7 Going beyond Natural Local Ecosystems, I
Carp Aquaculture As Ecological Revolution[1]

7.1 Eating from outside Natural Local Ecosystems

On rare occasions fortuitous conjunction of a detailed written record with well-preserved and assiduously excavated archaeology can personalize a far-reaching general trend or historic transition. Such is the case of Christoffels Jans, a crossbow maker in the modest Flemish town of Aalst, midway between Ghent and Brussels and some fifty kilometers from the Scheldt estuary.[2] The Jans family diet in the 1490s highlights the material transformation of European relations with aquatic life. Late medieval consumers of all social ranks increasingly ate fish taken from other than the natural local ecosystems on which their forebears had long relied.

Jans was a skilled artisan retained on salary by his city and its shooting guild. From 1489 to 1498 he and his household lived and worked in a house with a thatched roof, brick floor, and small basement opposite the cattle market at the edge of town, close to the guild's armory. In 1497 the local Carmelite friars acquired the armory and then the house, so Christoffels moved elsewhere, though remaining until 1526 with the guild. To construct a new abbey the convent razed buildings around the market, so sealing three cesspits where the bowyer's household had discarded waste from both their craft and daily lives. Artifacts from the site plus modest written records indicate a fairly well-off urban craft establishment, described by the archaeologists as belonging to the town's 'upper middle class' meaning a settled household economy but well below the status of wealthy merchants, much less regional lower nobility. Think of this domestic group as middling urban consumers.

Meticulous recovery of remains revealed the Jans family enjoying a diverse fish diet, consuming at least twenty-five taxa, dominated by

[1] Seen in retrospect, earlier and provisional versions of this chapter and the next appeared as Hoffmann, "Carp, cods, connections" in Henninger-Voss, ed., *Animals in Human Histories*.

[2] Lentacker et al., "Dierlijke resten," 304–322, with context from De Groote and Moens, eds., *Archeologie en geschiedenis*, 45–80 and 373–430.

herring, several species of flatfishes, eel, haddock, cod, and various cyprinids, most notably common carp. In nearly every feature remains of marine fish outnumbered freshwater varieties by two to one. Other than eel, which were taken in fresh water, diadromous species were vanishingly rare. Costly fishes such as sturgeon, salmon, or large freshwater pike or catfish, left barely a trace. Little changed over time except in one pit where earliest deposits likely predate the Jans household: older cod there ran around 65 cm in length but the newer ones (?late? 1490s) around one meter. In the mix of species and in the fishes' origins, Christoffel's family shopper was finding on the local market a quite different menu than had been the case in the Low Countries two or three centuries before. The household ate an exotic species bred and reared in artificial ponds and several others brought in from the economy's distant marine frontiers. Were the Jans somehow eccentric? Not at all. This new relation to aquatic ecosystems they shared with contemporaries across western Christendom.

From North Sea shores to the Danube and south beyond the Tiber, by the close of the Middle Ages many Europeans were eating different fishes from different waters than had their high medieval forebears (compare Table 5.1). Specific novelties varied from place to place but the most noteworthy originated in local fish farms or distant marine waters, sometimes both.

Despite different socio-economic standings Flemish neighbours to the Jans household shared a quite similar fish diet. Monks at late fifteenth-century Ename priory consumed mostly herrings which had been gutted before delivery, various codfishes, and carp.[3] Not far away, the household of Countess van Buren at Eindhoven castle ate 60 percent marine species, half of them cods, and one-third fishes from fresh water, of which one in ten were carp.[4] At contemporary Flemish urban sites (review Figure 2.2) flatfishes and gadids dominated the fish waste, although cod trailed whiting and/or haddock. Herring frequencies varied, while freshwater and diadromous taxa together ran below 20 percent.[5]

[3] Van Neer and Ervynck, "Food rules and status," 155–164.

[4] Jong, "Huisdieren, jachtwild, vissen en weekdieren," 214–231, and "Fish consumption at Eindhoven," 129–138. Comparable dietary habits are visible in remains of the fifteenth–sixteenth centuries from castles at Bodenteich and Plesse in inland lower Saxony, where no consumption of marine fishes had been evident before the 1200s (Heinrich, "Fish remains of two medieval castles," 211–216, and Heinrich, "Fischreste von Bodenteich," 187).

[5] Van Neer and Ervynck, "Rise of sea fish consumption," 164–167. At Mechelen, where eel had long ruled, herring, whiting, plaice, and carp gained significance in the thirteenth century but cod only after 1450, when 80% of remains were of marine origin (Wouters, "1,000 years of fishing").

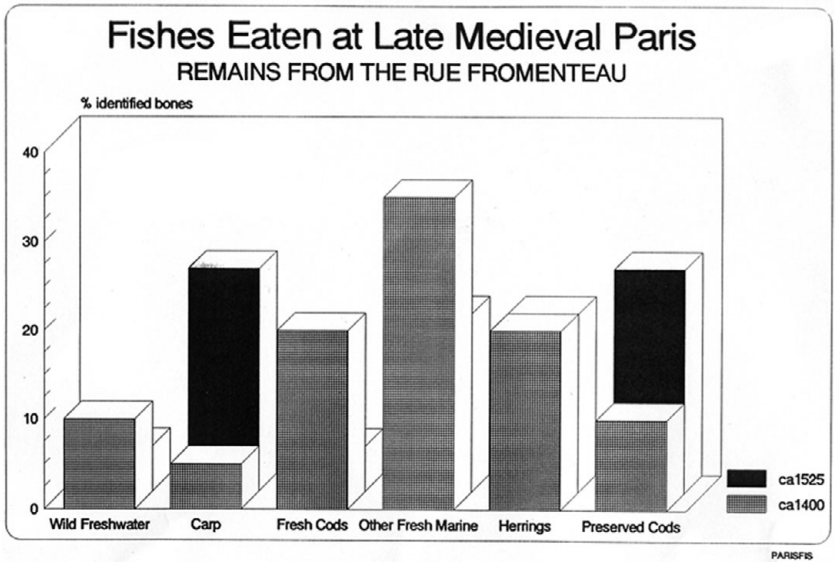

Figure 7.1 Fishes consumed at Rue Fromenteau, Paris, *c.*1400 and *c.* 1525. Data from Desse and Desse-Berset. "Pêches locales, côtières ou lointaines," graphed by R. Hoffmann. © R. Hoffmann.

In an Amiens neighbourhood of shopkeepers and cloth workers, where eel had ruled twelfth-century tables, from the late fourteenth century through the sixteenth the most common fish had become herring.[6] Reasonably well-off late medieval Parisians who lived on Rue Fromenteau near the king's Louvre palace brushed into their garbage heaps and cesspits (Figure 7.1) 62 percent remains from fishes from the sea – after about 1450 often headless cod – and 30 percent from fresh water – after 1450 nearly all carp of uniform size.[7] Further south at Orleans, 15,004 fish bones from a latrine dated 1490–1568 at a collegiate church came from thirty species, but 52 percent were carp and 23 percent cod.[8] Up the Loire, monks at contemporary La Charité also ate more carp than all other fishes combined, but no marine organisms.[9]

[6] Cloquier and Clavel, "Consommation d'animaux," fig. 2 and pp. 93–94.
[7] Desse and Desse-Berset, "Pêches locales, côtières ou lointaines," 119–126. Preliminary counts from another Parisian site of the early sixteenth century show comparably numerous herrings, headless cods, carp, and pike (Sternberg, "L'approvisionnement de Paris," 127–130). Clavel, *L'animal*, 143, has the overall picture.
[8] Marinval-Vigne, "Consommation d'animaux sauvages," 474–483.
[9] Audoin-Rouzeau, *Ossements*, 146–147. As at Ename, these monks were Benedictines.

English experience provided a precocious precedent. In the massive assemblage of fish remains from York, freshwater and diadromous varieties, even eel, are by the fourteenth and fifteenth centuries vanishingly rare; locals threw out more herring bones than any others and many from gadids of North Sea and more distant origin. Yet unlike the continental sites just described, this fish menu differed only subtly from that in the thirteenth-century city.[10] Stable isotope studies of human remains (see Chapter 2) at York confirm one in three in the eleventh–twelfth centuries had consumed significant marine protein and by 1300 that pattern looks fairly general across northern England. At London composite analysis of carefully chosen samples from 7,270 contexts on 142 sites with 35,187 fish bones dating to medieval times identifies a dramatic eleventh–twelfth-century increase in herring remains which changed little thereafter. Cod, however, though present from the tenth century, surged in the thirteenth and, after an early fifteenth-century lull, rose again from the mid-1400s and still higher after 1500, when their remains finally surpassed those of herring in the leavings from Londoners' tables. Use of freshwater fishes had by then dwindled to quantitative insignificance.[11] England's insular situation allowed provision of marine fishes by intensified exploitation of surrounding local aquatic systems or from distant waters. What share of England's increased consumption of marine fishes, the so-called Fish Event Horizon, ought then to be traced to that distinctive ecological and economic context?

No such massive fishbone assemblages of late medieval or early modern date are available from interior continental Europe, but there are regionally interesting cases. Some 600 kilometers east from the Jens family in Aalst, young Martin Luther was then growing up in Mansfeld, a mining town on the eastern edge of the Harz. Later celebrity justified thorough local study of his roots, including meticulous excavation of waste pits at the Luther family home and at an inn just across what is now Lutherstrasse. Among both the 1304 identified fish bones from the house and the 744 from the inn, herring were most numerous, comprising a third to a quarter of remains. The moderately well-off Luther household ate 57 percent fish from the 300-kilometer distant sea, notably also flatfishes but also almost 3 percent cod, all received in preserved state. Their 40 percent from freshwater fish, plainly fresh specimens,

[10] Harland et al., "Fishing and fish trade," 178–198. Compare Table 5.1 above.

[11] Orton et al., "Catch per unit research effort," 8–15, use sophisticated sampling techniques to control for varying intensity of archaeozoological research across London's 2,000-year history. This confirmed and refined conclusions presented in Orton et al., "Fish for the city," 516–530, and "Fish for London," 207–213.

were almost equal parts pike and various cyprinids, including a few carp. Across the way the herring had less company, with few additional marine fishes and only a token trace of cod beside 53 percent freshwater varieties. Among the latter, cyprinids made up a third of the total, with one bone in five from carp, and then again a strong representation of pike but also more perch than the carp.[12]

Further southeast still, only a composite study of a few thousand remains from more than a dozen religious and secular sites in the Vienna basin and along nearby Danube tributaries hints at general developments. Carp and other cyprinids there comprise the most common single taxon, about one in every four identified remains. In diminishing order follow those of perch, sculpin, trout, and pike. Of marine species only herring approach the top five from fresh water and none but flatfishes accompany them. No bones of gadids or any Mediterranean fishes have been found in the Austrian or Hungarian sites.[13]

Across the mountains a bare whisper of archaeological record leaves mainly written sources to document arrival of Atlantic fishes on inland and Mediterranean tables. Among the more robust evidence are accounts of toll collectors at Sevilla – where the annual value of hake, conger, and sardines arriving from Galicia doubled after 1450 to reach more than nine million maravedis in the 1490s – and at Valencia – where clerks noted the actual volume of goods. Each year during the 1490s the latter port landed between seven and eleven million Galician sardines and some 200,000 dried hake (a cod relative ten times the size of a sardine), twice the number of a half-century before; conger deliveries stabilized at about twenty-two metric tonnes.[14] Pack trains conveyed these sturdy goods to fishmongers and consumers across inland Spain.[15]

[12] Heinrich, "Fischknochen aus des Gasthof" and "Fischkonsum in Luthers Eldernhaus." Martin came to Mansfeld as a one-year old in 1484 and left for school in 1497, then university in 1501.

[13] Galik et al., "Fish remains," 342–345. Oh for a large and sieved assemblage from Nürnberg, Prague, Zürich, or Lyon! Apart from Danubian Pannonia, the closest to such from late medieval interior Europe are finds from Poznań dated thirteenth-fifteenth century but excavated before 1960 (so not sieved) in one instance and published without quantitative record in the other. Neither mentions any but freshwater and diadromous varieties familiar to the central Warta drainage (summary data in Makowiecki, *Historia ryb*, Aneks items 207–208, p. 188).

[14] Ferreira Priegue, *Galicia*, 667–672 and 728–739. A team led by Arturo Morales has presented the first long-term overview of hake consumption in Spain. This includes several medieval and sixteenth-century sites, primarily along the Galician coast but some in the deep interior of the peninsula. (Morales et al., "Looking for needles in haystacks" and "Hindcasting to forecast.")

[15] Martínez García, "La asistencia material en los hospitales," 352–355; Menjot, "Marché de l'alimentation," 202–203; Rucquoi, "Alimentation des riches," 302; Vincent, "Consommation alimentaire," 449–453.

Published studies of fish remains from late medieval Italian sites present a consistent pattern of consuming local, commonly freshwater or estuarine fishes. In Rome and its environs people at distinctly littoral sites ate a lot of nearshore Mediterranean marine taxa such as mullet, sea bass, and sea breams, while only a score of kilometers inland freshwater pike and tench provided the most bones. Especially in the south, however, the share of sites with some marine fishes doubled from two in ten to four in ten by the end of the Middle Ages.[16]

Written records do indicate some changes, including the first known shipment of dried hake and brined sardines from the Atlantic to feed an Aragonese garrison at Naples in 1426.[17] A century later when papal courtier Paolo Giovio inventoried the diverse taxa on offer in Rome, he highlighted the Mediterranean marine and indigenous Italian freshwater fishes, but also marked the salted and smoked *aringhae* which he traced to Danish coasts and from Sweden and Norway the *merlucciae* (literally hake but here likely cod), dried hard and favoured by German visitors. Yet Roman households especially enjoyed salted sardines from Liguria, and the city's taverns and food stalls were replete with brined tuna from Sicily and Provence.[18] Already in the 1380s–1390s wealthy Francesco Datini, merchant of Prato and Florence, though preferring tench, pike, and eel from Tuscan waters, was also eating barreled tuna as well as dry-salted herrings. He did good Lenten business with the latter, too, importing from Southampton and especially Bruges hundreds of bundles (*balle*) each of 1,010 herrings.[19] A generation or two before Datini, however,

[16] Salvadori, "La pesca nel Medioevo," 302 and table 2; De Grossi Mazzarin, "I resti archeozoologici." De Nicolò, "Production et consommation du poisson de mer," 54–55, finds even fourteenth–early sixteenth-century Adriatic coastal towns importing freshwater fish from the interior and themselves exploiting only lagoons and other inshore waters.

[17] Henri Bresc, "La pêche et les madragues," 168–169.

[18] Giovio, "*De romanis piscibus*," cap. xlii (p. 60). As observed in Chapter 2 (p. 67 and note 39) only seven of thirty-six human skeletons from a Roman neighbourhood cemetery about 1480 show the high $\partial^{15}N$ indicative of extensive fish consumption, but accompanying $\partial^{13}C$ values leave dubious the origin of those fish in Atlantic rather than Italian fresh or Mediterranean waters.

[19] On fish consumption in the Datini household see Origo, *Merchant of Prato*, 285–286, and Margherita Datini, *Letters to Francesco*, notably nos. 15, 48, and 49 (pp. 56, 113, and 115). Nigro, "Mangiare," 119–121 and 133–135, details Datini's own large-scale trade in herrings during 1384–1410 and contrasts this with small expectations of the early 1300s. Saminato de' Ricci's 1396 *Il manuale di mercatura* likewise describes a bulk trade in herring from Bruges to Tuscany (Borlandi, ed., 129.) Both brined tuna (*tonnina*) and 'herring' (*aringa*), absent from 1383 market regulations at consumption centre Bologna, are there in similar texts from 1436 and 1482 (Pucci Donati, "Mercato del pesce," 52–55). Caution is required with Italian 'herring', for some sold in Tuscany around 1400 were said to be from Ragusa (Dubrovnik) (Marshall, *Local Merchants*, 34); as no *Clupea harengus* live in the Adriatic, were these brined anchovy or sardines?

merchant venturers like Francesco Pegolotti (active *c.* 1310–1340) had considered *allecis* or *aringhe* entirely a commodity in north European trade, so even northern Italian consumers tasted only occasional small amounts.[20] Indeed Italian cookbooks and recipe collections of the fourteenth and fifteenth centuries mention no Atlantic fishes at all.[21]

Cod, carp, tuna, even hake, sardine, and in many places herring had been absent, rare, or strictly seasonal on twelfth-century western and southern tables.[22] To serve rising demand unmet by failing favourites, high and late medieval provisioners began to substitute the flesh of creatures foreign to the consumers' homelands. This they supplied from two fundamental medieval innovations in the European fishing sector, namely the invention and inland spread of aquaculture and the large-scale commercial exploitation of offshore and distant-water resources on Europe's (mainly marine Atlantic) frontiers. Understood in context, what occurred in interior and in maritime Europe responded to different and distinct segments of medieval consumption demand. Yet, as this and the following chapter will argue, both formed new and seminal relations between people and environments, projecting human use of aquatic life beyond the historic bounds of natural local ecosystems.

Prior to this chapter we observed medieval Europeans responding to fears of a shortfall in natural local supplies of fish by trying to adjust interactions among humans, changing culturally learned behaviours through enhanced ownership rights, market mechanisms, and regulatory constraints on fishing methods. All those measures essentially took local nature as given. By some time in the twelfth and thirteenth centuries, this approach was beginning to leave some demand unsatisfied. In further response, Europeans began to engage nature differently, looking to modify it or to exploit new parts of it to meet human wants. This more aggressive alternative should be familiar, for it is the dominant modern one. People who want more than nature offers try to 'improve' nature better to serve human wishes or to discover 'untapped' resources they

[20] Pegolotti, *La Pratica*, pp. 253 and 380.

[21] Boström, ed., *Anonimo Meridionale*; Faccioli, ed., *Arte della cucina*, I: 19–204; and Platina, *De honeste voluptate* (ed. Faccioli). Johannes von Bockenheim, the German chef whom Martin V (1417–1431) acquired at the Council of Constance along with the papal title, described dried cod (stockfish) as something prepared expressly for Thuringians, Hessians, and Swabians (Laurioux, "Le 'Registre de cuisine'," 740–742). All thirty-one fish taxa named in a late fifteenth-century Neapolitan cookbook are native to the western Mediterranean (Scully, ed., *Cuoco Napoletano*, 43–105).

[22] Thirty-five archaeological settings from northern France, with 80% of fish remains of marine origin during the fourteenth – seventeenth centuries, had contained from the twelfth century only one-third marine fishes – and those almost exclusively herring – and among that earlier freshwater majority (60%) no carp at all. Clavel, *L'Animal*, 143.

can make 'useful'.[23] A different program calls for different work in the natural sphere. More intense colonization of natural ecosystems aims to channel a greater share of natural productivity to what humans value. Frontier expansion extends human efforts to spaces hitherto ignored.

Always there is a catch. What one observer might think economic development, another could call human manipulation or environmental destruction. With respect to aquatic resources, artificial fish culture constructs synthetic ecosystems to concentrate biological production on organisms humans want. Distant water fisheries export the pressure of demand to foreign ecosystems. Both strategies brought to specific socio-natural sites the major transformations in human relations with non-human nature that are ecological revolutions.[24] Driven by consumers' desire for fish to eat, each medieval strategy triggered complex cultural and environmental consequences, some of which resonate still in present-day crises of regional and global fisheries. This chapter looks at fish farming, the next goes to sea.

7.2 From Wildlife Management to Aquaculture

Twelfth-century western Europeans, almost certainly French, worked out ways to control water and the fish they put into it in order to procure consistent and seasonally useful food. When the technology was joined, probably not much before the mid-1200s, to that naturally well-adapted fast-growing fish of exotic eastern European origin, the carp, they together formed the dominant and most advanced artificial fish production system used from the Atlantic to the Urals well into the nineteenth century and, in some areas, still today. Carp aquaculture revolutionized local ecologies and human relations with them, forming and controlling synthetic habitats for the sake of a non-native animal and to the probable harm of some native varieties. Whether aimed at indirect subsistence or market sales, medieval fish farms made ordinary people and nature alike submit in new ways to elite cultural preferences and powers.

Pisciculture may be thought one extreme of a continuum running from wild capture fisheries to fish farms. English landscape historian Stephen Rippon refers to a progression from exploiting a natural resource to modifying and ultimately transforming it into something else.[25] That

[23] On the modernist refusal to acknowledge nature's limits see Worster, *Shrinking the Earth*, notably 3–138.
[24] Merchant, "Theoretical structure," 265–274.
[25] Rippon, *Transformation of Coastal Wetlands*, 1–53, provides a useful framework for following the coadaptations of socio-natural sites.

something else is a fully colonized anthropogenic ecosystem. Genuine fish culture entails human manipulation of all the same variables as agriculture. Aquatic systems fully colonized by humans for aquaculture share key anthropogenic features with terrestrial farms, mobilizing land, labour, and capital to produce biomass for cultural purposes, normally human food. Managers select specific varieties for production and individuals for reproduction (breeding stock). Reproductive isolation drives evolution of domesticated varieties, genetically distinct from wild populations. Habitat is closely controlled to maintain supplies and quality of water and of energy (nutrients). Such environmental variables as predators, pests, and pathogens are monitored and combated. The aquaculturist's work to manage inputs and outputs more resembles that of a shepherd or grain farmer than of a fisher trying to find and gain possession of an animal in the wild. For fisheries in particular, earlier chapters have already noted many steps along the way, perhaps better conceived as the hazy zone between historic capture techniques and habitat modifications still well short of a fully anthropogenic colonized aquatic ecosystem.

Simple measures to get more use from fisheries were always commonplace. Venetian *valle de pesce* seasonally confined migratory schools of wild fish to be harvested at need and convenience. Across Europe landowners, artisan fishers, and fishmongers used tanks, cages, millponds, moats, or even specially designed structures to keep captured fish alive and convenient for kitchen or sale. Such live storage is a functional equivalent to preservation of processed fish flesh for future consumption. Even the boundary between storage and artificial transfer of wild fish into new waters is blurry. While Charlemagne ordered estate managers to keep replenishing stocks in his fishponds,[26] the actual activity is long hard to trace. Later, about the time Pietro de Crescenzi would advise choosing local fishes for ponds,[27] we witness eel, pike, and crayfish being set to grow in L. Trasimeno[28] and pike-perch in the lakes and millponds which Preetz convent owned in Holstein.[29] Such small-scale undertakings were ubiquitous at the margin of indirect seigneurial subsistence and of

[26] *Cap. de villis*, c. 21 and 65, ed. Boretius, *MGH Legum*, II, #32.

[27] Crescenzi, *Ruralia commoda*, 9:81; like advice was compiled from late Roman sources in mid-ninth-century Byzantium as bk. 20, c. 1, of the *Geoponika* attributed to Cassianus Bassus, ed. Beckh, p. 511 (tr. Dalby, p. 339).

[28] Mira, *Pesca nel medioevo*, 48; Biganti, "Pesca nel Lago Trasimeno," 797; Vincenti, "Tutela ambientale," 124–135. In coastal Languedoc eel were transferred from one salt pond to another (Puig, "Ressources de l'étang et de la mer," 112–119).

[29] Buchwald, "Anna von Buchwald," 27–28. Thames-side drainage ditches on the bishop of Winchester's manor of Southwark were stocked with boatloads of wild-caught burbot (Carlin, *Medieval Southwark*, 38). Additional examples of stocking local wild fish are provided in the Supplement.

artisanal fisheries. Live storage, use of handy artificial watercourses, and haphazard transfers of wild juveniles belonged to the historical setting but ought not be confused with domesticated fish farming.[30]

To make clear the distinction and hence the developmental process, this chapter now identifies features of carp aquaculture as practiced in early modern East Central Europe. These are well documented in managerial records of productive enterprises and in instructional manuals prepared by knowledgeable contemporaries. It then teases out traces of how these distinctive practices had earlier evolved on high medieval estates in what is now northern France and subsequently spread eastwards. A concluding analysis of enterprises across the aquaculture regions of late medieval Europe identifies consequences for aquatic ecosystems and human societies which arose from introduction and operation of fish farming.

7.2.1 A Benchmark: Advanced Traditional European Fish Farming

The history of aquaculture in medieval Europe may best be approached by establishing as a benchmark the profusely documented methods used at the close of the Middle Ages in East Central Europe, then acknowledged as leading this field.[31] Unprecedented contemporary didactic manuals describe the 'state of the art' management and techniques used by Czech, Polish, and Austrian fish farmers. First published was *De piscinis* ("On Fishponds"), which future Moravian bishop Jan Dubravius composed in the 1530s for mining capitalist and landowner Jakob Fugger. The work achieved wide circulation, with the first printing in Wrocław in 1547 (Figure 7.2), another in Zürich in 1559, and by

[30] A point well made in Lampen, *Fischerei und Fischhandel*, 125.

[31] The subject, still often poorly known elsewhere, has received much attention, sometimes repetitive, from regional writers on aquaculture and history: Teplý, "O rybnikářstvi," "Význam Vítkoviců a Viléma z Pernštejna," "Obraz rybnikářství," "Stavba rybníků," and *Příspěvky k dějinám českého rybnikářství*; Ofczarek, "Die Teichwirtschaft in Südböhmen"; Andreska, *Vývoj rybářstv*; "Development of fish-pond culture," 77–89; *Rybářství a jeho tradice*, 32–51; and *Lesk a Sláva českého Rybářství*, 57–106; Boháč, "Historical-ecological aspects," 42–47; Bůžek, "Goldene Zeitalter"; Čechura, "Adliger Grundherrn," 44–77 and 99–103; Knittler, *Nutzen – Renten – Erträge*, 146–181, and "Teiche als Konjunkturbarometer?"; Brzozowski and Tobiasz, "Z dziejów rybactwa małopolskiego," 11–37; Górzyński, *Zarys historii rybołówstwa*, 41–50 and 59–60; Hurt, *Déjiny rybnikařství*, vol. I, pp. 53–219; Nyrek, *Gospodarka rybna na Górnym Śląsku*, 89–154; Szczygielski, *Gospodarka stawowa* and *Z dziejów gospodarki rybnej*. Compare Roberts, "Fish culture in sixteenth-century Poland." Sowina, *Water, Towns and People*, 121–135 (a revised translation of Sowina, *Woda i Ludzie*, 115–132) discusses rearing fish in small garden ponds around late medieval Kraków.

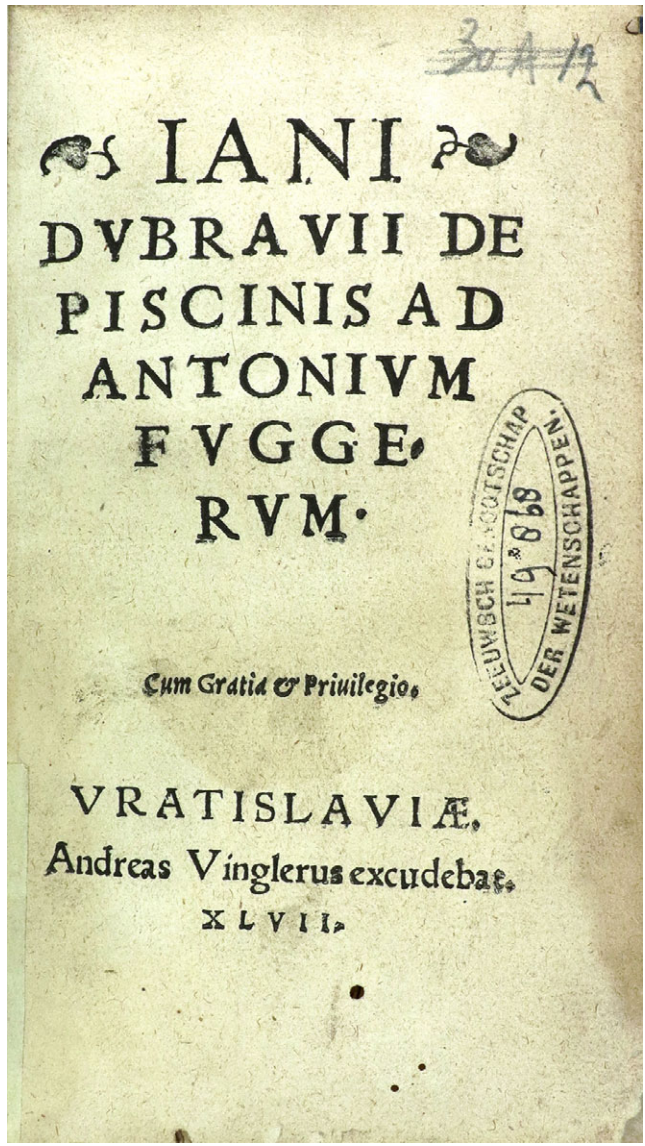

Figure 7.2 Title page for the first published instructions on carp culture: Jan Dubravius, *De piscinis*. In Wratsliavia [Wrocław]: Andreas Vinglerus, 1547.
Jan Dubravius, *De piscinis*. In Wratislaviæ [Wrocław]: Andreas Vinglerus, 1547. Public domain. Image and reproduction rights courtesy of the Zeeland Library, Middleburg, Netherlands.

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1600 also translations into Polish and English.[32] Olbrycht Strumieński's 1573 Polish book on ponds gained authority from the author's experience as a professional manager.[33] Recently identified manuscript instructions of slightly earlier date in Czech and German[34] augment the printed sources. Older handbooks are nowhere recorded.

Operational records from contemporary central European fishpond enterprises corroborate what the instructional literature advanced as normal and best practice. There are surveys of Polish royal estates near Kraków in 1564,[35] complete operating accounts from pond enterprises in the southwestern Polish duchy of Oswięcim-Zator during the 1510s–30s,[36] rich working archives from holdings of Bohemian magnate families Rožmberk and Pernšteyn,[37] and widespread if piecemeal documents of practice from lesser Polish, Czech, Austrian, and Franconian noble and monastic producers.[38] All these show the same procedures for an integrated production system.

At the end of the Middle Ages the best-reputed fish farmers in Europe produced fresh fish primarily for well-to-do regional consumers, both landowners and patrons of urban markets. They reared mainly common carp, with a side-crop of pike and sometimes a few bream or crucian carp. Cold-water fishes such as trout and grayling lacked importance.

[32] Dubravius, *De piscinis* (1547) and subsequent editions and translations. Compare Figures 6.3 and 6.4 as other links of fisheries to new media and management culture in late medieval decades.

[33] Strumieński, *O sprawie, sypaniu, wymierzaniu i rybnieniu stawów*. For both printed handbooks the 1960 source analysis and review by Inglot and Nyrek, "Jana Dubraviusa i Olbrychta Strumieńskiego," remains authoritative (Sawicki, "Jana Dubrawiusza," provides more biographical background but focuses on techniques for surveying, not fisheries management). Also available in print are instructions on rearing fish from the manuscript *Haushaltung in Vorwerken* (Ermische and Wuttke, eds., 195–206 and 254–257), associated with the court of Elector August of Saxony (r.1553–1586).

[34] Andreska, *Rybářství a jeho tradice*, 49–51, mentions economic instructions prepared in 1525 by Vojtěch z Pernštejna, the "Instrukce rybní pro panství Potštýnské a Litické," and a 1540 agricultural manual by Jan Brtvína z Ploskovic with chapters on pond culture. On the former see also Teplý, "Význam Vítkoviců a Viléma z Pernštejna." I hope in future to edit three texts with advice on fish culture hitherto unknown to scholars: Trier Stadtbibliothek, Hs 608 (1954) [1958/1422 4°], fols. 1–38, "Friedrich von Flersheim, Fischbuch 1530"; and two items in Vienna ÖNB, Codex vindobonensis 13103, "Anzaigung unnd underweysung der nottorfft so zu teichten und weyer steten gehoren im 1542 Jar" (fols. 7r–20r) and "Vischpuechl 1545" (fols. 1r–6r).

[35] Małecki, ed., *Lustracja województwa krakowskiego 1564*, vol. 2, 225–226 *et passim*.

[36] Rybarski, *Gospodarstwo Księstwa Oświęcimskiego*, 56–84.

[37] Šusta, *Fünf Jahrhunderte*, 1–29; Búžek, "Goldene Zeitalter"; and Čechura, *Adelige Grundherrn*, 44–47, 70–77, 99–103, and 121–125.

[38] Besides items in note 31 above see Topolski, "Rybołówstwo i gospodarstwo rybne," and Cnopf, *Entwicklung*.

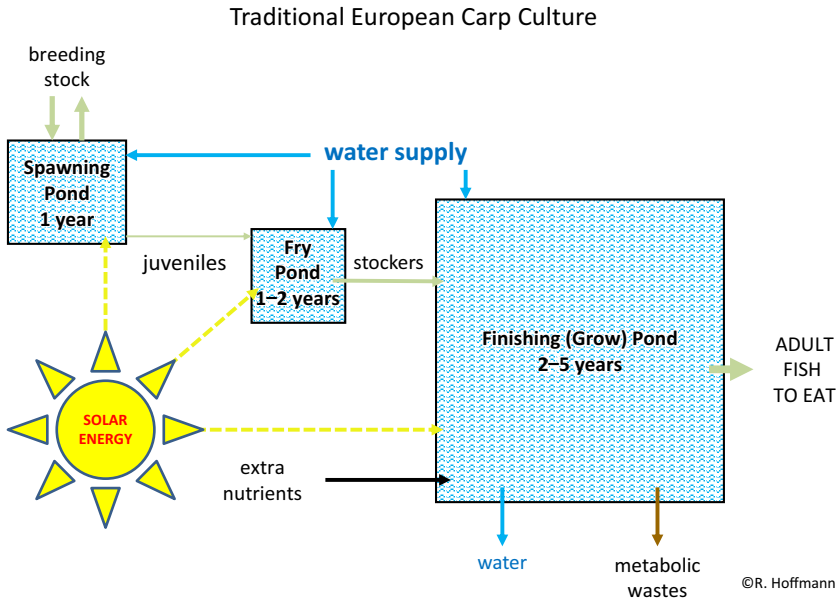

Figure 7.3 Traditional European carp culture.

Cultural methods emphasized full control over water and fish through each stage of production (Figure 7.3).

Reliably continual output required coordinated management of multiple ponds, each equipped to adjust the inflow, outflow, and level of water, from fully filled to partly empty or entirely dry, without undesired entry or exit of fish. Overland drainage (surface runoff and streams) from arable and pastures supplied the preferred nutrient-rich water. Ecological integration occurred at the landscape level by throughput of used water and sometimes removal of decomposing bottom sediments for use as fertilizer for the fields. Experts laid out ponds according to the terrain, preferring broad to deep ones even if the former required longer dams. Engineering skill predetermined the area to be flooded. In valleys a sequence of ponds, ideally with bypass channels, could feed one another downslope. Dams and dikes of beaten earth, sometimes with internal timber frames, were armoured against erosion by turf, wicker, wood, or stone sheathing. Wooden or metal grates and gates controlled passage through sluiceways made from the same selected materials.[39] Large

[39] Dams, sluices, and pipes dating from 1468/9 at Blankenheim in the Eifel are well reported and displayed in Keller, "Beobachtungen."

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Figure 7.4 Bezdrev Fishpond, Czechia.
A view across Bezdrev Fishpond near Hluboká nad Vltavou, constructed 1490–1492 on the Hluboká estate of Vilém of Pernštejn. Second largest fishpond in Czechia at 520 hectares (2.008 square miles). Few medievalists have any idea of the scale of such enterprises. This artificial lake is half again larger than New York's Central Park, 20 percent greater than London's Hyde Park plus Kensington Gardens, and 2.5 times the Principality of Monaco. Some fishtank!
© R. Hoffmann.

aquaculture enterprises had use for tanks only a few dozen meters square and for regulated lakes up to 500 hectares (just over two square miles), such as Bezdrev pond built at Hluboka in southern Bohemia in 1492. The view in Figure 7.4 is well beyond what most medievalists or modern observers imagine as a 'fish pond'.

Managers bred the fish from selected stock, though not by artificial means,[40] and moved them as a uniform age group (year class, cohort) through a sequence of special-purpose ponds. As the water in a shallow and vegetated spawning or fry pond (Figure 7.5) warmed enough in late spring the pond master introduced chosen ripe adult carp to emit and

[40] Unlike trout or salmon, for instance, cyprinids do not naturally pair up and make nests for their eggs, but groups of ripe females and males gather in vegetated shallows and emit eggs and milt simultaneously, with much splashing and mixing, after which the adults leave the shallow nursery habitat.

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Figure 7.5 Fry ponds at Rožmberk Fishpond, Czechia.
Fry ponds built at sixteenth-century Rožmberk pond, near Třeboň, Czechia (seen to the rear of a twentieth-century generator station).
© R. Hoffmann.

fertilize eggs in their natural way, then removed the parents. A summer in those protected and warm conditions grew the carp larvae into tiny fish by the time they were moved en masse to deeper waters for the winter.[41] The cohort of young carp were left another year or two in a fry pond where they would reach 'stocker' (*setzling*) size of a hand's span, before being set into a much larger, recently refilled, and otherwise uninhabited finishing pond to grow big enough to harvest. Their numbers were calibrated to pond size and experience of its productivity.

Carp eat mainly small invertebrates they find on water plants or grub out of the bottom sediment and crush with the teeth in their throats. Nutrient-rich waters offer more natural food, so if necessary managers promoted growth by adding manure or channeling runoff from animal or human wastes into their ponds.[42] They also learned to concentrate the carp biomass into harvestable adults by introducing piscivorous pike to eat

[41] As remarked in Chapter 5, heat capture in spawning and fry ponds may have been crucial to consistent success rearing carp in colder areas of Europe under Little Ice Age conditions. Wintering fry in deep water further protected them from the worst cold.
[42] Handbook authors praise carp for needing no artificial food.

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any fry bred by precociously mature members of the class. Depending on local temperature and climatic conditions, the carp reached a standard table size (commonly 40–60 cm (15–20 inches) long, weighing about a kilogram (2.2 lb.)) by year four, five, or six. By 1550 Polish records suggest two distinctive quick-growing domestic races of carp had evolved, 'mirror carp' with a few large scales and entirely scaleless 'leather carp'.

Demand-focused harvest took place in weekly stages during Lent when the market reached its annual peak, sometimes even where this meant breaking ice to get nets into the pond, or in a single push in the fall, when the crop not needed for Advent consumption could be stored alive in tanks for the Lenten season. Aquaculture made fresh fish available to fit a human, not nature's, calendar. In cool weather carp survive some days wrapped in damp cloths or straw for overland transport; portable tanks and boats with live wells also sometimes served. Water in the big finishing ponds, which had been designed with large warm, shallow, biologically productive areas at the periphery and a much smaller deep central channel, was lowered to concentrate the fish (Figure 7.6). When all were netted out (Figure 7.7) the flow of water was, if possible, entirely diverted and the pond site left to dry. Best practice called for the bottom to be plowed up, seeded with oats or barley, and then the grain used to pasture livestock through the summer. This fallow season or year readied the finishing pond for another cohort of young carp.

Productive operation of a late medieval fishpond enterprise thus called for integrated management of some tens or dozens of ponds and, exclusive of breeding stock, some half-dozen year classes of carp. In the first half of the sixteenth century these methods sustained, for instance, annual shipments of some 1,500 tonnes of live fish from the ponds of Upper Silesia (chiefly Oswięcim-Zator) to Kraków.[43] Enterprises in Czechia may have doubled that. But the integrated system was unknown in central Europe before the mid-fourteenth century and remained rare there until enterprises using it proliferated in southern Bohemia, Moravia, and Poland during the late fifteenth century. Having learned the characteristic multiple ponds, water control, selected breeding, and management by year classes of the mature system, we can detect their development some centuries earlier and further west. As Chapter 5 described, introduction of the exotic carp there capped cultural evolution of practices already being worked out with pond fishes native to Atlantic drainages.

[43] Nyrek, *Gospodarka*, 29–38, thinks the Polish capital thus received about 50–90% of Upper Silesian output.

Figure 7.6 Munický Fishpond, Czechia, lowered for harvest. Munický Fishpond (117 ha) lowered for harvest. Constructed for Vojtěch z Pernštejn at Hluboka nad Vltavou (then called Podhrad or Frauenberg), completed 1514. © R. Hoffmann.

7.2.2 Emerging Technologies: Engineering, Practices, Fish

Now recognizable even at historical distance, the process which resulted in traditional European aquaculture involved transition from live storage to long-term rearing of fish plus design and construction of infrastructure capable of manipulating the water and the fish for consistent growth and production. The new kinds of hydraulic engineering being installed in central France during the eleventh and twelfth centuries now deserve closer attention than Chapter 5 provided.[44]

[44] Note the timing reasonably coincident with England's Fish Remains Horizon (Barrett et al., "'Dark Age economics' revisited"). Explicit identification of eleventh-century ponds as innovations in Benoît and Mattéoni, "Conclusion" to the 2004 collective volume on freshwater fisheries in medieval France. Earlier such statements in Benoit and Wabont, "Mittelalterliche Wasserversorgung," 189–196; Gislain, "Rôle des étangs," 89; Guillerme, *Age of Water*, 54; and Benoît, *Étangs de la Dombes*, 24. Writers on ponds and fish culture in medieval France are commonly unaware of their counterparts in late medieval and early modern east central Europe (and vice versa).

Fichtenau, *Living in the Tenth Century*, 281, confirms the lack of solid evidence for early medieval fish culture. Likewise the rich records of Cluny at its height of wealth and prestige up to the 1150s refer to catching and storing fish from the Saône and its tributaries, but have no trace of their being reared (Ulrich of Cluny, "Consuetudines," II.4 (*PL*, 149, col. 703; administrative instructions, surveys, and accounts in Bernard and Bruel, eds., *Recueil des chartes*, nos. 3789, 3790, 4132, and 4143; Duby, "Le budget," 155–171, and "Un inventaire des profits," 129–140).

Figure 7.7 Harvesting a fishpond.
Harvesting a fishpond with a seine net, a view from Swabia. As illustrated in Bidpai, *Buch der Weisheit der alten Weisen*, fol. 44v. Ulm: Lienhardt Holle, 1483. Woodcut image and use with permission of Newberry Library, Chicago.

Certain disputes over water rights and flooding indicate the construction and rhythmic operation of pond systems without earlier counterparts elsewhere. Recent radiocarbon research dates the oldest such structures

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in Berry to the late tenth and especially eleventh centuries.[45] Even property inventories from that region mention no ponds until the eleventh century, when charters dated to the 1050s, 1081, and 1092 treat them as novelties.[46] In written records from around 1080 St. Vincent of Mans and other lay and religious lordships in Maine and Poitou, such as the lords of Laval at Marennes, undertake to excavate and build dams for multi-pond projects.[47] Monks at Ronceray complained in 1141 to Count Geoffrey IV of Anjou and canons of Bourges in 1160 to Count Étienne of Sancerre because the counts' new ponds had flooded properties of the religious.[48] While the original twelfth-century ponds at Citeaux provided water supply and drainage, with fish an afterthought,[49] Cistercians at Châalis in the Valois initiated complex pond systems shortly after 1160 and Burgundian nobles and monasteries began to do likewise between 1184 and 1206.[50]

Some charters hint how these facilities were run. A pond built by St.-Père of Chartres flooded land of a neighbour named Aucher: sometime between 1101 and 1129 the parties agreed that when the pond was filled, water and fish belonged to the abbey, but when it was dry, land and crop were Aucher's. Because some ponds on a Norman watercourse belonged to a knight and others to the monks of La Trappe, in 1215 the parties arranged to coordinate their draining and later refilling (Figure 7.8).[51] By 1263 the knight Pierre de Palluau had his ponds at Ograis in Berry emptied and dried every three years, while new constructions along the eastern edge of the Paris basin in Champagne came equipped with a full set of sluice-gates and drains.[52]

[45] Pichot and Marguerie, "Approche pluridisciplinaire," 119–124; Stauner, "Les étangs de l'est du Berry."

[46] Querrien, "Pêche et consummation" 2003, 412–418, with emphasis that in Berry a *lacus* was a natural water body, a *stagnum* created by an artificial barrier, and a *vivarium* a small basin for keeping live fish. The watershed of the small river Céphons, awash with more than a score of ponds in the later Middle Ages, had none before the eleventh century. Lay seigneurs took the lead here (Querrien, "Pêche et consummation" 2004).

[47] Delatouche, "Poisson d'eau douce," 174–175, and works there cited; Sanfaçon, *Défrichements*, 26 and 85–89; Beech, *A Rural Society*, 38 and 106. Benarrous, *Grand Brenne*, 97–104, 130–144, and 342–344, provides detailed textual and sedimentary evidence of similar date.

[48] Gislain, "Rôle des étangs," 95 n. 5; Devailly, *Le Berry*, 298, and compare 295–296.

[49] Recall the reluctance of Cistercians to add fish to their diets (Chapter 2, notes 51–52).

[50] Berthier, "Gestion des étangs" 2004; Blary, *Domaine de Châalis*, 31–40; Richard, "Le commerce du poisson," 181–197; Richard, "Les Etangs et le commerce," 99.

[51] Grand and Delatouche, *L'Agriculture*, 541.

[52] Devailly, *Le Berry*, 556–557; Maas, *Les moines-défricheurs*, 74–75. Richard, "Commerce du poisson," 187–188, details rapid construction of new ponds in the mid–late 1200s by Burgundian seigneurs around Autun.

Figure 7.8 Étang de Chaumont, La Trappe, Normandy. The Étang de Chaumont, probably of twelfth-century origin, at La Trappe abbey is and was one among the dozens of medieval ponds constructed along the little river Iton, a headwaters stream of the Eure, a tributary of the Seine. Photograph by Terryl Kinder. Used with permission.

Some of the same sorts of landowners were then also handling fish with forethought. Duke William of Normandy and monks of St.-Benoit-sur-Loire agreed in 1067 to share the fish taken regularly from one of the ponds at St.-Jacques de Beuvron.[53] Surviving scraps of financial records kept for the Count of Champagne in 1217 indicate systematic stocking of his ponds,[54] and the 1235 ordinance on fiefs of King Louis IX assumed that fishponds had a five-year production cycle.[55] These anonymous fish were probably natives, most often bream, the variety most consumed at La Charité-sur-Loire at this time.[56] In England, where after 1066 an ethnically and culturally French elite possessed pond systems wholly like those of their continental cousins, Henry III's own fishponds commonly supplied "fat mother bream" (*bremas matrices et grassas*) and pike for

[53] Gislain, "Rôle des étangs," 95 n. 6.
[54] Longnon, ed., *Documents*, III: 3–6. The scribe did not name the variety stocked.
[55] Laurière et al., eds., *Ordonnances des roys*, vol. I: 55–56.
[56] Audoin, *Ossements animaux*, 147, discusses fish remains from the floor of an eleventh–twelfth-century refectory.

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stocking his other ponds and those of his favourites.[57] A late thirteenth-century guide to estate management, *Fleta*, explicitly recommended bream and perch for ponds.[58] And even in 1299 French royal officials were putting hundreds of *bramis* into ponds in Auvergne.[59]

Shortly before 1240 the English-born, Paris-educated Franciscan encyclopedist Bartholomaeus Anglicus described the ponds to which his contemporaries were accustomed:

> A *piscina* is water gathered to nourish fish; although through ironic contradiction, as Isidore says, a gathering of waters without fishes is often called *piscina*. However for good quality a pond needs firm ground, pure inflowing water, and continuous flows. For where the ground is slimy and marshy, tasty fishes are no way to be nourished. Also where fresh water does not flow, the standing and stagnant water is easily corrupted. And therefore for renewal of the *piscina* sweet and fresh water is brought in through channels and pipes, with banks and walls protecting the boundaries of the pond lest the incoming water flow on out. From the ponds also are brought rivulets to irrigate gardens.[60]

'Hard' engineering would manage water for fish or other purposes, but the handling of the 'wet ware', living fish, remained somewhat haphazard.

Chapter 5's discussion of carp as an invasive species in medieval western Europe sets the stage for its purposeful management and domestication (recall Map 5.1). To reiterate, from an ancient native range confined to the Balkans, between the sixth and eleventh centuries carp spread west and northwards to the middle Odra and Elbe and into right-bank tributaries of the Rhine. By the mid-twelfth century the newcomer had reached the main stem of the middle Rhine, but not likely further. Only in the mid-thirteenth century does evidence of carp's presence explode across northern France and the Low Countries. Paris-based

[57] Steane, "Royal fishponds," 45 *et passim*; McDonnell, *Inland Fisheries*, 9–12; Roberts, "Bishop of Winchester's fishponds."

[58] *Fleta*, ed. Richardson and Sayles, bk. II, c. 73 (p. 247). Contra Grand and Delatouche, *L'Agriculture*, 544, this text has no carp.

[59] Fawtier and Maillard, eds., *Comptes royaux*, vol. 3, Tome 1, nos. 10713, 10717, and 10718.

[60] *De rerum proprietatibus*, ed. Pontanus, lib. 13, cap. xiiii, p. 566. *De piscina* : *Piscina est aqua ad nutriendum pisces collecta, quamuis per antiphrasim aquarum collectio non habens pisces, piscinis saepius nominetur, ut dicit Isidorus. Ad bonitatem autem piscine exigitur fundi soliditas, aquae influentis puritas, & influentiae continuitas. Vbi enim fundus est limosus & paludosus, pisces saporosi nullatenus nutriuntur. Vbi etiam recens aqua non fluit, aquae stantes & non motae de facili corrumpuntur. Et ideo ad piscinae renouationem per canales & fistulas aquae dulces & recentes inducuntur, vallibus & aggeribus ne influentes aquae effluant, piscinarum termini minuuntur. De piscinis etiam riuuli ad hortorum irrigationem deducuntur.*

English translator John Trevisa (*On the Properties of Things*, ed. Seymour *et al.*, I: 661–662), in 1398/9 gave *nutriendum* as "fedynge" and *nutriuntur* as "ynorisshed." The passage ought not be construed as referring to purposely breeding fish, selective or not.

scholastic encyclopedists in the generation after Bartholomaeus associated the wild fish with slow rivers and still waters. Contemporaries around 1260 themselves named carp and other species as being stocked in ponds in Brie Champagnoise and sold on the Paris market. Consumers discarded the bones into waste heaps near the Louvre where modern archaeozoologists identify the same taxa. Until that time the carp's westwards expansion had looked like an unintended consequence of human activity under favourably warm climatic conditions: across the heartlands of Latin Christendom whatever bodies of water people used or built to store live fish or for other purposes proved well suited as habitats for a hardy, omnivorous, and adaptable warm-water fish. Uneaten survivors could be transferred or simply escape and start new wild populations.

Hence with the 1200s seigneurs and their estate managers with experience handling stocks of native fishes in controllable multi-pond systems could identify and turn to the more fecund newcomer. Especially those mid-century encyclopedists confirm a new contemporary awareness of carp in the French heartland. Thomas of Cantimpré, Vincent of Beauvais, and Albert the Great, respectively sons of the Low Countries, northern France, and near Augsburg, spent much of their careers in Paris, where between the mid-1240s and early 1260s each compiled Aristotelian observations on natural history which then circulated widely. All three describe carp as a fish of still waters adept at evading nets. Thomas and after him Vincent appealed to popular knowledge ("*Opinio vulgi est*…") in relating how this fish spawned in water weeds, its young liked warm shallows, and the sickness they suffered in stagnant August conditions was cured by fresh river water. Albert added that carp spawn in certain waters and grow large in others, the best having clay bottoms seeded to wheat and plowed over before flooding.[61] All this highlighted features of carp aquaculture. With carp's entry into these widely distributed reference books, after the 1260s mere learned mention is no longer evidence for local presence of the species, but other signs of purposeful management proliferate.

From the Paris basin to Burgundy and from Hainaut to the middle Loire, by the turn of the thirteenth century carp seem almost ubiquitous – carp growing in ponds, little carp for stocking, big carp for breeding, carp

[61] Thomas of Cantimpré, *Liber de natura rerum*, 7:23, ed. Boese, 258–259; Vincent of Beauvais, *Speculum naturale*, 17:40 (1624 ed., col. 1274); Albert the Great, *De animalibus*, 24:26, ed. Stadler, 1525–1526.

in elite kitchens and on elite tables.[62] On most elite estates – royal, aristocratic, monastic – those fish lived in habitats equipped for full control of water supply and levels.[63] Agents for the count of Namur inventoried his dozen ponds in 1289 and specified each was stocked with carp for harvest on a four-year cycle.[64] In 1319 the pond at Millançay in Sologne was fished every two or three years followed by one dry year before restocking.[65] Already in 1285 the Count of Champagne's pond at Chaumont was producing carp by the thousands, and in both 1339 and 1345 the duke of Burgundy's Saint-Seine pond at Laperrière-sur Saône yielded about 16.5 metric tonnes of adult carp and of other varieties only a fraction of that.[66] While most of those big carp from Saint-Seine were destined for live storage and the duke's palace table at Argilly, output

[62] Find carp recipes and menus in the oldest late thirteenth-century form of what would come to be called the "Viandier" of Taillevent (Scully, ed., *Viandier*. 1–31 and notably recipe 102), in the "Enseignements" of *c.* 1300 (in Lozinski, ed., *La Bataille*, 185–186), and in the literary satire on court customs written in Paris in 1316, the "Roman du Comte d'Anjou," l. 1132 (*ibid*., 192–193. Commentary by Planche, "La Table comme signe)," 253–254).

[63] Examples of dam construction, adjustable sluices, bypass channels, and other engineering particulars appear in Rouillard and Maupoume, "Les étangs royaux"; Hoffmann, "*Carpes pour le duc*," 38–39; Deligne, "Carp in the city," 284–286; Berthier, "La gestion des étangs" 2006, 281–286; Hoffmann, "Aquaculture in Champagne," 76; Querrien, "Pêche et consummation" 2003, 418. But not all ponds were so equipped: dams on those built about 1290 for the display gardens at Hesdin, though harbouring carp and other managed fishes, had to be 'ruptured' to drain for harvest or maintenance (Farmer, "Power and the 'natural' landscape," 659–662). Some Burgundian ponds in the 1340s also had to be 'broken' for harvest (Richard, "Commerce du poisson," 188–189).

Further human colonization of the natural sphere included the predator control exercised by otter catchers deployed on estates of the count of Artois (Farmer, "Power and the 'natural' landscape," *ibid*.) and the dowager queen Jeanne d'Évreux (Longnon, ed., *Documents*, III: 439–440) and the heron hunters hired by the count of Bar in 1334 (Collin, "Le train de vie," 804).

As the above references imply, present knowledge of medieval French fish culture, especially that before *c.* 1350, rests almost exclusively on extant financial accounts from the highest elite estates. While this mostly reflects the precocious development and fortuitous survival of administrative records from that sociopolitical level, it also indicates the reluctance of historians to pursue what may survive from smaller properties and to study pre-plague conditions as thoroughly as they have records from *c.* 1350–1500. Some resulting lacunae are also mentioned later in this chapter.

[64] Brouwers, ed., *Cens et rentes*, vol. 2, pt. 2, pp. 433–434; compare discussion in Balon, "La peche et le commerce," 27–28.

[65] Guérin, *La vie rurale*, 140. Besides what appears in this paragraph, Supplement 7.2.2 has further evidence of rotations, output, and disposition of fish from French seigneurial ponds before 1350.

[66] Longnon, ed., *Documents*, III: 17–20. Accounts for Saint-Seine unusually describe the carp in terms of measured size, notably mature fish "*d'un piez et pleine palme de long*", so about 40 cm, a size at which modern feral carp weigh about 1.5 kg. In each harvest year the pond yielded more than 11,000 such fish (Hoffmann, "*Carpes pour le duc*," 35–38).

from fish farms belonging to the king, to the queen dowager, and, it appears, to the abbey of Citeaux was also sold in varying proportions to local merchants and some with Parisian connections. Other large numbers of small fish (*norriens*, *alevins*) went to restock the owner's own or neighbours' recently refilled ponds.[67]

Transfers of juvenile carp obscure the extent of selected breeding then carried out by these enterprises. In 1347 managers of the queen dowager's ponds in Brie returned 100 of the 900 large carp harvested from the Parc pond near Coulommiers in order to repopulate it.[68] Sixty years earlier assessors on the count of Namur's estate found the pond Huve near Tavier exclusively dedicated to "large carps chosen to restock the other ponds."[69] Did selective breeding also imply specialized spawning/fry ponds? Such facilities may have existed before 1350 on the Citeaux estate, where they are recorded by the end of that century, while on properties of the duke of Burgundy and neighbouring princes they occur, along with specified 'mother carps' (*carpes meres*) only shortly after 1370.[70] Despite the sparse early evidence of reproduction control, well before the Black Death of 1348–1351 marked a secular turn in Europe's economic climate, clerks for great and lesser lords in northern Francophone Europe were surveying and keeping account books for carp-rearing enterprises closely resembling those in Bohemia or Poland two centuries later.[71]

Not so across the Channel. English pond managers also kept fine accounts in the thirteenth century, but they never once mentioned a

[67] Hoffmann, "*Carpes pour le duc*"; Hoffmann, "Aquaculture in Champagne," 75; Rouillard and Maupoume, "Etangs royaux." Berthier, "Gestion des étangs" 2006, 286–289, documents such sales by Citeaux immediately after the plague epidemic and implies they occurred earlier as well. This abbey's aquaculture enterprise faced the unusual demand each autumn to feed abbots from all the Order's houses attending the compulsory general chapter.

[68] Longnon, ed., *Documents*, III: 448–449.

[69] "*queil vivier on a mis d'an en an [carpes] de chief et kewe por rapissonner les autres viviers*" (Brouwers, ed., *Cens et rentes*, fol. 2, pt. 2, pp. 433–434 (with brackets *sic* in the published text). Even in the absence of carp the selection principle was visible in late twelfth- and early thirteenth-century English royal gifts of 'mother breams' (*bremias matrices*) (McDonnell, *Inland Fisheries*, 11–12).

[70] Berthier, "Gestion des étangs" 2006, 287–289. For clear late fourteenth-/early fifteenth-century documentation of ponds dedicated to spawning and larval carp see Beck, *Eaux et forêts*, 301–311, and Gresser, *Pêche et pisciculture*, 193–206, while discussions in Benoît, *Étangs de la Dombes*, 50–55, and Deligne, "Carp in the city," 289–291, are more ambiguous. Chapter 5, p. 226 above pointed out the importance of this technique in reducing risk of reproductive failure during a climatic transition to the Little Ice Age.

[71] Hence Amacher, "Teichwirtschaft," 71–73, and other writers who rightly observe expansion of carp culture after 1350 in their own regions, should not deny its significant earlier presence in France, the adjoining Low Countries, and southern Germany (see also pp. 293–95 below).

carp. When King Edward II and his wife Isabelle of France visited Paris for the knighting of her brothers in 1313, her father, Philip IV, provided the couple with the food for a banquet to thank their hosts. The gift included 200 large and 40 small pike and 160 carp.[72] Yet the species leaves no trace in the British Isles before the very end of the fourteenth century, and well into the sixteenth was there acknowledged a rare and recent introduction (also the date of the earliest credible bone finds).[73] Delayed entry of carp to England contrasts with Anglo-Norman or Angevin introduction of exotic fallow deer, rabbits, and probably peafowl, all for the sake of elite luxury food and entertainment.[74]

7.2.3 Diffusion of Innovations

Well-evidenced signposts on the continent mark the subsequent spread of the entire integrated aquaculture system (multiple ponds used in rotation to rear chiefly carp in segregated size groupings) from northern France across other regions of transalpine Europe. One vector went east from ducal Burgundy into Franche-Comté – where production accounts dating 1338–1383 report all the now-familiar features[75] – and down the Saône/Rhône (or up the Loire) into Dombes, Forez, and west into Brenne. The latter regions experienced two waves of pond construction. Early initiatives in the 1230s were emulated on a large scale only fifty and more years later, when lords invested in pond systems as one form of market-linked agricultural improvement. Further purposeful flooding after the mid-fourteenth century commonly tried to get some use out of abandoned farmlands by serving regional demand for fish. Large-scale market-oriented carp production by a wide range of social groups became central to regional economies – though the best operational records are, of course, for the nineteen large and more small ponds of the count of Forez and the equivalent estates of the lords of Thoire-Villars in Dombes and the duke of Savoy in Bresse.[76]

[72] Fawtier and Maillard, eds., *Comptes royaux*, nos. 27701 and 27760–27764. Edward III also consumed carp on the continent (Serjeantson and Woolgar, "Fish consumption," 126).

[73] Further detail and evidence regarding the belated entry and environmental insignificance of medieval carp in England and Mediterranean Europe appear in the Supplement for this chapter.

[74] Sykes, *Norman Conquest*, 63 and 76–84; Grant, "Food, status and religion," 141–143; Rackham, *History of the Countryside*, 47–50 and 123–125.

[75] Gresser and Hintzy, "Les étangs du domaine comtal"; Gresser, *Pêche et pisciculture*, 151–225.

[76] Benoît, *Les étangs*, 23–31, documents the appearance of ponds in the Dombes, but see also the more interpretive ideas of Perceveaux, "Essai sur l'origine," 81–90, and "Structures et relations économiques." Egloff, *Paysan Dombiste*, 89–94, makes the region's long-lasting pond-centred society peculiarly accessible. Conditions in Forez are treated in Durand, "De l'établissement des étangs," 101–108; Fréminville,

While aquaculture in Hainaut and Brabant seems participant in the French experience, its more tenuous spread further north in the Low Countries is so far better traced through the proliferation of carp in food remains and customs schedules.[77]

The trail of aquaculture spreading eastward into central Europe might see one signpost at Heilsbronn, a Cistercian monastery located about twenty-five kilometers southwest of Nürnberg on the Schwabach, a headwaters stream in the Main–Rhine drainage. This lordship roughly midway between France and Bohemia can stand for a whole belt of ponds in Upper Franconia.[78] During the 1260s Heilsbronn, already more than a century old, began acquiring first natural, then artificial ponds in its general environs. By the 1340s the monks were buying and rearing stocker carp for a multipond enterprise which extended to more than thirty kilometers from the convent and still mainly served their own consumption needs. In the late fifteenth and sixteenth centuries, however, and eventually as a state-managed foundation, Heilsbronn's large output joined that of many neighbouring landholders who invested in aquaculture to supply urban consumers, especially in prosperous Nürnberg.[79]

Adjacent to Upper Franconia are the Czech lands, where pond construction for aquaculture first surged under the auspices of Emperor

"Comptes du maître des étangs"; Fournial, *Les villes et l'économie*, 687–690; and Mattéoni, "La pêche des étangs." Fernand Braudel (*Identity of France*, 204–206) turned this data into an intriguing case study. Benarrous, *Grande Brenne*, 224–227, can document coincident increases in pond construction but only lament the lack of surviving medieval evidence of practice (pp. 227–256).

[77] Deligne, *Bruxelles et sa rivière*, 131–178, and "Carp in the city," 289–291, dates expansion of carp culture around Brussels *c.* 1250–1380, with peak prosperity from supplying the fourteenth-century city. Then see van Mieris, ed., *Groot charterboek*, vol. II, p. 656. To early finds in Chapter 5, note 108, add those in Brinkhuizen, "Preliminary notes on fish remains," 83–90, and "Visresten uit twee middeleeuwse vindplaatsen," 19–20; Jong, *Tolbrugstraat, Breda*; Ervynck and Van Neer, "A preliminary survey," 304; and Seeman, "Monnickendam," 125–134

[78] Patrick Götz compiled in his unpublished *Zulassungsarbeit*, "Karpfen in Franken im Mittelalter: Eine wirtschaftsgeschichtliche Untersuchung," Friedrich-Alexander Universität Erlangen-Nürnberg, Institut für Geschichte, Sommersemester 2009, a thorough overview of the regional aquaculture which emerged in medieval upper Franconia. I am grateful to the author for sending me a copy.

[79] Heilsbronn's interest in fish culture coincided with that of Salem mentioned in the Introduction, p. 13. Findings of Heidacher, *Entstehungs- und Wirtschaftsgeschichte*, 118–119, need adjustment in light of the chronology of land acquisition revealed by charters published in Schuhmann and Hirschmann, eds., *Urkundenregesten Heilsbronn*, and of the management information from 1338–1374 in Staatsarchiv Nürnberg, Klosterverwalteramt Heilsbronn, Rechnungen, Bd. 1. Cnopf, *Entwicklung*, 26–82, examines operations of the seventy-one ponds Heilsbronn had in the 1500s. To compare the Swiss situation see the Supplement.

Charles IV (r.1347–1378), who also had family and personal connections in France. Charles is even reputed to have urged pond building not only "to hold fish for people's food and to drain water from swampy areas," but also to retain rain and snow melt for flood protection.[80] Dwarfing all known earlier hydraulic works in the region, at least eighty-seven new projects are known before the Hussite revolt in 1418 seized Czech attention.[81] Though late fourteenth-century pond masters there favoured hill country, which made for cheaper short dams but less productive deep ponds, some built the oldest large ponds (100 ha plus) which still survive, installed elaborate sluices and valves, populated ponds with age-class stockers, and selected fish for breeding. Their output went to towns in Bohemia, Germany, and Austria.[82] Czech politics calmed again after 1450 – when the Rožmberk estate at Třeboň already had three large ponds covering 700 hectares and seventeen smaller ones – and gave occasion for more large engineering works in both southern Bohemia and the flat lands of the upper Labe (Elbe) basin. Then the Pernštejns, for instance, improved their Hluboka estate with the huge Bezdrev pond (see Figure 7.4) and master Štěpánek Netolický secured stable water supplies for Třeboň, which he managed from 1516 to 1530, by diverting a river through a forty-five-kilometer artificial canal, the Zlata Stoka, 'Golden Drain'.[83] Such were the enterprises familiar to Jan Dubravius.

Fish culture facilities were being built in central Silesia, then a dependency of the Czech crown, even during the difficult 1430s and 40s,[84] and by the 1450s comparable ones had come into the principalities of Oświęcim-Zator, at the low divide between the upper Odra and Wisła basins where Bohemian and Polish influence intersected. As earlier observed, carp from here supplied Kraków in the early sixteenth century.

[80] Boháč, "Historical-ecological aspects," 25–26, and comments by contemporary chronicler Beneš of Veitmíle, "Chronica ecclesiae Pragensis," 516. But several alleged particulars of Charles's involvement, though repeated by solid Czech historians since the nineteenth century, cannot now be traced to any known medieval source (see Bauch and Labbe, "Karpfen mit Spätburgunder," 8–10).

[81] Graus, *Dějiny venkovského lidu*, vol. 2: pp. 32–35, 345–346, and 483–486; Šusta, *Fünf Jahrhunderte*, 2; Boháč, "Historical-ecological aspects," 42–47.

[82] The general narrative found in Kalný, "Stará práva rybolovu," 67–74; Andreska, "Development of fish-pond culture," 77–80; Andreska, *Lesk a Sláva Českého Rybářství*, 57–106; and Búžek, "Goldene Zeitalter," needs the balance of the well-grounded historical evidence in Charvátova, "Manorial farms," 133; Neumann, *Prameny*, nr. 20, pp. 130–133; Šusta, *Purkrabské*, 34; and Hemmerle, ed., *Deutschordens-Ballei Böhmen*, 139 and 154.

[83] Šusta, *Fünf Jahrhunderte*, 4. The chronology in Lower Austria matched that in Bohemia (Knittler, *Nutzen – Renten – Erträge*, 152–158). Purkarthofer, "Teichwirtschaft Herberstein," 97–99, reports sixteenth-century pond creation further south in Styria.

[84] Hoffmann, *Land, Liberties, and Lordship*, 365–367.

That territory also probably transmitted state of the art techniques still further farther east and north in Poland to the zone between Kraków and Sandomierz and the region of Kalisz-Sieradz, where production grew after 1550.[85]

So what socio-natural implications had this four century wave of local aquacultural innovation?

7.3 Aquaculture As Ecological Revolution

Fishponds fascinated foreign visitors. A follower of exiled Ottoman prince Jem (Çem Sultan), held in the mid-1480s as an honoured hostage or political pawn at Bourganeuf in Limousin amidst pond-filled Brenne, Berri, and Forez, told Turkish readers the French reared fish in lakes they created by damming watercourses and bringing in stock on pack horses. After four or five years the harvest was proclaimed, the pond drained, and people travelled some days to buy "pieces of gold of fish" by the thousands. Owners kept the best to repopulate the lake and sold the rest to town dwellers who had storage tanks to fatten the fish for later consumption.[86] Not quite a century later Venetian ambassador Giovanni Michiel reported the ponds of Bohemia so teemed with fish that they contributed a large share of the country's wealth.[87] The demand structure for this high-status food combined with natural and social production requirements to transform regional environmental relations in distinctive ways.

7.3.1 Demand: Live Fresh Fish for Inland Elites

The segment of consumption demand which medieval aquaculture served shaped its character and structured its impacts. Fish farms provided live fresh fish for inland Europe's well-to-do. When the duke of Burgundy was in his titular principality, his pond masters delivered thousands of carp to his castles. When the ducal family went to Bruges in coastal Flanders, they ate fresh seafood, but a two-day journey inland put the pond fish back on their menu again.[88] Thirteenth-century English ponds delivered fresh bream and pike to the king and other

[85] Szczygielski, *Gospodarka stawowa*, 21–23.
[86] Vatin, "A propos de l'exotisme," 241–242; Vatin, "Pratiques agricoles en Limousin," 265, has the Turkish text and French translation. For context see Freely, *Jem Sultan*, 118–162.
[87] As cited in Montanari, *Culture of Food*, 81.
[88] Beck, "L'Approvisionnement en bourgogne ducale," 175–176; Hoffmann, "*Carpes*"; Sommé, "L'Alimentation quotidienne."

magnates as did those of the Polish king in 1420.[89] At Horn castle in Lower Austria, kitchen accounts from 1444 to 1446 show the resident von Puchaim family buying live carp during winter and Lent for up to twice what they paid for the ordinary 'river fish' eaten in other seasons.[90] When the ponds' product went on the market it was not cheap, even for fish. At Namur in 1356 a hundred carp for a wedding feast came at twice the price of a cow.[91] During the Council of Constance (1414–1418) a pound of carp cost the same as four pounds of beef or twenty loaves of bread.[92] Throughout this period fish from the ducal ponds in Burgundy sold as luxury items on regional markets. Late fourteenth-century carp averaged 1.5 *gros* and pike two to three, which matched the daily wages of pond workers (fishers, carpenters, earth movers). On the fifteenth-century market in Dijon, 100 carp went for four to twenty francs (48–240 *gros*) and single pike for 1.5–10.5 *gros* (30–210 *denier*), when a fat capon cost 3 *gros* (60 *d*) and a skinned rabbit 30*d*.[93]

Medieval fish farming acquired strong regional features. It belonged especially to interior Europe. From upper Poitou and the great arc of the middle Loire all the way to central Poland, zones famous for fish culture (Map 7.1) appeared inland of the roughly 150 kilometers across which medieval transport technology could safely haul fresh marine fish (compare Map 3.1). Resource endowments and consumption centers played further locational roles. Where large natural lakes offered ample and tasty competition, few fishpond enterprises endured.[94] Nor was all inland Christendom equally inundated. Areas distinguished for pond culture share impermeable soils and abundant water supplies. In Franconia, Burgundy, and Lorraine springs seep from discontinuities between porous and solid strata on valley slopes, while southern Bohemia, Dombes, Brenne, and Sologne rely on surface runoff and locally

[89] Steane, "Royal fishponds," 49–50; Roberts, "Bishop of Winchester's fishponds"; McDonnell, *Inland Fisheries*; Bond, "Monastic fisheries," 92–95; Currie, "Role of fishponds," 153–160. Compare Piekosiński, ed., *Rachunki dworu króla*, 545 *et passim*.

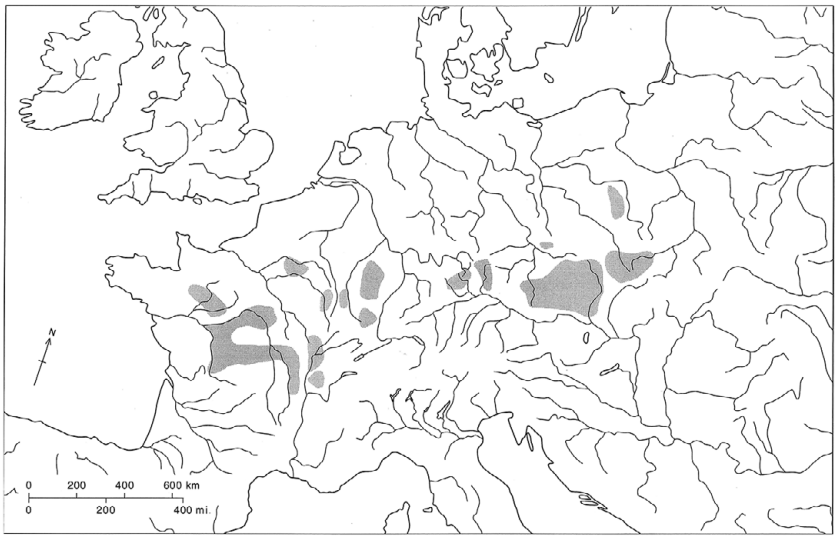
[90] Archiv Horn-Rosenburg, Hs. Horn 44 (used with thanks to Herbert Knittler). In contrast, barely fifteen years earlier high officials at the duke of Gelders' Rhine border station at Lobith ate no carp but during Lent enjoyed fresh sea and river fish as well as stockfish (Bosscha Erdbrink, ed., *Het 'Keuckenboeck' van Lobith*).

[91] Balon, "La pêche," 31.

[92] Hitzbleck, *Bedeutung des Fisches*, 105–108.

[93] Beck, *Eaux et forêts*, 323–324. Likewise in late sixteenth-century Paris, noble households contracting in advance for bulk food deliveries paid thirty-two times more for foot-long carp than for a pound of beef. Couperie, "marchés de pourvoierie," 245–246. More examples of relatively expensive carp appeared in Chapter 2, p. 82 above.

[94] Artificial ponds built near Tegernsee in 1455 were soon abandoned because the brethren found the fish "too mossy" beside their familiar native whitefish and trout (Kisslinger, *Chronik*, 96).



Map 7.1 Major regions of carp culture in late medieval Europe.

disordered drainage.[95] Natural potholes and intermittent wetlands made good sites for ponds. But for fish as for medieval commercial viticulture,[96] concentrated demand affected those suitable landscapes most accessible to it. Princes in Burgundy, Forez, and southern Bohemia and such monastic establishments as Citeaux, Maulbronn (Württemberg), and Halesowen (Worcestershire) created pond systems to supply their large domestic needs.[97] The papal household at Avignon sent special agents up the Rhône and Saône to buy and ship the output of Burgundian ponds.[98] Good-sized towns concentrated a well-off clientele: Lyon bought the fish of Dombes, Poitiers those of Brenne, and Brussels the carp grown in

[95] Devailly, *Le Berry*, 62–65; Guérin, *La vie rurale*, 131–135; Benoît, *Les étangs*, 22–24; Cnopf, *Entwicklung*, 23–26. The Lužnice basin around Třeboň is peat over impermeable clay.

[96] The great wine producers of medieval Europe were located, not in the best areas for the vine, but as close as possible (in terms of bulk transport) to thirsty northern consumers.

[97] Beck, "Pêche et étangs" and *Eaux et forêts*, 271–295; Hoffmann, "*Carpes pour le duc*"; Mattéoni, "La pêche des étangs"; Berthier, "Gestion des étangs" 2004 and "Gestion des étangs" 2006, 8–9; Grewe, "Wasserversorgung," 45–48; Bond, "Monastic fisheries," 98.

[98] Richard, "Commerce du poisson," 191; Richard, "Etangs et le commerce," and Richard, "Transports par eau," 40–44. Weiss, *Versorgung des päpstlichen Hofes*, 397–402, has the consumer's perspective.

periurban waters of the Senne.[99] Nürnberg, Bamberg, and other south German towns were supplied by Franconian ponds but also by those of southern Bohemia – insofar as the latter had surplus from the demand of local elites, Prague, and Vienna. Greatest consumer of all, Paris drew on the Seine basin (Valois, Champagne) and the Loire (Berry, Sologne). Medieval fish culture is associated with special resource endowments accessible to inland concentrations of wealth.[100]

7.3.2 Exercise of Elite Power

Aquaculture was shaped and spread in medieval Europe by exercise of elite power, the same agent then contesting customary access to wild fisheries. Regional elites satisfied demand for fish by imposing a new aquatic regime on reluctant neighbours and subjects.

Fishponds were private property. Most belonged to lords of the land. They were expensive investments. Assembling the acreage for a finishing pond at Massileux in Forez cost 1,000 livres and as much more to build it. Work for the pond made at Chomutov, Bohemia, in 1408/9 cost two or three times the owner's annual receipts from an entire agricultural village.[101] The standard production system promised no returns for two to five years, and thereafter also continuing costs of operation and maintenance.[102] Nevertheless under the right conditions the returns could be lucrative. In 1520 the seigneur of Mèziéres, leading landholder in Brenne, sold to a local merchant the entire output from ponds Piégu and Picadon for 1,600 livres, more than twice what building the latter pond had cost in 1494/5.[103] In those same decades around the turn of the fifteenth/sixteenth centuries lords in southern Bohemia and Lower

[99] Benoît, *Etangs de Dombes*, 30; Benarrous, *Grande Brenne*, 244–250; Deligne, *Bruxelles et sa rivière*, 177–178, and "Carp in the city," 289–293.

[100] English experience validates by contrast the importance here ascribed to inland wealth. During the twelfth and thirteenth centuries state-of-the-art fish culture enterprises were there installed on manors supplying royal, magnate, and monastic household needs (Serjeantson and Woolgar, "Fish consumption," 104) but most fell into disuse and were abandoned during the fourteenth century, when consistent commercial supplies of fresh marine fish became competitive throughout the country (see Locker, *Role of Stored Fish*). Certainly no known late medieval or early modern English fish farm compared in scale with major continental enterprises. Why should they?

[101] Fournial, *Les villes et l'économie*, 691; Hemmerle, ed., *Deutschordens-Ballei Böhmen*, 93.

[102] Mercier, *Seigneurie de Jaucourt*, 77–80, closely follows expenses for upkeep of ponds in the late fourteenth century. Beck, *Eaux et forêts*, 329–340, thinks production costs a major factor in the mid-fifteenth-century closure of aquaculture on Burgundian ducal domains.

[103] Benarrous, *Grande Brenne*, 247.

Austria who had invested heavily in pond construction also enjoyed very high returns.[104] Dubravius attributed to Vilém of Pernštejn (1449–1518), who had created the large aquaculture enterprises at Hluboka and Pardubice, a boast that all his great wealth flowed from his ponds.[105]

Yet beyond the prospect of domestic fish supplies and returns on sales, men of power built fishponds to show off their social superiority. Ponds were an essential feature of the estate park Robert II, Count of Artois, created at Hesdin in the 1290s to display by artifice and exoticism the gulf setting him above all lesser folk. Here the regular production cycle was rescheduled to entertain a royal visit and drainage postponed lest a bare and muddy expanse offend the eye of the countess. Robert's daughter and heir, Mahaut (1302–29) reveled in the luxury of eating fish from her own estate and watching her people work on the pond.[106] The symbolic function of ponds in Brenne confined their construction to seigneurs with high justice and the right of warren, a privilege still being enforced in the fifteenth century. Size mattered, too: in 1455 the Seigneur de Mèziéres began constructing what he called 'la Grant Mer de Brenne'.[107] His contemporary, John Howard, first Duke of Norfolk, paid close personal attention to the management of his ponds, even though he sold none of their output.[108]

Wherever the local innovators and owners of aquaculture enterprises are collectively identifiable, they prove to be a socially representative sample of regional landholders and not especially the monks of modern myth. In Dombes, for instance, lay owners of fishponds always outnumbered clerics by more than two to one and were in all centuries after the

[104] Knittler, *Nutzen – Renten – Erträge*, 156–165, and "Teiche als Konjunkturbarometer?" 209–213; Čechura, *Adelige Grundherrn*, 44–47 and 99–103; Bůžek, "Goldene Zeitalter," 91–92.

[105] Dubravius, *De piscinis*, lib. 1: cap. 3 (Schmidtová, ed., p. 24).

[106] Farmer, "Power and the 'natural' landscape," 659–662; Dowling, "Landscape of luxury," 375–379. Further on parks and ponds as expressions of aristocratic power see Creighton, *Designs upon the Land*, notably 122–166.

[107] Benarrous, *Grande Brenne*, 129 and 152–153. The duc de Berry had fishers netting the pond at his Château of Dourdan depicted in the April page of his *Trés riches Heures* (1411/16?).

[108] Turner, ed., *Manners and Household Expenses*, 560–564. Ponds were clearly a status symbol in late medieval England (Woolgar, *Great Household*, 68–70), but these records smack of self-indulgence, as also those of early Tudor churchmen (Hickling, "Prior More's fishponds," criticized in Currie, "Role of fishponds," 158–159), and eventually of well-known Elizabethan enthusiasm for imitation and experiment (as shown in the 1599 translation of Dubravius and in John Taverner's *Certain Experiments Concerning Fish and Frvite* from 1600).

thirteenth a majority among known builders of new ponds.[109] Surviving German documents likewise first associate ponds with religious houses and prelates, but from the 1200s noble landowners and both town citizens and corporations came to the fore.[110] Fourteenth-century Czech chronicler Beneš of Veitmíle was fully aware that the monarch, Charles IV, personally promoted pond construction and was then emulated by high aristocrats, lesser nobles, churchmen, and commoners alike.[111] A century later the post-Hussite burst of activity began with middling barons like Vilém of Pernštejn at Pardubice and Hluboka nad Vltavam and quasi-royal potentates like the Rožmberks around Český Krumlóv and Třeboň, but also attracted municipalities such as Česky Budejowice and Vodňany. Charles, at least, reputedly made plain his intent to transform landscapes, ordering construction of fishponds "to drain water from swampy ground and for the sun and warm winds to evaporate water from stagnant areas, which will benefit plants thereabouts."[112]

Waters manipulated for lords and their fish threatened the interests of others. In a litany of power, tropes of conflict and compensation run everywhere through detailed records. In mid-twelfth-century Berry, local seigneur Hervé Guitier took offence when Knights Templar of Villefranche made their dam so high they flooded the houses and roadway of Hervé's men, while the cathedral canons of St. Étienne at Bourges complained to Count William of Sancerre that his dam at Beaulieu had drowned their land.[113] Across the Channel a generation later Abbot Samson of Bury St. Edmunds stirred up resentment in and outside the

[109] Benoît, *Étangs de la Dombes*, 22–24; the same ratio of two lay to one clerical describes the thirty known builders of twenty-six new ponds in fourteenth–fifteenth-century Sologne (Guérin, *La vie rurale*, 157–160). While into the 1200s written records cover churches more fully than they do lay estates, from the start in the eleventh–twelfth centuries lay seigneurs in Berry led innovations in pond construction and management (Querrien, "Pêche et consummation" 2003, 412–418 and 434–435). Judicial and other records from Brenne likewise show religious and lay landowners engaged with ponds each in proportion to their holdings in the area (Benarrous, *Grande Brenne*, 153–202).

[110] Lampen, *Fischerei und Fischhandel*, 130–138.

[111] Beneš of Veitmíle, "Chronica ecclesia Pragensis," 516. Šmelhaus, "Vývoj nížinného rybničního hospodářství" tabulated lay and ecclesiastical pond owners in fourteenth-century eastern Bohemia.

[112] Instructions to the Czech estates in 1356, cited in Boháč, "Historical ecological aspects," 25. Compare Šusta, *Fünf Jahrhunderte*, 2, on Charles building ponds "*ut regnum nostrum piscibus et vaporibus abundaret*."

[113] Devailly, *Le Berry*, 296 and 361. Blary, *domaine de Châalis*, 56, and Maas, *Moines-défricheurs*, 75, have comparable tales from Valois and Champagne. Such conflicts continued: the collegial church of Levroux and the lords of Moulins reached an agreement in 1369 but were at odds again in 1515–1518 over damages the latter's Marmagne pond on the river Céphons did to land and a mill belonging to the chapter (Querrien, "Pêche et consummation" 2003, 416); in Brenne the pond called Cinq Bondes of the Hospitaller Commandery of Blizon stood dry for more than a century

abbey when he raised the dam of his fishpond at Babwell and inundated meadows, pastures, orchards, and arable of neighbours and other monks alike.[114] In upper Saxony the abbey of Altzelle was continually at odds with its small-town neighbours in Roßwein, whose lands Altzelle flooded; with a convent at Nimbschen, whose woodland Altzelle drowned raising a pond in 1495; and with another nearby town, Grimma, whose own pond washed out the abbey's mill.[115] When Ješek of Kosovy Hory, lord of Lomnice, built Dvořiště pond in 1367, the waters drove peasants off more than 300 ha of arable. By the early 1370s more places in southern Bohemia were described as "drowned by the pond". New constructions around Krumlóv in 1479–1484 inundated one-fourth of the estate's own village Radošovic – where the tenants received an equivalent rent reduction – and all of neighbouring Hummo – for which the Cistercians of Vyšší Brod got two villages in return.[116]

Where aquaculture became a major interest, normal practice encouraged entrepreneurs to flood first and deal with local objections later. Unauthorized constructions were confirmed retroactively, not removed. Seigneurs in much of central and southeastern France enjoyed a recognized customary *droit d'inonder* (*d'inondation*): they could build dams on their own land at will and then compensate neighbours for what the pond flooded, "for the construction of such a pond provides more benefit to the builder and the community than the inconvenience of neighbours whose properties are drowned in the flooding of the water."[117] The legal

because it had inundated the place where the abbey of Fontgombault meant to install their own pond (Benarrous, *Grande Brenne*, 199–200).

[114] Jocelin of Brakelond, *Chronicle*, tr. Butler, 130–131. Carpenter, *Minority of Henry III*, 357, relates a similar story from chronicler Matthew Paris.

[115] Beyer, *Cistercienser-Stift Alt-Zelle*, 176, 183–184, 420, 422, and 703–704.

[116] Ofczarek, *Teichwirtschaft*, 35–37 and 44–45. Boháč, "Historical-ecological aspects," 44–45, has more such Czech cases. Dubravius, *De piscinis*, advised tenants be compensated rather than deprived of resources or simply expelled.

[117] "*dummodo etiam ex constructione talis stagni afferatur majus commodum construi facienti et reipublicae, quam sit incommoditas vicinorum quorum proprietates ex inundatione aquae submerguntur*" (Durand, "De l'établissement des étangs," 105–107, quotes the "Decisiones Gratianopolitanae", questio 91, from the Dauphiné). Perceveaux, "Structures et relations économiques," 348, describes the "Coutume de Villars" of Dombes as parallel to those in Forez and Nivernais; Benoît, *Les étangs*, 64, adds Berry, Orleans, Lorris, and Montargis. The area of Brenne spread across three customary codes, with Touraine most favouring the arbitrary power of a seigneur and Berry and Poitou more open to side deals or licences (Benarrous, *Grande Brenne*, 147–153). French precedents thus suggest Jan z Rožmberk did peasants at Bugóv no special favour by letting them pasture livestock on the bottom of his pond when it was dry (Ofczarek, *Teichwirtschaft*, 29). No such right existed in England: by the late 1100s law, legal commentary, and evident practice there concurred that flooding without prior consent was a *novel disseisin* nuisance and required the perpetrator to restore prior conditions (Langdon, *Mills*, 259–268).

regime divided ownership of the waters and fish from that of the flooded land. Barring other compensation involuntary victims thus retained only the crop from years the pond was dry and the right to collect shoreline vegetation. But cases from thirteenth- and fourteenth-century Dombes, for example, show pond builders offering neighbours cash, land, or a share in the yield of fish.[118]

Some flooded Czech peasants were compensated by their lords, but practicing aquaculture at peasant expense was also one way lords wielded authority in east central Europe around 1500. To take but one example from a court book of the Kraków cathedral chapter, villagers at Choczianowice who complained in 1502 that the lord's fishpond "frequently damages their fields and floods their meadows," blamed the local administrator for having raised the dam and, in preparation for another pond, cut down the local woodlot.[119] On another lordship near Sandomierz already in 1405 the lord's steward was conceded "the right to make fishponds wherever he wishes".[120] Protest was vain. Peasants undoubtedly suffered when their superiors turned land into water. As one disgruntled Czech put it in 1508, "what was left after wars, fires, and plague is now mostly inundated by ponds".[121]

7.3.3 *Adaptive Economic Structures*

Depending on surrounding economic institutions, medieval fishpond enterprises operated in the customary economy, the market economy, or in east-central Europe, the newly coercive economy of neoserfdom. These cultural contexts shaped the supply of labour, but not the need for expertise, and constrained a lord's choice among indirect subsistence, market sales, or ending direct management in favour of leasing out individual ponds or even entire enterprises.

Whatever the setting, fish culture called for both heavy labour and, on the part of managers, high technical skill and environmental knowledge. Around 1300, tenants at Gressenhall manor in Norfolk were obliged to perform labour services '*facient stagnum*' or, in the 1315 English-language survey, 'damyng'. At the same time their counterparts on the count of Bar's Lorraine estates did compulsory service carting fry to stock

[118] Benoît, *Les étangs*, 59–66. Compare Helmlinger, *La Dombes*, 25–26, and Benarrous, *Grande Brenne*, 151–152.

[119] Ulanowski, ed., *Księgi sądowe wiejskie*, vol. II, pp. 430–432. Other instances of lords' fishponds harming peasant resources are *ibid*., 418, 421, 425, and 469–472; Górzynski, *Zarys historii rybołówstwa*, 48–49; and Hurt, *Déjiny rybnikařství*, 104–108.

[120] "*ius faciendi piscinas ubi placet*" (Ludat, *Lubuser Stiftsregister*, 71).

[121] Boháč, "Historical-ecological aspects," 45.

ponds.[122] Workers were later turned out to harvest fish from ponds for Ebrach, a monastery in Upper Franconia, as a thoroughly old-fashioned obligation on certain peasant tenements, limited to the specific task and with equally customary remuneration of meals and two fish.[123]

While expert monastic managers are curiously hard to identify,[124] a long catalog could be assembled of lay specialists, some employed on limited-term contract, others as long-time, high-ranking salaried servants with titles like 'pond master' or 'fish master'. We have already met Štępánek Netolický building the Zlata Stoka at Třeboň for the Rožmberks in 1516. Having learnt the craft in years assisting his predecessor, during his own fifteen-year tenure he designed and supervised construction of nine large and thirty-seven small ponds, traveled to advise the archbishop of Salzburg and the count of Salm, and for one tough engineering problem called in as consultant his counterpart from the Poděbrady estate. At a time when contract pond masters in Bohemia were getting 3 grosz a day the Rožmberks were paying Netolický 2,400 grosz a year. His retirement house still stands in a suburban part of Třeboň.[125] But such experts can be tracked just about as far back as detailed records of fish culture go. A team run by the clerk Colard de Coilly and bailiff Hugues Bernard stocked, harvested, and maintained ponds for the count of Champagne in 1258–1259 and 'Master Nicholas the Fisherman' toured southern England for at least eighteen years (1244–1262) for sake of the bishop of Winchester's ponds. During the 1330s–60s Reynaud le Tarroillon had charge of work on many ducal ponds in Burgundy.[126]

Wage labourers evidently did much of the physical work to multiply and maintain fishponds in key areas of late medieval France. Reynaud and his successors in ducal Burgundy recruited locally for construction and for harvesting the fish, but eventually came to rely on regional pools of workers. The duke's officers paid by the task or a daily rate, food and

[122] Turville-Petre, "Earliest English manorial survey," 75; Collin, "Les ressources alimentaires," 64–65.

[123] Weiss, *Zisterzienserabtei Ebrach*, 77–78. Customary tenants on a Polish estate of the bishop of Lebus in 1405 likewise owed two days a year of work on the fishpond (Ludat, *Lubuser Stiftsregister*, 46).

[124] Berthier, "Gestion des étangs" 2006, 286–287, found a layman managing fish culture at late fourteenth-century Citeaux.

[125] Netolický was one in a succession of trained pond masters who worked for the Rožmberks from the third quarter of the fifteenth century through the early seventeenth: Šusta, *Fünf Jahrhunderte*, 3–15; Ofczarek, *Teichwirtschaft*, 52–87; Bůžek, "Goldene Zeitalter," 82–85; Čechura, *Adelige Grundherrn*, 99–103.

[126] Longnon, ed., *Documents*, III: 17–21; Roberts, "Bishop of Winchester's fishponds," 130–135; Hoffmann, "*Carpes pour le duc*," 42–43; Beck, *Eaux et forêt*, 281–285. Supplement 7.3.3 notes more expert builders and managers elsewhere.

lodging plus 12 denier to 1¼ gros in the fourteenth century and 2 to 3 gros in 1450.[127] The same daily rate then went also to the local peasants whom Citeaux abbey hired for fishing its ponds, while using permanent servants and independent craftsmen for more skilled tasks.[128] Czech pond-builders worked for a wage, too: one grosz a day in the late 1300s and as much as two grosz a century later. But by that time forced labour service was becoming a norm in east-central Europe, also for heavy fishpond work. Account books for estates of Teutonic Knights and Hospitallers at Jindřichův Hradec often record forced labour (*robot*) on the ponds.[129] A survey of the Kraków chapter estates in 1531 made this obligation plain for villagers of Dłotów: "furthermore, the aforesaid men are bound to work at the fishing in the fishpond, however often it is demanded of them, and likewise on the repair of the dam of the fishpond and hauling the fish to the manor house at Pabianice, however often it is demanded of them."[130]

Cultured carp and other fish from the ponds might likewise be delivered in kind to the lord's household – a more dependable form of the indirect subsistence fisheries familiar in the earlier middle ages – or sold by auction or prior contract to merchants from town. Like elite claims on wild catches (see Chapter 3) primary household consumption often coincided with reliance on servant and obligatory peasant labour during early regional development of aquaculture. But relict practices persisted. Recorded shipments from thirteenth-century English ponds went almost exclusively to the king's, bishop's, or lord's residence, while during 1345, with the duchess of Burgundy dwelling in Argilly castle, more than 11,000 large carp arrived there from the St. Seine pond. Much later in 1522 the Polish king's ponds at Oświęcim put 32,640 carp and 6,045 pike into their master's kitchen.[131] As with wild fisheries, monastic establishments with large and localized demand for fish long retained this

[127] Beck, *Eaux et forêt*, 283–285. For like hiring in Sologne see Guerin, *La vie rurale*, 134–135.

[128] Berthier, "Gestion des étangs" 2006, 283–287.

[129] Ofczarek, "Teichwirtschaft," 18–22.

[130] Ulanowski, ed., *Księgi sądowe wiejskie*, vol. II, p. 472: "*praeterea fassi sunt homines praedicti teneri ad piscandum in piscina, quoties illis mandatur, similiter ad reformandum piscinae aggerem et ad deferendum pisces ad curiam Pabyanicze, quoties illis mandatur …*" For Czech cases see Čechura, "Lohn oder Fron?" and Bůžek, "Goldene Zeitalter," 87–89. Górzyński, *Zarys historii rybołówstwa*, 50; Hurt, *Dějiny rybnikařství*, 124–128; Szczygielski, *Gospodarka stawowa*, 150–164; and Míka, "České rybnikářství" all think this normal practice. The same applied at Altzelle (Beyer, *Cistercienser-Stift Alt-Zelle*, 428–429).

[131] Hoffmann, "Carpes pour le duc," 39–40; Rybarski, *Gospodarstwo Księstwa Oświęcimskiego*, 75. For distribution of many carp from enterprises elsewhere or later see Beck, "L'Approvisionement" and Supplement 7.3.3.

autarchic strategy: fifteenth-century monks at Citeaux ate nearly all of their own production and so did those at Heilsbronn and Chaalis. But lay lords of ponds in late medieval Brie Champenoise also favoured direct household consumption.[132]

Commercial sales of cultured fish are apparent in western Europe before 1300 and thereafter gained importance and spread eastwards. Coincident with the first artificial ponds in Berry, bream appear in 1100 as the only obligate freshwater fish in market regulations for Bourges.[133] Later ponds sent mainly carp and pike. Financial accounts kept under Philip IV for the nine royal pond complexes within 100 kilometers of Paris show varying divisions between supplying the court and markets: over a three-year period the western ponds run by Jean Harenger [!] gained 61 percent of their income from Parisian merchants. Managerial expectations are suggested by accounting for fish transferred to the king's *hotel* or other royal households in the same way as for sales elsewhere.[134] Every three to five years between 1386 and 1422 one pond at Saix in Dombes yielded daily sales in quantities like 200 carp, 515 carp, 975 carp and 12 pike, 650 carp, etc.[135] Carp from Burgundy supplied the papal court in Avignon and towns along the way. One sale at l'Eperviére-sur-Saône handled 3,400 carp and 190 pike, representing about 60 percent of that pond's harvest for 1353.[136] Historian Corinne Beck found in the annual accounts of Burgundian castellans a change of priority in the 1390s: henceforth most ducal ponds were managed for commercial production and sale, even of those fish designated for the court but left unused. This coincided with the duke's diminished presence in his principality.[137]

A mixed model of domestic consumption and market sales became the norm for central European pond enterprises from perhaps the fourteenth and indubitably the fifteenth century. Quantitative evidence lags. Dubravius had Vilém of Pernštejn brag that he made more from sale of fish (alone) than the entire wealth of ancient Roman senators; his Hluboka estate shipped to Prague and over the border hills to Bavaria

[132] Berthier, "Gestion des étangs," 288–289; Blary, *Domaine de Châalis*, 31–40, 46–81, 87–99; Cnopf, *Entwicklung der Teichwirtschaft*, 29–32; Heidacher, *Entstehungs- und Wirtschaftsgeschichte*, 118–119 and 131; Bauchet-Cubbada, "Patrimoine piscicole des seigneurs."

[133] Querrien, "Pêche et consummation" (2003), 427.

[134] Rouillard and Maupoune, "Etangs royaux."

[135] Benoît, *Les Étangs*, 67–68.

[136] Richard, "Le commerce du poisson"; Richard, "Les Étangs"; and Richard "Transports par eau." At the receiving end see Weiss, *Versorgung des päpstlichen Hofes*, 319–320 and 397–402.

[137] Beck, *Eaux et forêts*, 291–295.

and Austria.[138] As early as 1522 Silesian noble landowners around Wrocław were complaining to their king Louis of Bohemia that city officials interfered with "our fish on the fish market… which we ship there" (*unseren Fyschen vff dem Fyschmargkt … dy wir hynein furen…*). In 1534 the Polish king's Oświęcim ponds sold 26,100 carp, only 20 percent less than went to the royal household.[139] Land tax assessments from Lower Austria a generation later do indicate some lordships getting up to a quarter of their annual cash returns from sales of cultured carp.[140] Historians of early modern east-central Europe equate fish culture with more widespread local brewing monopolies and commercialized production of cereals for export sales as examples of 'landowner capitalism' or 'market feudalism'.[141]

Market conditions writ large thus affected the economic viability and even survival of regional aquacultures. Carp farming appeared and expanded where inland elites with access to land, water, and cheap labour demanded fresh fish for their own consumption and became aware of urban markets willing to pay for any surplus. When these conditions failed, princes and other large estate holders phased out their own participation and administrative documentation. Where the ponds then survived, their operation and management become more difficult to track.

The inland principalities of Brabant and Hainaut, centred around Brussels, provide a case in point. Aquaculture on ducal and other estates there expanded dynamically from the late thirteenth into the mid-fourteenth century. Elite investment met landowner needs and local market opportunities for fresh fish. Strong commercial involvement – investment by urban merchants, multi-purpose use of moats, specialized fry and storage ponds, markets in carp fry, etc. – continued for another generation or two. But about 1400 big pond owners were experiencing

[138] Dubravius, *De piscinis*, lib. 1, c. 3 (ed. Schmidtova, 23–24); Čechura, *Adlige Grundherrn*, 44–47 and 125. Annual sales from the Třeboň estate during the last decade of Netolický's management averaged 118,520 carp (Čechura, *Adlige Grundherrn*, 44–46 and 99–103; Bůžek, "Goldene Zeitalter," 121–124). Kunst and Galik, "Essen und Fasten," 252–253, find carp from Bohemia on Vienna's fish market.

[139] Klose, *Inneren Verhältnisse*, 32; Rybarski, *Gospodarstwo Księstwa Oświęcimskiego*, 76. Compare the estimates in Nyrek, *Gospodarka rybna*, 40–43, or Szczygielski, *Gospodarka stawowa*, 41–47 and 220–247, but note that in their regions of Poland counts of fish sold (in contrast to those stocked) occur only in later records.

[140] Knittler, *Nutzen – Renten – Erträge*, 162–166.

[141] An unresolved interpretive debate in Czech historiography can be traced through Míka, "České rybnikářství"; Válka, *Le grand domaine feodal*; Boháč, "Historical-ecological aspects," 45–48; Čechura, "Lohn oder Fron?"; and Čechura, *Adelige Grundherrn*. Elsewhere see Szczygielski, *Z dziejów gospodarki rybnej*, 52–63, and Knittler, "Teiche als Konjunkturbarometer?".

labour shortages, rising labour costs, and a greater supply of marine fishes competing for consumer choice. Burgundian succession in 1430/32 deprived most towns of resident courts and their business. By about 1500 large lay landowners, especially around Brussels, could supply their tables from the market and had shut down or leased out their ponds. Marine fish supplanted freshwater varieties in regional diets. Many ponds reverted to marsh or meadow. Fish culture became an affair of religious houses and poorly documented professional urban fishmongers.[142]

While leasing out arable demesne lands is a familiar trend across most of high and late medieval western Europe, short- or long-term leases of aquaculture enterprises appear related to establishment of stable market supplies of fish accessible to consuming households. Costs and reliability of labour for stocking, harvest, and maintenance also played a role. Leasing cut the landowner's administrative expenses, lowered risk, and promised a reasonably steady return on investments. The latter might or might not include continued supply of fish for household needs. Yet how much, if at all, did leasing out of big pond systems actually change the production system? Comparatively small private ponds had likely existed all along and eighteenth-century records reflect practices very like those of the fourteenth.

In certain interior parts of France late medieval economic and political changes eroded the importance of large princely fish farms, leaving the sector a thinly recorded commercially oriented activity of lesser seigneurs and urban-based dealers in fish. In Forez the comital enterprise lost its raison d'etre with the 1430 move of the family to Moulins, 150 kilometers and a different drainage basin from the ponds. The management office atrophied and in a generation all the count's ponds were out on lease. Urban interest in aquaculture already dated back a generation or more. In the 1480s an influential merchant of Montbrison, Pierre Cochard, held a nine-year lease on the main water bodies.[143] In ducal Burgundy by the late 1300s the resource office (*gruerie*) faced rising logistical problems – labour costs, shortage of *nourriens*, unstable weather, erratic output – and ever more frequent absence of the princely household. Some individual ponds were out on lease before 1400. In 1442/3 Duke Philip let the entire resource base go for twelve years to a private

[142] Deligne, *Brussels et sa rivière*, 136–174 and 177–178, and "Carp in the city," 289–293 and 301–302. A similar mix of large ecclesiastical foundations consuming the production of their own domains and small commercial enterprises also developed around fifteenth-century Paris (Benoît, "La pêche dans le domaine de la ville").

[143] Fournial, *Les villes et l'économie*, 194–195 and 691–692; Durand, "De l'établissement des étangs," 104–105.

consortium of ducal officials. When the term expired the lessees had lost money and failed to maintain fish stocks. From 1454 then, ponds went out in smaller units for longer periods to groups of local urban merchants and lesser seigneurs with earlier ill-documented experience in local fisheries and markets.[144] Brenne, in contrast, was a land of smaller seigneuries (and hence no surviving financial accounts) where a slow fourteenth-century increase in pond leases became more general after 1400. Most were taken up by town-based partnerships which by that century's end even invested in new pond construction. The student of Brenne's pond-filled landscape, Renaud Benarrous, even refers to a 'democratization' of pond ownership.[145]

Institutional variability at the ownership level and even in the disposition of the fish produced likely more affected contemporary and surviving documentation than it did material interaction between a human technology and the things and forces of nature it sought to manage. Once technologies for fish culture and markets for its product had been established, changes at the managerial level little affected the broader consequences. Despite differences in social stratification the landscape of Třeboň replicated the *paysage piscicole* of Brenne and human relations with those landscapes had close similarities.

7.3.4 Colonized Ecosystems

Hence technically advanced aquaculture could meet elite demand for fresh fish in late medieval interior Europe along a spectrum from old-fashioned seigneurial self-sufficiency to up-to-date commercialization. At all points, however, this response to wants backed up by power and wealth set off localized and small-scale but numerous and widespread 'ecological revolutions'.[146] Medieval programs and work to colonize nature for fishponds drove environmental change at numerous inland socio-natural sites. By transforming ecosystems aquaculture produced winners, losers, and changes in human experience.

[144] Beck, *Eaux et forêts*, 308, 315–317, and 340–344. *Gruerie* officials in adjacent Franche-Comté saw their lord even less and had many comital ponds out at lease by 1450 or simply gone derelict even before the destructive French conquest of 1478/80 (Gresser, *Pêche et pisciculture*, 151–167 and 323–335).

[145] Benarrous, *Grande Brenne*, 224–226 and 344–358. Aquaculture in Dombes and Sologne likewise retained into early modern times more diverse ownership structures and strong links to urban markets (Benoît, *Étangs de la Dombes*, 30–33; Guérin, *La vie rurale*, 148–150).

[146] The term is used advisedly to stress the scope and ramifications of "transformations in relations of humans with non-human nature" commensurate with the now-classic model advanced by Merchant, "The theoretical structure."

Medieval fish culture purposely furthered and locally intensified the changes medieval economic development in general was perpetrating on European watercourses (recall Chapter 5). Investors aimed to multiply formerly uncommon eutrophic stillwater habitats. Ponds sustained ecosystems unlike those of earlier running streams or seasonal wetlands. Stillwater organisms – rooted water plants, midges, mosquito larvae, perch, pike, roach, tench, bream – gained living space and notably those of moving water – gravel-loving invertebrates, gudgeon, grayling, trout, barbel, various migratory fishes – lost. The scale of transformation is impressive, for the fish culture regions acquired vast numbers of ponds. Careful local experts concur on the order of magnitude: 25,000 ponds in Bohemia and 22,000 in upper Franconia; 25,000 hectares of ponded surface in upper Silesia; 40,000 hectares in central France.[147] With ample evidence of modern drainage of medieval ponds in areas as far apart as France and Poland, it is hard to dispute Robert Delatouche's guess that the historic province of Maine, for instance, had contained at the end of the Middle Ages twenty-five times more ponds than 500 years later.[148]

Principal intended immediate beneficiary of this transformation of aquatic habitat was the carp. Fish culture meant the large-scale human introduction of an exotic animal across large areas of western Europe where it had not previously lived. Just the surviving written records from the thirteenth and fourteenth centuries count hundreds of thousands, perhaps millions, of small carp going into ponds. Pond masters saw to their food supply, protected them from predators, and arranged their reproduction.[149] As objects of controlled monoculture these fish were becoming domesticates. Select domesticated races of carp certainly had emerged in Europe by the sixteenth century.[150] Yet more telling, physiological features symptomatic of domestication remain visible in all wild-living European carp populations west of the middle Danube.[151] In other

[147] Andreska, "Development of fish-pond culture"; Nyrek, *Gospodarka rybna*, 42–43; Bautier, *Economic Development*, 198–199; Cnopf, *Entwicklung*, 22. In the early twenty-first century water still covers more than 8,000 ha in each of the southern Czech Republic, Aischgrund, Upper Lusatia, and Brenne (Benarrous, *Grande Brenne*, 61–62).

[148] Delatouche, "Le poisson d'eau douce," 173–175; Szczygielski, *Gospodarka stawowa*, 19. Compare Benoît, *Étangs de Dombes*, 12–13.

[149] See, for examples, Benarrous, *Grande Brenne*, 227–230, and Beck, *Eaux et forêts*, 266–269.

[150] Galik, "Historical and ichthyological evidence," found scales of mirror carp in fifteenth-century layers at Lanzenkirchen castle, Lower Austria, a site destroyed in the sixteenth century.

[151] Balon, "The common carp"; Ervynck and Van Neer, "Preliminary survey"; Boddeke, *Vissen en vissen*, 124–130.

words, even the 'wild' carp of central and western Europe are feral descendants of domesticates. Given a start, carp themselves became a dynamic natural element, colonizing wild habitats so promptly that astute medieval observers soon recognized them in nature. Both late thirteenth-century French fisheries regulations and the first Polish writer on fishes, Stefan Falimirz in 1534, grouped carp among wild fishes of the river as well as cultivated ponds.[152]

Together and separately the ponds and the carp worked wider change on the larger environment. Some of this followed an intentional cultural program: like other agroecosystems aquaculture is meant to control and simplify environmental variables so biomass concentrated in one desired species. But then this exotic animal 'went native' with what are now predictable – if historically undocumentable – consequences for the aquatic ecosystems receiving it.[153] Biologists watching the carp spread into new continents during the late nineteenth century found it unusually quick to colonize temperate still-water environments – which medieval economic development was proliferating – and to disrupt relatively simple fish populations which were already under stress from overfishing and environmental change – like the native cold-water fishes of medieval Europe. In wild ecosystems carp behaviour harmed native species by accelerating changes to habitat and biomass.[154] Had French king Philip IV, for instance, a freshwater research station, historians could now hope for more than just proliferating documentary references to carp.

More visible is the environmental impact of the ponds themselves. Medieval records let modern scholars see the eastern edge of the Paris basin (Champagne–Lorraine) and the valley lands of Sologne and Brenne transformed from seasonally flooded woods to arable and ponds, permanently open water where there had been little or none. Shaded springs and trickling streams became sunny or mist-shrouded expanses of water and reeds. Czech archaeologists provide copious evidence of

[152] Lespinasse and Bonnardot, eds., *Les métiers et corporations*, 212–218; Rostafiński, *Średniowieczna historia naturalna*, vol. 1, pp. 70–71.

[153] "Successful establishment of an exotic species must necessarily precipitate changes in the physical and biological characteristics of the aquatic ecosystem receiving the introduction … That no effects should result from such perturbations strains one's confidence in ecological principles" (Taylor et al., "Known impacts of exotic fishes," 323 and 352).

[154] Wheeler, *Fishes of the British Isles*, 178–179, summarizes carp biology, and more is in Heuschmann, *Die Weißfische*, 53–63, and the discussion and references provided by Kottelat and Freyhof, *Handbook*, 146–148. Welcomme, "International transfers of inland fish species," 33–36, reviews exotic fish introductions; Taylor et al., "Known impacts of exotic fishes," classify ecological effects (324–326) and catalog those of carp (335, 336, 342, 345, and 349).

how late fifteenth century pond construction changed drainage and vegetation patterns in southern Moravia. Around Třeboň thousands of hectares of heath drowned beneath the Rožmberk ponds alone.[155] Like other aspects of medieval economic development this multiplied eutrophic still-water habitats in regions where they had been rare. Pond ecosystems differed from those of streams or seasonal wetlands. Inhabitants of still water gained living space and those of moving water lost. Organisms adapted to slow annual oscillation of water levels now encountered flooding year-round, occasionally punctuated by the artificial drought of a pond drained for harvest. Silt accumulated behind dams on the river Allier.[156] In Brenne the ponds themselves raised the water table and fed newly emergent wetlands.[157]

Charles IV himself reportedly testified (p. 300 above) to the ponds' humidifying effect on microclimates, but this minimizes the change. Landscapes had been simplified and reordered at large scale. Ten percent of the surface in five rural communes of central Brenne is still submerged and a late seventeenth century map shows water covering more than 25 percent of Třeboň lordship.[158] Folk culture in Brenne comprehended the change by populating the ponds with beings inimical to humankind: the *Grande Bissexte* reared its upper body out of the water to seize unwary humans, drag them down, and devour them; a white doe chased and drowned those who attempted a nocturnal crossing along the dam of Mer Rouge, the region's largest impoundment.[159] Later more enlightened observers would deplore the insalubrious damp of the pond-filled regions. Dombes, Sologne, and Forez in particular had by the nineteenth century well-deserved malarial reputations, a disease later learned to spread not by 'bad air' but by mosquitos bred in standing water.[160]

Lakes and ponds are, moreover, ephemeral landscape features always fated to fill with sediment and revert to dry land. Like all artificial

[155] Maas, *Moines-défricheurs*, 78, sees a 'symbiosis'; Devailly, *Le Berry*, 567, eschews progressive claims. Petřík et al., "Rybník Jako Součást Hospodářství Vrchnostenského … a Indikátor Podoby Krajiny."

[156] Defosse, "Pêche et pêcheries." In the 1440s workmen had to remove more than a meter of silt from three small ponds on the manor of Baddesley Clinton, Warwickshire (Aston and Bond, "Warwickshire fishponds," 429).

[157] Benarrous, *Grande Brenne*, 318–326, emphasizes the absence of *marais* before the fifteenth century.

[158] Coulon, "Étangs de la Brenne," 15; Andreska, *Lesk a Sláva Českého Rybářství*, 74.

[159] de La Véronne, *La Brenne*, 61–65.

[160] Grand and Delatouche, *L'Agriculture*, 540; Perceveaux, "Essai sur l'origine des étangs" and "Structures et relations économiques"; Durand, "De l'établissement des étangs"; Braudel, *Identity of France*, 204–206; Guérin, *La vie rurale*, 131.

impoundments, each pond had to be maneuvered between that risk of deposition and normal biological succession on the one hand and the opposite hazard of erosion downcutting the barrier dam to restore running water. Without continual upkeep dams crumbled, sluices decayed, vegetation encroached, and many artificial fishponds ceased to be functional still-water ecosystems. Annual maintenance and decade-scale rejuvenation projects permeate Dubravius's list of necessary tasks and likewise records of practice since those of Philip the Fair's Norman ponds.[161] Managers also knew that organically enriched water from densely stocked ponds could inhibit growth of fishes downstream, and set up their water systems to reduce that threat to their crop. Even more than agriculture in general, lacking regular inputs of labour and materials, aquaculture was dubiously sustainable.

Aquaculture transformed human experience of the natural world. After 1292 residents of Hesdin, Artois, no longer lived among suburban fields and meadows but saw or had to work in ponds and woodlands as key elements of a landscape created for luxury display. Across Brenne the river Claise and other streams with vegetated banks where Merovingian St. Cyran (Sigiramnus) had sheltered to fish and high medieval countrymen pastured their livestock,[162] sank beneath permanent water bodies in the rising waves of the late fourteenth century and then the 1450s–1550s. The seasonal wetlands along the Lužnice where in 1379 men of Třeboň still paid for licence to fish,[163] began to vanish. A century later it took only one or two generations to turn the valley into a network of more than fifty interconnected artificial ponds, some small, some immense, and a share of which were at any given time barren dry beds. We have already seen the new pattern of ecological knowledge and physical work required to operate the ponds.

[161] Dubravius, *De piscinis*, lib. 4, chs. 1–2, 5, and 7, and lib. 5, cap. 9. Work on royal ponds at Breteuil, Verneuil, and Glapon in 1313/14 employed the king's *pionnier*, Jean de Moustier, the royal carpenter, and uncounted earth movers at a cost of more than 2,000 livres (Rouillard and Maupoume, "Étangs royaux"); Benoît, *Étangs de Dombes*, 48–49 and 56–57, details maintenance operations on ponds of the lords of Thoire-Villars during decades around 1400. More ongoing maintenance work and expenses appear in Steane, "Royal fishponds," 50–52; Beck, *Eaux et forêts*, 288–291; Benarrous, *Grande Brenne*, 218–224; and Deligne, "Carp in the city," 291–293.

[162] Benarrous, *Grande Brenne*, 262–268 and 315–330, uses pollen profiles, charcoal analysis, and other evidence to correct the myth of a waterlogged early medieval Brenne, so it was rather the region's natural network of streams which had supported the saint's well-remembered fishing (Krusch, ed., "Vita Sigiramni abbatis," caps. 19–22 (pp. 617–619); Laugardière, *L'Église de Bourges*, 179–188; Coulon, "Les étangs," 10–11)

[163] Henningsen, *Besitz und Einkünfte*, 25–26 and 55–59; Bůžek, "Goldene Zeitalter," 82–83.

Long-term social effects were destabilizing, too. Besides the professional pond masters, some ordinary rural people did find opportunity in the fishpond sector servicing large producers or small local markets. Fishers and fishmongers who had worked for or with princes in Burgundy eventually took leases on fragments of the former estates.[164] Wider social circles acquired ponds just in time to drive the post-1450 expansion in Brenne. In Silesia, Poland, and south Germany village notables prominently appear in possession of one or two small ponds. On big estates this could add up. When Himmelskron abbey was secularized in 1547, eighty-two ponds were inventoried on its peasant tenements. Twenty villages in the Pszczyń district of Silesia had in 1536 seventy-one peasant ponds with capacity to produce almost 100,000 juvenile carp.[165]

But for understandable reasons peasants' resistance to aquaculture did not abate. It rather intensified their familiar opposition to privatized natural fisheries. The twelfth-century writer Wace was sure that Norman peasant rebels back in 997 wanted not the generic water rights reported in his source but in particular "to seize the fish from the fishponds."[166] Against theft of fish from an artificial pond laws customary and written made special provisions – *Sachsenspiegel*, for instance, set fines ten times higher[167] – and lords posted special guards, especially when water was lowered for harvest. Who watched the watchers? In Franche-Comté two guards, Fourquon Boison and Jehan Beire of Dampierre, hired in 1371/2 to protect the count's pond, instead themselves broke the dam and caught the fish. A few years later tenants were refusing to work harvesting carp and others to cart *norriens* between ponds.[168] Complaints about illicit and clandestine removal of fish from ponds are a commonplace of court records. Some labourers beat up Pierre de l'Aleu in April 1387 when he tried to stop them fishing in his pond at Neuvy-en-Sologne.[169] In Dombes, Jean-Claude Schmitt has

[164] Beck, *Eaux et forêts*, 304–305 and 329–345.

[165] Schmidt, "Himmelkron," 51; Nyrek, *Gospodarka rybna*, 55. Fournial, *Les villes et l'économie*, 689–690, found some peasant pond owners marketing fish in late fourteenth-century Forez.

[166] "*Es viviers prendre les peissuns*." Wace, *Roman de rou*, bk. 2, line 891 (ed. Andresen, vol. II, p. 64).

[167] Eike von Repgow, *Sachsenspiegel Landrecht*, II: 28, 1–2 (ed. Eckhardt, 157). Like provisions in the Charter of Beaumont, a model of customary law in Lorraine, are remarked in Collin, "Les ressources alimentaires," 43.

[168] Gresser, *Pêche et pisciculture*, 300–308, with several more cases. See also Gresser, "Les délits." Similar events in the duchy of Burgundy are reported in Beck, *Eaux et forêts*, 275–281.

[169] Guérin, *La vie rurale*, 150. More cases are in Gislain, "Rôle des étangs," 92; Querrien, "Pêche et consommation" 2003, 433; McDonnell, *Inland Fisheries*, 18; Aston and

argued, thirteenth-century peasant anger against widespread flooding sublimated into legends where evil emanated from the lord's pond. In 1388 and 1440, however, rebellious peasants there just publicly broke the dams.[170] Collective fishing and destruction of ponds followed by common public meals of the lord's fish are well known from the German Peasants' War – where the social content of such acts is blatant – but also from feuds between Staffordshire factions in the 1530s.[171]

Finally thousands of localized ecological revolutions coloured general cultural style and expectation. The magnate offering 'fish from our own ponds' asserted social power with at least tacit environmental implications: people and nature were both subject to human control and turned to private purpose. Sellers and buyers of pond-reared fish dealt in a standardized commercial product. Dubravius discusses regional customs of selling carp by measure (volume) or by count, favouring the latter to avoid dispute "where carp of equal size are sold."[172] As the Moravian described, so the Polish and the Austrian pond masters behaved, selling their carp and pike in units of sixty (*kop*, *schock*, *sexagena*).[173] Earlier French fish farmers counted by hundreds. Nature had become a unit of account.

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Fish farms served an elite segment of medieval demand for fish. Medieval aquaculture intentionally transformed fish and landscape to fit human ends. Colonizing interventions in the environment achieved intended results and others not intended as well. What nature failed to provide was remedied by altering nature, in this instance by establishing artificial ecosystems to domesticate a useful animal and introduce an exotic life form into still-natural surroundings. Neither environmentally nor socially neutral, the aquaculture response – intensified development – to rising European demand for fish modeled an expectation that fisheries

Bond, "Worcestershire fishponds," 440 and 442; Hartley, "Leicestershire," 294; and Górzyński, *Zarys historii*, 49–50.

[170] Schmitt, *Holy Greyhound*, 164–165. The 1370s–80s were an especially restless time in both England and France, but poaching and attacks on seigneurial property in the latter need study.

[171] Heimpel, "Fischerei und Bauernkrieg"; Currie, "Early history of the carp," 102–103. In the tension-ridden England of 1376 sixty people attacked a park of Evesham Abbey near Ombersley in Worcestershire and took 100 shillings' worth of fish from the pond (Dyer, "Consumption," 35).

[172] "*Statim emptor et sine lite cum uenditore transigit, ubi pares statura Cyprini uenundatur*," Dubravius, *De piscinis*, lib. 5, cap. 7 (ed. Schmidtova, 65).

[173] Rybarski, *Gospodarstwo Księstwa Oświęcimskiego*, 75; Małecki, ed., *Lustracja województwa krakowskiego*, 241.

in particular and nature in general were subject to human authority and invention. The ponds created in Brenne, around Třeboň, and elsewhere in late medieval *paysages piscicole* remain strong human imprints on regional landscapes, now so distinctive as to be protected natural parks and UNESCO biosphere reserves. Again, an east-central European source articulates what cryptic western charters and account books can only suggest had been going on since the high Middle Ages: an inspection team touring lordships of the Kraków cathedral chapter in 1533 was instructed "if there are no fish in a pond, ask who took them out."[174] Fish are present or absent by human agency. It encapsulates a fundamental assumption of the modernist managerial mind.[175]

[174] Ulanowski, ed., *Księgi sdowe wiejskie*, vol. II, p. 481: "*quodsi in eis pisce modo non sunt, inquiratur diligenter, quis eos expiscatus fuerit*."
[175] Compare Towle, "Authored ecosystems" or McNeill, *Something New*, 325–336.

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