INVESTIGATIONS INTO WATERMILL LOCATIONS AND TYPES ON 34 RIVER CATCHMENTS

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Cover Photos

Top: Buckfast Abbey Watermill – Overshot Waterwheel, fed by lade

Below: Harnham Watermill – Undershot Waterwheels fed by River Nadder channelled under the mill

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Synopsis

The document pulls together information gathered in the course of a project which described historical journeys along 34 British rivers. Watermills featured strongly in the accounts, and for each journey, an Appendix was produced, which located all the post-1750 watermills in the catchment and identified their types, e.g., cornmills, textile mills, etc. The tabulated results in the pamphlet amount to information about 3414 commercial and farm watermills, and are presented in such a way as to allow comparisons between areas and river catchments. An overview highlights similarities and differences, but as the project is still work in progress, any conclusions should be regarded as interim. The further work which is envisaged will increase the depth of coverage of English and Welsh watermills to replicate the Scottish template, as regards farm mills, and complete further river journeys, principally in England to achieve broader coverage.

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Investigations into Watermill Locations and Types, on 34 River Catchments

1. Introduction

The purpose of this document is to pull together, summarise, and discuss the information, which we have gathered so far about the locations and types of watermills, which operated after 1750. Much of the information has been made available on the website https://historicaljourneysalongbritishrivers.com/, but there, it is dispersed amongst accounts of historical journeys in a total of 34 main river catchments, so any overview is limited. The document will be placed on the website.

Our main focus here is on Scottish watermills, because most work has been done on them. However, the methodologies developed and applied to Scottish watermills, have also been applied to a number of river catchments in England and Wales, and these results are also presented and discussed. An explanation for the selected time period is needed. Our choice was influenced by the fact that the National Library of Scotland has produced digitised maps, which cover that period; the early Ordinance Survey maps, from the mid-19th century on, were invaluable for locating mills and their types, and though less detailed, earlier maps back to that of Roy in 1750, were also helpful. There are other useful sources, but information about watermills in earlier times is extremely patchy, and generally limited, so there was no possibility of building comprehensive pictures of the distributions of watermills before 1750. For England and Wales the availability of information about the medieval period is greater, given the existence of the Domesday Book of 1086, and more extensive documentation of watermill sites since. However, at this stage we have applied the same criteria, as in Scotland. One other important clarification is that we say only that watermills of the defined types operated at certain locations after 1750; nothing is said about precisely when watermills operated within the period.

Some clarification of the expression 'types of watermills' is required; we divide watermills into 2 classes, namely commercial mills and farm mills. The former were often on the banks of substantial rivers, and in centres of population; the assumption is that agricultural products, for example, corn or sheep's fleeces, were brought to them and processed in the mill. In recent times, such a mill would purchase the raw materials from a farmer and sell them on, after processing, but especially in the more distant past, the farmer would sometimes recover the product of milling, say flour and pay the miller in cash or kind. In either case, a commercial transaction would have taken place, hence the term, commercial, applied to such watermills, (and indeed mills powered by wind, steam or electricity). Farm mills were sited in farmsteads, and were under the control of the owners or tenants; such mills performed operations, which either prepared a farm product for processing in a commercial mill, as for example, threshing mills, which separated grains of corn, or less commonly made products for direct sale as for examples churns, which made butter and cheese from milk. Obviously, there was no payment for mill processing in such cases.

A further sub-division is possible into types by function, and this is an important part of the information we have gathered. However, we go no further into the details of individual watermills and their operation; what matters to us is the fact that they utilised a waterwheel to extract power from flowing water to carry out specific functions. To use common parlance, for us, mills are black boxes with inputs of power, and raw materials, and outputs of finished or semi-finished products. Of course, we are aware that the power transmitted by the rotating waterwheel shaft was often taken by way of gear wheels to one or more separate operations in the mill building,

and that the mode of application of the power could be changed by such devices as gears and cranks, but those are not our concerns here.

Table 1, below, lists classes and some types, which appear in the pamphlet. Note that sawmills are not always commercial as the term has been defined; some certainly are often in large population centres, but others are estate mills, at the unpaid service of those living and working there. We include them all as commercial mills in what follows, but acknowledge the distinction.

Class	**Type**
Commercial	Corn/flour Textile, including spinning, weaving, and fulling Paper Gunpowder Snuff Stone crushing Sawmills
Farm	Threshing Churn

We do feel a need to say more about watermills in general, and to understand their capabilities, and limitations as a power source, and this is covered in a later section, after a brief description of our project, and an explanation for how the subject matter of the pamphlet has emerged. Thereafter, the next section concerns the methodology, explaining first what we set out to achieve, and then how we went about doing it, and overcame some challenges along the way. The results which follow, are of two forms, first a sample of the detailed results produced for a single river catchment, chosen fairly randomly from those looked at so far, and secondly, tabulations of all the mill types found in selected areas of Scotland, and in river catchments in England and Wales. Notes are appended to each presentation, and constitute the discussion, along with an overview, which makes some comparisons intended particularly to illustrate the value of information in the Tables. Finally, we draw some conclusions, but as they refer to an incomplete exercise, they are necessarily brief, general and provisional, and we also indicate our intentions as regards future work.

2. The Development of the Project

The contents of this document have grown out of an original intention to produce accounts of journeys along rivers, a genre well populated in the literature, but strongly biased towards famous rivers like the Thames, Warwickshire Avon, and Wye. We thought that there was much interest in the surroundings of many smaller rivers, especially if considered from a mainly historical viewpoint, and developed a template for describing virtual journeys along the rivers, firstly in areas we knew best, namely in the Lothians and Fife. We call them virtual, because we have not tracked along the whole lengths of the rivers in question, but have identified features of interest, many already visited, but some investigated as a part of the project; all have been tied into accounts of journeys. We have maintained a convention that journeys proceed from source to mouth, and when a significant tributary has been encountered, it also has been tracked from source to mouth. The project grew to consider other rivers, known to us through periods of residence and holidays, so that the list of virtual journeys includes the following 34 rivers:

The Rivers of the Lothians;

1. River Tyne (Lothian)
2. Rivers Esk + South Esk + North Esk
3. Water of Leith
4. River Almond
5. River Avon

The Rivers of Fife and Clackmannanshire

1. River Eden
2. River Leven
3. River Devon

The Rivers of Dumfriesshire

1. River Esk (Border)
2. River Sark
3. Kirtle Water
4. River Annan
5. River Lochar
6. River Nith

The Rivers of Galloway

1. Water of Urr
2. River Dee
3. Water of Fleet
4. River Cree
5. River Bladnoch
6. Water of Luce
7. Piltanton Burn

River Tees

River Esk (Yorkshire)

River Don (Yorkshire)

River Welland

River Witham

The Rivers of East Norfolk

1. River Yare
2. River Wensum
3. River Bure
4. River Waveney

River Usk

River Towy

River Teifi

Other authors have written accounts of a few of these rivers and some of the best benefit from an intimate connection with the river in question, obtained from making an actual journey, mainly on foot. Our versions tie

feature of interest together with linking words, rather than footsteps, hence our use of the word virtual. They are slanted towards the historical artefacts and people of the past associated with the river catchments, and much less towards the present environment, the wildlife, the plant life, and the scenery. The historic artefacts include castles, mansions, abbeys, churches, manor houses, town houses, monuments, and Roman and Prehistoric sites, and also disused railways, and canals. However, we recognised at the outset that two riverside constructs were special in the closeness of their associations with the rivers, namely old bridges and watermills. The former have their place in the accounts, and more general analyses are presented on the website https://historicbridgesofbritain.com/ . The latter also have a place in the accounts, and it was decided early that the locations and functions of every mill in each catchment should be presented in sketch maps and tabulations. As described in the Introduction, it was quickly realised that although there were many medieval mills in Scotland, information concerning them was too patchy to allow any kind of overview, though obviously such information as was available appears in the body of the accounts. Instead, it was decided to focus on the watermills, in both the commercial watermill class, and the farm watermill class, which operated, post-1750. The methodology, which was developed utilised a range of sources, and is described in the next section, but suffice to say here, that it was a lot more complex, than originally anticipated.

When we began looking at English and Welsh rivers, the same template was used, and, as regards watermills, similar techniques have been applied to identify the commercial watermills in the catchments, though there are differences in the availability of maps and other information, some positive, others negative. It is fair to say that much has been learnt as regards finding watermills and identifying their types, in the course of the project, and the information presented for rivers outside Scotland will be reviewed, though we think it reasonably accurate. As yet, we have not really attempted to identify the farm mills in any of the English and Welsh catchments, though we are aware that distributions will be different, for reasons touched on earlier. The motivation for producing the pamphlet grew out of the recognition that although there was much information about watermills in our website, https://historicaljourneysalongbritishrivers.com/ , it has not been pulled together in coherent fashion, and in consequence, few inferences have been made. It is hoped that this document will change that. We end this section by making it clear that our intentions are very different from the creators of a number of fine websites and other publications, some of which are referenced. They give details of many individual watermills, in a number of counties; our purposes are to look at and compare distributions.

3. The Capabilities and Limitations of Watermills

It is likely that the Romans brought watermills to England, and they spread throughout the medieval period all over Britain and Ireland, (there were thousands in total), in the possession of monasteries, landowners, and burghs. Although medieval innovators had realised that a waterwheel could provide the power to carry out other tasks, the great majority were used for flour production, until much later. Medieval watermills sometimes employed horizontal wheels immersed in a flowing stream, but by early modern times, vertical wheels, as shown in the simple diagram of a corn mill, were ubiquitous; water rotates the waterwheel on the left, the drive system changes the rotation axis from horizontal to vertical, and increases the speed of rotation; the top mill-stone is rotated over the fixed lower stone to grind corn, producing flour which passes through grooves to be collected.

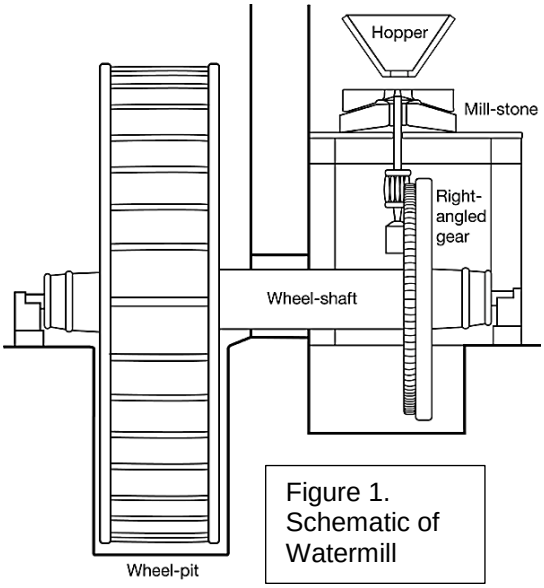


Figure 1. Schematic of Watermill

As might be expected after 1750, in an era of revolutionary improvement of many facets of life, mill wrights and their employers looked to enhance mill technology. The Yorkshire engineer, John Smeaton made mill design a science, and in particular used small scale models to compare the efficiencies of different schemes for delivering water to the wheel. He showed that the so-called undershot design, in which wheel blades, attached to the rim, dipped into water flowing in a lade, when near the 6 o'clock position to be pushed forward by the flow momentum of the stream, were only 20% efficient in utilising energy from the water. Breast-shot, and over-shot designs where the water was directed into buckets at a high point on the wheel, (respectively at the '9 o'clock' and '12 o'clock' points on the circumference) and emptied as the buckets reached a low point, did much better with 75% efficiencies possible. Of course, choice of design was not as simple as that, because the latter types depended on water being made available at a level significantly above the downstream return point, into a river or stream.

Delving a little further into the technical aspects of watermills; the power available is fairly easily calculated, as

Power (kW) = 0.001 X E X 9.81 X M X H,

where E is efficiency, 9.81m/s^2 is the gravitational constant, which converts the distance dropped by the water, between the point where it enters and leaves the wheel (the head), H metres, into a force, M kg/s is the mass flow rate of water over the wheel; note that H is effectively the diameter of the wheel for an overshot wheel, and slightly greater than the radius for breast-shot designs. (The calculation is more complex for undershot wheels, where the calculation requires the stream momentum, to be expressed as a height, dropped by the water, using a standard formula).

Considering an imaginary over-shot mill receiving 5000 gallons per minute, equivalent to 380kg/s, with a waterwheel, 4m in diameter, and an efficiency of 0.7 (70%); the power generated would be 10.5kW, (14.2 hp). Close to twice as much power may be delivered in very favourable circumstances, but even this may seem small compared with car engines generating c100kW, and a modern jet engine, c50000 kW, but on the other hand the best a horse can do over an extended period is 0.5kW, while a very fit man on a treadmill would

struggle to reach 0.1kW over any significant time period. The latter were the comparisons, which mattered to mill-builders in earlier centuries.

Another key parameter is the speed of rotation, and the optimum value for maximum efficiency of an over-shot or breast-shot wheel is given by an empirical formula, 21 ÷ (wheel diameter in metres)^{½}, so would be 10.5 RPM for the imaginary mill discussed above. This formula makes assumptions about a number of factors including the smoothness of the delivery of water, into the wheel containers, with splashing and air entrapment minimised, the subject of much successful experimentation by the Scottish engineer, William Fairbairn. Almost always, the operations carried out by a mill, require rotation speeds higher than reasonable for the water wheel itself, and the gap is bridged by gearing incorporated in the drive train. So, in a corn mill, the movable grinding stone might rotate at 200 RPM, up to 20 times faster than the waterwheel, and governors will often be fitted to limit speed variability, but a price is paid in reduced efficiency, and thus power available, which in turn might limit the sizes of the grindstones and the through-put rate. Hopefully, these paragraphs convey the fact that mill design was not straight-forward, and the improvements made by the likes of Smeaton, and Fairbairn, made a great difference, especially when more complex operations associated with textile manufacture had to be carried out. It should also be added that some of the improvements to the power train were just as important, when a steam engine replaced a waterwheel.

One more aspect, which had to be got right, was the water delivery system. On medium-sized rivers, falling at a moderate rate, the system normally comprised a weir, a sluice gate and a lade or leat, which conveyed a fraction of the river water to the wheel, and returned it to the river from the wheel pit through a tail race. Typically, a weir might be up to a metre high, and water would back up behind it in a pool of that depth. A mill lade, fed normally through a sluice gate, upstream of the weir, tracked the river downstream, sometimes carrying water to one mill, sometimes to a series of mills, and sometimes extending for less than a hundred metres, sometimes more than a kilometre. The elevation at which water arrived at the mill, in comparison with the surface of the river, there or a little downstream, was the main determinant of whether the watermill could be of over-shot, or breast-shot design. Typically a lade might be c1m wide, and only slightly wider than the wheel to minimise the waste of power-delivering water.

Watermills were not only sited on medium sized rivers; there were many on smaller streams. In those cases the lade did not proceed directly to a mill, but fed a mill pond nearby, topping it up at times when the mill was not operating. In this way the mill could be driven by a larger and steadier flow, controlled by a sluice gate, where the delivery channel left the pond, than the stream in question could have provided directly, but of course operation could only be intermittent, to allow refilling of the pond. Finally in this context, in Southern England especially, many rivers descend very slowly, so the head to allow overshot or breast shot feeding to a waterwheel could not be made available. In such cases, watermills were frequently sited over the river taking its whole flow through one or more channels in which undershot waterwheels were positioned, an example is shown on the front cover. Diverts were made to allow water to bypass the mill when it was not operating, but such mills caused disputes, when installed on otherwise navigable rivers. During the 19th century, major towns and cities sought to pipe clean water from springs and headwaters upstream of watermills, and in such cases they had to guarantee a minimum river flowrate to the mill owners. Many reservoirs were built for this purpose, rather than to supply water for domestic and industrial use.

The period after 1750, saw the increasing use of steam power to drive mills, because of the greater power that could be made available, albeit at greater cost, and the flexibility in siting of mills that was conferred, which became more important as more grain was imported. However, many watermills survived well into the 20th century, and a few still operate today, either generating electricity or powering a mill making craft products. Countless mill buildings, often in idyllic settings, have been converted into residences; mill ponds have often been preserved, either as estate features or stocked fishing lakes. Most lades have been filled in, but their routes can often be tracked as hedgerows, or persistent features on grassland.

……..

There was another development in the period, which has had a large part in our work, and needs some comment. Until the late 18th century, threshing (or thrashing) was a manual, labour-intensive, and wasteful operation, and there are even poetic accounts of how unpleasant the task was for the farm workers involved, because of the dust and their physical exertions. Harvested corn stems carrying cobs were laid out on a hard core floor and beaten with flails. This process detached the grain, but separation was a haphazard process, involving the removal by hand of the stems or straw, an important food for farm animals, sweeping up the remaining detritus on the floor and sieving it, so isolating the grain, which could be bagged ready for delivery to a commercial cornmill. It was thought that there was no activity on a medium-sized arable farm that occupied more man hours in a year; there was obvious waste during the process, while it was so slow that deterioration of the crop was probable, before the operation could be completed.

Unsurprisingly, inventive engineers and millwrights designed machines to do the job in the 18th century, with varying but limited degrees of success, until Andrew Meikle, born in Preston, East Lothian, came up with his successful prototype around 1790. The flailing operation was replicated by a rotating drum with curved vanes, which beat the corn stalks fed in from above, against bars making up a cage around the drum, so tearing off the grain, which fell into judiciously placed sacks; the stalks were also discharged in a controlled way. Meikle's machine could be driven by teams of horses, so-called horse gins, but the added power and drum rotation speeds achievable, if the machine was driven by a waterwheel made the process more effective and cheaper to run, if costlier to install.

The story thereafter is of astonishingly rapid spread, of both horse and water powered threshing machines, out from the Lothians where Meikle lived and worked, to neighbouring areas and soon to most of Scotland; at first found mainly on large farms, installations spread down the size range. Shaw, in his magisterial account of Scottish watermills, suggests that up to 4500 were installed in Scotland by 1830, and that saturation was in sight. Our numbers are supportive of his thesis. The technology spread into England and Wales as well, but we know that this part of the story differs in two regards; firstly, installations caused rioting in Cumbria and Wiltshire, in other parts of England, and in parts of South Wales, because farmworkers quite correctly saw them as a threat to employment, (regardless of the fact that it was an unpleasant job, it was better than no job) and secondly, the spread took time, so threshing mills were evolving into portable units powered by steam by the time they reached some counties like Norfolk. By then, the threshing machine could be belt-driven by a steam traction engine, which doubled as the means of moving the machine as required. (This meant that threshing machines were not identifiable as permanent fixtures on OS maps.) The final step in the process was the development of the combine harvester, which incorporated a reaper, a threshing machine, and a mechanism

for bundling straw into bales. Nowadays, these machines are often owned by contractors who service many farms, driving the large vehicles at a few miles per hour, often along narrow roads between venues.

4. Methodology

4.1 Scotland ,

(i) The Investigations

The intention was to identify, as far as practicable, all commercial and farm watermills operating in the Lothians, Fife & Clackmannanshire, Dumfries, and Galloway, at any time between around 1750 and the early 20th century. All river catchments in each area were investigated.

(ii) Sources of Information

The principle source was the first edition of 6 inch to the mile Ordnance Survey (OS) Maps which are freely available on the National Library of Scotland Map Images website (https://maps.nls.uk/) . The following were also referred to for additional information, as appropriate:

a). 25 inch to the mile OS maps, first edition where available but generally second edition
b). The NLS Scottish Watermills Website and the NLS from "Water to Steam" Project website (https://maps.nls.uk/projects/mills/#zoom=6&lat=57.4000&lon=-3.7300) and (https://geo.nls.uk/maps/mills/#zoom=7&lat=56.7708&lon=-4.1603) respectively.
c). Scotland's Places website which holds the Ordnance Survey Name Books for Scotland https://scotlandsplaces.gov.uk/
d). "Water Power in Scotland 1550-1870, John Shaw, 1984, Published by John Donald, Edinburgh
e). Late 18th century or early 19th century maps that are available on the NLS website, according to their quality and availability
f). Google searches for specific place names, local history societies and historians.

(iii) Identification of Commercial Mills

a). Mills were initially identified from 6 inch OS first edition maps, the surveys for which were undertaken between the late 1840s and the late 1860s for the catchments investigated.
b). For each catchment, the name and function of every water mill or suspected water mill marked on the map was recorded, starting at the mouth of the main river and working upstream on the main river. Weirs, mill lades or mill ponds upstream of the potential mill site were used as confirmation of the presence of a water mill.
c). This process was repeated for all tributaries and their tributaries, working upstream systematically. The tributary name, the name of the millstream, mill name and mill function were recorded.
d). Where there was doubt, the mills identified were checked using the 25 inch OS second edition map to confirm whether the mills were water mills and fill in some gaps relating to mill type.
e). If 1st edition 25 inch OS maps were available, a limited number of specific mills where uncertainty remained were checked to obtain further information.
f). The list obtained from the first 5 steps on a spreadsheet was compared with the mills marked on the NLS Scottish Watermills Website or the "From Water to Steam" Project website. Any mills that had been missed were added.

g). Specific mills were looked up using the search function on Scotland's Places, when there were gaps in mill type.

h.) Google searches for specific locations were periodically undertaken in the hope of confirming, or otherwise, the presence of a water mill or to identify a mill type.

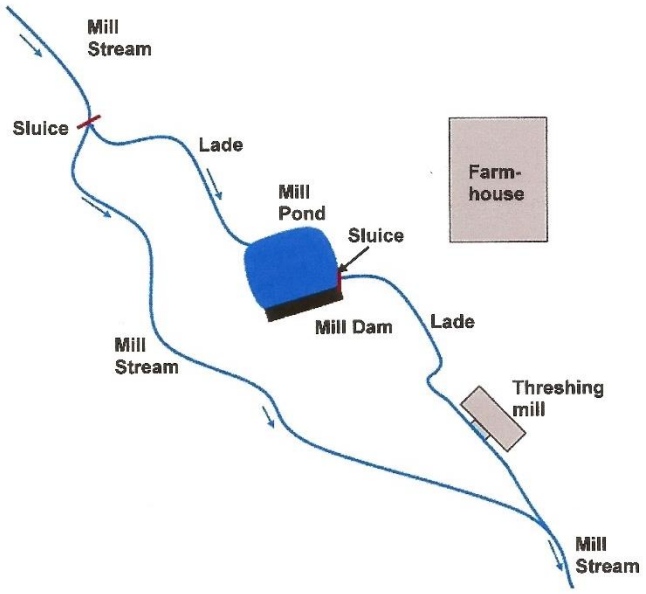
I).The index of Shaw was scanned to determine whether additional mills were listed there. Any omissions in the list were rectified.

j). Late 18th century or early 19th century maps where available on the NLS website were examined to determine whether some water mills had closed before the OS surveys had been made.

(iv) Identification of Farm Mills

The same basic principles were followed as for commercial mills but there were significant differences: A schematic diagram of typical water supply arrangements is shown in Figure 2.

Figure 2: Schematic Diagram of Threshing Mill showing the Water Supply Arrangements commonly observed in First Edition 6 Inches to the Mile OS maps



a). The starting point was the 6 inch OS first edition maps and the same process of systematically working upstream for the main rivers and all other watercourses in the catchment was followed.

b). For each farm identified as having a farm mill, the farm name, the type of mill, the tributary name and the name of the millstream were recorded.

c). There are substantial differences between individual first edition 6 inch OS maps with respect to threshing mills and this was taken into account with the methods applied. In particular water-powered threshing mills are associated with specific water supply features which may include mill lades, mill ponds, mill dams and sluices.

d). Any farms labelled on the 6 inch OS maps as having threshing **mills** were recorded as having threshing mills.

e). Farms where threshing machines had been identified were checked on the first edition 6 inches to the mile OS maps and, often, on the second edition 25 inches to the mile OS maps (as water courses are marked more clearly on this series). Farms were listed as having threshing mills where there was a credible water supply (mill pond, mill dam or mill lade), as in Figure 2.

f). Mill lades and dams were marked on OS maps on a number of farms which were not labelled as having threshing mills or threshing machines but there was mention of threshing in their description in the "Scotland's Places" website. These farms were listed as having Threshing mills.

g). Mill lades and dams were marked on OS maps on a number of farms which were not labelled as having threshing mills or threshing machines and there was no mention of threshing in their description in the "Scotland's Places" website. Each of these farms were recorded as "Farm Mills". Threshing mills were by far

the most common farm mill and each “farm mill” was therefore considered to be a threshing mill. These observations may reflect the fact that the water-powered mills had fallen into disuse by the time of the map surveys. In addition, there were inconsistencies in data recording between the map surveyors and clearly not all threshing mills identified were marked on the maps.

h). A small number of churn mills were marked on farms in the OS Maps of West Lothian. These have been listed as Churn Mills with the catchment, tributary and mill stream recorded.

i). Note that the differences in recording practice for threshing mills between maps/surveyors on the first edition 6 inch maps can be substantial. The maps of Dumfriesshire were quite different in this regard from those in east Kirkcudbrightshire. Relatively few threshing mills or machines were marked in Dumfriesshire although there was a good number of farms with mill ponds and lades. In east Kirkcudbrightshire, almost every farm seemed to be marked as having a threshing mill or threshing machine. There are stretches of East Lothian, where there were virtually no threshing machines marked, but again there were farm mill ponds and lades.

j). The list of threshing mills for the catchment was put on a spreadsheet together with the names of the rivers, tributaries and millstreams, as appropriate. This list was compared with the mills marked on the NLS Watermills Website, adding any that were missed.

4.2. England and Wales

(i) The investigations

Only commercial mills have been investigated so far in England and Wales. These investigations included nine English rivers (Tees, Don, Wensum, Yare, Bure, Waveney, Welland, Witham and the Yorkshire Esk) and three Welsh rivers (Usk, Towy and Teifi). For eight of the above-listed rivers, the presence of watermills was investigated only on the named rivers and their major tributaries. For the ninth English river (the Yorkshire Esk) and the three Welsh rivers, all rivers and streams within the catchment were investigated to determine the presence of commercial watermills.

(ii) Sources

The first and second editions of 6 inch to the mile Ordnance Survey (OS) Maps were the main sources of water mill information for most catchments investigated. The surveys for the first edition 6 inch OS maps used for English and Welsh catchments were undertaken in the 1860s, 1870s and 1880s, significantly later than the surveys for the equivalent Scottish maps. The second edition surveys were between 1898 and 1913. These sources were backed up using:

a). The excellent Norfolk Mills Website (http://www.norfolkmills.co.uk/) provided essential information for the Norfolk catchments.

b). The Coflein website (https://coflein.gov.uk/en/) was an enormous help for the work on the three Welsh Catchments.

c). Water Power on the Sheffield Rivers (2nd Edition Ball C., Crossley D. & Flavell N. ed. South Yorkshire Ind. Hist. Soc. 2006) provided a huge body of information on Sheffield Watermills in the River Don catchment.

d). The first edition and second edition 25 inch to the mile OS maps were used to find additional information when appropriate and when they were available on the NLS map site.

e). Late 18th century or early 19th century maps were used to supplement the above information when these were readily available.

f). Google searches for specific locations were periodically undertaken to attempt to confirm, or otherwise, the presence of a water mill or to identify a mill function.

(iii) Identification of Commercial Watermills

The second edition 6 inch OS maps were used as a starting point as these were available as a seamless zoomable layer on the NLS Maps website. The first edition 6 inch OS maps are only available as individual sheets in England and Wales and therefore more difficult to use when following many river courses. They were used in conjunction with the second edition maps to provide additional information, particularly on mill type.

a). For each catchment, the name and function of every water mill or suspected water mill marked on the map was recorded, starting at the mouth of the main river and working upstream on the main river. Upstream weirs, mill lades or mill ponds were used as confirmation of a water mill.
b). For the Rivers Tees,' Don, Wensum, Yare, Bure, Waveney, Welland and Witham, this was repeated for the main tributaries only, working upstream systematically. As well as the names and functions of the mills, the tributary names and mill streams were recorded.
c). For the Yorkshire Esk and the three Welsh rivers investigated (Usk, Towy and Teifi) all rivers and streams within the catchment were investigated, again working upstream systematically. As well as the names and functions of the mills, the tributary name and the name of the millstream, were recorded.
d). Where there was doubt, the mills identified were checked using the 25 inch OS second edition map (if it was available) to confirm whether the mills were water mills and to fill gaps relating to mill function. If 1st edition 25 inch OS maps were available, a limited number of specific mills where uncertainty remained were checked to obtain further information.
e). This information was supplemented, as appropriate, by information from the Norfolk Mill Site, Coflein and other local sources.
f). The mills on the River Don and its tributaries in the Sheffield area that are listed in "Water Power on the Sheffield Rivers" were included in our listings.
g). Google searches for specific locations were periodically undertaken in the hope of confirming, or otherwise, the presence of a water mill or to identify a mill function.
h). Where available, late 18th century or early 19th century maps were examined to determine whether some water mills had closed before the OS surveys.

In this section dealing with our methodology, we have given a very full account, to aid anyone wishing to do similar work in the future. Obviously we should be pleased to hear of any lines we have not pursued. The painstaking investigations have been both time consuming and somewhat tedious, but hopefully the results will be viewed as making the effort involved, worthwhile.

5. Results

The results presented in the pamphlet are of two types. In sub-section 5.1, an example of the information available about the locations and types of watermills, is given in Tables 2, 3, & 4. The choice of the River Eden in Fife was random from a total of 34 main rivers, for which similar information is available in appendices attached to accounts of river journeys on the website https://historicaljourneysalongbritishrivers.com/. In addition there is comparable information available for a number of lesser streams in Scotland on the website. One rider is necessary, in that it is only for Scottish rivers, that the watermills on the smallest tributaries have been identified, and for those rivers only, information on farm mills (mainly threshing mills) is presented.

In sub-section 5.2, Tables 5, 6, 7, 8, 9, & 10, summarise the results of the type shown in Tables 2, 3, & 4, for the catchments of all the rivers considered, giving the frequencies of occurrence of each mill type. The Tables group the rivers as follows;

Table 5 – Rivers of the Lothians

Table 6 – Rivers of Fife & Clackmannanshire

Table 7 – Rivers of Dumfriesshire

Table 8 – Rivers of Galloway

Table 9 – English Rivers

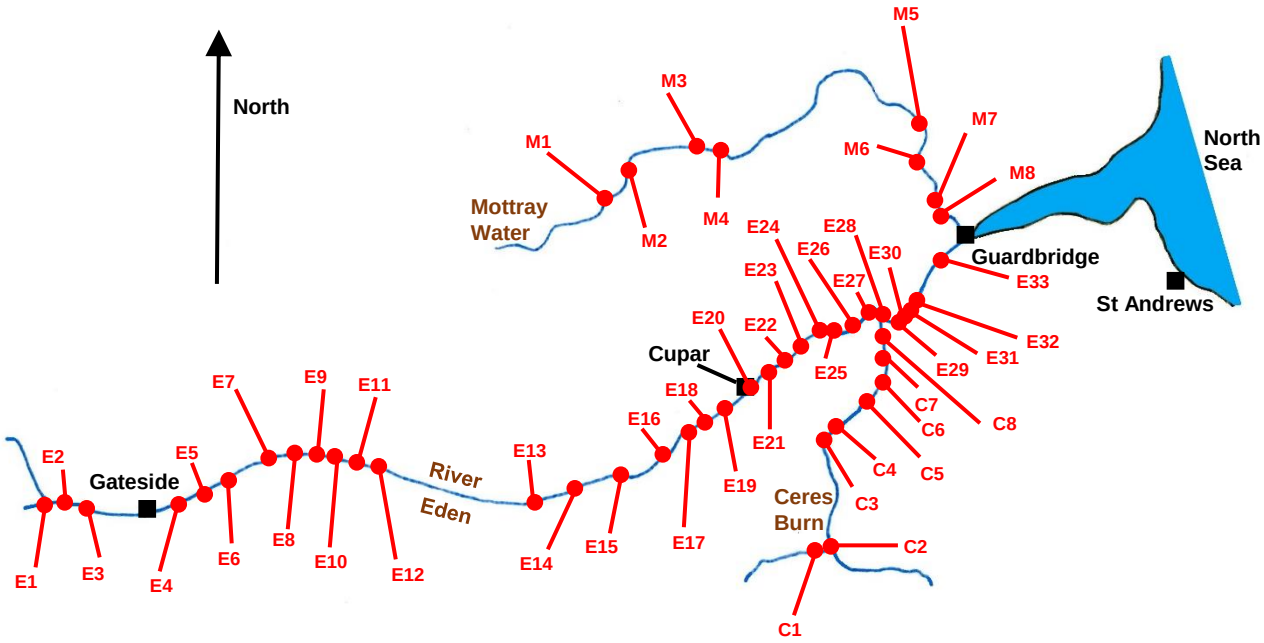
Table 10 – Welsh Rivers

Below each Table are notes which comment on interesting features therein.

In subsection 5.3, there is an overview, which seeks to briefly compare and contrast aspects of the totality of information presented in the Tables.

5.1 Locations and Types

Table 2: Water Mills on the River Eden and its tributaries



River Eden

Code	Mill	Type	Code	Mill	Type
E1	Burnside	Corn	E20	Cupar Flax Mills	Flax, Wash Mill, Snuff, Coffee
E2	Gleneden	Starch			
E3	Barnaty	Flour	E20	Cupar Mills	Corn, Flax, Threshing
E4	Edensbank	Textiles, Saw	E20	Edenside Print Works	Printing
E5	Colin's Den Mill	Barley	E21	Thomaston	Corn & Flour
E6	Corston	Corn, Wauk	E22	Bullass Mill	Unknown
E7	Strathmiglo West	Corn	E23	Tailabout	Flour
E8	Strathmiglo	Bleachfield	E24	New Mills (1)	Flour & Barley
E9	Strathmiglo East	Corn	E25	New Mills (2)	Flax Spinning
E10	Wauk Mill	Wauk	E26	New Mills (3)	Saw
E11	Cash	Corn	E27	Rumgay	Unknown
E12	Dunshalt	Bleachfield, starch	E28	Dairsie	Corn
E13	Ramornie	Beetling, Lint	E29	Lydox (1)	Flax Spinning
E14	Pitlessie	Corn & Barley	E30	Lydox (2)	Corn
E15	Cults (1)	Wash Mill	E31	Dron (1)	Corn
E16	Cults (2)	Corn & Flour, saw	E32	Dron (2)	Threshing
E18	Springfield Russell	Flax Spinning	E33	Nydie	Corn
E19	Tarvit	Flax Spinning			

Tributaries

Mottray Water

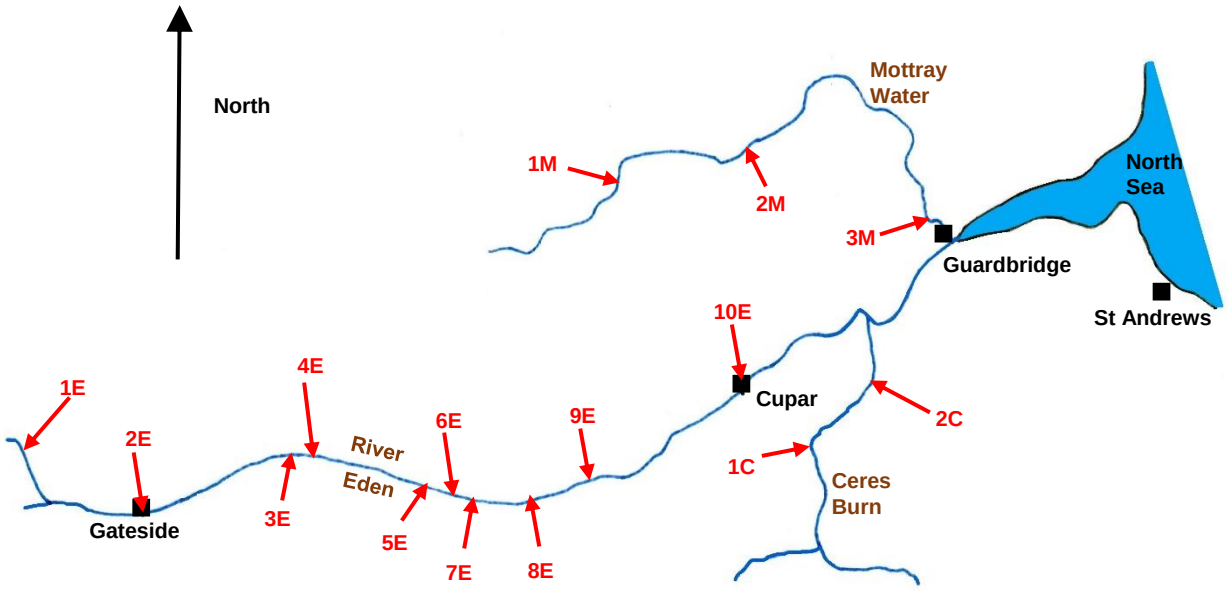
Code	Mill	Type
M1	Rathillet	Corn
M2	Sturton	Corn
M3	Kilmany 1	Corn
M4	Kilmany 2	Saw
M5	Brackmont	Corn
M6	Southead	Flour
M7	Milton 1	Corn
M8	Milton 2	Saw

Ceres Burn

Code	Mill	Type
C1	Teasses	Corn
C2	St Ann's	Bleachfield
C3	Bridgend	Bleachfield
C4	Ceres	Corn, lint
C5	Pitscottie	Flax spinning
C6	Blebo	2 X textiles, Barley
C7	Yoolfield	Flax spinning
C8	Kemback	Saw

Table 3: Mills on other River Eden Tributaries

Locations of Tributaries, see tables below for the key to the codes



River Eden

Tributary Code	Tributary	Mill stream	Mill	Mill Type
1E	Carmore Burn	Carmore Burn	Balcanqual	Corn
2E	Morton Burn	Morton Burn	Pitlochie	Unknown
2E	Morton Burn	Morton Burn	Edentown	Corn
3E	Auchtermuchty Burn	Auchtermuchty Burn	Auchtermuchty (1)	Corn
3E	Auchtermuchty Burn	Auchtermuchty Burn	Auchtermuchty (2)	Textiles
3E	Auchtermuchty Burn	Pitcairlie Burn	Lochmill	Corn, Threshing
3E	Auchtermuchty Burn	Pitcairlie Burn	Lumquhat Mill	Unknown, Threshing
3E	Auchtermuchty Burn	Auchtermuchty Burn	Auchtermuchty Bleachfield	Bleachfield
3E	Auchtermuchty Burn	Auchtermuchty Burn	Reedie Mill	Sawmill
4E	Falkland Burn	Falkland Burn	Falkland Lint	Textiles
4E	Falkland Burn	Ballingall Burn	Drumdreel	Sawmill
4E	Falkland Burn	Ballingall Burn	Woodmill	Corn
4E	Falkland Burn	Maspie Burn	Falkland	Flour
5E	Moss Burn	Moss Burn	Lathirsk	Unknown
6E	Rossie Drain	Black Burn	Woodmill	Flour
6E	Rossie Drain	Collessie Burn	Collessie Mill	Corn
7E	Freuchie Burn	Freuchie Burn	Kirkforther	Textiles
7E	Freuchie Burn	Freuchie Burn	Forther	Corn
7E	Freuchie Burn	Freuchie Burn	Whole/Wauk	Textiles
7E	Freuchie Burn	Freuchie Burn	Channelhall (1&2)	Textiles
7E	Freuchie Burn	Freuchie Burn	Freuchie	Corn
7E	Freuchie Burn	Freuchie Burn	Orkie	Unknown
8E	Kettle Burn	Rameldry Burn	Rameldry 1	Corn
8E	Kettle Burn	Rameldry Burn	Rameldry 2	Saw
9E	Rankeilour Burn	Rankeilour Burn	Daft	Corn
9E	Rankeilour Burn	Rankeilour Burn	Rankeilour Mains	Saw

Tributary Code	Tributary	Mill stream	Mill	Mill Type
9E	Rankeilour Burn	Rankeilour Burn	Peterhead	Saw
9E	Rankeilour Burn	Rankeilour Burn	Rankeilour	Unknown
9E	Rankeilour Burn	Rankeilour Burn	Ballomill	Unknown
9E	Rankeilour Burn	Fernie Burn	Connochy	Unknown
10E	Lady Burn	Kinloss Burn	Clink	Corn
10E	Lady Burn	Lady Burn	Cupar Grain Mill	Corn
10E	Lady Burn	Lady Burn	Lebanon Sawmills	Saw, Flax, Wash Mill
10E	Lady Burn	Lady Burn	Burn Square Tannery	Tannery

Tributaries
Ceres Burn

Tributary Code	Tributary	Mill stream	Mill	Mill Type
C1	Craigrothie Burn	Craigrothie Burn	Craigrothie	Corn
C1	Craigrothie Burn	Craigrothie Burn	Baltilly	Corn
C2	Kinninmonth Burn	Kinninmonth Burn	Baldinny	Unknown

Mottray Water

Tributary Code	Tributary	Mill stream	Mill	Mill Type
M1	Windygates Burn	Windygates Burn	Luthrie Mill	Corn
M2	Forret Burn	Forret Burn	Forret	Corn
M3	Moonzie Burn	Moonzie Burn	Cairnie	Unknown
M3	Moonzie Burn	Moonzie Burn	Fingus	Unknown
M3	Moonzie Burn	Moonzie Burn	Moonzie	Corn

Table 4: Farm Mills in the River Eden Catchment

(a) River Eden

River/tributary	Mill Stream	Mill	Type
Unknown	Unknown	Wester Gospetry	Threshing*
Lappie Burn	Lappie Burn	Lappie	Threshing*
Unknown	Unknown	Wester Upper Urquhart	Threshing
Auchtermuchty Burn	Unknown	Newhill	Threshing*
Auchtermuchty Burn	Auchtermuchty Burn	Lumquhat Mill	Threshing
Auchtermuchty Burn	Clements Burn	Lochiebank	Threshing*
Rossie Drain	Rossie Drain	Rossie	Threshing
Rossie Drain	Unknown	Cornhill	Threshing
Freuchie Burn	Freuchie Burn	Orchie	Threshing*
Morton Burn	Morton Burn	Upper Pitlochie	Threshing*
Morton Burn	Morton Burn	Nether Pitlochie	Threshing*
Freuchie Burn	Freuchie Burn	Orkie	Threshing*
Kettle Burn	Kettle Burn	Holekettle	Threshing*
Cults Burn	Unknown	Lower Bunzion	Threshing*
Cults Burn	Unknown	Cults	Threshing
Rankeilour Burn	Fernie Burn	Glenduckie	Threshing
Rankeilour Burn	Fernie Burn	Lindifferon	Threshing
Rankeilour Burn	Unknown	Pathcondie	Threshing
Rankeilour Burn	Unknown	Nisbetfield	Threshing*
Rankeilour Burn	Ballintaggart Burn	Ballintaggart	Threshing
Unknown	Unknown	Springfield farm	Threshing*

River/tributary	Mill Stream	Mill	Type
Lady Burn	Unknown	Kilmaron	Threshing
Lady Burn	Unknown	Easter Balgarvie	Threshing
Lady Burn	Unknown	Springfield House	Threshing
Unknown	Unknown	Todhall	Threshing
River Eden	River Eden	Dron (2)	Threshing
Unknown	Unknown	Seafield	Threshing

* These mills were identified from the presence of mill lades, dams or ponds on the farm

(b) Mottray Water

River/tributary	Mill Stream	Mill	Type
Mottray Water	Unknown	Blinkbonny	Threshing*
Mottray Water	Unknown	Balmeadow	Threshing*
Mottray Water	Mottray Water	Starr	Threshing*
Mottray Water	Unknown	Denmuir	Threshing
Mottray Water	Unknown	Ayton	Threshing*
Mottray Water	Unknown	Starr	Threshing*
Mottray Water	Unknown	LewisGrange	Threshing*
Mottray Water	Unknown	Fincraigs	Threshing*
Mottray Water	Unknown	Brighouse	Threshing*
Mottray Water	Unknown	Easter Kinnear	Threshing*
Moonzie Burn	Unknown	Fingask	Threshing

* These mills were identified from the presence of mill lades, dams or ponds on the farm

(c) Ceres Burn

River/tributary	Mill Stream	Mill	Type
Craighall Burn	Craighall Burn	Bandirran	Threshing*
Craighall Burn	Unknown	Newbigging of Craighall	Oats, Threshing
Kinninmonth Burn	Wilkieston Burn	Burnsquare	Threshing*
Kinninmonth Burn	West Baldinnie Burn	Upper Baldinnie	Threshing
Kinninmonth Burn	Kinninmonth Burn	North Callange	Threshing
Kinninmonth Burn	Kinninmonth Burn	Kinninmonth	Threshing
Unknown	Unknown	Backfield of Ladeddie	Threshing*

* These mills were identified from the presence of mill lades, dams or ponds on the farm

5.2. Frequencies of Occurrence of Mill Types

Table 5. Summary of the Types and Numbers of Water Mills on Lothian Rivers

Mill Type	Numbers of Mills							
	Main Catchments					Totals		
Commercial	Tyne	Esk	Water of Leith	Almond	Avon	Main Catchments	Other Catchments	Grand Total
Corn	29	18	40	23	20	130	30	160
Brewing/ distilling				1	2	3	6	3
Farina						0	1	1
Textile	14	14	13	4	11	56	6	62
Paper	2	15	13	5	3	38	1	39
Leather/ tannery	5	1	2			8		8
Clay/brick					2	2		2
Foundry				2	1	3		3
Glue			2			2		2
Snuff		1	3			4		4
Unknown	4	2		7	5	18	7	25
Saw	9	5	9	9	3	34	5	41
Total	**47**	**52**	**68**	**48**	**46**	**261**	**51**	**312**
Farm Mills								
Threshing	58	47	30	61	36	232	68	300
Churn				3	5	8	0	8
Total	**58**	**47**	**30**	**62**	**38**	**235**	**68**	**303**
Totals: All Mills	**105**	**95**	**97**	**107**	**84**	**488**	**119**	**607**

Totals in the columns do not always add because watermill functions changed on occasion

Notes:

1. The total number of watermills operating in the Lothian river catchments at some time after 1750 was 607. This seems to us a very large number, and while we may have missed a few, and included a few which were not water-powered, we believe our estimate to be accurate.

2. Of these watermills, 312 were commercial mills as we have defined them, and 303 were farm mills; that balance would have been altered if we had assigned 41 saw mills differently, as discussed earlier.

3. More than half of the commercial mills were corn mills, 160, understandable given that the Lothians, and especially East Lothian, have a long history as corn-growing farmland. It may surprise that so many are on the Water of Leith, but those building corn mills could locate them near the growing areas, or in a centre of population like Edinburgh where the flour produced would be used. Transport costs would be little different for grain or flour.

4. The Table highlights some industrial specialisations in different river catchments like paper-making in the River Esk and Water of Leith catchments, and that textiles were manufactured in all catchments.

5. As regards threshing mills, they were fairly uniformly spread through all the catchments, including those of the lesser and smallest streams.

6. The numbers in the Table refer to watermills which operated for a part of the period after 1750. None should be assumed to have operated concurrently with any other, or for the whole defined period, though for some, it is possible to be more precise, and this information appears in river journey texts.

Table 6. Summary of the Types and Numbers of Water Mills on Fife and Clackmannan Rivers

Mill Type	Numbers of Mills					
	Main Catchments			Totals		
Commercial Mills	**Eden**	**Leven**	**Devon**	**Main Catchments**	**Other Catchments**	**Grand Total**
Corn, flour	46	43	3	92	59	151
Brewing, distilling	2	1	1	4	4	8
Starch	2			2		2
Textiles, leather	28	41	29	98	28	126
Paper, printing	1	4	2	7		7
Iron		2		2	5	7
Snuff	1	1		2	1	3
Flint		1		1		1
Slate Pencil		1		1		1
Coffee	1			1		1
Bone				0	1	1
Unknown	10	2		12	12	24
Saw	12	20	5	37	15	52
Total	**94**	**111**	**39**	**234**	**124**	**368**
Farm Mills						
Threshing	50	37	12	99	47	146
Grand Total	**140**	**147**	**51**	**338**	**167**	**505**

Totals in the columns do not always add because watermill functions changed on occasion.

Notes:

1. The total number of watermills operating in the Fife and Clackmannan river catchments at some time after 1750 was 505. This seems to us a very large number, and while we may have missed a few, and included a few which were not water-powered, we believe our estimate to be reasonably accurate.

2. Of these watermills, 368 were commercial mills as we have defined them, and 146 were threshing mills; that balance would have been altered if we had assigned 52 saw mills differently.

3. Almost half of the commercial mills were corn mills, understandable, given that arable farms predominated in large parts of the countryside. The exception was the River Devon catchment, where even given the landscape, high ground upstream, and coalfields downstream, the number is remarkably small.

4. The Table highlights the importance of textile production throughout the area, but the Table hides differences; woollen cloth was produced in the River Devon catchment, but linen was produced elsewhere.

5. As regards water powered threshing mills, they were fairly uniformly spread through all the catchments, including those of the lesser and smallest streams except unsurprisingly that of the River Devon.

6. Horse driven threshing mills (horse gins) have no necessary association with river catchments. However, applying methods developed by Professor Bishop, 179 horse gins were found in the River Eden catchment, as compared with 50 water powered threshing mills. It should be remembered that we are dealing with quite a dry region, so water sources utilisable to power threshing mills were most likely limited.

7. The numbers in the Table refer to watermills which operated for a part of the period after 1750. None should be assumed to have operated concurrently with any other, or for the whole defined period, though for some, it is possible to be more precise, and this information appears in river journey texts.

Table 7. Summary of the Types and Numbers of Water Mills on Dumfriesshire Rivers

Mill Type	Numbers of Mills								
	Main Catchments						Totals		
Commercial	**Esk**	**Sark**	**Kirtle**	**Annan**	**Lochar**	**Nith**	**Main Rivers**	**Lesser Rivers**	**All Rivers**
Corn	20	2	5	29	4	31	91	3	**94**
Brewing/ distilling	2			1			3		**3**
Farina							0		**0**
Starch							0		**0**
Textile	6		1	10		14	31		**31**
Paper							0		**0**
Tannery	1			1		3	5		**5**
Mining/ quarrying						3	3	1	**4**
Forge/ smithy		1	1	1		3	6		**6**
Bone		1		1		1	3		**3**
Snuff							0		**0**
Other					1		1		**1**
Unknown				4	2		6		**6**
Saw	8	1	4	25	4	25	67	2	**69**
Total	**37**	**5**	**11**	**65**	**11**	**79**	**208**	**6**	**214**
Farm Mills									
Threshing	20	6	5	76	28	239	374	5	**379**
Totals: All Mills	**57**	**11**	**16**	**141**	**39**	**315**	**579**	**11**	**590**

Totals in columns do not always add because watermill functions changed on occasion.

Notes:

1. The total number of watermills operating in the Dumfriesshire river catchments at some time after 1750 was 590. This seems to us a very large number, and while we may have missed a few, and included a few which were not water-powered, we believe our estimate to be accurate.

2. Of these watermills, 214 were commercial mills as we have defined them, and 379 were farm mills; that balance would have been altered if we had assigned 69 saw mills differently.

3. Corn mills and saw mills predominate amongst the Commercial watermills, perhaps highlighting the fact that Dumfriesshire is predominantly rural. The distribution of both indicates the changes in landscape in the upper river valleys; in the 19th century corn was grown in areas now afforested or rough moorland.

4. As regards water powered threshing mills, they were not uniformly spread through the catchments. They were surprisingly rare in the eastern catchments, common on the River Annan, and remarkably common in the River Nith catchment, especially in the lower reaches.

5. The numbers in the Table refer to watermills which operated for a part of the period after 1750. None should be assumed to have operated concurrently with any other, or for the whole defined period, though for some, it is possible to be more precise, and this information appears in river journey texts.

Table 8. Summary of the Types and Numbers of Water Mills in Galloway Rivers

Mill Type	Numbers of Mills									
	Main Catchments							Totals		
Commercial	Urr	Dee	Fleet	Cree	Bladnoch	Luce	Piltanton	Main Rivers	Other Rivers	Grand Total
Corn	17	26	6	7	9	3	1	69	29	98
Brewing/ distilling			1	1	1			3		3
Farina			1	2	1		1	5	1	6
Starch					1		1	2	2	4
Textile	5	5	5	6	3	3		27	9	36
Paper	1	1						2		2
Tannery		1	2	2		2		7		7
Mining/ quarrying	1	1		1				3	1	4
Forge/ smithy	2				1			3	1	4
Bone		1						1	2	3
Snuff		1		2				3		3
Other	1							1		1
Unknown	3	3	2	1	2	1		12	4	16
Saw	9	10	3	5	6	0	1	34	13	47
Total	**36**	**48**	**19**	**23**	**24**	**8**	**4**	**162**	**54**	**216**
Farm Mills										
Threshing	99	118	32	52	37	17	22	377	196	573
Totals: All Mills	**135**	**166**	**51**	**74**	**61**	**25**	**26**	**538**	**245**	**783**

Totals in the columns do not always add because watermill functions changed on occasion.

Notes:

1. The total number of watermills operating in the Galloway river catchments at some time after 1750 was 783. This seems to us a very large number, and while we may have missed a few, and included a few which were not water-powered, we believe our estimate to be accurate.

2. Of these watermills, 216 were commercial mills as we have defined them, and 573 were farm mills; that balance would have been altered a little but not substantially, if we had assigned 47 saw mills differently.

3. Corn mills and saw mills predominate amongst the Commercial watermills, perhaps highlighting the fact that Galloway is predominantly rural. The distribution of both indicates the changes in landscape in the upper river valleys; in the 19th century corn was grown in areas now afforested or rough moorland.

4. As regards water powered threshing mills, they seem fairly uniformly spread, given differences in sizes of catchments. The very large numbers on the many small streams, which were not considered separately, make a large contribution to the total.

5. Horse driven threshing mills (horse gins) have no necessary association with river catchments. However, applying methods developed by Professor Bishop, evidence for 37 horse gins was found in the River Urr catchment, as compared with 99 water powered threshing mills. Far more water sources were probably available in this comparatively wet region than near the drier east coast. There was evidence on 11 farms for the use of both horse power and water power. It is reasonable to think that this shows a progression from the use of horse power to more effective water power, but we cannot be certain.

6. The numbers in the Table refer to watermills which operated for a part of the period after 1750. None should be assumed to have operated concurrently with any other, or for the whole defined period, though for some, it is possible to be more precise, and this information appears in river journey texts.

Table 9. Types and Numbers of Commercial Mills on English Rivers and Main Tributaries after 1750.

Mill Type	Numbers of Mills								
	Don	**Tees**	**Wensum**	**Yare**	**Bure**	**Waveney**	**Welland**	**Witham**	**Esk**
Corn	63	34	17	15	20	14	28	25	18
Textile	20	13	1	2	2	3	1	1	6
Paper	16	4	4	2	1	0	0	2	1
Bark/leather	1	0	0	0	0	0	0	0	0
Metal industry	117	1	0	0	0	0	0	0	0
Slate	0	0	0	0	0	0	0	1	0
Bone	1	0	1	0	0	0	0	0	0
Snuff	4	0	0	0	0	0	0	0	0
Pencil	0	1	0	0	0	0	0	0	0
Glass grinding	1	0	0	0	0	0	0	0	0
Tobacco	1	0	0	0	0	0	0	0	0
Mustard	0	0	0	1	0	0	0	0	0
Unknown	10	3	0	0	1	0	0	1	0
Saw	7	3	1	1	0	0	0	1	1
Total	**213**	**49**	**18**	**17**	**21**	**14**	**29**	**30**	**24**

Notes:

1. On each river, except the River Don, the number of watermills, under the umbrella term, cornmill, (essentially all those processing cereal grains) greatly exceeds the number performing all other tasks.

2. The picture for the Yorkshire River Don is completely different from those for all the other rivers, not just in England, thanks to the very large number of metal processing watermills in and around Sheffield. It should be noted that there were also many cornmills, mainly higher in the catchment, unsurprising given the large population to be fed.

3. The numbers of watermills, and especially cornmills in East Norfolk, (Rivers Wensum, Yare, Bure and Waveney) may seem surprisingly small, but according to the website http://www.norfolkmills.co.uk/index.html, there were 4 or 5 times as many windmills as watermills operating in the 19th century. Windmills may well have played a significant role in other low-lying regions of Eastern England, where wind was easier to use than water.

4. Significant numbers of textile mills operated on the northern rivers, and again caution must be shown as regards low numbers elsewhere, but given the dominance of the woollen industry at different periods in different parts of England, it is surprising that more watermills in this grouping do not appear to have survived.

5. The small numbers of sawmills are surprising, and we have no clear explanation, as yet.

6. We have identified 415 commercial watermills on English rivers so far, which operated after 1750, and the data is interesting. However, this is work in progress, and we expect to be able to say more in future, as we attempt to build towards a complete picture.

Table 10. Summary of the Types and Numbers of Commercial Mills in the Catchments of 3 Welsh Rivers after 1750

Mill Type	Number of Mills		
	Usk	**Towy**	**Teifi**
Corn	52	115	57
Textile	6	62	84
Paper	4	0	0
Bark/leather	0	1	0
Metal industry	13	6	2
Slate	0	0	0
Brick	0	0	1
Bone	0	0	0
Snuff	0	0	0
Pencil	0	0	0
Glass grinding	0	0	0
Tobacco	0	0	0
Mustard	0	0	0
Unknown	20	49	25
Saw	3	9	11
Total	**97**	**239**	**178**

Notes:

1. The numbers of cornmills and textile mills taken together greatly exceed the number of all other types, on each river. However, the balance between the types is completely different, with few textile mills in the River Usk catchment, a predominance of them in the River Teifi catchment, with the River Towy catchment in between, though still with a very large number of textile mills.

2. Watermills employed in the metal industry are most common in the River Usk catchment, and specifically along the tributaries of the lower reaches, like the River Ebbw, but the numbers are nowhere near as large as those on the Yorkshire River Don.

3. There are more watermills of types as yet unknown to us in these catchments. We are of course at the mercy of such sources as we can find in this regard, but would hope to reduce the number in that category.

4. The numbers of commercial watermills in each Welsh river catchment, seem much more like the numbers found in Scottish river catchments than the numbers in most English river catchments. Certainly there is no suggestion that wind-power has had a significant role in South Wales

5. We have identified 514 watermills on 3 Welsh rivers, which operated after 1750, so far, and the data is interesting. However, this is work in progress, and we expect to be able to say more in future, as we attempt to build towards a complete picture.

5.3. Overview of the Data

1. A total of 1110 commercial watermills and 1401 farm watermills, which operated after 1750, in 4 areas of Scotland, have been identified and located. A total of 415 commercial watermills, which operated after 1750, on 9 English rivers have been identified and located. A total of 514 commercial watermills, which operated after 1750 on 3 Welsh rivers have been identified and located. For the great majority of these watermills, it has been possible to specify the operation (s), which they carried out, i.e., their types.

2. The notes following each of Tables 5 to 10 include brief comments about the watermills on individual rivers, and some comparisons are made between frequencies of occurrence of watermills of different types, picking out some specialities; here a few broader points are made to illustrate the use which can be made of the data.

3. As regards Scottish watermills, it is interesting to home in on the processing of corn as in **Table 11** below, though it is in one sense misleading;

Area	No. of Commercial Corn Watermills	No. of Threshing Watermills	Ratio of Threshing to Corn Watermills
Lothians	160	303	1.89
Fife & Clackmannanshire	151	146	0.97
Dumfriesshire	94	379	4.03
Galloway	98	573	5.85

More corn is certainly grown now in the drier, and lower eastern counties, and the numbers of commercial mills in the 1st column suggest that the same was true in the watermill era between 1750 and c1900, though it must be recognised that all commercial cornmills were not equal in throughput capability. Indeed, larger cornmills in the larger conurbations found in the eastern areas, probably increased the disparity, as regards amount of corn milled.

The numbers of threshing mills present a completely different pattern, as seen in the 3rd column. The fact that farms were larger in the eastern areas, means that a smaller number of threshing mills would be expected in any given area of cultivation, there than in the south-west; (there seems to have been very little sharing of farm mills). However, a greater factor can be recognised from the comparisons of the number of horse gins with water powered threshing mills, made between the catchments of the River Eden in Fife and Clackmannan, and the Water of Urr in Galloway. In the former there were 50 water powered threshing mills and 179 horse gins, while in the latter there were 99 water powered threshing mills and 37 horse gins; the respective ratios are 3.6, and 0.37. In qualitative terms, we think that apparent disparities in Table 11, are much reduced by taking horse gins into account, and that other factors may eliminate them, so bringing the results more or less into line with Shaw's estimate that saturation was reached in the numbers of installed farm threshing mills, in most of Scotland. There may also be some evidence of a trend, in which horse gins were replaced by water powered threshing mills.

4. In the course of the project, we have looked again at some river catchments, and our increased understanding applied to this iteration has caused us to remove some farm mills from the Tables. It would be wholly impractical to extend the iterative process to every catchment now, but we believe the numbers in the Tables are very good approximations that provide a unique insight to the distribution of threshing mills in 4 important agricultural areas of Scotland.

5. Looking at the data for the English watermills, the amazing situation on the Yorkshire River Don with the huge concentration of watermills associated with the production of iron products around Sheffield stands out. In the period after 1750, waterwheels powered the greatest such industry in the world. More generally making comparisons with Scottish rivers, the numbers of cornmills on the English rivers seem surprisingly low, but this is probably misleading. We do not consider windmills, but as was pointed out in the notes to Table 9, there were 4 or 5 times as many windmills as watermills operating in Norfolk in the 19th century.

6. As regards, the Welsh watermills, the large number of cornmills on the 3 rivers, 224, is no real surprise, though the contrast with most of the English rivers is certainly striking. There are 154 textile mills on the 3 rivers, with all but 6 on the Rivers Teifi and Towy, and almost all were concerned with the processing of wool; the picture is not unlike that on many Scottish rivers, especially when some account is taken of differences in the areas of the catchments. However, there is a great contrast with the English rivers, looked at so far. The 3 Welsh rivers are peripheral to the great industrial region of South Wales, which is why presumably the numbers of watermills associated with metal processing are relatively low. It is perhaps worth stressing here, that we do not consider the many applications of water-power within the mining industry, because we do not think that the term watermill can be stretched to cover applications in the great majority of collieries.

7. Obviously, the locations of watermills are related to the landscapes and especially the types of farming, which did or did not take place in the areas around them, during the years after 1750. Bulk transport was still primitive, and costly until the railways mushroomed, so as regards cornmills at least, the less movement of corn and grain, before processing, the better, and flour was a lighter, higher value product, if it had to be moved far. Arguments were more nuanced for textiles and other products that came out of watermills, and for them the case might be strong for a location in towns and other larger settlements, which provided a customer base.

It is important to recognise the differences between landscapes now, and those of say 1800. Choosing Dumfriesshire as an example, if one drives south down any of the river valleys, the upper reaches are dominated by coniferous forests on drained moorland, largely of 20th century origins, while the lower reaches show a mix of forests, arable farmland, and especially pasture on which cattle and some sheep are kept. The same trip in 1800, perhaps in a stagecoach, from Edinburgh to Annan, or Dumfries, would have passed through moorlands in the upper reaches with few trees, but with significant areas cleared and limed for farming, on which corn was grown. Especially, during the French Wars between 1793 and 1815, imports of corn were limited, and prices were at a high enough level to make farming on high marginal land just about viable. All this changed afterwards for reasons, which will not be gone into here, but it was gradual, so that cornmills in upland locations operated well into the 19th century. As regards the lower reaches in 1800, there was certainly arable farming and animal husbandry, but there were still areas of mosses and bogs, fit only for sheep grazing at best. Though conditions in different areas, and river catchments were not identical, similar patterns could probably have been observed, and the huge impact of drainage has been universal.

8. Even though the period after 1750 can be regarded as a great age of water power, it also saw a transition to the use of steam power. For watermills the effect increased with time. As early as the late 18th century, steam engines were fitted in commercial watermills, and provided back-up during periods of low waterflow, or simply supplied additional power to enhance milling operations. Even farm mills were affected in this way, at least on large farms as in East Lothian, where it is recorded that there were 80 steam powered threshing mills in 1830.

Use of steam power increased through the 19th century, and frequently the waterwheel became redundant, as steam engines supplied all the power required to carry out milling operations. This signalled the inevitable demise of watermills, because the use of steam power gave flexibility of location, i.e. the mills could be located in large population centres, given that transport of raw materials was by then relatively cheap, or near ports where a growing quantity of imported corn arrived in the country. In addition, economies of scale became possible, large mills could use the greater power of large steam engines, and later electric motors, to increase throughput rates, so fewer mills were required. This has been the progression through the 20th century and into the 21st century, so that many of the watermills still operating are heritage sites producing craft products, or coupled to generators, to produce electricity in isolated places. Given the vast increase in demand for all mill products, these changes were probably inevitable, but whether the accompanying wholesale closure of watermills was economically beneficial overall, rather than to a few large companies, may be less certain, and there must have been a cost to the environment. This pattern is being reversed to a degree as modernised, higher-powered, watermills are appearing on our rivers, just as wind turbines, modern windmills, multiply on land and at sea.

6. Conclusions and Future Intentions

1. Information about the locations and types of 3414 commercial and farm watermills, in Scotland, England, and Wales is presented on the website https://historicaljourneysalongbritishrivers.com/, and the data is summarised in Tables 5 to 10 in this pamphlet. The methodologies, which have been used to capture the data, have been described, in some detail.

2. The uses which can be made of the data summary in this form have been illustrated, by considering relationships between mill locations and land use, and identifying specialities of different river catchments.

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3. The main focus of future work will be on expanding the data set for English and Welsh rivers. We are in the midst of completing journeys along 9 British Rivers Avon (the River Avon in West Lothian has already been considered) as listed:

Warwickshire River Avon
Bristol River Avon
Hampshire River Avon
Devon River Avon
Little Avon (Gloucestershire)
Avon Water (Hampshire)
River Afan (Glamorgan)
Avon Water (Lanarkshire)
River Avon (Highland)

For them, as for those rivers already looked at in England and Wales, we shall consider the watermills on lesser tributaries of all of the rivers. That should bring our understanding of commercial watermills in the catchments up to the same level, as for Scottish rivers.

Although this may be trying to look too far ahead, we have a wish list, which includes the River Tamar, the Kentish Stour, the River Wyre (Lancashire), and the River Clwyd (North Wales), in order to further increase the breadth of our coverage.

4. There are a number of exceptional websites and other publications, some referenced here, dealing with English watermills on a county basis; we shall look to see, whether any of their data can be rendered into the form of our Tables, to allow better comparisons to be made across broader areas. It would be even better if the said authors were to be interested in doing something of that nature.

5. Although we have built considerable knowledge of farm threshing mills in Scotland, we know less about the balance between numbers of horse gins, and water and steam powered mills; further investigations would be valuable. Apart from the contents of a few good learned papers, we know little about threshing mills in England and Wales, and we should like to plug that gap. The contrast between the calm acceptance of the technology in Scotland, and the riots, which resulted from attempts to introduce threshing mills in England, has caught our attention, though we will not explore in depth the wider causes of disturbances.

6. The results of all of our future work on these and any other aspects will be made available on the website, https://historicaljourneysalongbritishrivers.com/, on which more prominence will be given to wider considerations

BIBLIOGRAPHY

As far as possible we have included key references at the appropriate places in the text, but there are some other items relevant to the contents that are listed here.

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Tom Robertson is a native of Edinburgh. His degrees are in physics and, after a career in the steel industry in England, he is now working on historical topics. Tom has written four books and his website, https://drtomsbooks.com/, demonstrates the range of his interests, which include 17th and 18th century historical figures and old bridges.

Alastair Robertson, also an Edinburgh native, is qualified in chemistry. He worked for many years in research and consultancy on issues relating to health at work and in the environment. As well as watermills, Alastair's current interests include maintaining and promoting local Leith's industrial heritage and its greenspaces.