# domesday *to the dawn of the* new millennium

ENVIRONMENT AGENCY

The hand of man and the neglect of our ancestors have deprived us of a river which must have been a vision of glittering beauty

ERNEST PHILLIPS 1921

The Don was once one of the country's finest salmon rivers. They have been absent from Salmon Pastures in Sheffield for more than two centuries. In fact for much of that time the river has been virtually fishless.

Chris Firth's fascinating history of the river is timely. We now have a thriving coarse fishery again and the first salmon was found in Doncaster on 31 December 1995. Chris's study shows how man's exploitation of the Don devastated its ecology long before the pollution of the industrial revolution.

Much has been achieved in recent years but much more remains to be done to protect and sustain the river.

JOHN FAWCETT

CHAIRMAN 1983 - 1997
YORKSHIRE REGIONAL FISHERIES ADVISORY COMMITTEE

Born and raised in the Don catchment, I have witnessed the river's misery throughout my childhood and into adult life. When in my professional life, the opportunity presented itself to begin the restoration of the Don I was eager to be involved. That is not to say that this document has been easy to produce. The collation of information from many varying sources has proved to be extremely challenging.

The final product of many months of hard work is not a scientific record but a reflection borne of personal and professional experience. As such the views it includes may not universally reflect the opinions of fellow professionals, it is however an account of the destructive demands that man's activities have imposed upon the Don system.

The success of the work undertaken over the last twenty years to restore this once magnificent river and its ecosystem is a testimony to the efforts of many hundreds of past and present employees of the Environment Agency and its predecessor organisations.

I hope that as a result of all our efforts future generations will be inspired to exercise greater care and consideration in the management of rivers everywhere and of the Don in particular.

CHRISTOPHER J FIRTH MBE

AREA FISHERIES OFFICER - RIDINGS AREA
ENVIRONMENT AGENCY

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The name Don or Dun as the river was originally called, is an ancient British word implying a deep or low channel. The name Dun is still retained by the Dun Drainage Commissioners, the largest Internal Drainage Board on the system. The village of Barnby Dun also retains the name, originally being *Barnby on the Dun.*


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## GENERAL DESCRIPTION OF THE CATCHMENT

### TOPOGRAPHY

The Don/Rother/Dearne catchment is bounded by the Pennines to the west, the Calder and lower Aire catchments to the north and the Trent catchment to the east and south.

From the heights of the Pennines, the main River Don flows east to its confluence with the River Ouse in the lowlands around Goole. The combined waters of the Ouse and Don then flow into the Humber Estuary.

The River Rother has its headwaters in the Peak District National Park where its tributary, the River Hipper rises. However, the Rother soon flows through urban and industrial areas around Chesterfield and Rotherham before its confluence with the Don just east of Sheffield.

The Dearne drains the high ground to the south and east of Huddersfield and the west of Barnsley. The steeply sided Dearne Valley opens out at Bretton Hall Country Park before passing through Barnsley, Wath and Mexborough, joining the main River Don at Conisbrough.

### GEOLOGY

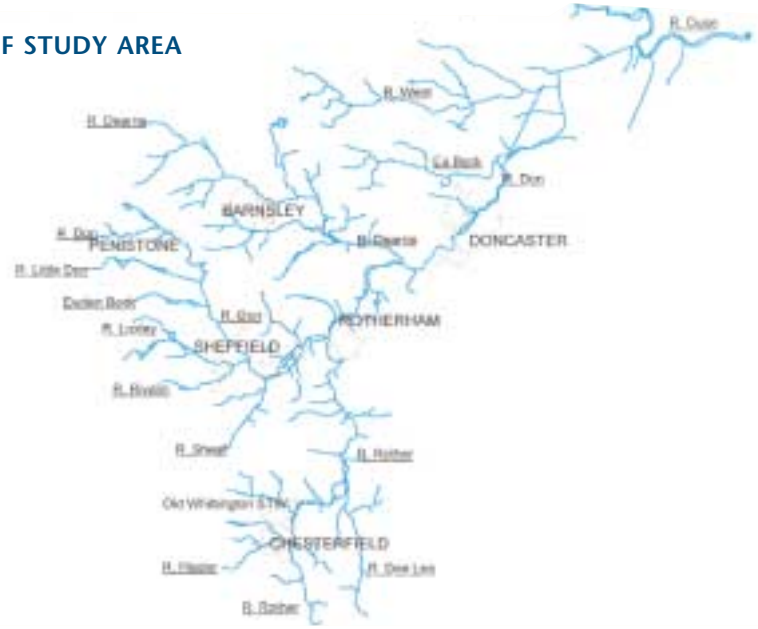
The headwaters of the catchment are formed in the Millstone Grit, a sequence of shales and grits that produce the characteristic moorlands of the Pennines. These are the oldest rocks in the catchment and they are overlain eastwards by successively younger groups of rocks.

The Coal Measures, also of carboniferous age comprise shales, grits and coal seams. Some of the grit horizons produce ridges of higher ground, such as the Wooley Edge Rock. Coal mining has been extensive in the past, originally in the area of outcrop but later moving eastwards and deeper. Many coal seams have been mined but the most notable has been the thick Barnsley seam.

The magnesian limestone that overlie the coal measures form a ridge running in a north south direction. This forms the eastern edge of the Rother catchment and controls drainage patterns as the waters of the Don, Rother and Dearne are channelled through the narrow valley in the limestone between Rotherham and Doncaster. The porous nature of the limestone also gives rise to an absence of watercourses flowing across it.

The soft Sherwood Sandstones form the low lying floodplain between Doncaster and Goole, where there are also extensive areas covered by glacial and alluvial material up to 20 metres thick.

### MAP OF STUDY AREA



# Introduction

"In that pleasant part of merry England which is watered by the River Don there extended in ancient times, a large forest covering the greater part of the beautiful hills and valleys which lie between Sheffield and the pleasant town of Doncaster. The remains of this ancient woodland, remain to be seen at the noble seats of Wentworth and Wharncliffe and around Rotherham".

1819

*These words, written in 1819 are the opening lines of Sir Walter Scott's novel Ivanhoe and help to create an attractive picture of the Don Valley as Scott found it in the early part of the* LAST CENTURY.

To present day inhabitants, the area would not be recognisable from this description. Industry, particularly iron and coal, and the attempts to tame the river for drainage, navigation and impoundment have left little of what apparently gladdened Scott's eye. Many of the beautiful hills and valleys that he referred to have been replaced by spoil heaps, factories, housing estates and the associated infrastructure. True, a part of the ancient forest at Wharncliffe is still apparent but even here, industrial activity intrudes upon the tranquil beauty of the area.

Beautiful as Scott found the valley, he could hardly have believed the extent to which man's activities had already changed the original river. For almost seven hundred years the inhabitants of the valley have been altering, manipulating and constraining the Don for their own purposes and insidiously the river's natural character has been eroded.

Impoundments, in the form of weirs, constituted the first major impact. These were formed to harness the power of the flow and served to supply the newly emerging technology of the time - water mills. Originally the mills were constructed to grind corn for flour, but progressively their use was broadened out to serve other needs, particularly the grinding wheels of the Sheffield cutlers and for textile and paper manufacture.

Following some four centuries after the introduction of impoundments came the next impact. Techniques for draining land by altering or manipulating the natural course of the river were introduced from the continent at the beginning of the 17th Century by Dutch engineers. These entrepreneurs quickly recognised the opportunities presented by the Don, and so began a process of remodelling that was to continue well into the present century.

Next came navigation, the Don had for centuries provided a dangerous passage for small boats as far as Doncaster. However, by the beginning of the 18th Century the developing industries of Rotherham and Sheffield were beginning to demand a cheaper and more reliable way of getting their goods to market. The construction of the navigation, as far as the outskirts of Sheffield, resulted in the creation of further, and often larger, impoundments as well as straightening and manipulating the natural channel.

The physical changes resulting from these three impacts were themselves extremely destructive to the life of the river but it was the final impact, one which occurred a half century after Scott's visit to the valley, which finally condemned the river to a period of almost total ecological destruction.

By 1850 chemical pollution of the water environment began to have serious effects on the River Don and by the turn of the century, the river had been reduced to little more than a foul smelling, lifeless sewer. These abominable conditions were to persist throughout most of the 20th Century and managed to earn for the Don the unenviable reputation for being one of the most polluted rivers in Europe.

These then were the four impacts which served to reduce the Don to the river it was in 1974. The following chapters chart the history and effects of each of these impacts, and use principally fish populations to demonstrate the changes which have occurred.

*Fish have been chosen to serve this purpose for two reasons:*

- they are at the top of the aquatic food chain and therefore reflect changes which have occurred lower down the order, in this case as a result of physical and chemical habitat alteration/destruction.
- historical records of fish populations tend to be more readily available due to their importance as a food resource.

Part 2 of the report charts the history of the restoration and management work undertaken on the Don system by the statutory bodies responsible for water management, Yorkshire Water Authority (1974-1989), National Rivers Authority (1989-1996) and the Environment Agency from April 1996. It attempts to combine the various sources of information regarding chemical quality, ecological status and river management practices and relate these to the improving biodiversity of the river through the 1990's.

Part 3 contains details of the Environment Agency's Local Environment Agency Plans (LEAPS) for the river Don catchment, which will identify the major issues and explains how improvement objectives will be achieved in the future.

## THE VALLEY OF THE RIVER DON PRE-1100AD

In common with many of the river catchments of England and Wales, the lower parts of the river Don once consisted of a massive flood plain with a mosaic of open water and wetland habitats linked to the river itself.

On the higher ground rising away from these areas, willow and alder carr would have been present, which in turn, as the ground rose higher and became dryer would have given way to forests of broad leaf trees. These extensive forest areas which consisted of species such as oak, birch, wych-elm, ash, hazel, elder and holly extended over huge areas of land surrounding the river and upstream to the edge of the Pennine moorland.

An example of these forest conditions, as earlier mentioned, can still be seen at Wharncliffe above Sheffield. Here the remnant woodlands have remained on the steep valley sides where agricultural improvement has been impossible. The soil, being generally thin and acid, supports a vegetation dominated by birch and oak, in particular the sessile oak, *Quercus petraea*. This type of woodland often grades into ash and wych-elm woodland in the valley bottom.

In its original condition, the Don had three separate channels feeding its waters to the sea. The channels formed a delta, with two arms extending in a south-easterly direction towards the Trent, and a third heading in a northerly direction towards the Aire. Running through the low lying lands of the flood plain, these channels frequently spilled over as a result of tidal fluctuations, and by doing so, helped to maintain an amazing biodiversity.

Indicative of the area's rich fauna was its importance as a Royal hunting ground. As well as fish and fowl in great abundance, these wetlands supported huge herds of deer and on the fringes of the forest, wild boar were present in large numbers.

In the 11th Century the Don boasted two tributaries, the rivers Idle and Torne which are no longer connected. They have long since been diverted to flow directly into the Trent, but originally they flowed out to this river via one of the Don's south-easterly flowing channels.

The tidal influence on the Don extended, as it does today, to the outskirts of Doncaster. Throughout this tidal section the river was bordered with marshes some of which remained intact well into the last century. In 1836 Laman Blanchard, writing in an article for the Sheffield Mercury described the river at Barnby Dun as being shallow, of considerable width and flowing through a green savannah. These conditions would have been typical of much of the river in its original state.

Upstream of Doncaster the character of the river began to change. As it passed through the magnificent Magnesium Limestone cliffs of the Don Gorge at Sprotborough, the river began to be characterised by long deep pools interspersed with sections of shallow fast flow where the river passed over rock outcrops in the bed. These pools formed the resting places for huge numbers of salmon as they waited for rain higher up the valley to induce them to proceed further towards their traditional spawning grounds high up in the headwaters. When the conditions became favourable the salmon would have been faced with a choice of continuing up the Don or of turning into one of its two major tributaries the Dearne or the Rother. Both contained excellent spawning and nursery facilities which ensured the success of the salmon population of the Don system.

Upon reaching what is now the centre of the city of Sheffield, the salmon would have found the river opening out into a complex of open water and marshes which had been formed as a result of the converging flows of the river Don with that of tributaries such as the Loxley and Sheaf. This fluvial plain helped to dissipate the energy of the floods which bore down the steep valleys following heavy rain high in the catchment.

The vegetation of this area probably consisted of reed beds, interspersed with willow carrs, enclosing shallow pools. These pools provided breeding and nursery areas to a range of coarse fish species which would have found rich feeding in the relatively warm, productive environment. The fish, in turn, would have supported a range of piscivorous birds such as herons, kingfishers and ospreys as well as mammalian predators such as otters.

Above this fluvial plain the river changed yet again assuming the characteristics of a typical Pennine spate stream. The gradient of the bed increased significantly and with it the velocity of the flow. From this point the river became the resident haunt of the brown trout and dipper. The woodlands described earlier, ran right down to the water's edge at this point often shrouding the bed under a verdant expanse. Towards the headwaters of the river, this cover began to open out giving way to alders spaced along the banks in very much the same way as they can be seen today around Hazelhead near Penistone. The headwaters then travelled across Pennine moorland characterised by wide expanses of semi-treeless open ground. Originally these moorland areas had themselves been part of the great forest that had covered most of old England in prehistoric times, but the trees had been removed by our ancestors many centuries before.

In these clear oxygen-rich upland headwaters which formed the infant river Don, the salmon which had travelled through the varied habitats of the lower river fulfilled their reproductive cycle. These salmon by their very abundance, demonstrated the biological quality of the river Don as it existed in 1100AD and have provided us with a baseline upon which we can assess the damage affected by man's destructive demands over the following nine centuries.

### LIST OF FISH SPECIES IDENTIFIED IN RIVER DON AND TRIBUTARIES PRE 1850

| SPECIES | LATIN NAME |
|---|---|
| Atlantic Salmon | Salmo salar |
| Sea Trout | Salmo trutta |
| Brown Trout | Salmo trutta |
| Grayling | Thymallus thymallus |
| Sturgeon | Acipenser sturio |
| Smelt | Osmerus eperianus |
| Pike | Esox lucuis |
| River Lamprey | Lampetra fluviatilis |
| Brook Lamprey | Lampetra planeri |
| Roach | Rutilus rutilus |
| Dace | Leuciscus leuciscus |
| Chub | Leuciscus cephalus |
| Minnow | Phoxinus phoxinus |
| Rudd | Scardinius erythrophthalmus |
| Tench | Tinca tinca |
| Gudgeon | Gobio gobio |
| Barbel | Barbus barbus |
| Bleak | Alburnus alburnus |
| Bronze Bream | Albramis brama |
| Silver Bream | Blicca bjoernka |
| Carp | Cyprinus carpio |
| Stone Loach | Neomacheilus barbatulus |
| Spined Loach | Cobitis taenia |
| Eel | Anguilla anguilla |
| Burbot | Lota lota |
| Three-spined Stickleback | Gasterosteus aculeatus |
| Ten-spined Stickleback | Pungitius pungitius |
| Perch | Perca fluviatilis |
| Ruffe | Gymnocephalus cernua |
| Bullhead | Cottus gobio |
| Flounder | Platichthys flesus |

## PART 1 - CHAPTER 1a

# Impounding the Flow of the River Don

*BULLHOUSE WEIR*
*One of the oldest & largest structures built across the River Don was the weir at Bullhouse which provided water for a flour mill*

Few rivers in Britain have contributed so significantly to the prosperity of the inhabitants of its valley as the River Don. The topography of the river, with its many suitable tributaries and ideal gradients, lent itself to the development of industries which could exploit the power provided by its descending flows.

The first opportunists in Britain to exploit these natural phenomena were flour millers who, using the technology developed in Europe, built water mills to grind their corn. From the contents of the Domesday Book we can ascertain that over 5,000 such operations were in existence in Britain by 1086. Strangely, it appears that the opportunities were not immediately exploited by the people of the Don Valley, who were somewhat late in taking advantage.

One of the first water mills to be constructed on the system was at Bedgrave on the River Rother. This structure was completed around 1100 and part of the mill is today used as the Visitor Centre of the Rother Valley Country Park. Others were to follow at Lady's Bridge, Sheffield 1210 and Sprotbrough 1279. The goit, or feeder channel, for this former operation is still in existence adjacent to the Kelham Island Industrial Museum in Sheffield.

In terms of longevity these early industries have few parallels and many continued operating for many centuries, the site at Sprotbrough being an excellent example. This mill was in almost continuous use until it was finally demolished in 1934 after almost 700 years of service.

*BEDGRAVE MILL*
*Built around 1100AD the mill was one of the first water powered operations on the Don System*

In order to harness the power of the river's flow, the millers built impoundments (weirs) across the channel to create the 'head' which they required, and directed the water they needed through a race or goit to the water wheel.

These structures constituted the first serious attempt at harnessing and controlling the power of the river and were to become a very significant factor in the future exploitation of the Don and its tributaries.

By the 17th Century several other forms of industry were developing using water power. The burgeoning cutlery trade was in existence, using the flow of the river to turn the grinding wheels which were to proliferate along the Don and its tributaries in the Sheffield area. In 1630, twenty eight such operations were in existence and this figure was to quadruple within the next century.

By 1770 the figure had grown to 161, equating to an impoundment structure feeding water to a grinding wheel every 328 yards (300 meters) of river length.

During periods of normal flow the operation of the grinding mills had only a minimal impact on the river. Only a percentage of the water was diverted, leaving an adequate amount to maintain the ecology of the channel. However, when low flow or drought conditions prevailed, the situation changed rapidly with every available drop of water being conserved to ensure the continuation of the mill's operation. In these conditions it was common for the entire flow to be diverted through the mill pond or goit to the water wheel, leaving the river bed dry between the intake and the outfall.

*UPPER CUT WHEEL DAM ON RIVER RIVELIN*
*A good example of the dams which were constructed to provide water to the mill of a cutlers grinding operation. The mill wheel can be seen in the foreground*

The scale of some of these later impounding structures can be determined from the survey report produced by William Palmer in 1722, which was carried out to identify the difficulties likely to be encountered in making the Don navigable.

Palmer surveyed the river downstream of Sheffield, below where most of the cutlers wheels were situated, however the information in his report gives a clear indication of the size and potential impact of some of the impoundments. The largest of the structures was Attercliffe Forge Dam at a staggering 5 yards (4.8 meters) high, with Holmes Slitting Mill near Rotherham at 4 yards (3.75 meters) coming a close second.

Between Doncaster and Sheffield, Palmer found that there were 13 major impoundments with others existing on the Dearne and Rother. By the turn of the 18th Century it is estimated that the Don and its tributaries had almost 200 such structures controlling their flow.

With the development of navigation, which was fully operational by 1750, further control of river flow was imposed. Locks to regulate the movement of water were introduced with bypass channels around weirs and areas of shallows. The history of the development of the navigation and its impacts is described in Part 1, Chapter 3a and 3b. As industrial operations grew in size and number, the difficulties of ensuring a supply of water for the continuation of their processes began to pose a serious problem to the early industrialists of the valley. Low flows were severely restrictive and often reduced daily operations to just a few hours. It is therefore, not surprising that these enterprising individuals began to look for ways of conserving water during high flow periods for use when the river levels began to drop.

## WATER MILLS - CASE STUDY

Most mills in Sheffield employed what is termed the bypass method of harnessing the power of flowing water. This method commonly involves the construction of a weir, head goit, wheel pit and tail goit. The weir is effectively a low dam built across the river with a sloping downstream face. Water has to back up against the dam before it can overtop the weir and continue downstream. This causes an increase in depth of water upstream of the weir, allowing a proportion of river water to be drawn off via a shuttle into a head goit.

The head goit, or mill race, is a channel that feeds water to the mill dam. The goit slopes downwards more gently than the bed of the river, which creates a difference in height between water in the mill dam and that in the river. It is the difference in height, or head, which determines the power output of the wheel. The mill dam stores the water required to turn the wheel during the working day, and also acts as a buffer against variations in river flow caused by weather or by the operation of mills further upstream. As the level of water in the dam falls, more is drawn from the river via the head goit. It is important that the dam remains watertight, and this is usually achieved with a lining of puddled clay. To guard against excess water entering the dam and flooding the mill, the goit below is connected from the downstream end directly back to the river. Deep drains may be incorporated in the overflow, controlled by shuttles, to allow the dam to be drained for maintenance. The downstream end of dam is termed the forebay. Often massively reinforced with stone, and further supported by the wall of the mill itself, it is the point where water is drawn off to turn the wheel. Water is fed into a pentrough, which is basically a wooden or cast iron box which sits over the wheel pit. From here it tumbles onto the paddles of the wheel below, causing it to turn. The rate at which water flows out of the pentrough, and thus the rate at which the wheel turns, is controlled from within the mill by means of a shuttle at the end of the pentrough called the penstock. It is vital that the flow of spent water away from the bottom of the wheel is unimpeded, otherwise the efficiency of the wheel is reduced. Therefore, the tail goit has to slope freely from the wheel pit to a point where the river is low enough to enable water to be discharged back to it. The tail goit also has to be sufficiently deep to offset the accumulation of silt and rubbish underneath the mill building. Excellent working examples of this method of water power are provided

at the Shepherd Wheel on the River Sheaf and at Abbeydale Industrial Hamlet. The system described above utilises an overshot wheel that is fed onto the top of the wheel. This is fine in areas where the river slopes steeply and a sufficient head of water can be developed. However, in areas where a river slopes more gently, such as the lower Don Valley, it is often not possible to create a sufficient head of water to utilise an overshot wheel. In this case, the wheel has to be mounted at a low level in relation to the river, and a much longer tail goit with sufficient gradient to allow a strong flow of water underneath the wheel is constructed. Such wheels are termed undershot wheels, because the water turns them from below. An example of an undershot wheel can still be seen at Malin Bridge on the River Loxley. An intermediate system between overshot and undershot, not surprisingly called breast shot, can also be employed. Royds Mill had a breast shot wheel.

### IMPOUNDING RESERVOIRS

The first project to store water for augmentation purposes was conceived in 1785. The site chosen was called Deadmans Ford, several miles above Penistone on the south side of the river. This reservoir, which was to be approximately 29 acres (12 hectares) in surface area and about 10 feet (3 meters) deep, would have retained about 24 million gallons (109 million litres) of water had it been completed. However, due to engineering difficulties, the scheme was finally abandoned leaving the mill owners frustrated and desperate for a solution to their problems.

They were to wait for almost half a century before any major moves were made to address their difficulties. By this time other industries were beginning to demand a more secure water supply. Steel manufacturing was reliant on copious amounts for quenching. Even more importantly, the rapidly growing population of workers which the industries needed to man their operations, required a reliable source for drinking purposes.

Their needs had, for almost a century, been supplied from five small drinking water reservoirs known as Whitehouse Dams which were situated adjacent to what is now Langsett Road. Later, other dams were added but as the population of the city expanded, demand continued to outstrip supply.

In 1830 by Act of Parliament the Sheffield Water Company was constituted. It commenced work on a series of projects including a large service reservoir at Crookes but far more significantly, began construction of the first major damming project on the Don system. This site was at Redmires, where the Wyming Brook was dammed forming Redmires Middle Reservoir.

The success of this project sparked off a series of further reservoir developments over the next century, which took full advantage of the ideal topography of the Don and its tributary valleys. Most were instituted by the Sheffield Corporation Water Works which assumed responsibility for the city's supply in 1887.

*REDMIRES MIDDLE RESERVOIR*
*The first large reservoir built on the Don system to provide water for drinking and industrial purposes constructed in 1830*

Important to these reservoir developments was the maintenance of a reliable supply of water down the rivers which had been dammed. For this purpose compensation reservoirs were built below the supply reservoirs and a statutory compensation release of water was imposed to protect the interests of industries which abstracted or utilised the flow downstream.

When setting the minima for these compensation releases, little or no consideration appears to have been given to the ecology of the rivers, as is amply demonstrated by the fact that many of the releases were timed to coincide with the working periods of industrial users. When the factories closed, the flow from the reservoirs ceased, denying the river its flow and leaving its aquatic inhabits struggling to exist.

The development of reservoirs on the upper Don system helped to satisfy the industrial and drinking water needs of Sheffield and neighbouring towns until the end of the Second World War, but by then it was becoming apparent that even the massive reserves held in the valleys would be inadequate to meet the future needs of its people and their industries.

Other forms of supply, using groundwater reserves, had been almost fully exploited by the late 1940's and it was becoming increasing clear that the catchments of the River Don system would be inadequate to meet the growing needs of its human population. The history of drinking water supply to the major population centres of the area and the way this impending shortfall was addressed is contained in Appendix II.

### RESERVOIRS ON THE RIVER DON 1996

| Name | Grid Ref | Year Built | Useable TCM Capacity | Max Depth (meters) | Surface Areas (hectares) |
|---|---|---|---|---|---|
| Redmires Upper | SK 250 855 | 1854 | 1423 | 13.5 | 23 |
| Redmires Middle | SK 264 855 | 1836 | 784 | 11.5 | 19 |
| Redmires Lower | SK 268 855 | 1849 | 566 | 12.5 | 12 |
| Rivelin Upper | SK 271 868 | 1848 | 220 | 9.1 | 4 |
| Rivelin Lower | SK 277 867 | 1848 | 525 | 14.6 | 12 |
| Strines | SK 232 905 | 1869 | 2059 | 23 | 22 |
| Dale Dyke | SK 243 917 | 1875 | 2118 | 22.5 | 25 |
| Agden | SK 261 923 | 1869 | 2541 | 25.9 | 25 |
| Damflask* | SK 284 907 | 1896 | 5037 | 27 | 47 |
| Broomhead | SK 269 959 | 1934 | 4919 | 27.9 | 50 |
| More Hall * | SK 287 958 | 1930 | 2027 | 21.3 | 26 |
| Langsett | SK 214 002 | 1905 | 5901 | 30.3 | 51 |
| Midhope | SK 223 994 | 1903 | 1632 | 26.5 | 21 |
| Underbank* | SK 253 992 | 1907 | 2727 | 16.5 | 42 |
| Wharncliffe (no longer used) | SK 308 978 | 1878 | 65 | 6.1 | 3 |
| Ingbirchworth | SE 216 060 | 1868 | 1332 | 15.5 | 23 |
| Royd Moor | SE 222 048 | 1934 | 832 | 18.4 | 15 |
| Scout Dyke* | SE 235 047 | 1928 | 709 | 13.2 | 16 |
| Windleden Upper | SE 153 013 | 1890 | 606 | 17.5 | 8 |
| Windleden Lower* | SE 158 019 | 1872 | 357 | 14.7 | 5 |
| Snailsden | SE 136 040 | 1899 | 176 | 12.2 | 4 |
| Harden | SE 153 037 | 1899 | 348 | 18.3 | 5 |
| Winscar* | SE 153 026 | 1975 | 8296 | 41.8 | 47 |
| Broadstones | SE 196 064 | 1859 | 367 | 11.1 | 8 |
| Rivelin Depositing Pond | SK 287 869 | 1869 | 30 | 5.5 | 1.6 |

* indicates compensation reservoirs

### RESERVOIRS ON THE SYSTEM WHICH ARE NO LONGER OPERATIONAL

| NAME | GRID REF | PREVIOUS USE |
|---|---|---|
| Thrybergh | SK 477 961 | Drinking water supply |
| (includes Firsby) | SK 494 958 | |
| Lineacre System | SK 334 725 | Drinking water supply |
| Crowhole | SK 321 748 | Drinking water supply |
| Worsborough | SE 349 034 | Canal Feeder |
| Elsecar | SE 384 995 | Canal Feeder |
| Ulley | SK 753 876 | Drinking water supply |
| Woodhall | SK 427 884 | Canal Feeder (dry)* |
| Killamarsh | SK 431 870 | Canal Feeder* |
| Harthill | SK 488 806 | British Rail Feeder |

Supplied water to the Barnsley Canal

* Supplied water to the Chesterfield Canal

## PART 1 - CHAPTER1b

## THE IMPACT OF IMPOUNDMENTS ON THE DON FISHERY

The construction of weirs and dams across the channels of the Don and its tributaries to harness the power of the descending waters was to have serious consequences for the fish populations of the river. Initially, most of the structures were relatively small and probably posed only minor difficulties to the salmon and sea trout populations as they ascended the river on their way to the spawning grounds in the headwaters. Progressively, the size and number of the structures was to increase as the centuries passed, gradually placing ever greater restrictions on the free movement of fish within the system.

*SALMON*
*Once prolific in the Don System, the Salmon had almost disappeared by 1800*

Water power, as described earlier, was to prove the key to the prosperity of the valley and in relation to the opportunities it provided, damage to the fishery was probably a minor consequence. In their defence, it was unlikely that our forefathers fully understood the implications of their actions, particularly as the damage was insidious and took many generations to fully manifest itself.

Initially it was the river's coarse fish populations which were subjected to the greatest impact. For the first time, their free movement within the system was restricted. Not possessing the salmon's ability to jump or swim over the structures, some species were trapped in isolated sections of the river and in some cases they would have been unable to reach traditional spawning areas. Initially the distance between the weirs would have been considerable and in its original condition, even in these isolated sections, the Don would have provided spawning habitats for the majority of the species present. However, as more and more structures were added, the sections became shorter and therefore less likely to be able to provide an appropriate range of habitats.

In addition to restricting movement, the weirs served to change the natural flow regime, creating ponded areas above the structures. These semi-static conditions allowed particles of sediment, which were normally carried downstream in the water column, to settle onto the river bed. Very quickly, deep accumulations of silt would have formed in these areas and aquatic plant life more suited to ponded conditions would have become established. In addition, subtle changes would also have occurred in the invertebrate communities which had been supported by the natural river conditions giving way to species more suited to the altered environment. In terms of fish populations, the semi-static conditions above the weirs favoured more sedentary species such as roach, bream and perch and it is likely that progressively such species became more common as further impoundments were added to the lower and middle reaches of the river.

*WEIR AT SPROTBROUGH*
*The weir at Sprotbrough impounded water for two milling operations. The earliest which was used for production of flour, was built around 1279 and remained in operation well into the 20th Century*

Below the weirs the opposite conditions were created. Falling water quickly scoured deep pools in the bed of the river forcing the scoured material downstream to create gravel bars as the velocities decreased. These areas became increasingly important to the maintenance of the populations of riverine species such as dace, chub, barbel and grayling. These were the species which had been increasingly denied the opportunity to follow their traditional migratory spawning routes. Their populations would have been under stress as the conditions changed and became more ponded.

To the early inhabitants of the valley the river provided an important source of food. Fish were a common item in the diet of the local people but surprisingly, salmon does not appear to have been favoured. Coarse fish species such as pike, perch and bream appear to have been the most popular, along with the eel and probably the burbot. (This latter species now believed to be extinct in Britain.)

It is recorded that in 1356 Edward Balliol, the ex-king of Scotland took up temporary residence at Wheatley, on the banks of the Don. Balliol was a renowned hunting and fishing man and within a short space of time was reputed to have killed two pike of 3 feet (1.15 meters) long, three of 3 feet (1 metre) long and 20 of 2 feet (0.75 metre) long as well as a large number of perch and bream. Whilst there appeared to be no laws or regulations to control Balliol's activities, which also included the killing of thirty nine deer, his actions brought disapproval and interference from the highest level, (probably the King). This does help to demonstrate the importance of the fish species concerned and also suggests a basic understanding of the need to conserve and protect against over exploitation.

*PIKE*
*An important predator species in the Don System which was valued more highly than salmon for eating purposes between the 14th & 16th Centuries*

By all accounts no such consideration was given to protecting salmon. Their numbers appeared to have been so great up until the late the 17th Century, that they were not deemed important enough to require protection. Salmon poaching, as we know it today, did not appear to be unlawful and in the main commoners were at liberty to catch what their tables required. Towards the end of the 17th Century several of the larger weir structures were fitted with hecks - a form of salmon trap. Regrettably no records exist to demonstrate the efficiency of these traps. However, if the price of salmon on Doncaster market was anything to go by, quantities available were not limited. In the historical notices of Doncaster, published in 1856, it refers to there being no regular commerce in salmon being carried out in 1689 in local markets as the fish was selling for less than 2d per pound (approx. 2p per kilogram).

By 1630 the use of water power to serve needs other than flour milling was well established. In the Sheffield area 28 cutlers wheels were operating using the flows of the Don and its tributaries the Loxley, Rivelin, Sheaf and Porter. It would appear that these operations were having only a limited effect on salmon movements according to Harrison writing in 1631 and referring to the Don at Sheffield, .." ye chiefest river within this manor is ye river that passeth through the same, wherein we get store of salmon, trout, chevins (chub) and other small fishes..".

During the next one hundred and fifty years, conditions were to change dramatically as the industries exploiting water power proliferated in the Sheffield area. Every possible opportunity to utilise the river's flow appears to have been taken both on the tributaries and on the Don itself. By 1770 the number of water powered operations had grown to a staggering 161 and the effects of this exploitation had disastrous implications for the salmon populations. Not only were they required to negotiate many obstacles on their journey upstream, but they were also subjected to heavily manipulated flow patterns. In order to ensure the continuation of their operations during periods of low flow, it became common practice for mill owners to divert as much water as possible through their mill ponds, often placing wooden boards across the weir crests to ensure that the whole flow was captured. In these conditions the bed of the river would often dry out between the weir and the outfall channel from the mill, in some cases a distance of several hundred meters. Inevitably the consequences for fish in these sections was dire. Some would have managed to exist by dropping back to take advantage of the outflow. Small fish would have survived temporarily in small static pools which were left as the water receded. But for salmon, this situation spelt disaster. Waiting to ascend the weirs, they were effectively trapped in any small pools of water that were left. In these conditions they were subjected to increasing temperatures and rapidly reducing dissolved oxygen levels. Such conditions were untenable for salmon, and unless the mill owners quickly released water over the weir, the salmon would inevitably have died.

It is doubtful that the mill owners would have been sympathetic to the salmon's needs. It is more likely that, along with their employees, they would take advantage of the opportunity presented to them and harvest the trapped salmon. The fish would be easily caught and either sold to local merchants or taken for food.

Under such intense pressures, it seems most unlikely that a self-sustaining salmon population remained in existence on the upper Don and tributaries such as the Loxley and Sheaf by the middle of the 18th Century.

Requiring less depth of water, brown trout and grayling managed to exist as remnant populations between the weirs, relying on the habitat conditions of their own isolated sections of the river to serve their needs. In some cases suitable spawning facilities, particularly suitable gravels, would have been limited or even totally absent. In these areas populations would have disappeared entirely or have relied on the fallout of immature stock from upstream sections.

In contrast, for more sedentary species of coarse such as roach and perch impoundments provided some benefits. Suitable habitats had been created by the mill owners in the form of mill ponds, which provided ideal feeding and spawning facilities. The fallout of stock from the mill ponds also helped to ensure their continued existence in the main river, where the semi-static state provided by the weir of the next operation downstream guaranteed suitable conditions.

*TIN MILL DAM*
*An example of a mill dam which originally provided water for milling purposes but has since been developed as a coarse fishery with exceptional recreational value*

By this means, the fish populations of the River Don and its tributaries through and above Sheffield changed markedly. The salmon had all but disappeared from this area by 1750. Undoubtedly occasional strays did appear, but no longer were these the progeny of parents who had laid their eggs in the gravels of the remote moorland areas above Penistone, more likely they were the results of spawning success in the Dearne and Rother. These rivers remained relatively undamaged by impoundments in comparison to the Don and still contained considerable salmon populations in the mid 18th Century. Unfortunately, there were other impacts which were beginning to pose a threat by this time, including the construction of a navigation. This impact will be described in more detail in a later chapter.

Despite the impact that milling had on parts of the upper river and its tributaries, some areas still supported good populations of fish. Brown trout, and probably grayling, existed in many of the upper reaches of streams such as Ewden Beck, which was renowned for the quality of its stocks well into the 19th Century. Regrettably, even in such relatively isolated areas, things were beginning to change. With the industrial base of the valley developing at a frantic pace, the demand for a more secure supply of water mounted. Seasonal variations in flow were starting to seriously affect industrial output, and the demands for drinking water from the growing army of workers could not be ignored.

For the fish populations in these upper reaches of the river the prospects were becoming increasingly bleak. The demand for water could only be supplied by the creation of impoundment reservoirs and in 1836 the first of these was built at Redmires above Sheffield. This effectively severed the Wyming Brook from its parent river, the Rivelin. Over the next half century, reservoirs were built on almost all of the Don's major tributaries above Sheffield. The reservoir construction had a disastrous effect on downstream fish populations. Fish which managed to survive the devastating effects of this construction work on water quality, were then faced with further problems. Isolated from their upstream spawning grounds, they were left with little option but to utilise the limited facilities available in the river below the dam.

Above the newly constructed reservoirs, the populations were slightly more fortunate, but even here they were often isolated in the headwaters of the streams. In these conditions, they were frequently subjected to flushes of acidic water, which flowed from the moorland peat areas following heavy rain. In many cases these conditions were untenable, and populations quickly disappeared, in other cases the native brown trout adapted to a life in the reservoir itself, utilising the streams only to serve their reproductive requirements. Few of these populations thrived, but examples of the Don's original genetic stock still exist in several of the reservoirs, most notably Agden.

The early water management regimes, employed for the operations of the reservoirs, posed yet another threat to those fish populations which had retained a hold in the river below. Minimum compensation flows were agreed by Act of Parliament, to ensure that downstream users were not denied their rights to water. However, these 'users' were invariably industrialists who required the water for the continuation of their processes, and generally cared little about the ecology of the river. As a result, compensation releases were timed to meet the operating requirements of industry, and would often cease at the end of the working day. When this happened the river below was often left to rely on a base flow derived from seepage from land adjacent. In some cases this was inadequate and often the result, particularly in periods of drought, could be a dry river bed. In these unstable conditions populations of fish, particularly brown trout and grayling, struggled to exist as the permanency of both their feeding and reproductive environments could not be guaranteed. Gradually these higher species disappeared, leaving only environmentally-less sensitive fish such as stone loach and sticklebacks remaining.

By the middle of the 19th Century there was at last recognition of the impact that construction of impoundments across river channels could have on fish populations. The status of the salmon, by this time had changed and it was the effect on their populations which prompted Parliament to introduce legislation. The new law required all new impoundments which imposed a restriction to the passage of migratory salmonids, to be fitted with a fish pass to ensure free passage for fish to their spawning grounds. For the Don Salmon population, legislation had come almost a century too late. The regulating, impounding and obstructing effects of dams, weirs and reservoirs on the river had dealt the system a decisive blow, which had been exacerbated by other impacts which are to be described in detail in the following chapters.

*FISH PASS*
*Current legislation demands that new obstructions or existing obstructions which are restored or rebuilt over more than 50% of their length are fitted with a fish pass*


*THE ORIGINAL RIVER DON*
*This shows the Don System before Vermuyden's scheme to encourage the whole flow of the River Don down a channel to the River Aire*

## PART 1 - CHAPTER 2a

# THE HISTORY OF LAND DRAINAGE AND FLOOD ALLEVIATION ON THE RIVER DON

### PRE. 19TH CENTURY

The earliest recorded date of land drainage work being carried out on the River Don was between 1626 and 1630 when Dutchman Cornelius Vermuyden made an agreement with Charles I to drain the low-lying lands to the east of Doncaster in exchange for a third of the area so drained. At that time, the River Don split into three channels at Thorne with two branches discharging to the River Trent and the more northerly branch discharging to the River Aire. Vermuyden blocked the channels leading to the River Trent and endeavoured to divert the whole of the flow of the River Don into the River Aire. Whilst this ingenious scheme succeeded in part, in that Vermuyden's land was temporarily prevented from flooding, it resulted in flooding of land to the north of the river which had previously been unaffected.

Following considerable litigation and riots almost leading to civil war, Vermuyden was enforced to construct an artificial channel from New Bridge, near Rawcliffe, leading to the River Ouse at Goole. This channel was originally designed to operate only as a flood relief channel. However, following a particularly high flood, the sluices constructed near New Bridge were washed away and the river continued along the more direct course to the Ouse and the branch leading to the Aire, part of which can still be seen, quickly silted up. To this day the length from New Bridge to Goole is known as the Dutch River.

No doubt local drainage courts and other interested parties carried out minor works to the flood banks of the River Don over the following centuries, but it was not until the 19th Century that a concerted effort was made to carry out further land drainage improvements to the river.

*DUTCH RIVER*
*The channel constructed by Vermuyden to alleviate the flooding to land on the north side of the river which his drainage of the Hatfield Chase had caused*

*OLD COURSE AT TURNBRIDGE*
*This relatively small bridge spanned the northern arm of the River Don leading to the Aire*

## POST. 19TH CENTURY

## LOWER RIVER DON CATCHMENT

In the latter part of the 19th Century, one of the larger Internal Drainage Boards known as the Dun Drainage Commissioners, carried out works on the river in the vicinity of Doncaster, mainly raising and strengthening floodbanks and completing minor channel improvements. At about the same time a protective bank known as the Sykehouse Barrier Bank was constructed to reduce the frequency of flooding to large areas of agricultural land from the River Went.

The Sheffield and South Yorkshire Navigation Company also utilised sections of the River Don as canal and carried out substantial works. For example, the section between Doncaster and Long Sandall was canalised and a 'flood drain' channel was constructed to the north for the discharge of flood waters. Ultimately the canal was isolated from the river and the 'flood drain' became the river as it is known today.

*FLOOD DRAIN, DOWNSTREAM OF DONCASTER*
*The flood drain was constructed to take excess water from the newly constructed navigation*

Between Doncaster and Stainforth, where the Dun Drainage Commissioners had raised and strengthened the flood banks, provision had been made for controlled over-spill of flood water by means of of a series of earthen spillways constructed in the northern flood embankment. The most upstream of these was at Black Pond on the opposite side of the river from where Doncaster Prison now stands. During extreme floods land to the north operated as a flood relief route and the extent of flooding was controlled by a secondary barrier bank constructed some 600 yards (548.5 meters) to the north of the main river bank. This route for relieving flood waters in Doncaster operated during the floods of 1886, 1892, 1931, 1932 and 1947.

*FLOOD ARCHES*
*These arches allow passage of flood water along the flood channel of the Don at Doncaster*

In a report produced by the Doncaster Regional Planning Board dated 1922, land in the Bentley and Arksey area was 'zoned', because it provided poor health and drainage conditions. The following paragraph appeared as one of the principle recommendations. 'The low lying land below the 25-30 feet (7.62-9.144 meters) contour should be reserved for agriculture or industry, and no new dwelling- houses should be built on it except what are absolutely essential for local agricultural purposes' .

The report stated that the greater part of Bentley was located on low-lying land unsuitable for housing. However, a report from the Doncaster Drainage Board in 1932 mentioned that between 1922 and 1931, 1029 houses were built in the Urban District of Bentley.

The River Don, as previously stated, was not and had never been capable of discharging more than a normal winter flood without overflowing its banks. The overflow principally spilled onto areas of land used for grazing purposes and which were known to flood at such times. The lands subjected to flooding extended nearly to the site of the Bentley Colliery and as the colliery workings proceeded, a subsided basin was formed which ultimately extended into the floodable area. As a result, the flood waters no longer stopped short at Bentley but poured into the subsided basin which had developed into a built-up urban area. Various schemes for dealing with this threat were assessed. All these schemes had to consider that as subsidence continued, the area and depth of flooding would increase and the problem would become even more acute and difficult to remedy.

Most of the land drainage problems which resulted from subsidence were dealt with under the legislation of the Doncaster Drainage Act 1929, and the Coal Mining (Subsidence) Act 1957. The majority of these problems were solved at that time, by raising floodbanks, such as the Bentley Barrier Bank and floodbanks along Tilts Drain (Ea Beck), and through improvements to existing colliery pumping arrangements.

There were a number of collieries working one or more seams in the Doncaster district which had caused subsidence of between 4-12 feet (1.2-3.7 meters). In view of this the Catchment Board decided that the only satisfactory solution was to enlarge the River Don to the extent necessary to render it capable of taking the maximum estimated flow of the river. The water from the subsided areas would be pumped back into the river and to ensure that the river bed itself did not subside a pillar of coal was to be left beneath for its support.

*BENTLEY COLLIERY*
*This and other collierys in the Doncaster area was responsible for subsidence problems in the land adjacent to the River Don.*

This was the state of affairs when the River Ouse (Yorkshire) Catchment Board was inaugurated in 1931. Flooding still occurred at frequent intervals, particularly in the vicinity of Fishlake and Stainforth where the tidal effect was a predominant factor. The River Don had, in the past, been enlarged by banking and other means to contain a normal flood flow of up to 9,000 cusecs [cubic feet per second] (254700 lps [litres per second]). The gauging of the flow of the river during the flood of May 1932 revealed that the waters were arriving at Doncaster at approximately 12,000 cusecs (339600 lps). It was decided therefore, to enlarge the river to contain a flood of 12,000 cusecs. (Approximately 38 cubic feet per second [1.1cumec] per thousand acres of catchment area of the Don above Doncaster.)

In 1934 the River Ouse (Yorkshire) Catchment Board implemented the lower Don Improvement scheme which has been described earlier.

From Thorne to Long Sandall a number of river diversions were cut at Thorne Waterside, Fishlake, Stainforth, Wilsic, Barnby Dun and Thwaite House and whilst small 'cradge' banks were constructed alongside the channel, the main floodbanks were set back several hundred feet from the main channel so as to provide a storage capacity at high tide.

*FLOODING AT SPROTBOROUGH & BENTLEY*
*Land to the north of Doncaster in the Bentley & Arksey area was frequently subjected to flooding before the new defences were completed*

*DIVERTED CHANNEL, BARNBY DUN*
*One of the oxbow sections of the lower River Don which were left separated from the main river by the flood defence operations carried out by the Yorkshire Ouse River Board between 1934-51*

Between Long Sandall and Doncaster the improvements were effected primarily by enlarging the channel and raising the flood embankments. The construction of the six major river diversions shortened the course of the River Don by 1.25 miles (2 km) and these works, together with the widening and deepening of the river, involved the excavation of 2,500,000 cubic yards (1911381 $m^3$) of material with over 40 miles (64.37km) of floodbank constructed.

This work was well underway when in 1947 a disastrous flood, which was even more severe than that of 1932, inundated more of the Bentley district of Doncaster than ever before. The flood affected almost a thousand houses and a considerable area of the surrounding countryside. During the flood, the Bentley Barrier Bank breached and the Army was called into blow a further hole in the floodbank at Grumble Hirst to allow the flood water to return to the river channel. The lower Don Improvement Scheme continued and was completed in the early 1950's.

Following commencement of the works on the lower Don improvement scheme, considerable development took place within the catchment area which would cause an increased rate of surface water run-off from road drainage and other sources. This situation was realised when the scheme was prepared, but the required works to offer flood protection in excess of 12,000 cusecs (340 cumecs) could not be justified economically. It was decided that the situation would only be met cost effectively by improved use of areas of flood water storage such as the washlands upstream of Doncaster, particularly in the Dearne and Rother Valleys.

After the completion of the lower Don scheme, a number of further improvements commenced in the late 1950's on the river system upstream of Doncaster. Most of the controlled washlands later constructed in the catchment lay within the South Yorkshire Coalfield, and hence the National Coal Board had to contribute to construction costs to meet the requirements of the Coal Mining (Subsidence) Act 1957. The formation of the majority of the controlled washlands typically consisted of the construction of embankments along the river channel with a spillway, boundary embankments, outlet sluices and improvements to the river channel for hydraulic efficiency. A number of controlled washlands of this design were constructed upstream of Doncaster along reaches of the rivers Don, Rother and Dearne. On the River Don itself, controlled washlands were formally constructed at Hexthorpe, Sprotbrough and Kilnhurst.

The lower River Don is influenced by natural tidal fluctuations. The maximum recorded level of the tide at Goole in 1969 was equal to the height of the floodbanks some 10-12 miles (16-19.3km) upstream. In order to retain a maximum flood within the embankments at high tide, it was necessary to raise the embankment considerably so as to permit a continuous discharge of 12,000 cusecs (339600 lps). During 1972, from Goole to New Bridge near Thorne (a distance of 9 miles/14.5km), the channel was improved by widening and deepening the channel and raising the flood embankments.

### RIVER ROTHER CATCHMENT

The River Rother Improvement Scheme was proposed in September 1958 to relieve areas of regular flooding in the Rother catchment. Treeton, Catcliffe, Beighton and Woodhouse Mill were areas which were particularly badly affected, most notably in 1958 when severe flooding occurred as a result of the River Rother over-topping its banks. A study of previous flood events had shown that the peak of flow from the River Rother was normally delayed until after the flood peak of the River Don had passed the confluence in Rotherham town centre. At that time it was identified that any improvements to the channel on the River Rother could cause an acceleration of flow, reducing the time lag between the flow peaks of the River Rother and River Don. This factor had the potential for compounding the flood problems at Rotherham and Doncaster.

Many of the natural washlands on the River Rother have been lost to uncontrolled land tipping and industrial development. However, between Canklow and Bedgreave viaduct, it was possible to utilise about 40 acres of low lying land for storage. This area had a history of mining subsidence. Subsequently a series of washlands

were formalised at Canklow, Treeton and Woodhouse Mill and in 1959 a regulator was installed in the Woodhouse Mill washland to enable more efficient use of the available area for flood water storage.

*CANKLOW REGULATOR*
*One of the control structures on the River Rother which helps to protect areas on the lower Don around Doncaster from flooding*

In 1961 a scheme commenced on the washland at Bedgreave. The village of Killamarsh had suffered frequent inundation due to inadequate sewer systems, which were prone to backing up during high river levels. Channel improvements were carried out in 1963 which lowered the river levels helping to relieve the drainage problem. In addition, a further washland was brought into use at Killamarsh Meadows, and together these two areas provided a total 1177156 $yd^3$ (900,000 cubic meters) of flood water storage.

In 1971 it was proposed by Sheffield City Council that following an extensive study, the floodplain be landscaped for active recreational use as part of the Mosborough Comprehensive Development Area. During this period, the National Coal Board Opencast Executive was independently planning to excavate coal seams beneath the area and were considering proposals for future land use in conjunction with Derbyshire County Council. Following discussions between the two parties, the proposals were later married together in a scheme for the development of a country park, which it was hoped would relieve pressure on the nearby Peak District National Park. Details of this and other washland improvement schemes, which were undertaken after 1974, are described in Part 2 of this document.

A further flow regulator was constructed in 1969 at Canklow in a revised scheme to allow for the construction of the M1 motorway and A630 trunk road across the washlands.

*ROTHER VALLEY COUNTRY PARK*
*Created out of the restoration of land which had previously been used by the coal mining and other industries. The Park is now one of the most important recreation sites in South Yorkshire*

*MEADOWGATE REGULATOR*
*This regulator controls flood water on the Rother below Staveley and in extreme conditions helps to flood the washland areas which are part of the Rother Valley Country Park Complex*

## RIVER DEARNE CATCHMENT

The River Dearne Improvement Scheme was initiated a few years after work had commenced on the River Rother. The scheme was carried out in the period 1963 to 1973, working progressively upstream from the confluence of the River Don. Near the confluence, a series of formalised controlled washlands were formed from the Dearne Mouth to Adwick Bridge. These washlands became known as Dearne Mouth (also known as Denaby Ings Nature Reserve), Harlington and North Ings. The Dearne Mouth washland was constructed with a manually operated sluice which was installed in 1963 (rebuilt in 1973). The sluice, constructed in the floodbank, allows the washland to fill if critically high flood levels are reached at the confluence with the Don.

*WINTER DAWN AT DENABY INGS NATURE RESERVE*
*The Ings, created as a result of subsidence, are now an important wetland habitat managed by Yorkshire Wildlife Trust*

The river channel through this section was realigned and straightened substantially. Between Adwick Bridge and Wath Railway Bridge, a further washland was formed which included a flood relief channel at Bolton upon Dearne.

In addition, works between Wath Railway Bridge and Marles resulted in two formalised controlled washlands being created, later to become known as Bolton Ings and Old Moor. The Bolton Regulator was installed in 1972 to compensate for some lost flood storage area in these washlands as a result of mining works. Subsequent to the completion of the Bolton and Old Moor sites, further controlled washlands were constructed at Wombwell Ings, (at the confluence of the River Dove), Darfield, Houghton and Cudworth.

## PART 1 - CHAPTER 2b

# EFFECTS OF LAND DRAINAGE AND FLOOD ALLEVIATION ON THE RIVER DON FISHERY

Without question, the most profound effect of land drainage works on the ecology of the Don system was that caused by Vermuyden's drainage of the Hatfield Chase and his diversion of the river's natural channels in the 17th Century.

The destruction of the wetland habitats of the chase would, by today's standards, be regarded as an ecological disaster of enormous proportions. The loss of the myriad of meandering channels, saltmarshes, freshwater ponds and reedbeds, which provided habitats to an almost unimaginable range of birds, animals and fish, could be argued as equal in proportion to the present day destruction of rainforests.

The river's two lower tributaries, the Rivers Idle and Torne, were lost to the Don System when they were diverted via a series of drainage channels directly to the River Trent.

Few areas of wetland were left untouched, as is clearly demonstrated by the general absence of natural lakes and ponds in the district today. In their place are left a series of straight drainage channels that provide little in terms of habitat diversity. To maintain their drainage capabilities, these channels need to be regularly dredged and the weed cut in order to remove any accumulation of material which could impede flow in flood conditions. The result is a largely sterile environment which provides little or no protection for juvenile fish from being swept away by the increased velocities associated with flood events

There are few records in existence which document what happened to the vast populations of fish including roach, bream, rudd, tench, pike, perch which must have thrived in the ponds, meres and lakes in the area before the drainage took place. Inevitably, many will have been buried as the shallow waters were drained and in-filled to level out the land for farming purposes.

In his book "Thorne Mere and the Old River Don", Martin Taylor describes the ecological significance of the pre-1626 Hatfield Chase as rivalling the wetland areas of the Cota Donana in Southern Spain. (This park is designated by UNESCO as a Biospheric Reserve.)

*THE NORFOLK BROADS*
*Probably a similar habitat to that which existed on the lower River Don before Vermuydens drainage of Hatfield Chase*

*WILD DEER*
*The Hatfield Chase was an important Royal hunting ground and deer roamed through woods & marshes in great numbers*

In addition to the loss of the fish populations, mammals such as deer, wild boar and otters, were displaced as the waters receded and their wetland habitats were destroyed. Birds, both resident and migratory were also severely affected. In its original condition, the Chase undoubtedly provided an important feeding and nesting area for many species of wildfowl which in turn provided one of the mainstays to the diet and income of the local human population.

As with the coarse fish of Hatfield Chase few records exist which allow us to accurately assess the effects of the channel diversion on the migration of salmon and other anadromous and catadromous fish species which ran into and out of the River Don. It is likely that most originally found their way into the river system by the most direct channel, an outfall into to the River Trent close to what is now called "Trent Falls". With this route and the other channel to the Trent severed, migrating anadromous fish, particularly salmon and sea trout, would initially have had to seek the more northerly channel which flowed into the River Aire. However, this was soon to be closed to them when the newly constructed channel, later to become known as the Dutch River, was completed taking the Don's water to the River Ouse at Goole.

It can be assumed that the initial impact was quite severe, with runs of fish substantially reduced. However, records suggest that the overall impact was fairly short term, as in 1689 the Corporation of Doncaster began erecting salmon hecks on a mill dam at Doncaster.

*SKETCH OF A TYPICAL SALMON HECK*
*Hecks were used to catch salmon as they attempted to jump the weirs which obstructed their passage up the river system. They were fitted to the front of the weir and trapped fish which failed in their attempt to ascend.*

As previously stated, there was no regular commerce in salmon in the mid 1650s , with the fish only raising 2d per pound (2p per kg) on local markets, as recorded in Doncaster Historical Notices of 1856. This seems to confirm that salmon was still a cheap and very abundant local food, and certainly not the delicacy it is today. This is supported by details in several apprentice contracts of the time, which restricted the serving of salmon as a meal on more than three occasions per week so as to provide some variety to a predominantly salmon-based diet.

The River Went was another small River Don tributary, which would have been seriously affected by Vermuyden's operations. Originally a tributary of the River Aire, it had at some point in history formed a connection with the River Don. The two then flowed out to the Aire using the Went's original course via the village of Turnbridge.

When Vermuyden constructed the new channel, the Went became a tributary of the Don and was therefore subject to the same effects on its fish population as the main river. Little is known about salmon stocks in the Went, although it is likely that a small population of this species existed. The Went was, however, highly regarded at the time as an eel fishery and appears to have contained very substantial populations of this species. Adrian de Prime, Vicar of Thorne 1701-1704, described the Went in his diaries such 'The River is no more than six yards wide but the crookedest and the deepest that I ever saw in my life. Every turn makes a great bog on the other side on which the water is thrown by the current and there is delicate fish therein. But such quantities of eels like was never seen. Sometimes there will break out or fall out from the hollow bank sides when the people are a-fishing such knots of eels, almost as big as a horse, that they break all their nets to pieces'.

It would be difficult to recognise the present River Went from this description given by de Prime. The river has clearly undergone many drainage operations since his time, and is essentially now a straight drainage channel.

In a further paragraph of his observations, de Prime describes the Went as feeding Trumfleet Water Mill. This indicates that the course has been substantially altered as Trumfleet is now a considerable distance from the river channel. The author goes on to describe annual elver migrations at Trumfleet Water Mill as follows, 'Commonly every May such vast numbers of young eels comes over the wheels with the waters and run into the mills, that they are forced to give over working and to send into town for the swine to devour them, for they are as innumerable as sand grains on the seashore'.

Eels are still commonly found in the River Went but the staggering quantities as described by de Prime have long been a thing of the past.

*THE RIVER WENT*
*The Went was described by Adrian De Prime in 1701 as one of the crookedest river channels he had seen in his life. The photograph shows the effect that land drainage & canalisation had on the river*

*AN OTTER*
*Once very common on the Don, this important species declined rapidly as the industrial revolution gained momentum*

By 1650 landowners along the lower Don Valley began to realise the commercial potential of draining their land and over the next century many expanses of important wetland alongside the river were reclaimed for farming.

The drainage of fringe wetlands alongside the River Don to improve agricultural yield and/or protect land against flooding had disastrous effects on the ecology of the river. These habitats were essential for the maintenance of the populations of many species of mammal, birds and fish and their loss would have inevitably resulted in a decline in their numbers, or in some cases, their complete eradication. To fish populations the wetland areas had provided sanctuary, particularly to juvenile fish in flood conditions and their disappearance would have inevitably resulted in less stable recruitment patterns. Particularly affected would have been the more sedentary species such as roach, bream and perch. Previously they had utilised the adjacent still waters as spawning grounds, but with the loss of the fringe areas, they were forced into reproducing in the main river channel. The result of this enforced change was that their eggs, larvae and fry were subjected to the variable, and sometimes adverse conditions which prevailed in the more volatile environment of the main channel.

Indicative of the wider damage that was done to the ecology of the river, by drainage operations was the progressive disappearance of the once common otter. As the pinnacle of the aquatic food chain, this predator's numbers provide a clear picture of the fish populations which existed. Although the species was zealously hunted, it was partly the loss of natural habitat and the dwindling fish populations that reduced its numbers and finally drove it from the lower reaches of the Don (see Appendix VI, Decline of Otters in River Don Catchment).

The landowners' determination to ensure that their land remained in a dry condition is well demonstrated by their opposition to the development of the river as a navigation. Records which appear in the publication 'The Early History of the Don Navigation' by T S Williams, indicated that opposition was almost unanimous amongst landowners and focused mainly on the fear that their drainage would be adversely affected by the further construction of weirs and locks which were necessary to allow boat passage. The Bill to allow the development of the navigation was eventually passed with the landowners receiving compensation and guarantees regarding the protection of their land. (Further details of this are contained in Chapter 3 on Navigation.)

As well as the desire to improve agricultural yields, there was also an increasing interest in altering the rivers' course to create land advantage. Early industry recognised the potential of diverting the channel to meet the needs of development and during the 19th Century a number of such schemes were implemented.

One good example was the site of the Duke of Norfolk's Hecla Steel Works at Attercliffe in Sheffield. Here, in 1884 the Duke diverted the course of the river and canalised it in order to create a flat site on the south bank to facilitate extensions to his works. As was common practice, the channel took little account of either the needs of the fishery or the general ecological value of the river corridor.

About 1 mile (2km) above the site of the Duke's diversion was the land adjacent to the confluence with the River Sheaf. Over the last century, fluvial deposits discovered during construction works in this area, indicated that originally a large expanse of wetland consisting of reed beds, pools and willow sallows existed at this location. This flat expanse of land would naturally have dissipated the flood flows of the river in ancient times. Evidence for this comes from the accumulations of blue clay and the remains of vegetable materials which can be traced to the Pennine headwaters of the system. It was probably at this point that the first, very basic attempt at land drainage was carried out on the Don system.

This is supported by further excavations at this location which have revealed the presence of hollowed out tree trunks, which appear to have been used to drain water away from these shallows back into the river's main channel. These primitive conduits probably represent the first attempts by man to alter the River Don's environment to suit his own purposes. It was at this place in 1112 that Sheffield Castle was built by William de Lovelot, a Norman knight, and it is almost certain that the site was chosen to take advantage of the marshy areas which provided the security of natural defensibility.

Progressively the whole of this area was drained and embanked and today the river is contained within its corridor by walls 19 feet (6 meters) or more in height.

Along with the drainage work which later took place further downstream, the reclaiming of this area would have had a considerable impact on fish populations. As well as the loss of habitat associated with the draining of shallow pools etc, constraining the river's flow within banks would have destroyed the naturally energy dissipating effects of this flood plain. The inevitable result would have been a far less stable environment for fish, with regular damage to both habitat and populations as the energy of floods carried on down river.

More modern land drainage activities have continued to affect adversely the potential of the river environment to sustain a healthy ecosystem. As described earlier, the River Don has always had a reputation for flooding and the land to the north east of Doncaster including the parishes of Bentley and Arksey was an area which was regularly inundated.

As was described in the section on the History of Land Drainage, a scheme was designed by the River Ouse (Yorkshire) Catchment Board in 1934 to control flooding in the Doncaster area. Work was carried out from Doncaster almost to the river's confluence with the River Ouse at Goole. It was achieved by channel enlargement, embanking and the draining of subsidence areas by pumping. Following the example of previous generations, the work took little account of the river's future potential as a fishery. It should be recognised, however, that at the time the river was grossly polluted and unable to sustain fish life.

The 'improvement' works continued until the early 1950's, latterly under the control of the Yorkshire Ouse River Board. Following the completion of this scheme, work commenced on the River Don above Doncaster and in particular on the two principal tributaries, the Rivers Dearne and Rother. By the time the work on the The lower Don had been completed, the river had lost almost a mile and a quarter of its original channel length between Doncaster and Goole.

As a result of intense mining activity in the Dearne valley, the river had for many years suffered serious subsidence problems. This was particularly evident in the vicinity of Denaby. The Dearne's natural channel was typical of a meandering lowland river and the remains of the old course can still be seen today adjacent to Denaby Ings Nature Reserve. The subsidence created by the mining caused serious flooding problems, as the river's natural gradient to the River Don was lost. Large areas of valuable farm land remained under water for long periods and in the late 1950's a scheme was designed to alleviate the problem. This involved the construction of a new channel which began above Harlington and eventually connected with the river Don downstream of Denaby. Once again, the design of this channel took little account of the river's future ecological potential, for at that time it too was polluted and fishless. Details of restoration work carried out on this section of the Dearne can be found in Part 2 - Chapter 3 of this report.

From the turn of the 20th Century, the physical characteristics of the River Rother were also increasingly subjected to change. Industrial opportunism often resulted in sections of the river being straightened and re-channelled to create extra land for development. This destructive activity accelerated towards the end of the 1950's era, as opencast mining operations became more popular and profitable. In many cases, coal deposits lay beneath the bed of the river itself and to successfully exploit these reserves, it was necessary to re-channel the river. Rarely was consideration given to the profile of the new channel to allow natural features to re-establish. The result was often the creation of a very straight and sterile river course. One extreme example of this type of activity commenced in the late 1960's between the villages of Beighton and Killamarsh. Here the river was diverted to facilitate the exploitation of huge coal reserves and on completion, the void which had been created, was infilled and a new channel constructed to take the river's flow. This area today is known as Rother Valley Country Park.