliche Inhalt der Rechnungsbücher der Tiroler Landesfürsten von 1288–1350*, Schlern-Schriften, vol. 175 (Innsbruck, 1957), 52–53.

⁴⁴ Franciszek Piekosiński, ed., *Rachunki dworu króla Władysława Jagiełły i królowej Jadwigi z lat 1388 do 1420*, Monumenta medii aevi historica res gestas poloniae illustrantia, tom. 15. (Kraków: PAU, 1896), 1–9 *et passim*; Stanisław Krzyżanowski, ed., *Księgi ławnicze Krakowskie 1365–1376 i 1390–1397*. *Acta scabinalia cracoviensia 1365–1376 et 1390–1397*, Wydawnictwa Archiwum Aktów Dawnych Miasta Krakowa, 1 (Kraków, 1904), no. 100; Adam Chmiel, ed., *Księgi radzieckie Kazimierskie 1369–1381 i 1385–1402*. *Acta consularia casimiriensia 1369–1381 et 1385–1402*, Wydawnictwa Archiwum Aktów Dawnych Miasta Krakowa, vol. 2 (Kraków, 1932), 354; Alfred Heidacher, *Die Entstehungs- und Wirtschaftsgeschichte des Klosters Heilsbrunn bis zum Ende des 15. Jahrhunderts: Gründung, Gründer, Wirtschafts- und Verfassungsgeschichte* (Bonn, 1955), 118–119; Hugo Weczerka, ‘Die Südostbeziehungen der Hanse’, in Norbert Angermann, ed., *Die Hanse und der deutschen Osten* (Lüneburg: Norddeutsches Kulturwerk, 1990), 120–124; E. von Ottenthal, ed., ‘Die ältesten Rechnungsbücher der Herren von Schlandersberg’, *Mitteilungen des Instituts für Österreichische Geschichtsforschung*, 2 (1881), 561–573.

⁴⁵ Gerhard Jaritz, ‘Die Reiner Rechnungsbücher (1395–1477) als Quelle zur klösterlichen Sachkultur des Spätmittelalters’, in *Die Funktion der schriftlichen Quelle in der Sachkulturforschung*, Veröffentlichungen des Instituts für mittelalterliche Realienkunde Österreichs, 1 = Sitzungsberichte der Österreichischen akademie der Wissenschaften, phil-hist. Klasse, 304/4 (Wien: Akademie, 1976), 182–187; Fügedi, ‘Aussenhandel.’ Regrettably, the new study of Carsten Jahnke, *Das Silber des Meeres. Fang und Vertrieb von Ostseehering zwischen Norwegen und Italien (12.–16. Jahrhundert)*, Quellen und Darstellungen zur hansische Geschichte, N.F. 49 (Köln: Böhlau, 2000), 227–260, obscures the *process* of herring’s diffusion into inland Europe by synchronic focus on routes and regions and attending less to the evolution of trade and consumption over several centuries of time.

⁴⁶ Louis Stoff, *Ravitaillement et alimentation en Provence aux XIVe et XVe siècles* (Paris: 1970), 231.

⁴⁷ Juan Ruiz, Archpriest of Hita, *Libro de Buen Amor*, ed. Anthony N. Zahareas, tr. Saralyn R. Daly (University Park, PA: Pennsylvania State University Press, 1978), stanzas 1067–1127.

⁴⁸ As reported in Massimo Montanari, *The Culture of Food*, tr. Carl Ipsen (Oxford, 1994), 80.

⁴⁹ Antonia Borlandi, ed., *Il manuale di mercatura di Saminato de' Ricci* (Genova: Di Stefano, 1963), 129.

⁵⁰ The deep antiquity of coastal marine subsistence strategies, cod fishing among them, is a commonplace in the archaeology and prehistory of Norway: for examples with different degrees of generality and analytical sophistication see Patricia Phillips, *The Prehistory of Europe* (Bloomington: Indiana University Press, 1980), 213, or papers in Helge Sørheim, ed., *Arkeologi og kystkultur: foredrag ved seminaret* (Ålesund: Sunnmøre Museum, 1997). Large middens of fishbone, some plainly beginning well before the Viking age, are common in northern coastal Norway. As with other kinds of zooarchaeology, specialists in fish remains use distinctive bone assemblies (statistically significant concentrations of bones from one part of an animal and reciprocal shortages of others) and 'cutmarks' (the traces of certain processing of the animal into meat) to distinguish between places where fish were cut up into edible and discarded pieces and places where food remains were disposed of. In the case of stockfish, removal of heads and most vertebrae before hanging the split fish by the tail to dry makes a distinctive pile of bones where that work was done; a different accumulation of cod bones with few elements from the head and many tail vertebrae marks a place where people ate the prepared carcass. If the remains occur where the animal does not, it probably suggests trade in that food.

⁵¹ Andrew K. G. Jones, 'The Fish Bones', in A. Rogerson, 'Excavations in Thetford', *East Anglian Archaeology Report*, 22 (1984), 192–194; Jennie Coy, 'Medieval records versus excavation results. Examples from Southern England', *Archaeofauna*, 5 (1996), 55–63; Sabine Sten, 'Trading with fish in Medieval Sweden. Some examples from archaeological bone finds', *Archaeofauna*, 4 (1995), 65–69; Alison Locker, 'Animal and Plant Remains', in J. N. Hare et al., *Battle Abbey. The Eastern Range and the Excavations of 1978–80*, Historical Buildings and Monuments Commission for England, Archaeological Report no. 2 (London: the Commission, 1985), 183–188.

⁵² Dirk Heinrich, 'Fish remains from Göttingen/Niedersachsen, excavation Johannesstrasse 21–25, 1270–1345 A.D.', *Ichthyo-osteo-archaeology News*, 4 (1987), 10–12; Dirk Heinrich, 'Fischknochen aus mittelalterlichen Siedlungsabfällen in Duisburg', in Günter Krause, ed., *Stadtarchäologie in Duisburg, 1980–1990*, Duisburger Forschungen, 38 (Duisburg: 1992), 292–305. Albertus Magnus, *De animalibus*, lib. 26, art. 102, ed. Hermann Stadler as *De Animalibus libri XXVI nach der Cölnher Handschrift*, Beiträge zur Geschichte der Philosophie des Mittelalters, vols 15–16 (Münster, 1916 and 1920), knew of dried fish (*salpa*) only in a citation from Pliny. Compare James J. Scanlan, tr., *Man and the Beasts. De animalibus (Books 22–26)*, Medieval and Renaissance Texts and Studies (Binghamton, NY, 1987), and Kenneth F. Kitchell, Jr., and Irven M. Resnick, trs., *Albertus Magnus 'On Animals': A Medieval 'Summa Zoologica'* (Baltimore: Johns Hopkins University Press, 1999).

⁵³ Anton Ervynck and Wim Van Neer, 'A preliminary survey of fish remains in medieval castles, abbeys and towns of Flanders (Belgium)', in Dirk Heinrich, ed., *Archaeo-Ichthyological Studies. Papers presented at the 6th Meeting of the I.C.A.Z. Fish Remains Working Group, Schleswig. Beiheft zur Offa*, 51 (Neumünster, 1994), 303–308. Maritime

North German sites (e.g. Schleswig) also have small local cods: Dirk Heinrich, 'Untersuchungen an mittelalterlichen Fischresten aus Schleswig: Ausgrabung Schild 1971–1975', *Ausgrabungen in Schleswig. Berichte und Studien*, vol. 6 (Neumünster: Karl Wachholtz Verlag, 1987), 186–189.

⁵⁴ Piekosiński ed., *Rachunki dworu*, 310; Jürgen Sarnowsky, *Die Wirtschaftsführung des Deutschen Ordens in Preußen (1382–1454)*, Veröffentlichungen aus den Archiven Preussischer Kulturbesitz, Bd. 34 (Köln: Böhlau, 1993), 143–153 and 283–284; Josef Hemmerle, ed., *Die Deutschordens-Ballei Böhmen in ihren Rechnungsbüchern 1382–1411*. Quellen und Studien zur Geschichte des Deutschen Ordens, Bd. 22 (Bonn, 1967), 63 and 128. This specific form of 'dried fish' is named in Viennese tax regulations and in poetic praise of Nürnberg's abundant food market: Anton Mayer, et al., eds., *Quellen zur Geschichte der Stadt Wien*, II. Abteilung: *Regesten aus dem Archive der Stadt Wien*, 5 vols. (Wien, 1898–1921), vol. 2, nr. 4040ter; Eberhard Schmauderer, *Studien zur Geschichte der Lebensmittelwissenschaft*, 2 vols., Vierteljahrsschrift für Sozial- und Wirtschaftsgeschichte, Beiheft 62 (Wiesbaden, 1975), 260–261.

⁵⁵ Alfred Galik, 'Historical and Ichthyological Evidence of Fish Consumption in Medieval Austria,' an oral paper delivered at the biennial meeting of the Fish Remains Working Group, I.C.A.Z., in New York, September 1999. Galik surveyed fish remains from about twenty medieval Austrian sites, most of which begin in the twelfth and thirteenth centuries. Excavations at Salzburg, where a large clerical population high in the mountains always worried about extracting Lenten fish supplies from ice-bound local waters, also yielded bones of marine flatfishes. Hans Freudlsperger, 'Kurze Fischereigeschichte des Erzstiftes Salzburg', *Mitteilungen der Gesellschaft für Salzburger Landeskunde*, 76 (1936), 81–128 and 77 (1937), 145–175.

⁵⁶ Arturo Morales Muniz, D.C. Morales, and E. Rosello, 'Sobre la presencia del bacalao (*Gadus morhua*) en la Cartuja Sevillana de Santa Maria de las Cuevas (siglos xv–xvi)', *Arquivo Hispalense*, 226 (1991), 17–24; Earl J. Hamilton, *American Treasure and the Price Revolution in Spain 1501–1650* (Cambridge, Mass.: Harvard University Press, 1934), 319. In contrast, careful local studies remark the *absence* of cod on markets served by Breton fishers before 1400 [Henri Touchard, *Le Commerce maritime breton a la fin du moyen age* (Paris, 1967), 58–61], in the coastal Basque province of Guipuzcoa during the fifteenth century [Beatriz Arizaga Bolumburu, 'La alimentacion en el pais vasco en la baja edad media: el caso de Guipuzcoa', in *Manger et boire au Moyen Age*, vol. 2. Colloque de Nice, 1982, Publications de la Faculté des lettres et sciences humaines de Nice, no. 27–28, 1ère serie (Paris, 1984), 202–204], and among Galician exports prior to 1500 [Elisa Ferreira Priegue, *Galicia en el comercio marítimo medieval* (La Coruña: Fundación 'Pedro Barrie de la Maza', 1988), 148]. A. H. Oliveira Marques, *Hansa e Portugal na Idade Média*. 2d ed. rev. (Lisboã, 1993), 64–75, 131, and 148–149, makes much of the exchange of Portuguese salt for Hanseatic herring but offers not one hint that codfishes or Norwegian goods went south to Portugal before the mid-fifteenth century.

⁵⁷ Charles L. Cutting, *Fish Saving: a History of Fish Processing from Ancient to Modern Times* (London: 1955), 53–70; Manfredt Klinkhardt, *Der Hering. Clupea harengus* (Magdeburg: 1996).

⁵⁸ Bede, *Historia ecclesiastica*, lib. 4, c.13; Alison Locker, 'Fish Bones', in Brian S. Ayers, *Excavations at Fishergate, Norwich, 1985*, East Anglian Archaeology Report No. 68 (Norwich, 1994), 42–44; Andrew K.G. Jones, 'Fish remains', in B. Ayers and P. Murphy, 'A waterfront excavation at Whitefriars Street car park, Norwich, 1979', *East*

Anglian Archaeology Report, 17 (1983), 32–34 and appendix, microfiche B5, reports a similar deposit.

⁵⁹ E. van Drival, ed., *Cartulaire de l'abbaye de Saint-Vaast d'Arras rédigé au XIIe siècle par Guimann* (Arras, 1875), 166; Hocquet, 'pêcheries médiévales', 48–49 and 79–86.

⁶⁰ Johannes Lepiksaar and Dirk Heinrich, *Untersuchungen an Fischresten aus der frühmittelalterlichen Siedlung Haithabu*, Berichte über die Ausgrabungen in Haithabu, vol. 10 (Neumunster, 1977), 119; Dirk Heinrich, 'Temporal Changes in Fishery and Fish Consumption between Early Medieval Haithabu and its Successor, Schleswig', in C. Grigson and J. Clutton-Brock, eds., *Animals and Archaeology: 2. Shell Middens, Fishes and Birds* (Oxford: BAR, 1983), 151–156. An introduction to this important site is Michael Müller-Wille, 'Hedeby', in Phillip Pulsiano *et al.*, eds., *Medieval Scandinavia. An Encyclopedia* (New York: Garland, 1993), 273–275.

⁶¹ Gallus Anonymous, 'Chronicon Poloniae', ed. Karol Maleczyński in *Monumenta Poloniae Historica*, series nova, 2 (Kraków: PAN, 1952); Leciejewicz, 'Z denara'; Leciejewicz 'Heringshandel.'

⁶² Hocquet, 'pêcheries médiévales', 39–42; Auguste Bernard and Alexandre Bruel, eds., *Recueil des chartes de l'abbaye de Cluny*, (Paris: 1876–1903), no. 4132.

⁶³ Raymond Delatouche, 'Importance relative des divers produits agricoles dans le "Gros Brief" de Flandre pour 1187', in *Bulletin Philologique et Historique (jusqu'à 1610) du Comité des Travaux Historiques et Scientifiques*, 99eme Congrès des Sociétés savantes, Tours, 1968, vol. 1: *Les Problèmes de l'alimentation* (Paris: Bibliothèque National, 1971), 30; Anne-Dominique Kapferer, *Fracas et murmures. Le bruit de l'eau dans un Moyen-Age picard et boulonnais* (Amiens: Trois Cailloux, Maison de la Culture d'Amiens, 1991), 93–96. See also: G. W. Coopland, *The Abbey of St. Bertin and its Neighbourhood, 900–1350* (Oxford: 1914), 47–48.

⁶⁴ Herbord of Michaelsberg, *Herbordi Dialogus de vita S. Ottonis episcopi Babenbergensis*, lib.2, c. 41, ed. Kazimierz Liman and Jan Wikarjak, *Monumenta Poloniae Historica*, series nova, VII: 3. (Warszawa, 1974), p. 141; Helmold of Bosau, *Helmoldi presbyteri Bozoviensis cronica Slavorum*, lib. 2, c. 108, ed. Bernhard Schmeidler, MGH SS i.u.s., 32. 3d ed. (Hannover: Hahnsche Buchhandlung, 1937). See also Leciejewicz, 'Z denara' and 'Heringshandel.'

⁶⁵ Alanus ab Insulis, *De planctu Naturae*, Prose 1; tr. James J. Sheridan as *The Plaint of Nature* (Toronto: PIMS, 1980), 94–98; Philippe de Mézières, *Le Songe d'un vieil pèlerin*, ed. G. W. Coopland (Cambridge: Cambridge University Press, 1969), 129–130 and 249–250.

⁶⁶ A. Saul, 'The Herring Industry at Great Yarmouth c. 1280–1400', *Norfolk Archaeology*, 38 (1981), 33–43; Caroline Bourlet, 'L'Approvisionnement de Paris en poisson de mer aux XIV^e et XV^e siècles, d'après les sources normatives', *Franco-British Studies*, 20 (1995), 5–22; François Maillard, 'Tarifs des 'coutumes' pour la vente du poisson du mer à Paris au début du XIVe siècle', *Bulletin philologique et historique*, 97 (1966), 247–258.

⁶⁷ Jahnke, *Silber des Meeres*, notably 39–119. This important new legal and economic study so concentrates on the west Baltic fishery after the mid-twelfth century that it misses the ecological and competitive context of earlier and contemporary producers in other waters.

⁶⁸ Richard W. Unger, 'The Netherlands Herring Fishery in the Late Middle Ages: the False Legend of William Beukels of Biervliet', *Viator*, 9 (1978), 335–356.

⁶⁹ Richard W. Unger, 'Dutch Herring, Technology, and International Trade in the Seventeenth Century', *Journal of Economic History*, 40 (1980), 256.

⁷⁰ Jan de Vries and Ad van der Woude, *The First Modern Economy: Success, Failure, and Perseverance of the Dutch Economy, 1500–1815* (Cambridge: Cambridge University Press, 1997), 235–237, continue to stress urban demand as the engine driving development of the Dutch fishery. See also Fudge, 'Supply', 29–39.

⁷¹ Ferreira Priegue, *Galicia*, 145–147, 152–156, 667–672 and 728–739; Henri Besc, 'La pêche et les madragues dans la Sicile médiévale' in Micheline Galley and L.L. Sebai, eds., *L'Homme Méditerranéen et la mer* (Tunis: Salammbô, 1985), 167–169.

⁷² Cold, dry subarctic conditions make this possible and so, too, the cod's storage of oil in the liver, not muscle tissue. On methods in ichthyoarchaeology review page 343 and note 50 above.

⁷³ Przemysław Urbańczyk, *Medieval Arctic Norway* (Warsaw: Institute of Archaeology and Ethnology, 1992); Arved Nedkvitne, 'Fishing, Whaling, and Seal Hunting' and 'Trade', in Pulsiano *et al.*, eds., *Medieval Scandinavia*, 194–196 and 649–653.

⁷⁴ Bruce S. Gelsinger, *Icelandic Enterprise: Commerce and Economy in the Middle Ages* (Columbia, S.C., 1981), 181–194; Kirsten Hastrup, *Nature and Policy in Iceland 1400–1800. An Anthropological Analysis of History and Mentality* (Oxford: Clarendon, 1990), 66–75; Terrence H. Lloyd, *England and the German Hanse, 1157–1611: a study of their trade and commercial diplomacy* (Cambridge and New York: Cambridge University Press, 1991), 137–140 and 173–204.

⁷⁵ Ferreira Priegue, *Galicia*.

⁷⁶ Coy, 'Medieval Records,' Maryanne Kowaleski, *Local Markets and Regional Trade in Medieval Exeter* (Cambridge: Cambridge University Press, 1995), 307–312; Hocquet, 'pêcheries médiévales', 111–112; Touchard, *Commerce maritime breton*, 58–61.

⁷⁷ Or, if the *docena* 'dozen' was not 12 but 20 or 36, up to 3 times as many more (Ferreira Priegue, *Galicia*, 728–739).

⁷⁸ Sten, 'Trading with Fish'.

⁷⁹ Berthold Benecke, 'Beiträge zur Geschichte der Fischerei in Ost- und Westpreussen', *Altpreussisch Monatsschrift*, 17 (1880), 314–315; Arthur Seligo, 'Zur Geschichte der Fischerei in Westpreussen', *Mitteilungen des westpreussischen Fischereivereins*, 14 (1902), 27; Horst A. Willam, 'Die Fischerei des Deutschen Ordens in Preussen bis zu Dietrich von Altenburg', *Jahrbuch der Albertus-Universität zu Königsberg/Pr.*, 11 (1961), 147–149; Sarnowsky, *Wirtschaftsführung*, 625–626 and 814–825; Franciszek Piekosiński and Józef Szujski, eds., *Najstarsze księgi i rachunki miasta Krakowa od r. 1300 do 1400*, Monumenta medii aevi historica res gestas Poloniae illustrantia, vol. 4. (Kraków: Polska Akademia Umiejętności. Komisja Historyczna, 1877–78), 235–241; Piekosiński, *Rachunki dworu*, 22, 246, and 294–312.

⁸⁰ Olaus Magnus, *Historia de Gentibus Septentrionalibus. Romae 1555. Description of the Northern Peoples. Rome 1555*, trans. Peter Fisher and Humphrey Higgens, ed. Peter Foote, The Hakluyt Society, 2d series, no. 182 (London: Hakluyt Society, 1996), lib. 2: c. 6 (p. 66). Czech visitors had gained the same strong impression of herring production at Dieppe in 1464, see: Jaroslav [the secretary], *Diary of an Embassy from King George of Bohemia to King Louis XI of France in the year of grace 1464*, tr. A. H. Wratislaw (London: 1871), 45.

⁸¹ Nils Friberg, *Stockholm i bottniska farvatten: Stockholms Bottniska Handelsfält under Senmedeltiden och Gustav Vasa* (Stockholm: Kommittén för Stockholmsforskning, 1983), 196–199 and 327–346.

⁸² A return migration along Provence was fished with these ‘factory’ methods only from the mid–late fifteenth century. Humans systematically exploited other tuna populations in the Bosphorus close to Constantinople since the tenth century [Gilbert Dagron, ‘Poissons, pêcheurs et poissonniers de Constantinople’, in Cyril Mango and Gilbert Dagron, eds., *Constantinople and its Hinterland* (Aldershot, Hants.: Variorum, 1995), 60–67], and since the fourteenth along the Dalmatian coast of the Adriatic for consumers in Venice and inland Croatia [Ivan Pederin, ‘Commercio, economia, pesca, arti e mestieri in Arbe nel Quattrocento’, *Archivio Storico Italiano*, 147:2 (1989), 237–239; Nataša Stefaneč personal communication].

⁸³ See several important treatments by Henri Bresc: ‘La pêche dans la Sicilie’, 168–180; ‘Pêche et coraillage aux derniers siècles du moyen âge: Sicile et Provence orientale’, in *L’Exploitation de la mer de l’Antiquité à nos jours*, Vèmes Recontres internationales d’archéologie et d’histoire d’Antibes, (Valbonne, 1985), 110–114; and *Un monde méditerranéen*, 261–274 and 561–565. But compare also Epstein, *Island for Itself*, 226, 284, 294–295, 303, 306, and 346. Francesco Balducci Pegolotti, *La Pratica della Mercatura*, ed. Allan Evans (Cambridge, Mass.: Medieval Academy of America, 1936), 181 and 205.

⁸⁴ James T. Carlton, ‘Apostrophe to the Ocean’, *Conservation Biology*, 12:6 (December 1998), 1165.

⁸⁵ Cosmas, *Chronica*, lib. 1, c. 2 (Bretholz ed., 6–7).

⁸⁶ Herbord, *Dialogus*, lib. 2, c. 41 (Liman and Wikarjak, eds., 141); Saxo Grammaticus, *Saxonis Gesta danorum*, preface 2,4, ed. J. Olrik and H. Ræder, 2 vols. (Copenhagen: 1931), I: 6; Mézières, *Songe*, I: 249–250.

⁸⁷ James A. Williamson, *The Cabot Voyages and Bristol Discovery under Henry VII*, Hakluyt Society, 2d series, vol. 120 (Cambridge: the Society, 1962), 208–211 and 266–268.

⁸⁸ Magnus, *Historia*, 66 (lib. 2, c.6).

⁸⁹ Even licences for bases on shore (not required in the open sea) set no limits on the marine catch.

⁹⁰ All exhibit schooling behaviour, whether continuous (herring, sardine, tuna) or just at spawning (codfishes, hake). Note that I have so far learned little about seasons and techniques for catching what became *strekfuss*.

⁹¹ In contrast, since at latest the mid-thirteenth century, the inshore Norman fishery each day loaded fast horse relays, the *chassée-mare*, with a great variety of fresh fishes for the many rich consumers of Paris. See Bernadette Auzary-Schmaltz, ‘Les Contentieux en matière d’approvisionnement, d’après les registres du parlement de Paris (XIV^e–XV^e siècles)’, *Franco-British Studies*, 20 (1995), 59–67, and Caroline Bourlet, ‘L’Approvisionnement de Paris en poisson de mer aux XIV^e et XV^e siècles, d’après les sources normatives’, *Ibid.*, 5–22.

⁹² This differs from, for instance, a summer fishery for lake trout feeding in open water or one taking young eel in spring as they leave the sea for the rivers where they will spend some years eating and growing. Such a feeding or other grouping may not be a breeding group, in which case capture would not be genetically selective. On the other hand, if one

targets organisms engaged in breeding one directly affects the gene pool of that population.

⁹³ Teresa Dunin-Wąsowicz, 'Natural Environment and Human Settlement over the Central European Lowland in the 13th Century', in Peter Brimblecombe and Christian Pfister, eds., *The Silent Countdown. Essays in European Environmental History* (Berlin, Heidelberg, New York, 1990), 95–95; findings of H. R. Bork, *Bodenerosion und Umwelt. Verlauf, Ursachen und Folgen der mittelalterlichen und neuzeitlichen Bodenerosion, Bodenerosionprozesse, Modelle und Simulationen* (Braunschweig: Technische Universität, 1988) are summarised in Rudolf Brazdil and Oldrich Kotyza, *History of Weather and Climate in the Czech Lands*, vol. 1: *Period 1000–1500*, Zürcher Geographische Schriften, Bd. 62, (Zürich: Geographisches Institut, Eidgenössische Technische Hochschule Zürich, 1995), 60 and 166.

⁹⁴ J. Filuk, 'Biologiczno-rybacka charakterystyka ichtiofauny zalewu wiślanego na tle badań paleoichtiologicznych, historycznych i współczesnych', *Pomorania antiqua*, 2 (1968), 146–147.

⁹⁵ Unger, 'Netherlands Herring Fishery', 345–353; John H. Munro, 'Patterns of Trade, Money, and Credit' in Brady, Oberman, and Tracy, eds., *Handbook*, 159–163. Soon herring prices in Kraków were the highest known (Juljan Pelc, *Ceny w Krakowie w latach 1369–1600*, *Badania z dziejów społecznych i gospodarczych*, no. 14 (Lwów: 1935), 38–39 and 152.

⁹⁶ Jean Grove, 'The Century Time-Scale' in T. S. Driver and G. P. Chapman, eds. *Time-Scales and Environmental Change* (New York: Routledge, 1996), 39–87; Mark Bailey, 'Per impetum maris, natural disaster and economic decline in eastern England, 1275–1350' in B. M. S. Campbell, ed., *Before the Black Death: Studies in the 'Crisis' of the Early Fourteenth Century* (Manchester: The University Press, 1991), 184–208. Specific and localised seasonal data is summarised in Christian Pfister, G. Schwarz-Zanetti, and M. Wegmann, 'Winter Severity in Europe: The Fourteenth Century', *Climatic Change*, 34 (1996), 91–108. Sadly, Jahnke, *Silber des Meeres*, e.g. 11–13 and 90–103, remains oblivious to change in non-human components of the herring fishery, not noticing his own report that the mean size of adult Baltic herring in the twentieth century is 20% smaller than that of those consumed at Haithabu a millennium before.

⁹⁷ *Rotuli Parliamentorum* (Westminster, n.d.), vol. 4, pp. 79–80: Parl. II Hen. V, at Westminster 1415 March 16, Commons petitions 4:79–80; Geoffrey J. Marcus, *The Conquest of the North Atlantic* (New York: Oxford University Press, 1980), 131.

⁹⁸ Ferreira Priegue, *Galicia*, 148; Michel Mollat, *La pêche a Dieppe au XV^e siècle* (Rouen: 1939), 12–13.

⁹⁹ Frédérique Audoin, 'Les ossements animaux dans les fouilles médiévales de La Charité-sur-Loire: Conclusions relatives à l'alimentation du XI^e au XVI^e siècle', *Académie des inscriptions de belles-lettres. Comptes rendus des séances* (Jan–March, 1984), 1984, 215–217, or Frédérique Audoin-Rouzeau, *Ossements animaux du Moyen-Age au monastère de La Charité-sur-Loire* (Paris: Publications de la Sorbonne, 1986), 146–147; Lepiksaar, 'Fischreste in Nürnberg.' See also Figure 6 above.

¹⁰⁰ Stockfish were served to noble guests at the 1404 funeral for the Duchess of Bar in Lorraine [Hubert Collin, 'Les ressources alimentaires en Lorraine pendant la première partie du XIV^eme siècle', *Bulletin Philologique et Historique (jusqu'à 1610) du Comité des Travaux Historiques et Scientifiques*, 99^{eme} Congrès des Sociétés savantes, Tours, 1968, vol. 1: *Les Problèmes de l'alimentation* (Paris: Bibliothèque National, 1971, 74]

and featured together with salmon and carp in festive meals endowed for a monastery near Köln in 1439 [Hans Mosler, ed., *Urkundenbuch der Abtei Altenberg*, vol. 2: 1400–1893 (Düsseldorf, 1955), nr.126].

¹⁰¹ *Bacalao* and similar words appear in southern records only at the end of the Middle Ages, while its Flemish (Dutch) model, *bakkeljaw*, is attested in medieval sources as a metathesis from middle Flemish *kabeljaw* (*cabbelau*), already occurring together with other identifiable names of fishes in a charter by Count Philip of Flanders in 1163. French *cabillaud* is documented since 1278. Consult, among others, Charles Du Cange et al., *Glossarium mediae et infimae latinitatis conditum a Carolo DuFresne, domino Du Cange* (Paris: Fermin Didot, 1840–1850); Walther von Wartburg, *Französisches Etymologisches Wörterbuch* (Basel, 1971); Real Academia Española, *Diccionario de Autoridades* (Madrid: the Academia, 1962 facsimile of the 1726 first edition).

¹⁰² *Menagier*, lib. 2, V, §194 (Brereton and Ferrier eds., 237).