THE NORFOLK RIVERS TRUST

RESTORING NORFOLK'S RIVERS

THE RIVER HEACHAM

A WATER FRAMEWORK DIRECTIVE LOCAL CATCHMENT PLAN

DEVELOPED IN PARTNERSHIP WITH

Environment Agency

CONTENTS

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INTRODUCTION

This plan has been produced by Norfolk Rivers Trust in consultation with relevant agencies, landowners, farmers and residents in the Heacham Catchment. The aim of the plan is to provide a framework for improvement of the ecological status of the Heacham, guided by the Water Framework Directive. Delivery of the actions outlined in the plan will lead to ecological improvements to the river which may enhance the amenity value of the river, and encourage economically valuable fish species.

The plan begins by providing an audit of the current state of the catchment, put together by a combination of river walks, reviews of existing data, consultation with stakeholders and requests for specialist reports from relevant individuals and organisations. These data are then used to identify ecological pressures in the catchment. In the final stages of the plan, solutions to these pressures are identified, costed and prioritised.

THE WATER FRAMEWORK DIRECTIVE

The Water Framework Directive (WFD) was introduced in 2000 and commits European Union member states to improving the physical and ecological quality of their rivers, groundwater areas and lakes. The quality of these waters is measured using a range of indicators outlined below which combine to give a picture of a river's health. Using this combination of indicators a river (or groundwater unit or lake) is then graded on its overall "ecological status", and designated as either bad, poor, moderate, good or high. Each member state is required to bring its water bodies to good status by 2015. Where this is not possible, good status must be achieved by 2021 or 2027, depending on the severity of the barrier to good status. The majority of Britain's rivers currently fail to attain good status due to a wide variety of pressures. In England, the Environment Agency is responsible for WFD delivery.

Water Framework Directive Status	Current river Status (2009)	Predicted by 2015
Bad		
Poor		
Moderate	**Overall status, Fish**	**Overall status, Fish**
Good	**Macro-invertebrates**	**Macro-invertebrates**
High	**Dissolved oxygen, pH, Ammonia, Phosphate**	**Dissolved oxygen, pH, Ammonia, Phosphate**
	Heavily modified water body – Flood protection	**Heavily modified water body – Flood protection**
	Hydrology supports good status	**Hydrology supports good status**

Table 1. Results of detailed water body investigations undertaken by the Environment Agency to determine the status of the River Heacham. A prediction about the status at the next "waypoint" in the WFD schedule (2015) is also shown.

A CHOICE FOR THE FUT URE OF OUR RIVERS…

Emmie van Biervliet

RIVER HEACHAM STATISTICS

Approximate river length:	11 km
Catchment area:	59 km2 (Approximate, as this is not quite entire catchment)
Discharge at named point:	Heacham Gauging station in Heacham. National Rivers Archive. Base Flow Index: 0.96 Mean Flow: 0.208 m^3/s
Protected Areas:	Coastal area into which Heacham discharges is a Ramsar site and SSSI.
Legal designations:	Bathing Water Directive, Freshwater Fish Directive, Natura 2000 (Habitats and/or Birds Directive), Nitrates Directive, Shellfish Water Directive.

WHY RESTORE RIVERS?

Britain's rivers generally fail to reach "good" ecological quality. This is both a problem in itself and a sentinel of trouble.

A well-functioning river system is an inseparable combination of good water quality, distinctive physical processes and diverse wildlife. These factors interact to provide benefits. A naturally functioning river has a floodplain with sufficient capacity to absorb inundation and to act as a store for silt carried by high flows. The river channel is also naturally self-scouring. This reduces flood risk and the need for expensive management. Headwater forests reduce surges of water into the system by increasing drainage and removal of water. Moreover, the vegetation, microbes and invertebrates in the river corridor also absorb and process pollutants. This enhances water quality within limits. However, very polluted rivers have less wildlife and in turn a reduced capacity to provide such benefits. This leads to a downward spiral. Wildlife itself also has an intrinsic value and is enjoyed by interest groups such as fishermen, ramblers and bird watchers.

If any of the three pillars of the river system are damaged (water quality, physical processes, ecosystem), then the value of the entire interconnected system is reduced. Arguably, we also have a responsibility to repair our damaged natural heritage for future generations. Thus, ecological restoration aims to enhance the functioning, as well as the intrinsic value of our beautiful rivers.

SECTION 1 THE CATCHMENT

The River Heacham is a chalk stream which flows through an undulating landscape from its source to its outfall at North Beach in Heacham. A majority of the catchment overlies high permeability bedrock, making the aquifer productive, and accounting for a high proportion of the flow originating from the aquifer. A Water Framework Directive report undertaken by the Environment Agency has designated hydrology as "good." Nevertheless, many local people are concerned about abstraction in the upper part of the river which has allegedly suffered from increasingly long periods of seasonal drying.

COMMUNITY INVOLVEMENT

It is part of the Norfolk Rivers Trust's mission to gain the active participation of the community to restore their river. Stakeholders help us to set objectives, keep us informed about issues on the ground such as pollution, and actively volunteer to make many more worthwhile projects possible.

Norfolk Rivers Trust have recently started to work in the Heacham catchment, and we were very pleased to receive over 100 people at our latest event. So far, we have also been very pleased with the enthusiasm and participation of several locals in the process of planning future conservation work, and would be very happy to hear from anyone who has an interest in conservation around the River Heacham.

Cooperation from landowners and support from volunteers have been vital in the first projects which we have undertaken on the Heacham, such as the work at Heacham Lavender which was underway in March 2014.

Interested people discussing the river in a community session lead by Norfolk Rivers Trust.

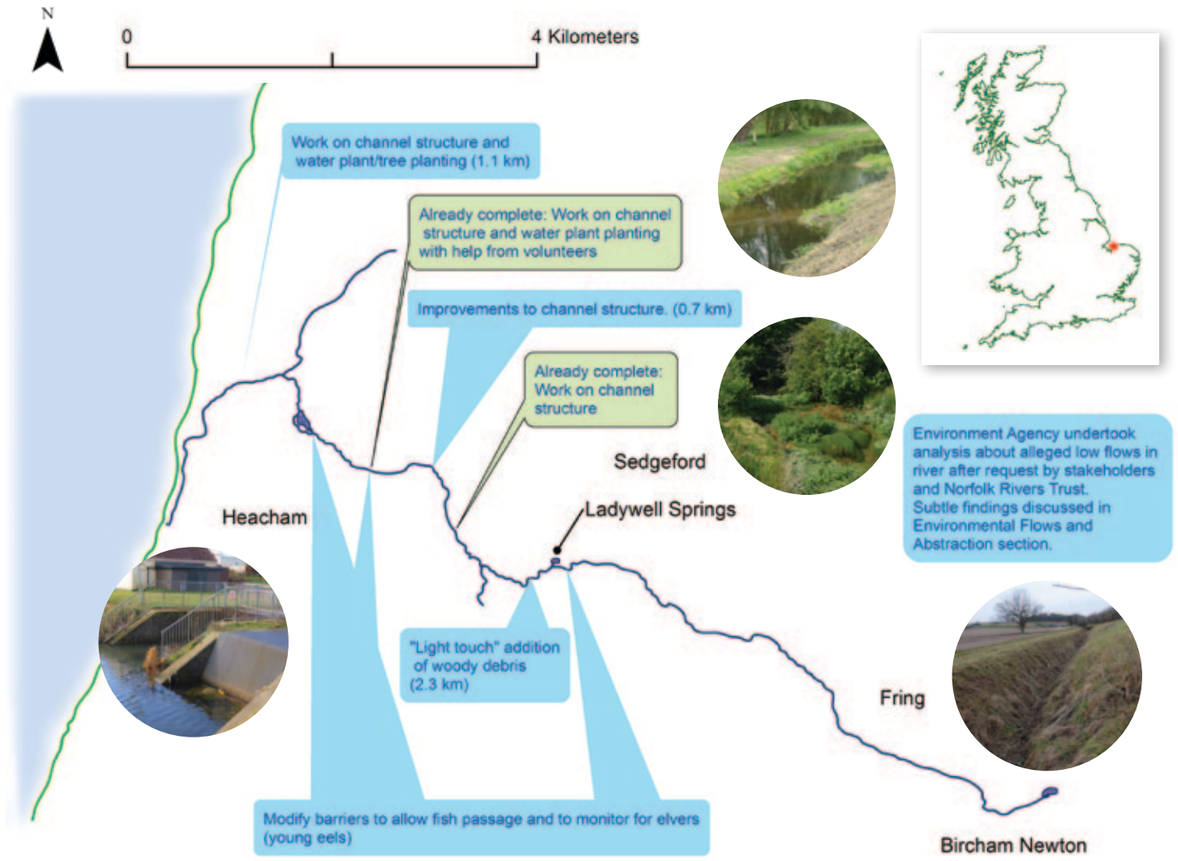
Volunteers and Norfolk Rivers Trust staff work together to plant an area of marginal habitat created at Heacham lavender.

Before restoration work.

Immediately after restoration work.

OVERVIEW OF RESTORATIONS OPTIONS

Summary of possible restoration options on the river Heacham. These proposals will greatly enhance the value, water quality and wildlife value of the river. It is stressed that these are subject to landowner consent and are only outline ideas at this stage.



Map 1. Approximate locations of possible restoration options on the River Heacham.

GEOLOGY AND GEODIVERSITY

Introducing Chalk Rivers

Chalk rivers are a distinctive part of England's landscape. There are more found here than anywhere else in the world. They are located wherever rivers flow across chalk bedrock or chalk-rich superficial deposits, in a tract of land stretching from East Yorkshire, Norfolk and the Chilterns to Wiltshire and Dorset. There are at least 12 such rivers in Norfolk. They are fed principally from groundwater rather than surface water, and flow is gradually released through springs or directly up through the river bed. Chalk rivers have a distinctive flow regime: their springheads tend to have steady flow, although some headwater valleys may be dry in summer when groundwater levels fall. They tend to have more stable temperature regimes than other rivers due to a constant baseflow component. Their waters are highly alkaline, which gives rise to a distinctive ecology and suite of plants and animals. High quality chalk streams are prized by anglers because they support abundant brown trout populations, which shelter and feed amongst characteristic water plants such as water crowfoot.

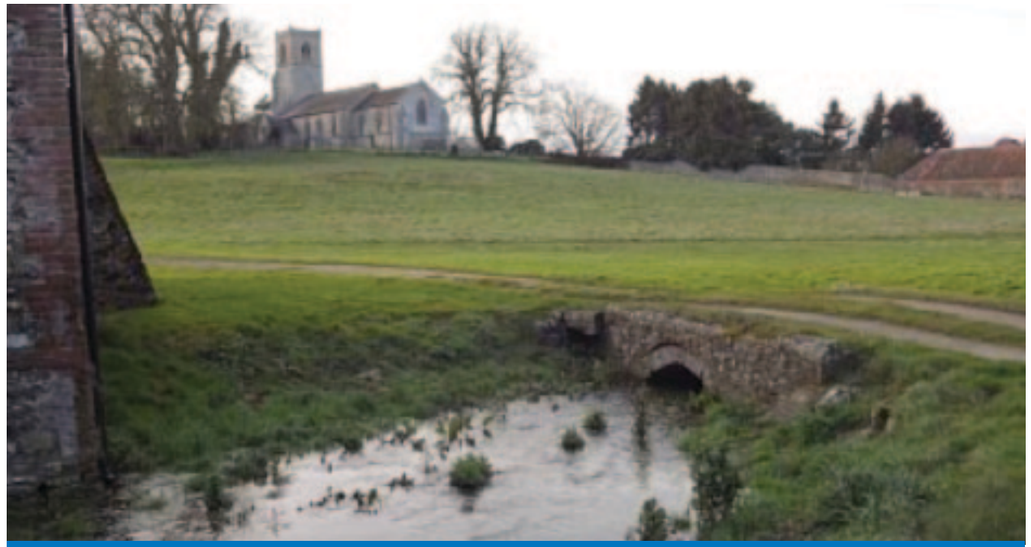
The Heacham River: a Norfolk chalk stream, having clear, lime-rich water flowing over flint and chalk gravel.

Chalk underlies most of Norfolk, but only reaches the surface in the western and northern parts of the county, also in valleys where rivers have incised down to bedrock. Chalk is also found in the glacial deposits which form a superficial layer across much of Norfolk, as it was readily eroded and redeposited by ice sheets during the Pleistocene period (2.6 million to 10,000 years ago); these chalk-rich glacial deposits are known colloquially as Marly Drift. Thus the chalk rivers of Norfolk have a mixed geological origin, which subtly alters the chemical composition of their waters. A Norfolk chalk river will typically flow through several geological zones and soil types on its way to the sea, but will still retain its characteristic 'chalk river' flow regime and basic alkaline chemistry.

Wildlife in chalk rivers is vulnerable to changes in river structure and processes. Over-abstraction can lead to lowered flows and siltation. Flood defence and drainage work may lead to an alteration of the channel shape by deepening and straightening, with knock-on effects on river flow and biodiversity.

The headwaters

The Heacham River has its source at Sedgeford, although its head valley extends south-eastwards for over 5 km (3 miles) in the direction of Fring and Bircham. The uplands here are underlain by Marly Drift glacial deposits overlying Cretaceous Chalk bedrock. Rainwater falling on the uplands of the catchment trickles down through permeable, chalk-rich soils to charge the aquifer. From here it emerges periodically as winterbourne streams and springs in the valley floor, as at Fring Docks pond. Surface water used to flow more actively here in the past. In Mediaeval times a Benedictine priory at Fring was served by a stream which ran through its enclosure precinct. In the 1950s, a cluster of public water supply boreholes were installed near the head of the valley, thus lowering water levels in the aquifer. Diffuse nitrate pollution entering the aquifer from agriculture mean that a water treatment plant has recently been installed near Fring. Springs are only active during wet winters, and surface flows are now channelled into ditches along the valley sides.



A winterbourne flowing strongly at Church Farm, Fring, in February 2014. Downstream, the water vanished into the ground after a distance of some 500 m (546 yds).

The chalk river

The permanent source of the river is located in a zone of springs at Sedgeford. It is classified as a chalk river for 3.3 km (2 miles) between here and Heacham. Depending on groundwater levels, the highest springs are located near Sedgeford Hall, while others emerge more regularly to feed a series of artificial ponds and tracts of alder carr (wet) woodland and also fen (known as the Reeddam) near the village. The strongest springs are located where

St Mary's Well at Sedgeford is a permanent spring feeding the river with chalk-rich groundwater. Seen here flowing strongly, February 2014.

a hard band of chalk, the Melbourn Rock, outcrops in the valley floor; groundwater also emerges higher on the valley sides, as in the floor of Sedgeford Chalk Pit. West of the village, the hard Nettleton Stone horizon generates more springs such as the historic Ladywell springs. There is a long history of water management in the valley: in Mediaeval times water levels were raised for growing reeds at the Reeddam, and two mill sites are known in the village. Downstream near Eaton Farm, a Mediaeval mill site ('Kyme Mill') has evidence of a lock to allow small boats to pass upstream which is a reminder that water levels were once higher in the valley. The river takes a meandering, unconstrained course through Sedgeford Carr, and is characterised by gravel runs with banks of mobile sand and good floodplain connectivity. A stretch 1500 m (1640 yds) long at Eaton Farm has recently been subject to restoration work to improve wildlife habitat and encourage natural river behaviour. Measures taken have included regrading over-steepened banks, adding chicanes to speed up local flow, making marginal terraces and making backwater areas; these changes will benefit spawning fish such as trout.

Downstream of Eaton Bridge, the valley widens out and the river flows over a floodplain which may once have been the floor of a proglacial lake of Devensian (last glacial) age. A spread of sandy superficial deposits here overlies a bedrock of sandstone (Carstone) which acts as an aquifer as well as the overlying Chalk. The river pursues a meandering course but has been canalised and constrained by embanked dredging spoil. There is further evidence of water management at Caley's Mill, Heacham. The river widens out at the site of a former upper mill pond, then its waters are diverted southwards into a lower pond embanked above the valley floor, to produce a substantial 3-metre (9.8 ft) fall of water at the mill. The river resumes the course of its former channel through the village, passing through a ponded area at Mill House.

Transition to the sea

Beyond the village, the river skirts the southern side of Heacham Park, and part of its flow becomes diverted via a weir into an artificial fishing lake. The geology becomes more complex, as the margins of the former Devensian ice sheet are reached. The river meanders between an apron of sandy superficial deposits and a body of glacial till; these overlie poorly permeable bedrock of Snettisham Clay and Dersingham Beds which bring groundwater to the surface and help maintain bedflow. The river bed is a varied one of gravel runs and sand banks before giving way to more uniform gravels; in one steeper stretch it flows over rapids, possibly developed over an ironstone horizon. The river slows markedly as it enters the flatlands near Heacham golf course, where it becomes canalised and its bed is dominated by sand and silt. It flows westwards over a bed of thick alluvial soils developed on reclaimed saltmarshes, then turns southwards as a straight marsh drain beside the 19th century sea wall. It flows under the wall at Kalla Jugga sluice, and continues southwards confined between the barrier beach and reclaimed marshes for 1 km (0.6 miles) as far as South Beach Road. Here, the water is discharged through a sluice into The Wash by gravity at low tide; the sluice prevents the lowest reaches of the river from becoming salinated, but may impede the passage of migratory fish.

Tim Holt-Wilson
Norfolk Geodiversity Partnership

The river is channelled where it passes through Heacham golf course, and has lost natural connection with its floodplain.

WILDLIFE

Despite the many challenges which the wildlife in the Heacham valley faces, the catchment supports a diversity of organisms which benefit from the river.

Species profile: Silverhorn caddisfly, *Mystacides nigra*

Caddis flies are a distinctive group of aquatic insects which start life as aquatic larvae, often in cases stuck together by glue-like secretions, and then metamorphose into winged adults to disperse and breed. The cased caddisfly species *Mystacides nigra* (longhorn or silverhorn caddisfly) are a regionally notable species which are found on the Heacham River. The larval stages of this insect live in the river and have a protective case which is composed of sand grains and small plant fragments. They are a small species, growing to approximately 12mm long. *M. nigra* are found in still or slow-flowing regions of rivers and large streams and are found on stony substratum, tree roots and other aquatic vegetation. They are not found in muddy or sandy river beds. They are a notable species because they are usually found in very low numbers, along with larger numbers of other *Mystacides* species.

Nina Birkby, Environment Agency

Photograph: Ben Tormentil

Species profile: River Kingfisher, *Alcedo atthis*

When walking down a gurgling river, one is sometimes lucky enough to be graced by the teal blue flash of a kingfisher speeding busily past. This incredible little bird feeds on small fish and invertebrates at a voracious rate, consuming its entire body weight each day. During the mating season, the kingfisher will catch 5,000 small fish to sustain itself and its young. Kingfishers do not have a beautiful song to match their striking colours, but they do have a variety of calls with different meanings. In fact, one call signifies to their mate and young: "I'm home!"

In the winter, when some of the kingfishers' feeding spots freeze over, the birds migrates towards coastal estuaries where the warming effect of the sea, and the salt water prevent freezing. Most of the time, however, kingfishers stick to a particular territory and will be seen in the same spot routinely.

Kingfisher

Photograph: © Jonathan Lewis.

Wildlife profile: River plants

The benefits of aquatic plants for lowland river systems are threefold: they reduce pollution, they improve river structure and they are a vital habitat for other wildlife.

Scientific studies have shown that plants remove excess nutrients caused by sewage effluent or agriculture. Their sinuous fronds create a large surface area for colonisation by algae, bacteria and invertebrates which process nutrients and organic matter within the river. Their roots directly remove nutrients. They also stabilise sediment and thus prevent movement of toxins which may be bound to sediment particles. Water plants' physical role is also vital. They narrow the channel in places and cause water to accelerate, as well as holding water up in other places. This allows differential scour and deposition of sediment, which helps river channels to remove and store sediment. Together with trees, they are nature's architects of channel structure, helping rivers which have been artificially straightened to recover to a more meandering form. Water plants are also a rich habitat for invertebrates which feed the larger animals in the river system. Last, but not least, their delicate greens and subtle white flowers are also one of the wonders of the British countryside.

Ten years ago this section of stream was absolutely straight and featureless. Growth of plants and sediment deposition around dead plants has caused a return to a more natural meandering form, which in turn has started to cause pools and riffles to develop. (Photo: Olly van Biervliet, Fox's Beck, Norfolk. With thanks to John Dowland)

Water crowfoot in flower.

Water plants cause flow variation which also encourages sediment storage and scour.

Varied water plants represent shelter and food for a diversity of other wildlife.

A HISTORY OF HUMAN MANAGEMENT

From at least the twelfth to the fifteenth centuries, a diverse range of benefits were derived from the River Heacham meandering down from Fring towards the small sea port of Heacham. The river and its marginal environs furnished fresh fish, watercress, watering for animals, and irrigation for crops. Osier (willow -Salix viminalis) coppices were exploited for weaving baskets of all sizes, hazel coppices for hurdle production and alder for clog soles. Moreover, the River Heacham was used to fill fish ponds and the moated courts of the manor of Sedgeford.

One of Sedgeford's lucrative crops was the annual harvest of reed, much of which was grown in the reed bed, still called Reeddam, which is located to the east of the Sedgeford Road Bridge. Most roofs of the Romano-British to the medieval period were thatched, and the best thatching material was reed sometimes mixed with sedge. It is likely that the marginal areas of the river at Sedgeford were also used for reed or sedge production. A measure of Sedgeford's prosperity and accessibility was the size of a large vineyard established at Sedgeford in around 1263. In this year vine stock was brought from Ely by boat, almost certainly via the River Ouse, then the Wash and finally the Heacham. The journey of these vines also underlines the importance of water courses as navigable routes during this period.

Sedgeford was well endowed with means of land communication benefiting from the prehistoric Icknield Way connecting Norfolk with the south of England. It is also bounded on the east by the Peddar's Way, the Roman road connecting Suffolk to Holme-next-the-Sea. Nevertheless, the River Heacham was important for the transport of goods to and from the settlements clustered upon its short course. Goods and agricultural produce from Sedgeford which were too heavy or too cumbersome to transported easily over the very poor medieval roads such as grain, wool or reeds could be carried via the river. Evidence that the Heacham was used for Navigation is provided by the remains of Kyme Mill located in the land of Eaton Farm. It can be discerned from the remains that it was a small undershot water mill which appears to be of medieval in origin or older. Perhaps the most remarkable element of the mill site is a lock, partly built in carrstone and two and half meters in width, which would have enabled small punts to negotiate a one meter difference in water level. Additional dams would have ensured year round navigability.

The River Heacham is now very different from the one which provided an important transport route and a diversity of goods to the riparian communities in medieval times. It has helped to determine the positions of current settlements, and has itself been heavily modified by man. Nevertheless, it remains an important part of the landscape to this day.

Courtesy of Janet Hammond local historian

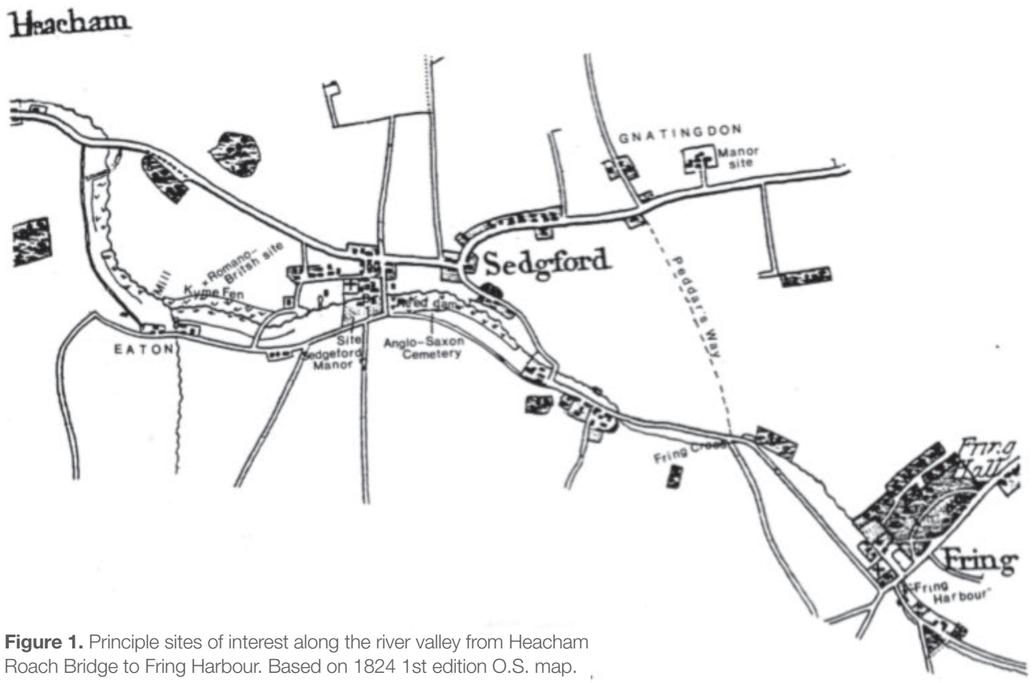


Figure 1. Principle sites of interest along the river valley from Heacham Roach Bridge to Fring Harbour. Based on 1824 1st edition O.S. map.

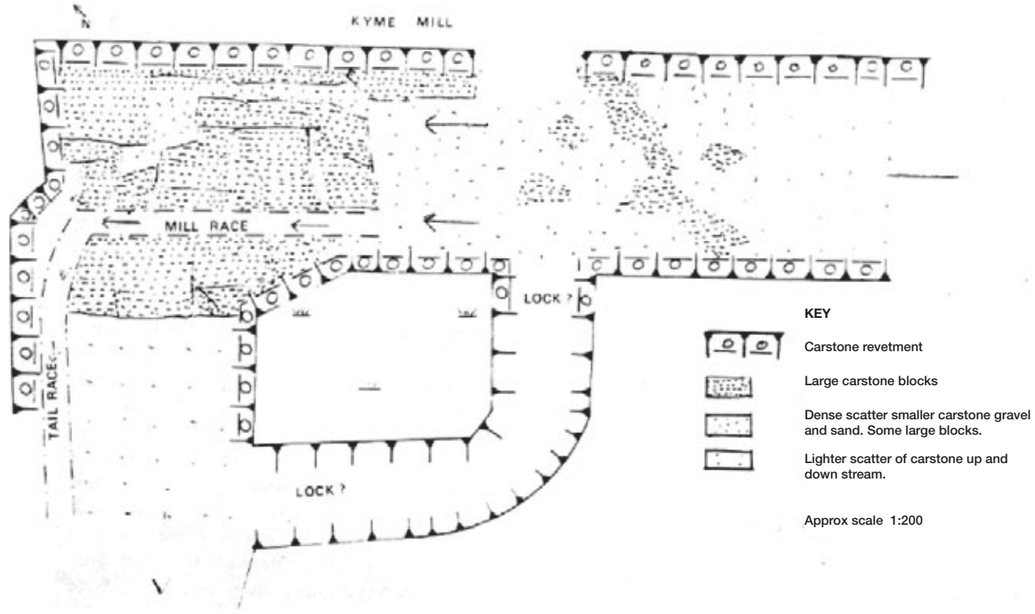


Figure 2. Kyme Watermill at Eaton showing stone revetments and lock channel.

THE HEACHAM FROM SOURCE TO MOUTH

Section 1 – Fring to Ladywell Springs (located to West of Sedgeford)

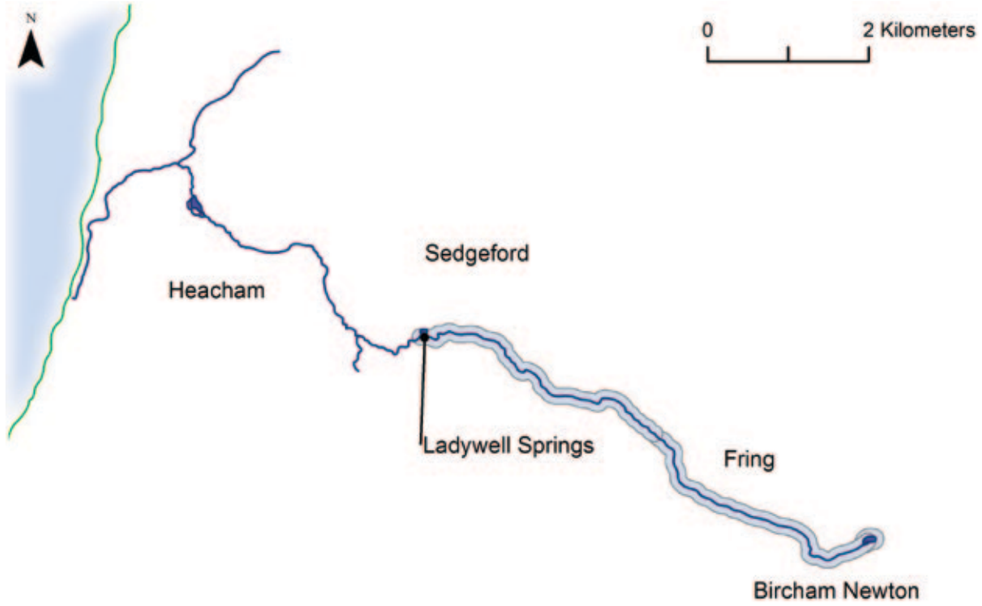
The highest section of the River Heacham is naturally a winterbourne river, or in other words naturally runs dry seasonally. This is because the position of springs are variable depending on the height of the water table in the chalk aquifer. It is therefore not useful to think of it having a single source, but seasonally determined starting points variously at Bircham Newton, Fring and just upstream of Sedgeford. However, the effect of human activity on the proportion of the year for which the river is dry is a matter for further investigation.

The stream has been trained along the side of the road for much of this section, and as a result it is straightened and featureless. This is not the case throughout the entire stretch, however, and some to the river immediately above Sedgeford has potential to have high conservation value.

Within Sedgeford itself, the bed of the River Heacham usually contains water, but often has a very slow flow and is more similar to a long ditch or pool during periods of moderate water levels. It is impounded by a "water gate" in the village, which further reduces flow speeds and causes sediment accumulation behind it (Photo 4).

Photo 1. A pond in Fring which is periodically filled by water from the Heacham, but which is currently dry (autumn 2013). It is called "Fring Harbour" by some locals due to historical accounts that small barges once navigated the river Heacham up until this point.

Photo 2. Dry section of stream in winterborne section of Heacham.



Map 2. Upper section River Heacham. Much of this section is a winterbourne (seasonally flowing).

Photo 3. Start of permanently wet section of River Heacham in Sedgeford.

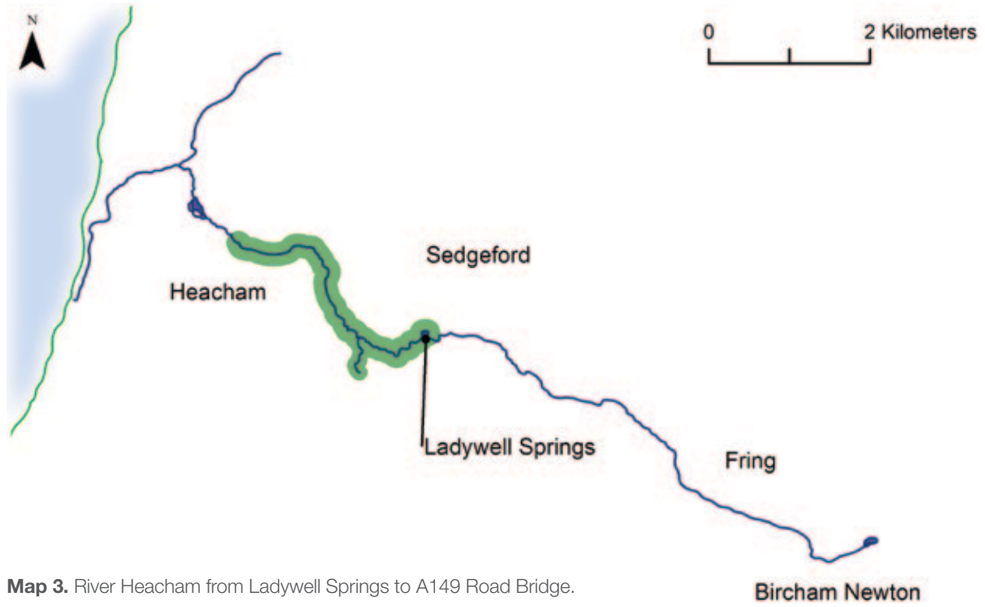
Photo 4. Water gate impounding flow in Sedgeford.

Section 2 – Ladywell springs to A149 Road Bridge

Ladywell springs, to the western side of Sedgeford, and substantial water sources nearby provide a high proportion of the river flow. In this area water oozes from the bottom of crystal-clear pools and then spills down into the river. These contributions to flow result in clear gravels and high quality water. The canopy at this point is dense and provides deep shade which continues through Sedgeford Carr.

Below Sedgeford Carr, the Heacham traverses an area of cattle grazing land, where the cattle are predominantly fenced out of the river. Some poaching occurs where they access the river, and this is a sediment source. Nevertheless, due to the combination of a generously buffered channel and pool-riffle sequences which have been reinstated by ecological restoration works, this section of river has potential to develop into high quality habitat.

At Norfolk Lavender the river is impounded and backs up into slow moving water in an until-recently straight-sided and featureless channel. This is a rare point where the public can view the river, and recently completed rehabilitation works on this section should greatly improve people's enjoyment of the area.



Map 3. River Heacham from Ladywell Springs to A149 Road Bridge.

Ladywell springs.

River restoration and fencing of livestock has reinstated a variety of river habitat at Eaton Farm.

Lavender mill pond before and after March 2014 habitat enhancement.

Heacham Lavender Mill. A beautiful building, but also a barrier to fish passage.

An attractive section of the river flowing through Heacham.

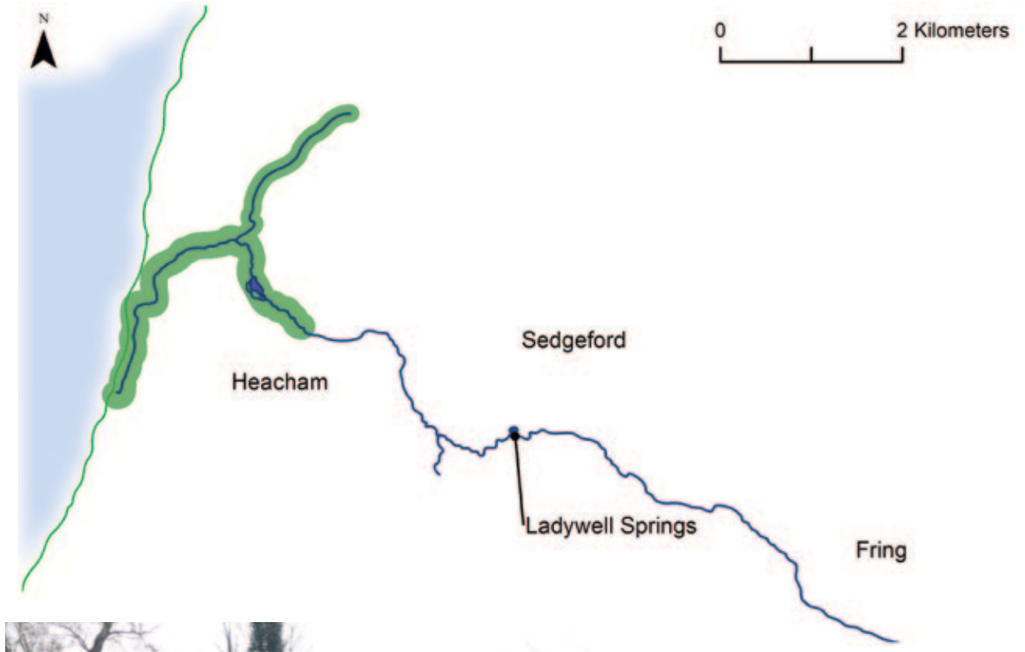
Section 3 – A149 Road Bridge to Outfall

Below the A149 road bridge the River Heacham flows through some gardens then parkland, and several hundred metres of golf course and arable fields. Finally it ponds up behind sea defences in an area surrounded by caravan parks. The river itself has a variety of depths and flows in Heacham Park, with some woody habitat in the channel in places. There is an impoundment (about 40 cm high) which diverts some flow through Pocahontas Fishing Lake Photo below). This would be a barrier to passage of course fish and migratory fish (which are better able to pass obstructions) under most flow conditions.

As the Heacham passes the golf course it becomes over-deepened and over-widened. As a result, the stream has increasingly slow flows, the river deposits sediment, and reeds grow across the channel in many places. Whilst not a problem for wildlife or currently for flood risk, the reeds traversing the channel are not considered aesthetically pleasing by stakeholders. The sedimentation and reed growth are a response of the river system to the over-widened channel, and would eventually result in a narrowed channel if allowed to proceed. This can be seen in several places, as exemplified in the top central photo on the following page. Management options could include re-grading the channel, planting and sinuous weed cutting, thus speeding up the progress towards a more aesthetically pleasing narrower channel with a greater variety of flows and habitat.

Below the golf course, the river flows past the Kala Jugga Sluice located at a secondary sea wall, and then through the caravan parks. Downstream of the sluice the stream resembles a long pond with barely-perceptible flow. It discharges to sea close to the end of Beach road through another sluice and out of a pipe which goes under the beach for about 160 metres.

Environment Agency monitoring shows a good population of course fish such as roach, rudd, dace and common bream in the lowest section of the river. Trout were also present in low numbers throughout the lower and middle sections of the Heacham.



Map 4. Lower sections of River Heacham and a tributary joining the stream from the direction of Ringsted.

Impoundment near Pocahontas Lake, Heacham. Channel flowing towards photo flows through the fishing lake and then back into the river. The impoundment will prevent course fish passage, and would be a barrier to migratory species under most flow conditions

High quality water plant growth bordering the Heacham Park area.

Section of River Heacham flowing through Searles Golf Course.

A narrower channel cuts through reeds in channel, assuming a size closer to the natural width of the river.

Kala Jugga sluice gate.

Lower Heacham between caravan parks.

Tidal sluice.

SECTION 2 THE PROBLEMS AND SOLUTIONS

The River Heacham would naturally have been a stream which would have flowed from its source through woodland towards a meandering lowland section with good connectivity to its floodplain. It is likely that marshes were a feature of the lower section of the river. The ecosystem of the River Heacham still benefits from a high standard of water quality, but barriers to fish passage as well as poor habitat quality in the river have prevented the ecosystem from thriving.

RIVER STRUCTURE

The entire river Heacham is the product of centuries of modification. It has been straightened and canalised throughout its length, with a resultant reduction in habitat value. The lowest sections of the River Heacham have been especially widened. This results in very slow flows, which encourages sedimentation of the channel and results in reeds growing across the channel.

CONNECTIVITY BETWEEN THE RIVER AND ITS FLOOD-PLAIN AND FISH PASSAGE

There is almost no connection between the river and its floodplain in any section under normal seasonal high flows. This means that the ecologically valuable fluxes of sediment, nutrients and water which occur on natural floodplains are reduced.

Navigation of the river by migratory and course fish is impaired by 5 impoundments, 4 of which are concentrated towards the lower end of the river.

ENVIRONMENTAL FLOWS AND ABSTRACTION

Several people who live locally to the upper reaches of the Heacham consistently voice concerns about low and zero-flows in the river. There is evidence from medieval locks for boat passage incorporated on to a historic mill that flat-bottomed barges used to negotiate the river towards the upper reaches. This could suggest that flows used to be greater than currently experienced. However, cursory analysis of contemporary data shows that overall average river flow has not changed significantly in the last 49 years, as shown in Figure 1.

Nevertheless, concerns voiced by stakeholders to the Norfolk Rivers Trust (NRT) were taken on board by the Environment Agency (EA). The EA carried out a detailed study to determine whether there might be a problem. The Norfolk Rivers Trust commend the EA for this action especially given the funding cuts which have impaired the capability of the EA to carry out this kind of work. The key findings of the study were as follows:

1. The wildlife in the river is vulnerable to low–flows (invertebrate community composition has shown negative responses to low-flow conditions in the past, showing sensitivity).

2. The Catchment of the River Heacham is hydrologically complex and experts are unclear of the actual size of the catchment. More boreholes would be required to determine this.

3. Point 2 is of key importance, because (without going into detail) there are two possible scenarios. Either the Heacham Catchment includes significant abstractions to the North (in which case it is likely that it is over-abstracted), or it does not.

Previously to the Environment Agency study, Anglian Water had voluntarily reduced their abstraction limit from 3 million cubic metres per year to 2.5 as of May 2014. This decrease which was initially voluntary, cannot now be reversed without a thorough Environmental Impact Assessment which will answer point 2 and give vital additional information. NRT have responded by prioritising habitat restoration works which will increase the resilience of the river to low-flows (these measures are a precaution and will be beneficial whether or not the river is over-abstracted). NRT are also looking into the possibility of funding “ephemeral reach analysis” which will determine to what extent abstraction increases the number of dry days (if at all) in the upper river.

When discussing environmental flows we need to remember that we are all consumers of both drinking water and the food products for which irrigation is important.

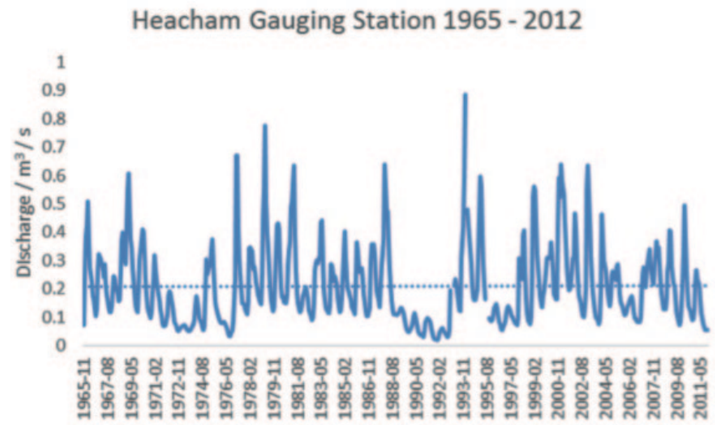


Figure 1. Gauged flows on the River Heacham at (Grid reference: TF6852337484). Fitting a line of best fit to the data, shows that there is negligible change in flow over this period.

STATUS OF INVASIVE NON-NATIVE SPECIES ON THE RIVER HEACHAM

The Norfolk Non-native Species Initiative have analysed the Heacham catchment to identify current invasive non-native species (INS), management options and future risks. Invasive species spread rapidly and can cause both economic and environmental problems. They are considered one of the greatest threats to biodiversity (second only to habitat destruction) and cost the UK economy approximately £2 billion a year.

Distribution maps

We have interrogated the NBIS database to identify any reports of invasive non-native species from the Heacham catchment in the last 5 years. Within the catchment we have received reports of:

Egyptian goose

Muntjac deer

New Zealand pygmyweed

Himalayan balsam

Giant hogweed

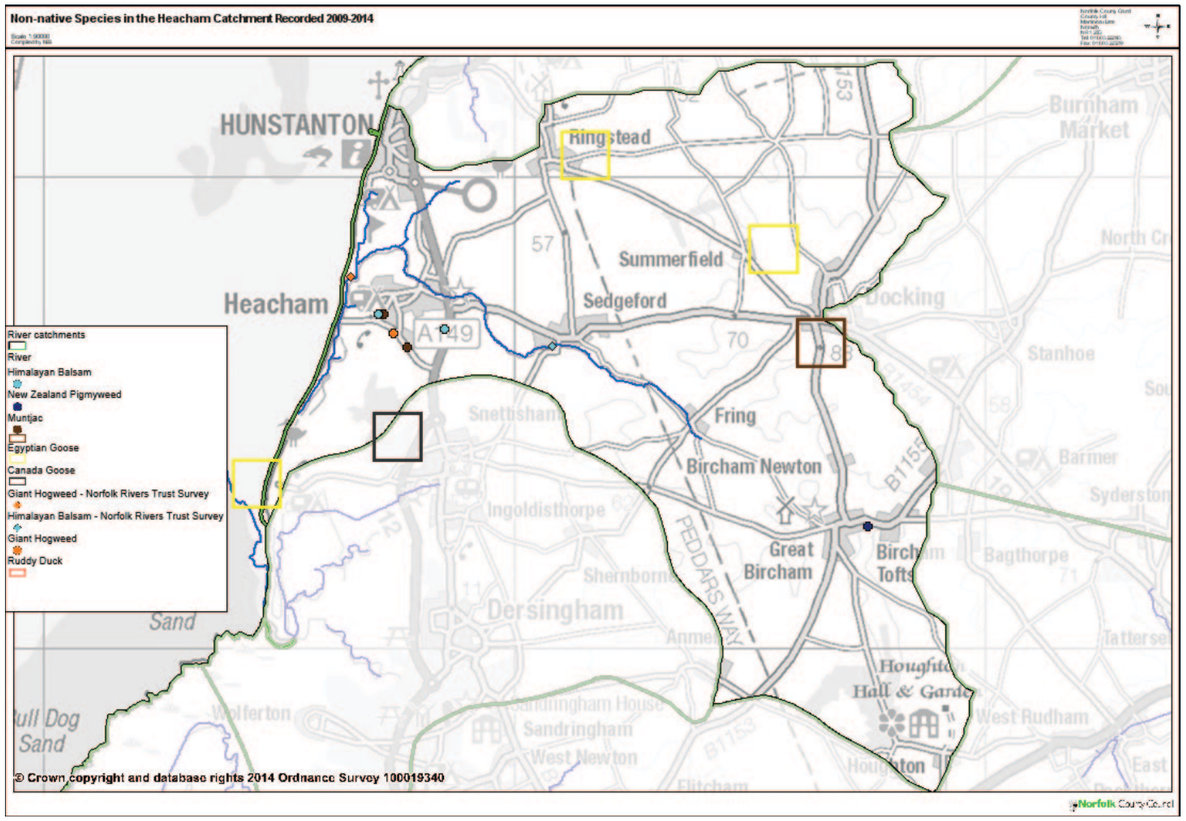
The Norfolk Non-native Species Initiative also attended the Norfolk Rivers Trust's community engagement day at Sedgeford in February 2014. By speaking to members of the local community we received three new reliable records – two of giant hogweed and one of Himalayan balsam. These are also shown on the map.

Muntjac deer graze on your trees, preventing regeneration of the woodland that is so important for river systems.

Photograph: © The Scottish Deer Centre

The rest of this report focuses on invasive species close to the river itself.

Map 3. Positions of invasive species in the Heacham catchment.



KEY INVASIVE SPECIES CLOSE TO THE RIVER HEACHAM

Giant hogweed - Giant hogweed is a terrestrial perennial plant originating from the Caucasus mountains in south-west Russia and Georgia. It was first recorded in the wild in the UK during the late 19th century. The plant can grow up to five metres in height with the lower leaves reaching up to 1.5 metres in length. The plant spreads solely by seed, with a single flower head producing up to 50,000 seeds.

Giant hogweed presents a significant health risk as even small amounts of the plants sap can cause severe blistering of the skin following exposure to sunlight. Problems can persist for up to six years after exposure to the sap. The plant is also able to outcompete many native plant species and can cause increased bank erosion in riparian environments.

Management – Giant hogweed reproduces by seed. This means that different eradication methods are available.

The plant can be eradicated using a glyphosate based herbicide which should be applied in late-April or May, when the leaves of the plant are large enough to absorb a sufficient dose of the herbicide's active ingredient to kill the plant. It is also possible to kill the plant by cutting its taproot. This can be done using a spade, and should be carried out earlier in the year, as soon as the plants are visible (late-March to early-April).

Whenever any control of giant hogweed is undertaken great care must be taken not to brush against the plant with bare skin, or allow any of the plant's sap to get on you as the plant's sap causes severe blistering.

Photograph: © Olaf Booy

Giant hogweed

WHAT CAN YOU DO?

You can help us by reporting any sightings of INS to the Norfolk Non-native Species Initiative. This can be done using RINSE's new smartphone App (**http://www.rinse-europe.eu/smartphone-apps**), the NBIS website (**http://www.nbis.org.uk/**) or by e-mail (**nnnsi@norfolk.gov.uk**).'

Himalayan balsam - Himalayan balsam was introduced to Britain in 1839 and quickly escaped into the wild. Reaching up to three metres in height, Himalayan balsam is the tallest annual herb in Britain. Each plant can produce up to 800 seeds. These are spread by exploding seed pods which can fire seeds up to seven metres away from the parent plant. Seeds can remain viable for up to 18 months. It is an attractive plant which has purplish-pink, slipper-shaped flowers between June and August. Once introduced to a river system, Himalayan Balsam's primary dispersal pathway is downstream and therefore it is vital to target infested areas in the upper catchment to prevent further spread.

Himalayan balsam grows vigorously in wet areas, such as river banks. It can shade out other vegetation, leading to an impoverished plant community. After dominating a river bank in the summer months, the plant dies back in the winter, leaving the bank bare and susceptible to erosion. It has been suggested that Himalayan balsam might benefit bees, and other nectar feeding insects, but this has largely been disproven and the latest advice from the British Beekeepers Assocation suggests that the negative impacts of Himalayan balsam far outweigh the benefits.

Management – Similarly to giant hogweed, Himalayan balsam spreads solely by seed. The plant is an annual with seeds that remain viable for up to 3 years, so providing it can be prevented from seeding for this period it should be eradicated. This makes it one of the easier invasive plants to tackle, but a persistent and strategic approach it still required.

For small patches of Himalayan balsam hand pulling is one of the easiest removal methods. Pulling firmly and steadily from the base of the plant should ensure that the roots are also removed and prevent any re-growth. This should be done early in the season before seed pods appear. If the patch is larger then the plant can be cut using a strimmer or brushcutter. Providing the stem is cut below the lowest node the plant should be unable to re-grow. In areas where it is difficult to use a brushcutter or strimmer, herbicide applied using a knapsack sprayer with a long lance might be a suitable alternative control technique.

Photograph: © Mike Sutton-Croft

Himalayan Balsam (Impatiens glandulifera).

BIOSECURITY CONSIDERATIONS

It is widely accepted that it is far better to prevent invasive species from becoming established than to have to eradicate them or control them in the longer term. New INS can be prevented from entering a catchment if key pathways of introduction are restricted by certain user groups undertaking simple biosecurity measures (eg anglers, boaters, contractors).

In common with many of Norfolk's northern chalk rivers, the wider catchment of the River Heacham contains relatively few invasive non-native species. This is probably at least partly due to its isolated nature. No boating takes place anywhere on the river and fishing is restricted to a small number of locations. The river is much further away from the Broads catchment than some other chalk rivers in North Norfolk, so the spread of killer shrimp *Dikerogammarus villosus* is less likely here, although this is still theoretically possible. Having reviewed the understood pathways of spread identified in various other biosecurity plans, the majority of these do not apply to this small and isolated catchment. In the Heacham catchment I believe that the key potential pathways of introduction are associated anglers, conservation workers, tourists, gardeners, landowners and land managers.

for this to be carried out. The landowner's details will be passed to the Norfolk Rivers Trust to follow up on this.

The record of New Zealand pygmyweed (*Crassula helmsii*) is worrying and should be investigated further. If the species is in a situation where it could be eradicated then this should be attempted. The only eradication method that we have had success with in Norfolk involves filling in the infested waterbody and digging a new one, which is clearly not an option in many circumstances. Eradication should be possible using a glyphosate-based herbicide providing the waterbody can be drained, but this is still a very difficult and costly process, with no guarantee of success. Thankfully the record of New Zealand pygmyweed is quite a long way from any of the catchment's watercourses.

The future health of this river will rely on a small number of key groups carrying out appropriate biosecurity measures. It seems likely that most introductions will be carried out by those who own or manage stretches of the waterways in the catchment. This includes contractors who may be brought in to do work in or near the river. Before any machinery is brought on to the site the contract manager should check where the machinery was last (if it was in an area that killer shrimp or crayfish plague is known to be present then particular care should be taken) and the machinery must be cleaned. Groups such as gardeners and landowners could be made more aware of INS of concern, how they can prevent their introduction and what to do if they find them through targeted campaigns such as those that have recently been run in the Broads (eg the 'Go native for Norfolk!' garden centre accreditation scheme and the Workshops and training materials generated through the RINSE project for farmers and landowners). Signage should be erected at areas used by anglers advising them of the biosecurity measures that they should undertake.

Mike Sutton Croft
Norfolk Non-native Species Initiative (NNSI)

SUMMARY AND RECOMMENDATIONS

This catchment contains relatively few records of INS when compared with other areas of Norfolk, and there are few potential pathways of introduction.

At the Community Engagement event we received three new records for invasive plants directly adjacent to the river. There were two records of giant hogweed, one in Sedgeford and the other very near the outflow of the river at Heacham. It is quite likely that these records are linked, and possible that there are other patches of giant hogweed between Sedgeford and Heacham that have not yet been recorded. The landowner assured me that the giant hogweed at Sedgeford has been dealt with, and the patch of giant hogweed in Heacham is now being actively controlled, so providing this information is correct these infestations should be dealt with in the next few years. The record of Himalayan balsam is also in Sedgeford, but slightly further away from the river. This is not currently being controlled, but the landowner gave permission

THE ECOSYSTEM

Norfolk Rivers Trust take a holistic view of river ecosystems, and value all wildlife whether it inhabits the water or the river corridor. The River Heacham's wider ecosystem is not well understood, but the poor success of key fish species is a concern. Having said this, the river has a good course fish population in the lower river, but these populations are isolated from other reaches. The key finding of a recent Environment Agency Waterbody Investigation suggests that impoundments to fish passage and poor brown trout (*Salmo trutta*) spawning habitat account for the failure of the waterbody to reach "good" ecological status. Nevertheless, the presence of flounder (*Platichthys flesus*) in the lower river shows that migration of fish to and from the sea is possible and this gives hope that the Heacham could be a haven for migratory fish in the future. Interestingly, the Water Framework Directive failure is compounded by an absence of bullhead (*Cottus gobio*) from the Heacham. However, this species has never been recorded in this or several other adjacent rivers and it cannot be ruled out that its absence is a natural phenomenon.

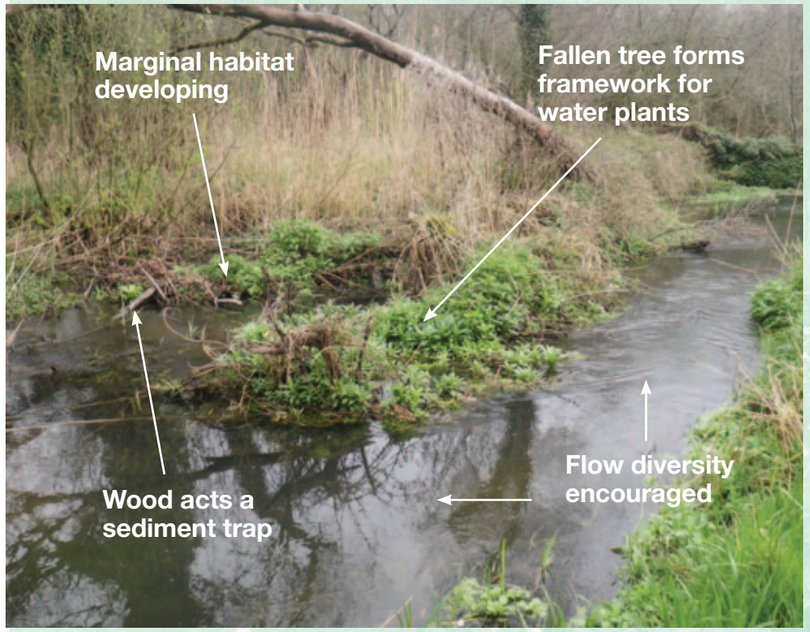
TREES AND WOODY HABITAT

Over the past two decades the importance of trees bordering rivers has become increasingly apparent. Recent research has highlighted the threat that climate change poses to aquatic ecosystems through changing water temperatures. As water warms the oxygen levels decrease in water and this can cause death of aquatic organisms. The recent Environment Agency project "Keeping Rivers Cool" highlights the importance preventing dangerous temperature increases in the water by shading.

Trees also intercept and modulate agricultural nutrients and sediment. They can increase infiltration, thus reducing flooding.

Trees are vital as "architects" of river structure. Live trees act as hard points, stabilizing banks and helping meanders to develop. Tree roots in banks provide vital habitats for a multitude of species, notably native crayfish, otters and eels. Dead trees in the river are equally important. They are a key habitat. Moreover, large dead wood (especially entire trees) initiate the natural recovery of rivers from straightening and cause flow diversity. In fact, tree planting and addition of large woody material are the most cost effective and among the most beneficial measures which Norfolk Rivers Trust undertake.

The Heacham is relatively well served for tree cover, but some increase in trees would be beneficial in the lowest sections. Moreover, large wood could be used to speed up natural recovery in sections of straightened river, and to provide resilience to low-flows to which the Heacham's wildlife is vulnerable.



Natural tree fall has several benefits for habitat creation, channel structure and sediment modulation.

Growing trees have changed this former straightened drainage channel into a river with a more natural structure and in-stream islands (*anastonising* channel).

Tree acts as a hard point and has caused a meander to develop.

Tree acts as a hard point and has caused the development of a pool. Submerged tree roots are also excellent habitat for brown trout.

Natural tree fall has caused a great range of microhabitats and greatly increased in-stream surface area for a diversity of river invertebrates.

SECTION 3 AN ACTION PLAN

River Heacham is a river with excellent water quality and increasingly good habitat. Ecological restoration work, undertaken recently under the direction of Norfolk Rivers Trust (and in partnership with the Environment Agency) and ongoing work at the time of writing is helping to enhance the impoverished habitat in the river. In the future the River Heacham could be a haven for wildlife, acting as a corridor for migratory fish in the channel and birds, insects and mammals on the vegetated fringes. In order for this to happen, targeted ecological restoration works will need to continue to along the river with the help and support of the local community.

SECTION 1 – FRING TO LADYWELL SPRINGS

This section is ephemeral and has been canalised throughout its length. Management should involve avoiding pollution for instance sediment runoff to the channel even during dry periods. In the longer term, determination of whether abstraction is causing unnaturally long dry periods could be undertaken using a hydrological modelling technique called “ephemeral reach analysis.” The Environment Agency has recently undertaken a preliminary study on this matter at the requests of the Norfolk Rivers Trust.

SECTION 2 – LADYWELL SPRINGS TO NORFOLK LAVENDER WEIR

At Ladywell springs, a substantial volume of clear groundwater joins the Heacham. These assured flows give good water quality and expose clean gravels. Some light management of trees to increase the woody habitat in the channel close to Ladywell springs could be desirable. Further down, it is hoped that the river restoration work carried out by Norolk Rivers Trust on Eaton Farm’s land will improve the habitat which was canalised and lacked variation. Visually the work looks successful at this early stage, but only monitoring of the site over time will determine if the wildlife has been benefitted from the work.

The section of the Heacham running through Norfolk Lavendar itself contains habitat which is straightened and deepened with an embanked channel. Recently completed work at this site should serve to improve this situation. The mill’s weir itself is a barrier to fish and this could be modified to allow fish passage in the future.

SECTION 3 – A149 ROAD BRIDGE TO OUTFALL

In the top part of this section, gardeners can make an effort to allow wild areas where native plants are allowed to grow on the border of their gardens. This will encourage native flows such as the yellow flag iris and mammals such as the water vole.

Further down, opportunities could be taken to re-naturalise channel morphology and increase habitat diversity by tree planting and management of native plants. In particular, work could be done to encourage a channel with a smaller and faster flowing central channel in the golf course area. This would reduce siltation in the currently over widened channel and prevent water plants (macrophytes) from growing across the channel. Such a project could be both aesthetically pleasing and good for wildlife.

COSTS AND TIMELINE

The Water Framework Directive objective for the Heacham is to reach Good Ecological Potential by 2027, and each of the actions set out in this report will assist in achieving that goal.

The river is approximately 11 km long with a distinctly ephemeral nature in its upper reaches. Due to centuries of modification, some section of the river would benefit from re-naturalisation where this is possible within the constraints of flood defences. Some ecological restoration work has already commenced.

Overall, the order of priorities for the river are as follows:

1. To complete channel structure and woody habitat work on identified sections of the river.
2. To undertake further monitoring and analysis to fully understand the impact of abstraction.
3. To improve fish passage.

Measures to improve channel morphology have already been undertaken and further work is ongoing at the time of writing. An extension of these improvements to the river structure in the lower river would be desirable in the future, subject to landowner agreement.

Understanding the hydrology of the upper section of the river is important and should be undertaken when funds are available. It would also be desirable to ensure that all barriers to fish passage are passable in the long term. With the gradually improving habitat and already good quality of the river Heacham, it could become a valuable feeding and breeding site for migratory species such as sea trout, lampreys and eels.

Action	Number of kilometres / sites	Predicted cost	Achievable timeline	Responsibility / capability
Naturalise Lavender Mill pond	0.4 km	Inclusive cost of £11,000 (About £30 a metre)	Done	Volunteers/Norfolk Rivers Trust (NRT) Environment Agency (EA)
Addition of woody habitat	2.3 km	£30,158	By 2021	Volunteers/ NRT / IDB
Wetland mosaic to emulate habitats which have been lost and increase resilience against low-flows. Immediately downstream of Sedgeford.	2.3 km	£8,707	By 2021	Volunteers/ NRT / IDB
Hydrological modelling : “ephemeral reach analysis”	1	Pending answer from EA	By 2021	NRT/EA/Internal Drainage Board (IDB)
Channel structure work and water plant-planting at golf course	1.1 km	£33,000 (Based on Heacham Lavendar costs)	By 2021	NRT/EA/IDB
Tree planting (if desirable) at golf course	1.1 km	£347	By 2021	Volunteers/NRT /IDB
Channel structure work upstream of Heacham Lavendar	0.7 km	£23,100	By 2021	Volunteers/NRT /IDB
Fish passage: Sedgeford “water gate”	1	Good will agreement	2015	NRT/EA/IDB
Fish passage: Pocahunus Lake abstraction weir	1	£3,000	By 2021	NRT/EA/IDB
Fish passage: Lavender Mill (Caley Mill)	1	£300,000	By 2021	NRT/EA/IDB
Fish passage: Cala Jugga sluice	1	£20,000	By 2021	NRT/EA/IDB

*Note: costs include another 10% for monitoring where appropriate and always include VAT.

FURTHER INFORMATION

Environment Agency - Keeping Rivers Cool report
Rivers by Design - rethinking development and river restoration
World Wildlife Fund - Why are chalk streams special?
River Restoration Centre manual of river restoration techniques
Norfolk Wildlife Trust
River Rehabilitation for Eastern England Rivers
Environment Agency homepage
Introduction to the Water Framework Directive

THE RIVER HEACHAM A WATER FRAMEWORK DIRECTIVE LOCAL CATCHMENT PLAN

www.norfolkriverstrust.org

THE NORFOLK RIVERS TRUST

RESTORING NORFOLK'S RIVERS

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